Decreasing data demand; a behavioral approach

Thesis report

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PREFACE

Whilst pursuing an interest in human-computer interaction I realised how many wonderful and promising information technologies were used to turn people into productive machines, optimizing their lives without truly living. Our imagination extends far beyond the limitations of the physical world and by developing technologies that are pushing the boundaries of biology and eco-systems we try to reach for ever greater heights. With this project I wanted to contribute to an alternative movement where we actually try to be less productive so that we may sustain our way of living for longer. For our societies to flourish we must establish a new interaction between human and machine where machine stays machine and human stays human. By delving into both computer and human sciences I want to open myself to up these different worlds so that a new form of cooperation between human and machine can be designed. A cooperation that does not merely benefit efficiency but starts from social values that benefit our planet. Please join me on my exploration into the world of data consumption.

Acknowledgements

In this endeavour I have had the support of many great individuals that encouraged me to follow these ambitions. A big thank you goes out to the supervisory team, first of all for taking this step with me into an area that was still quite unexplored and for the enthusiasm that motivated me to keep going. Jeroen, Lise and Maria, I have greatly enjoyed working with you all and am thankful for your expertise and support along the entire way of the project. I also want to thank Conny Martens for all her positivity and the expertise she shared on user research and Martin Havranek for sharing his prototyping skills. Besides these individuals I also want to thank family and friends for their support during the entirety of my studies and all the experiences that we shared along the way. A final acknowledgement goes out to KPN, a company that was brave enough to have a critical look at the industry they themselves operate in.

SUMMARY

ABSTRACT

In a matter of decades, information technologies have become omni-present in the lives of more than a billion people. Whilst holding many promises for more efficient and therefore seemingly more sustainable practices, this fast-growing industry is expanding its footprint rapidly. Exponential advancements in hardware and software are kept in check by a quickly rising demand for data-driven products and services. With a climate and energy crisis on our hands, now is the time to ask ourselves whether this superfluous consumption of data is really necessary. By investigating the workings of the physical network and the interaction between humans and digital products, an inquiry is made into changing consumer behaviour to benefit sustainability. The resulting design demonstrates how a different approach to the way we interact with the digital world can facilitate new practices that are sustainable in the broadest sense of the word. By actively reflecting on their online behaviour, internet users are enabled to fulfil personal values that benefit people and climate.

RESEARCH

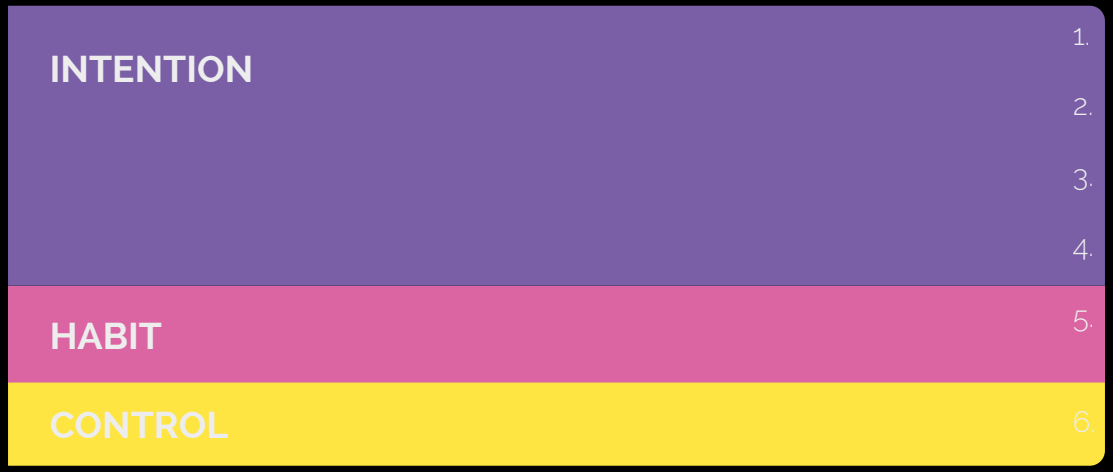
The inquiry into the various stakeholders related to data consumption depicts an infinitely complex network with various players. Together they share a responsibility to for the social impact that the internet has on our society but in the current situation these individual parties mainly act out of self-interest. Digital services providers and their users behave in immoral and unethical ways to satisfy immediate cravings which stands in the way of fulfilling social values. All stakeholders are put under enormous stress by this fast consumption pattern which the project categorises as somewhat uncivilised. This uncivilised behaviour is further defined in three 'pillars' that lie at the root of the current value conflicts.

I Norms & regulation
Perverse pleasure seeking, deceptive technologies and social misbehavior threaten the individual on the web.

II Moderation & modesty
Constant distractions and the acceleration at which we increase productivity lead to an overload of information that humans are not capable of handling.

III Active involvement
The lack of physicality of data infrastructure combined with a generally apathetic mindset leads to a loss of autonomy and control.

“To reduce the burden on people and environment caused by data consumption I want KPN customers to use the internet in a more civilised manner by making their usage explicit in a social context”



The three phases of changing a behaviour and designing for this change

DESIGN

From experiments with possible interventions it is concluded that to start making a change towards a more civilised behaviour, data consumption needs to be made more concrete in a way that facilitates debate about the topic. A final concept is proposed that embodies this philosophy by encouraging KPN customers to start caring about the impact of data consumption on themselves, their close peers and the environment. It does so through the following set of criteria:

1. Installing awareness about data usage by educating and framing
2. Eliciting a social frame of reference for internet users to adhere to
3. Helping consumers commit to purposeful decisions
4. Materialising the benefits of data reduction
5. Affording inconvenience when users want to engage in meaningless behaviour
6. Making low data use standard in daily practices

Besides this intervention targeted at consumers, the design and research also hold various implications for the other stakeholders within the project context.

“We are the one and only unlimiteds”
- Typhoon

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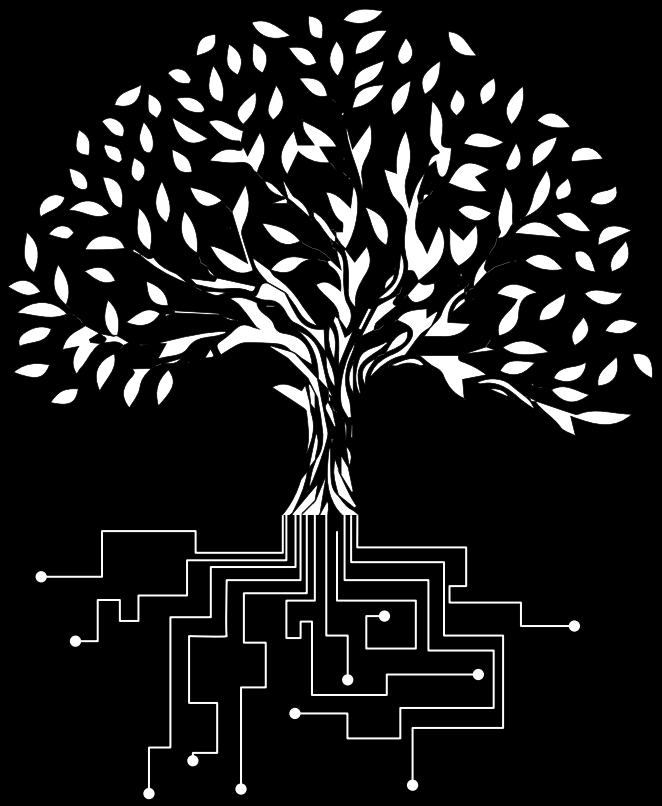

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PROJECT INTRODUCTION

This chapter will introduce the initial brief of the project, an overview of the relevant stakeholders as well as the research fields in which it is grounded. At the end, the approach for the project is discussed.

CONTEXT

The way we interact with data-enabled devices in day to day practices is changing rapidly as many new technologies are emerging. When designed correctly these new information technologies can contribute to better fulfilling consumer needs and solving complicated challenges, also on a societal scale. The recent COVID-pandamic has sped up these developments even further and showed us how services like video conferencing can reduce morning traffic by enabling us to work from home. Cases like these and many others envision how the digitalization of our society can have major benefits in terms of mitigating CO_2 emissions in various sectors and can contribute to realizing global sustainability goals (Corbett, 2018). However, this remedy also comes with a risk as data-driven products themselves require energy and infrastructure in great quantities. When used abundantly and recklessly, the potential of IT to reduce climate impact will then (partly) be nullified through irresponsible use of the very same technologies. To illustrate; during the same period where video conferencing allowed us to drive less, the massive increase in use of digital services from home compelled the European commission to intervene. Streaming services were requested to lower their base quality so that internet service providers (ISP's) would not get overrun by the surge in demand (Gonny van der Zwaag, iCulture, 2020). To better manage our demand for data and ensure IT has a positive impact on the climate, this project aims to shine more light on the material aspects of the internet.

The increasing demand on our internet infrastructure has not gone unnoticed. Efforts in reducing the ecological footprint of the IT sector have been made but mainly by operators of data centers and ISP's such as KPN. They focus on increasing the efficiency of their hardware which is in line with the dominant 'cornucopian' mindset where technological advancements will always meet society's demand for resources. Despite their good intentions however, research suggests that efficiency gains alone will not be enough to reduce IT related emissions as they are outweighed by increases in demand (Andrae & Edler, 2015 & Schneider electric, 2021). So far, the end users themselves take much less responsibility for their "digital footprint", partly due to the lack of awareness and transparency in the complex and invisible world of 'clouds and data'. Moderating the way users interact with products and services has proven to be an effective way in reducing climate impact and is considered as an essential step in reaching climate agreements (Klaniecki et al., 2019).

THE COMPANY

As already briefly mentioned, the company involved with this project is KPN. KPN is a Dutch telecom provider that offers the biggest and fastest internet network in the country, with the Netherlands being amongst the best in the world. Being an internet service provider they form the gateway for many users to access the internet on a daily basis. With their service they aspire to offer people the ability to go anywhere online, connect with peers in society, enable inspiring innovations and doing so in both a safe and sustainable manner. On the front of sustainability KPN is already making a lot of progress by increasing hardware efficiency and using green electricity but also on the user end by developing circular user devices and eco-modes (kpn, 2021). To have an even bigger impact, this project aims to investigate how changes in the consumption of digital products and services by KPN customers could lead to positive climate impact whilst still fulfilling the values the company champions.

FIELDS OF RESEARCH

In this challenge two expertise areas within the field of design come together. As the challenge entails performing research into the way people interact with digital systems, it taps into the field of Interaction design and human-computer interaction design (HCI) in particular. HCI studies the interaction between humans and the machines that they make use of. Key to the design of these interactions is the understanding that the value users derive from a product or service comes from a back and forth between user and system. Another important principle regards the fact that both human and system influence each other and that shaping the design of a digital product or service holds implications for how it is used and how we behave around them.

This flows directly into the second research area which concerns designing for a behavioral change (DfBH). This field of knowledge discusses the way behavior can be changed in favor of more desirable outcomes that serve a greater purpose than that of only the user. The theories propose many techniques and ways to achieve change through design but central to a successful and permanent change in behavior is the understanding that many techniques should be applied at multiple levels simultaneously and for a longer period of time (Bhamra et al., 2011). To successfully design for a change in behavior the current situation must first be sufficiently understood. This means mapping personal values, desires and emotions on an individual level, looking for barriers and enablers on an interaction level and scoping out norms and beliefs on a societal level. According to Widdicks & Pargman it is especially these personal values that could be leveraged in so called "value synergies" (Widdicks & Pargman, 2019). As there is a growing concern for other values being threatened by the digitalization of our society these could provide additional momentum to create a change in a more sustainable direction.

PROJECT SCOPE

In order to gather these insights, the project aims to focus on the contextual research of user interactions with digital products and services in the light of data consumption. As mentioned, the way we use information technologies such as email and streaming services into our daily lives holds valuable implications for how we might change this behavior in favor of sustainability. This type of empirical information on user behavior is often missing from existing studies on the topic and is considered as a necessary next step in making a change. Combined with existing knowledge on the environmental impact of data usage this analysis can be a starting point for new interventions and guidelines.

As the project aims to highlight the perspective of the individual user and their behavior, it will zoom in on the more personal consumption of IT services such as digital entertainment. Currently, this forms a large share of overall data usage both globally as well as amongst private consumers that make use of KPN's network. Therefore the context in which this project will take place is further specified as:

"the personal consumption of digital information and communication (media) products and services by KPN consumers on in-home and mobile networks"

Examples of digital products and services are digital media such as streaming or gaming services and information/ communication services like search engines and email.

APPROACH

The design project is split into three phases. First, a research phase will scope out the aforementioned context to gain an understanding of the relationship between data consumption and the environment. To do so, it will try to answer the following two research questions:

Q1 "How does data consumption have an impact on sustainability?"

&

Q2 "What drives the consumption behavior of digital products and services?"

To answer the first research question the infrastructure of the internet will discussed alongside with all the relevant stakeholders in this data landscape. Resulting from this will be a set of factors related to data consumption and the use of digital products and services that have an impact on the environment. These will drive a research consisting of user studies and analysis of current digital products into the consumption of data. By mapping out the drivers behind this consumption research question 2 should be sufficiently explored.

After this knowledge is gathered, it will be processed in the definition phase. Here, the current behaviour and the implications it holds for the future will be viewed through a critical lens. Coming forth will be a new view that challenges the current mindset around data consumption.
Design opportunities for interventions are then distilled using the behavior change and interaction design theories. This also leads up to the third and overarching research question:

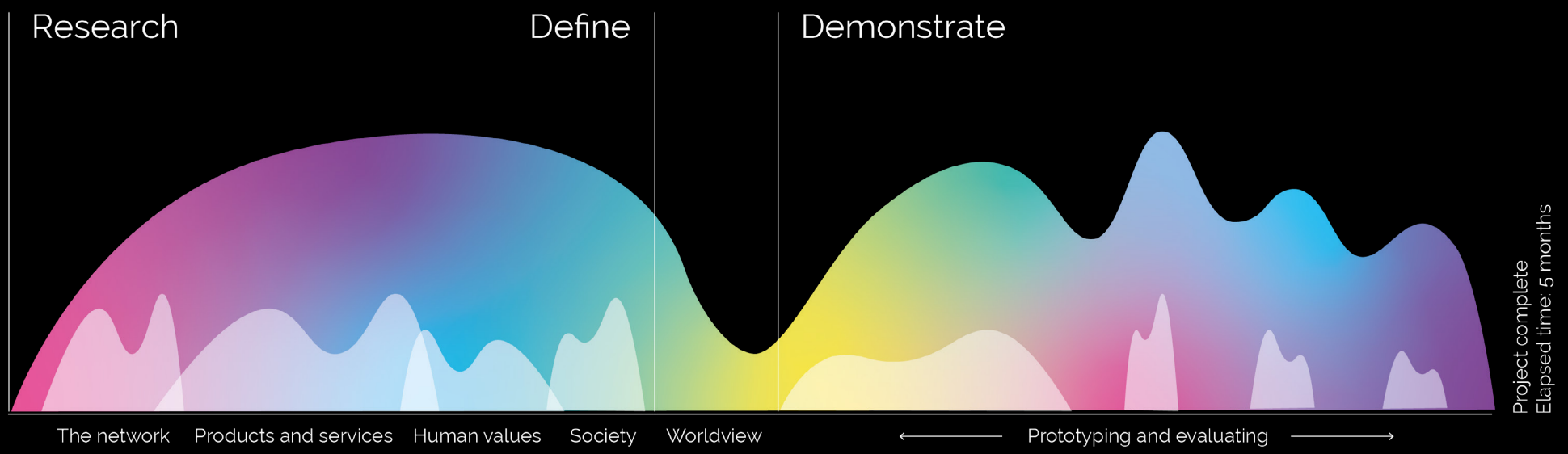
Q3: "How can data consumption behavior be changed in favor of sustainability?"

The last phase of the project will aim to answer this question by experimenting with possible interventions through prototypes and testing. This process of creating and reviewing is not linear but iterative and might include a repetition of previous activities with adjustments to the design direction as a result. As final outcome an intervention or set of interventions will be proposed based on the findings from the prototyping activities. The process is visualised in the project timeline.

ViP method

The underlying structure of this approach is the Vision in Product design methodology. In this iterative design process, various aspects of the project context are analysed to derive a comprehensive understanding from which meaningful concepts can come forth. Within the project all research findings are distilled into context relevant factors that somehow influence the current relation between data consumption and sustainability. After each step of the research process these factors are summarised at the end of the corresponding chapter. In order to create a deeper understanding, these factors are then combined into clusters during the definition phase. Together, the clusters amount to a worldview that depicts the current situation and its relation to the project goals. The worldview aims to form a solid basis from which to start designing new interventions that create the desired change in an appropriate way.

PROJECT TIMELINE



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THE NETWORK

In this chapter the physical infrastructure of the internet will be discussed in order to scope out the impact that this network has on the environment. First, an introduction will be given about the data landscape followed by a more thorough overview of data flows and their implications for sustainability. A final paragraph will analyze the self-reinforcing nature of the system and its alarming growth. The information in this chapter is the result of literature reviews and informal interviews with experts at KPN.

THE DATA LANDSCAPE

To understand the impact of the internet on the environment we must first ask ourselves the question; "what is the internet?". Despite how it is commonly depicted in society, the internet is far from a collection of fluffy clouds hovering somewhere in our universe. Instead, the internet is a large network of servers, transmitters and computing devices all connected with each other through a massive number cables and signals (Costenaro & Duer, 2012). So many cables in fact, that the total length is estimated to be over 900000 kilometres (Kate Crawford & Vladan Joler, 2018). All these cables run along the ocean floor connecting various parts of the world and new connections covering thousands of kilometres are still being made to facilitate the increase in data traffic (Microsoft, 2017)(figure 2).

The purpose of all this hardware is quite straightforward: to connect people around the world in order for them to share information. But given its enormous size these simple connections have grown into a web of billions of users. In this complicated web of connections that are several groups of users and facilitators that each form a part of this network. It is important to understand that the internet does not merely have users but the users actually make up the internet itself, all providing a small piece of the hardware required. An analysis of all these users, or stakeholders if you will, can give more insight into the workings of the web.

Internet ***in-ter-net***
Usually the internet (except when used before a noun).
A vast computer network linking smaller computer networks worldwide. The internet includes commercial, educational, governmental, and other networks, all of which use the same set of communications protocols:

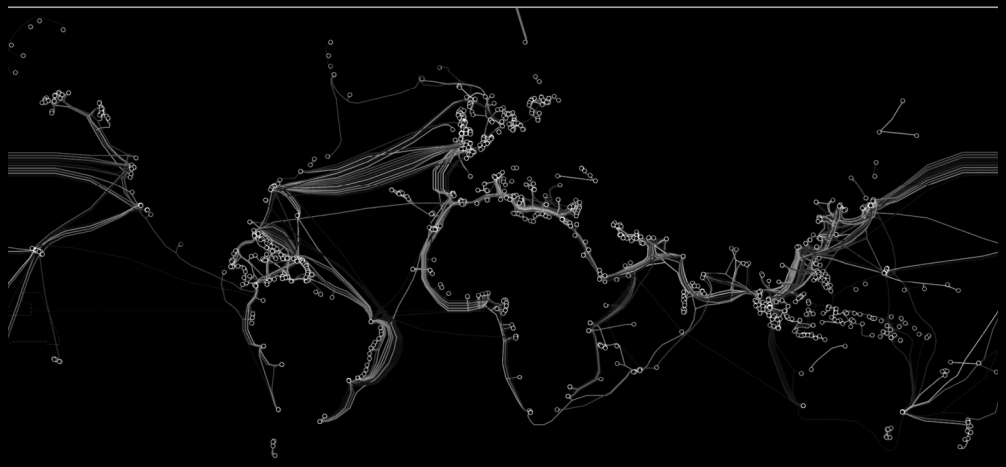

figure 2 - internet cable infrastructure as visualised by Crawford & Joler

First and foremost are the end users who stand at the receiving end of all operations and together make up the demand for data. The internet can offer them a wide range of applications and platforms that all address certain needs. In the next chapter, these interactions between user and service will be explored in more detail. In return, internet users make payments to digital service providers (DSPs) who design and maintain the applications and platforms. Along with them the end users facilitate part of the network by providing end use devices and powering them. Amongst these devices are user devices such as TVs and smartphones but also peripherals such as routers and set-top boxes. Peripherals are oftentimes supplied by the internet service provider (ISP), the third group of stakeholders within the data landscape. ISPs are the carriers of the internet that transport all data between the internet user, DSPs and data centres. In a very complex and layered network they are the very fibre of the internet and manage all the cables. In reality, this network consists of many players that all facilitate a part of the journey that a typical data packet would travel (Costenaro & Duer, 2012). For the purpose of this project however, the transportation side of the internet is represented by the local ISPs that typically handle the first and final parts of the journey and interact with the other stakeholders

in this domain. Connected to the network are also servers which store and compute all information before it can be transported across the globe. This is also where DSPs host their platforms and services. If the computing and storage demand are small, end users and DSPs might choose the store the information on private servers that are connected to the internet. As more storage and computational power is required, this is often outsourced to large scale data centres. These data centres contain a large amount of servers all working together to store great amount of data. These specialised data handlers are another stakeholder in this domain.

Less central to actual consumption of data are two more groups that have an important stake in the internet; energy suppliers and governments. Energy, or more specifically electricity, is one of the key resources underlying the data landscape. Suppliers of electricity therefore interact with almost all stakeholders in this domain and all parties rely heavily on each other's actions if they wish to meet the demand for energy. They function much like the ISPs in the way that they have a facilitating role in a very layered network where every party takes care of part of the total journey that a data packet or Joule of energy travels. The last stakeholders are the governments of the countries in which data is stored and handled. As the industry grows and digital services become more embedded in our lives, governments are required to regulate and oversee this growth. Next to creating rules and guidelines for the services and how they handle data, it is also becoming increasingly important that they organise the development of infrastructure on both national and international scales (R.E.O.S, 2019).

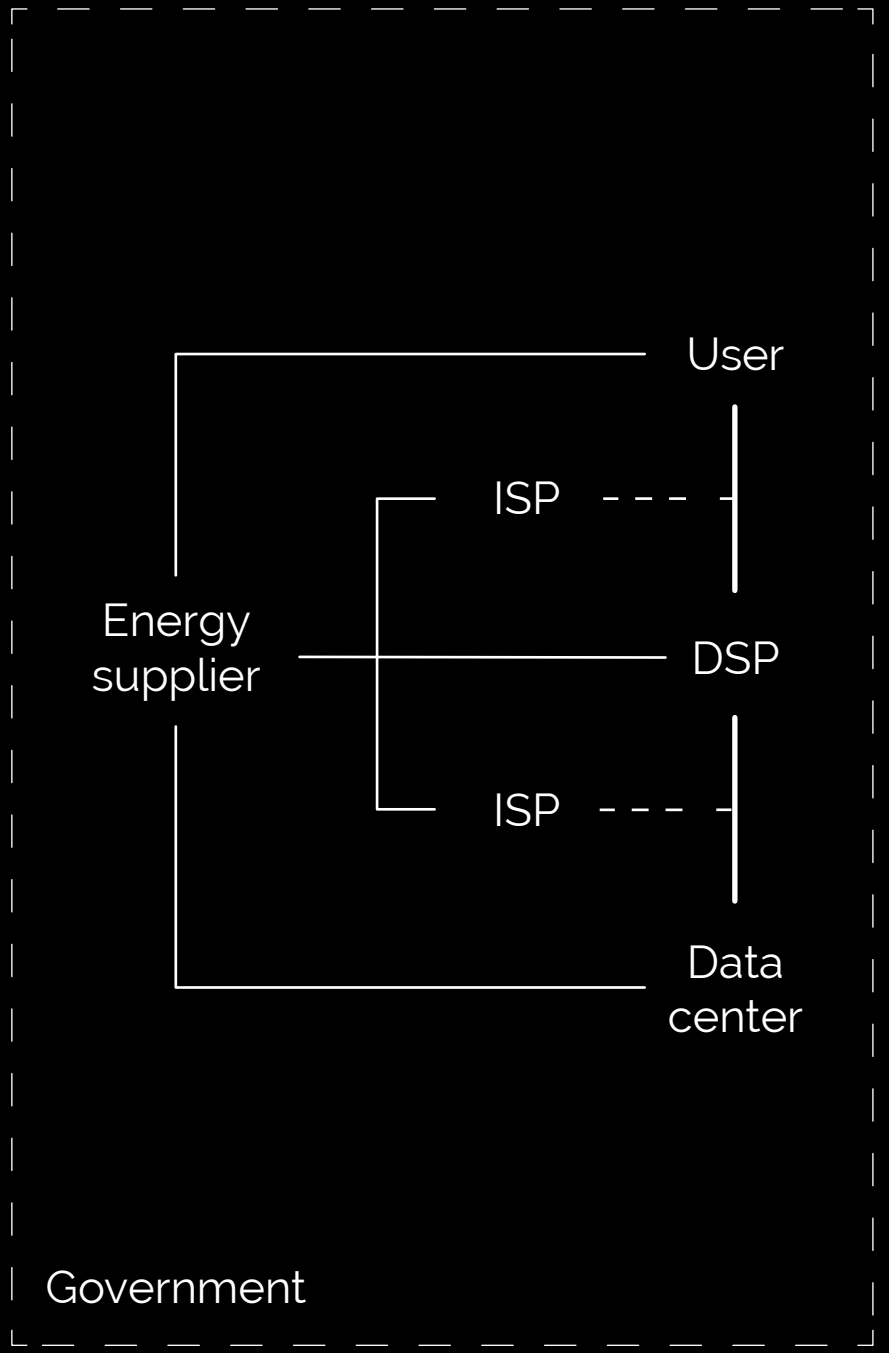

figure 3 - the overview of stakeholders

ECOLOGICAL IMPACT OF DATA CONSUMPTION

Typically, there are three main categories of data handling: transfer, storage and computing. As already mentioned, all these activities require great amounts of energy to be executed. To generate all this electricity a mix of fossil and sustainable energy sources is generally utilised but this differs greatly between countries (Carbon Trust, 2021). The production method of the electricity used by internet infrastructure is therefore a deciding factor in the amount of CO_2 that gets released as a result of data handling and therefore also the impact it has on the environment. Along with that, the total demand for power from the ICT industry is another main driver for ecological impact, not only because it drives the production of energy but higher loads on power networks also reduce the efficiency at which energy can be distributed. Energy suppliers are central to understanding the impact of data handling and are displayed in the middle of the overview in figure 4. The overview also shows three of the beforementioned stakeholders which all have a significant effect on the total energy demand and negatively affect other ecological factors.

If we follow the journey of a data packet through this system we start at the end users. Their demand for energy comes mainly from their own devices. These devices require energy in order to be produced and at a later stage to power them during use. Production of user devices not only uses up energy but also requires the mining and refining of rare minerals which are sourced from natural landscapes. This has the potential to heavily impact the surrounding nature whilst emitting a substantial amount of Greenhouse gases (GHG). The process of refining also includes using dangerous chemicals and fresh water, further negatively impacting the environment (European environment agency, 2021). Important factors that influence the weight of this impact are the total amount of devices, the rate at which they are replaced, their rated power (kW/h) and the duration of use.
After the end users request information stored a certain location, the request is carried over by the network of cables managed by the ISP. In order for the request to travel all this distance, the cables are connected by repeaters that each give the data packet another shove through the network. Similar to the end user, this infrastructure impacts the environment through the powering and production of the hardware. Again, repeaters and cables need minerals to be extracted in order for them to be build, using energy in the process. Energy is also used to power the repeaters and other hardware like cables. To estimate the amount of energy an important factor is the maximum volume of transfer possible, also known as the peak. This peak demand for transfer not only determines how much infrastructure is needed but also greatly influences the amount of energy needed to power it as the network requires a certain baseload of power in order to operate. Next to the peak demand, the total amount of traffic is also of influence together with the efficiency of the hardware. Efficiency improvements can be realised by newer hardware and making better use of existing hardware through a process called virtualization (Carbon Trust, 2021).

> **How the peak demand works can be explained by the analogy of a bus driving a certain route. To drive the bus a certain amount of energy is needed regardless of the passengers and any passenger getting on will only have a small effect on the total energy required. However, if the bus is fully loaded an additional bus must be added to the route to facilitate the traffic, greatly increasing the fuel consumption. Together with the vastness of the network, this characteristic makes allocating the impact of internet usage to individual users incredibly difficult (Carbon Trust, 2021).*

The request ends its journey at the data centres. These parks filled with servers need to be produced and require energy to operate much like all other infrastructure. Special to these however, is the fact that they get extremely hot during operation and need water to cool them (Ristic et al., 2015). And the issues don't end here, the largest data centres (also known as hyperscale) take up as much space as 245 football fields, seriously impacting the landscape (Heleen Ekker & Nando Kasteleijn, 2021). How much computing power is needed and how much data is stored both drive the need for data centres and their energy demands. This is influenced by the total available computing power, amount of computing that takes place, virtualization of servers, amount of stored data and the uptime of data (the length of the period during which it can be accessed).

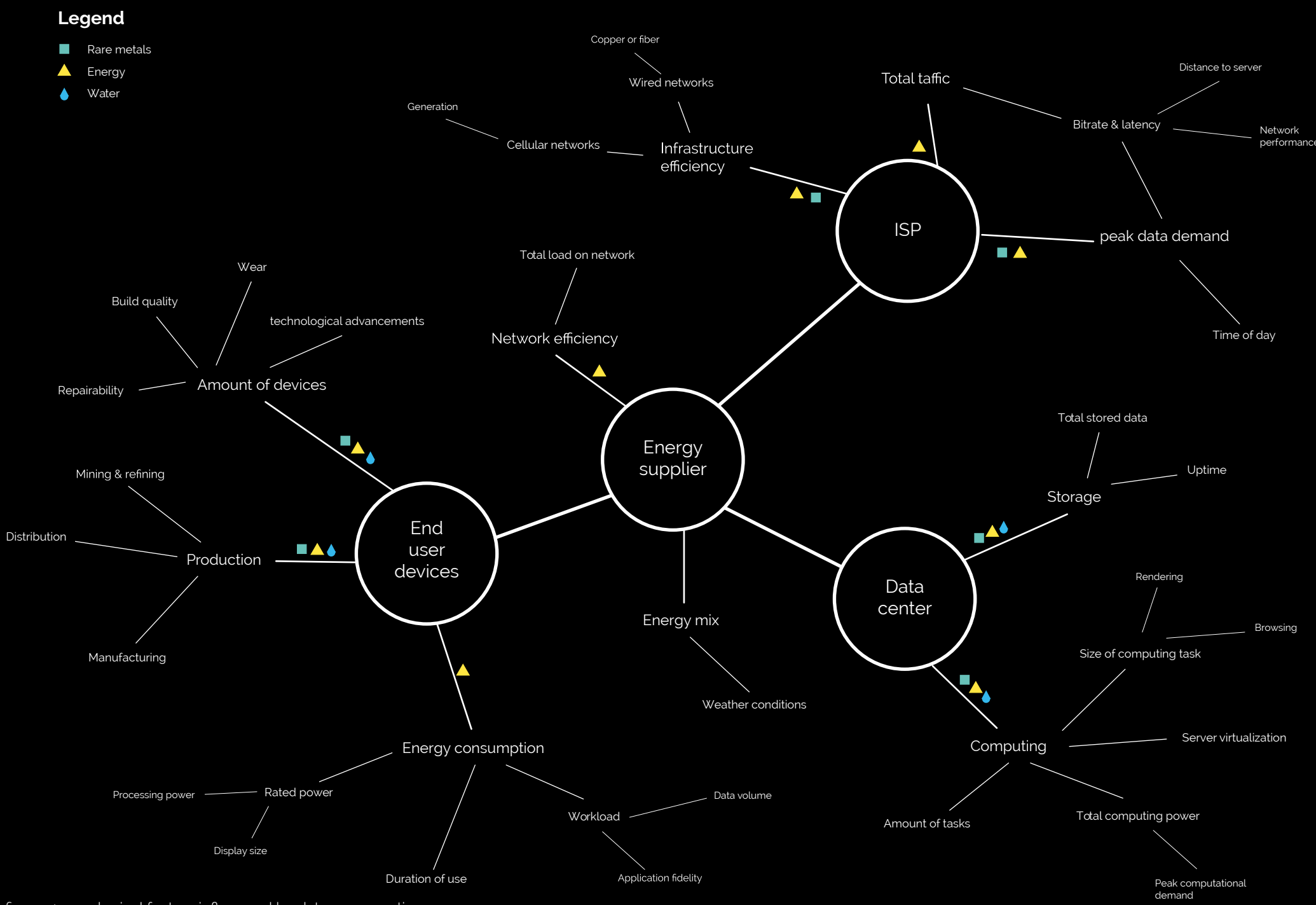

figure 4 - ecological factors influenced by data consumption

Size of impact

From the overview it becomes clear that internet usage affects the environment on many fronts but to what extent is still unclear. Already mentioned is the difficulty to get a concrete measurement of the impact of individual users, but when zoomed out the size of the impact becomes more clear. Looking at global GHG emissions the ICT sector is already at the level of the aviation industry and has also surpassed the food and tobacco industry (Carbon Trust, 2021; Corbett, 2018). In times where we consider to eat less meat for the sake of the environment we must consider our data diet too. And it's not likely that the growth in emissions made by the sector is going to come to a halt. Many studies try to forecast the impact of ICT in the future and come to the conclusion that the share of GHG emissions could increase up to 14 or even 23% of total worldwide emissions (Andrae & Edler, 2015; Belkhir & Elmeligi, 2018). They conclude that exponential increases in efficiency (Koomey et al., 2011) are in a precarious balance with the exponential growth in demand. Emerging technologies such as 5G and IoT and barriers for efficiency advancements like edge computing (Ning et al., 2019) could tilt the balance in the wrong way (Petit et al., 2021).

Interesting is also what parts of the internet account for what share in these emissions. In figure 5 is shown how end users make up for the biggest part of GHG emissions, followed by data transfer and lastly data centres. However, all parties cannot exist without each other meaning that they share a responsibility for all emissions.

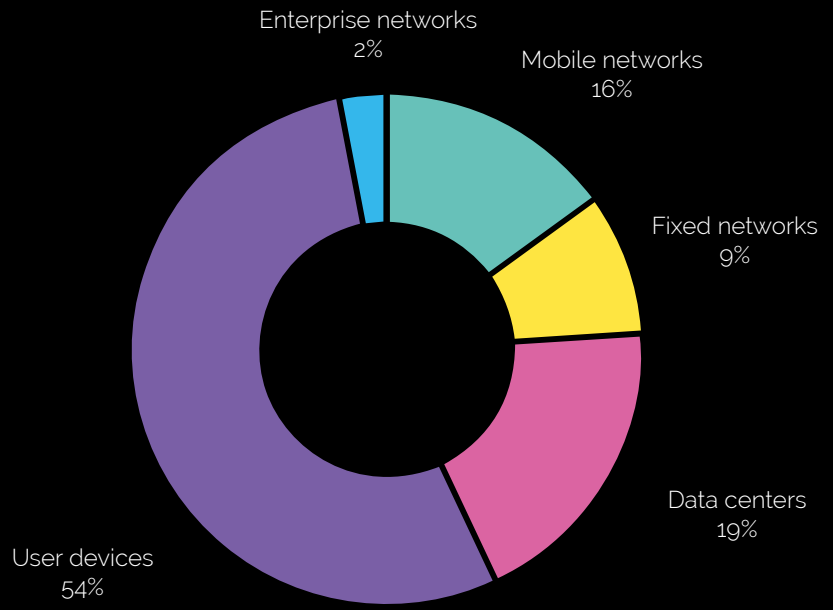

figure 5 - division of energy demand in the network as visualised by Carbon Trust

Mining activities leave a ravaged landscape that takes long to recover

FACTORS OF USE

In order to investigate with end users how using digital services relates to ecological impact, the findings from the overview are categorised in use factors that together drive data consumption. Three main factors are identified consisting of smaller contributors that link to consumption more directly. The factors 'data infrastructure' and 'total load on the electricity grid' are not used in the remainder of the research as they are too indirectly related to data consumption, leaving them out of the scope of this study.

1. ***Peak data demand; maximum amount of traffic the network can handle***
    a. Time of use/consumption
    b. Type of network (wired or aerial)
    c. Data intensity (rate at which is consumed; load on devices, bitrate and computational load of data servers)
    d. Device rated power (total power of end use devices)
    e. Data infrastructure (efficiency of network and data centres)
    f. Total load on electricity grid (demand for energy related to time of use)

2. ***Flexible data demand; amount of traffic over a given timeframe***
    a. Duration of use/consumption
    b. Type of network (wired or aerial)
    c. Data intensity (rate at which is consumed; load on devices, bitrate and computational load of data servers)
    d. Device rated power (total power of end use devices)
    e. Data infrastructure (efficiency of network and data centres)
    f. Total load on electricity grid (demand for energy within the timeframe)

3. ***Purchase rate of devices***

*It is important to notice that despite DSPs not being present in the overview, their platforms and services do have a significant impact on the factors above. This will be discussed in more detail in chapter 3.

SELF-REINFORCING LOOP

One of the reasons why the impact of digitalisation has always been a subject of controversy are the ongoing advancements in efficiency. Currently, KPN is rolling out a new fibre optics network in the Netherlands which affords for even higher efficiencies and most importantly, higher speeds. These speeds are key to understanding exactly why demand is rising so exponentially. Higher speeds afford for more complicated and data heavy applications which in turn raise consumption. More consumption calls for better infrastructure which in turn leads to higher speeds, completing the loop. Breaking with this self-reinforcing process is fundamental to lowering the impact of the ICT sector on the planet.

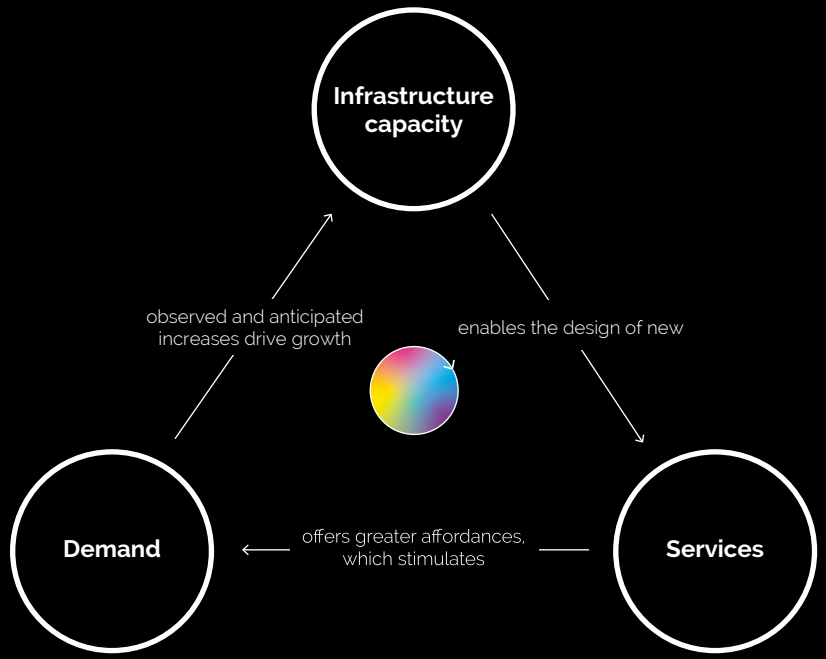

figure 6 - the self-reinforcing loop as visualised by Carbon Trust

CONTEXT FACTORS

- Computing efficiency doubles every 1.57 years according to "Koomey's law"
- Data centres (and their corresponding energy infrastructure) claim valuable space in natural landscapes
- Energy consumption of ICT is mainly characterised by the total peak demand the network can handle
- New fibre optic infrastructure allows for higher speeds and efficiency
- Better infrastructure enable new types of services and content that enable new consumption behaviour, requiring better infrastructure (self-reinforcing loop)

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DATA CONSUMPTION

In this chapter the interaction between end users and digital applications is discussed in order to find out how data is consumed and discover possible opportunities to intervene. The consumption of data is approached from two perspectives, the design of digital products and services and the people that use them. Both perspectives are researched through empirical research in the form of observations, qualitative research and an analysis of digital applications. In some cases literature is used to substantiate the findings.

3.1 METHODS

In the next chapters the findings will be discussed from empirical research conducted during this project. Two methods are used which will briefly be introduced here.

SERVICE ANALYSIS

To map out different types of services and the way they are designed, the features of personal devices and apps of the researcher are evaluated. Characteristics and features that might influence consumption behavior are carefully noted down and when possible isolated by removing and adding them to verify their effect. Additional apps that are designed with data saving in mind are downloaded in order to compare them to traditional app design.

To further verify the effect, a data measurement tool is used called Glasswire. This software keeps track of all data used by specific applications on smartphones and computers and can therefore be used to estimate the data intensity of apps when the duration of use is also taken into account. Use duration is found by retrieving information on screen time from the wellbeing app. As not all apps require the screen to be turned on during use, data intensity for these cases is estimated based on averages found in online sources. Resulting intensities are shown on the right and a full list of relevant apps and their data intensity can be found in appendix 2.

Service	Measured intensity MB/h
YouTube	403 – 616 – 1066
NOS	200 – 305 – 797
Spotify*	40 - 72 - 136
Reddit	555 – 686 – 1000
Facebook	996 – 1260 – 1660
Facebook Lite	84 – 84 – 160
Chrome	169 – 291 – 542
LinkedIn	159.5 – 303 – 313
Instagram	1370 – 1461 – 1530
Netflix	199 – 252 – 400
WhatsApp	3.5 –39 – 750 (Video call)
Google Maps	34.4 – 87.6 – 537

*As there is no screen time for spotify three standard intensities are used (Schofield, 2020)

INTERVIEWING

Additional to the research into hardware and software, a qualitative study into user experiences and behaviour is also conducted in the form of semi-structured interviews. Following the theory from DfBC, this study aimes to find out what values underlie the users behaviour, what barriers users might face when trying to consume less data and to what extent people are aware of the physical implications the internet has on the environment. Along with this, existing interventions aimed at limiting the use of digital products such as digital wellbeing apps and productivity apps are also discussed.

In total, 11 internet users participated in the study who were all KPN customers. They were sourced by recruiting in the 'up to data' panel, a user panel of KPN and Simyo customers who regularly partake in online questionnaires sent out by the company. From this recruitment process 7 people were selected and 4 additional participants were sourced through convenience sampling to ensure an even spread in age. This is important as the adoption of digital applications tends to vary greatly between generations (Dreier, 2017). The mix of participants contained 4 students/young professionals aged 21-27, 4 working adults aged 45-58 and 3 retired adults aged 62-68.

The study consists of a small homework exercise to prepare participants followed by an interview of roughly 45 minutes. In the exercise participants were asked to identify the internet source in their own homes and make a list of all 'SMART' devices connected to the internet in their house by means of photographing them. During the interview the interaction with these devices and the services that they run was discussed by engaging in small collaborative tasks with the participants. Most interviews were held online via teams and Miro except for 2 which were conducted in person, also using Miro. A detailed overview of the setup with the tasks and interview guide can be found in appendix A1. All interviews were recorded and processed into findings and quotes after they had taken place. An overview of these findings and the findings from the service analysis can be found in appendix A3 and appendix A2 respectively.

Participants

Order	Pseudonym	Age
1	Jules	57
2	Nicky	21
3	Alex	66
4	Noah	45
5	Blake	68
6	Taylor	58
7	Jordan	58
8	Sam	27
9	Cameron	62
10	Logan	25
11	Charlie	27

3.2 PRODUCTS AND SERVICES

In the next chapters the findings will be discussed from empirical research conducted during this project. Two methods are used which will briefly be introduced here.

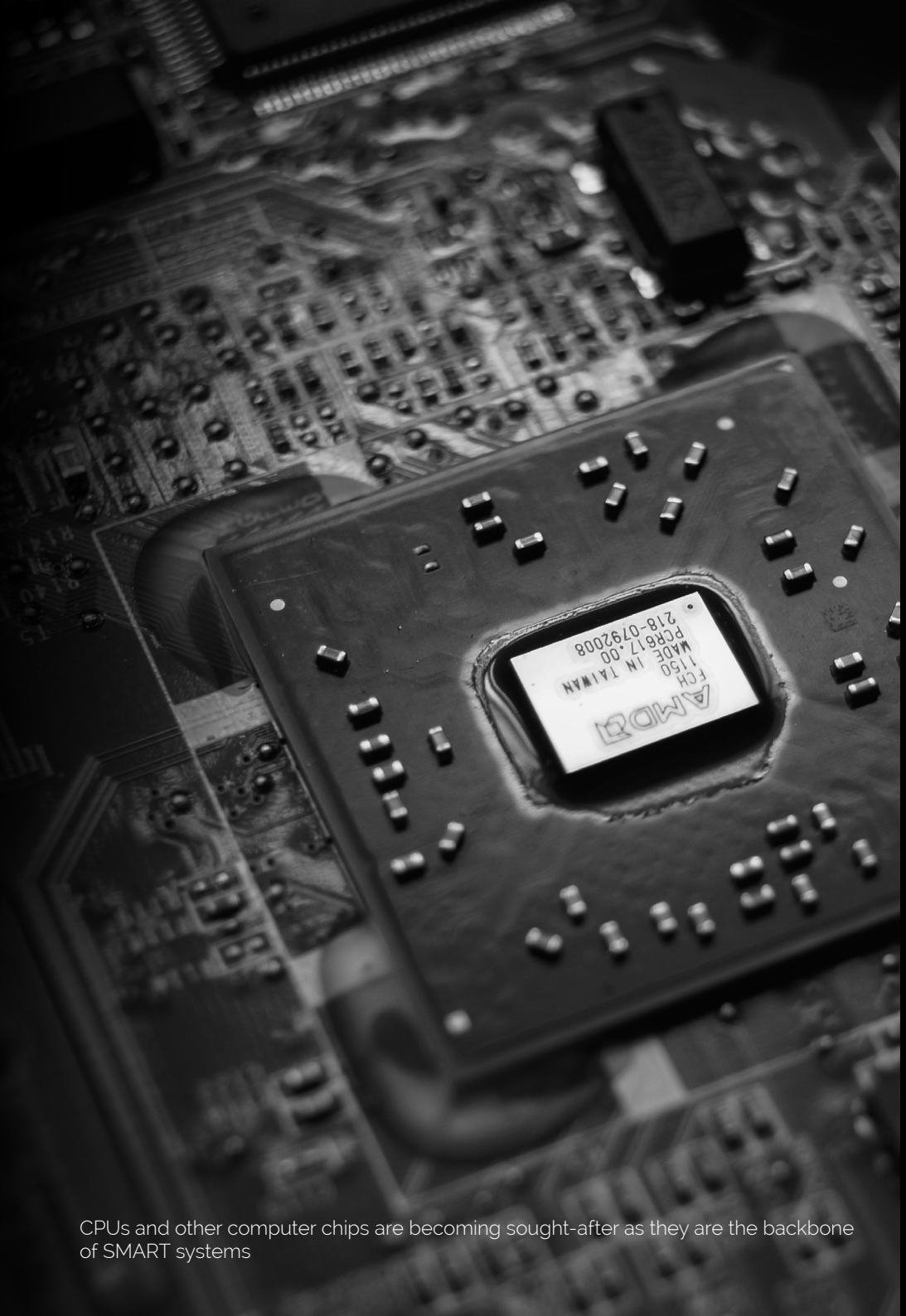
DEVICES

The SMART revolution

Over the past decades the amount of electronic devices that has entered our homes has increased drastically. In 20 years we have gone from having one computer in the house to having several smartphones and laptops per person (A3.12). More recently this also includes the addition of an increasing amount of 'SMART' devices, electronical appliances connected to the internet that generally have sensing and actuating capabilities. Most common are smartphones, laptops and PCs which use touchscreens, monitors and other forms of input and output to afford interactions between people and the internet. But sensors, cameras and touch screens are making their way into almost any device found in and around the house like SMART fridges, SMART doorbells or SMART surveillance cameras just to name a few (Ring, n.d.; Samsung, n.d.). By sensing information from the environment, these devices create streams of data that all need to be handled in order for someone to make use of it. The total amount of data handled can amount to staggering numbers which has even earned surveillance cameras a spot amongst the top contributors to the total traffic of data (Carbon Trust, 2021). Besides the generation of data in the background, the SMART revolution has also led to digital services being accessible from almost anywhere at any time. A simple look at the time on a SMART watch invites users to also look at received messages and so does turning off the smartphone alarm in the morning (A3.9). This leads to an increase in usage of these services.

Performance

To facilitate all these extra capabilities the devices that we use rely heavily on their performance. Along with the exponential improvement in efficiency, device performance has also increased along this trend. New devices bolster bigger screens, higher resolutions and more processing power to render graphic content and handle other types of information. These fast advancements mean that to keep up to date with the newest features users must replace devices long before their expiration date (European environment agency, 2021). This is clearly reflected in the design of mobile phones where users are expected to replace their models after a period of two years whereas they would prefer to keep using them. Recently, more and more people decide to hold on to their phones for longer however, which could be the result of a decreasing added benefit of technological advancements combined with higher pricing (CSS Insight, n.d.). Another reason for this trend could be the introduction of cloud computing. To ease their hunger for computing power users can also turn to data centres to run applications for them and only stream back the resulting outcomes. This puts less of a burden on end use devices and moves consumption further away from the user. Whilst this central computing is more efficient than decentral computing across millions of devices, it also generates an enormous amount of data streams. Along with that it also makes heavy computing more accessible and affordable which will encourage more usage. If cloud computing becomes more common through services like Google stadia, a cloud gaming platform, this will have a severe impact on carbon emissions by ICT (Marsden et al., 2020).



CPUs and other computer chips are becoming sought-after as they are the backbone of SMART systems

CONTEXT FACTORS

- Homes contain more electrical devices and more and more are also connected to the internet "IoT"
- Integration of sensors and cameras in SMART devices enables live footage and monitoring with a lot of data handling as a result
- Digital applications are accessible from anywhere and on many devices

- Phone purchases are declining as higher performance isn't always required anymore
- To suit performance requirements computing is moving to the cloud so that hardware is not needed anymore
- Screen size and resolution increases rapidly enabling visual formats which consume more energy/data

SERVICES

In order to analyse the services that all these devices enable, it helps to first categorise all that is offered. The internet is home to a vast amount of different applications that often cover a similar purpose for the end user. Based on these kinds of purposes and quantitative data on the share of digital applications in total data consumption (Carbon Trust, 2021; Morley et al., 2018), six categories are formed. These categories are not exhaustive as they do not cover all applications but rather function as filters to give the analysis points to focus on.

Audio-visual media

Many online activity concerns entertainment. One of the ways we like to relax is by watching movies, series and listening to music. This category contains the streaming services that have begun to replace TV signal and physical copies of music albums or movies. Services in this category make up the biggest share in total data traffic and also require a significant amount of storage to store content and user data. This data is generally used to generate personalised offers which also requires computing power.

Data intensity

Transfer	Storage	Computing
High - very High	Medium	Low- Medium

	>40%

Share in total data traffic

Examples: Netflix, Disney+, Amazon Prime, Videoland, NL ziet, Spotify

Streaming service Netflix

Gaming

Another form of entertainment is gaming. This more interactive form of visual content consumes data through game downloads, updates and online multiplayer games. Services like Steam have replaced Blu-ray discs with online downloads which for larger download sizes proves to be more carbon intensive (Corbett, 2018). To render imagery during gameplay, a lot of computing power is also needed which makes this category intensive for hardware. Its impact on data traffic is still relatively small but can rise quickly when computing is moved to the cloud. This is also reflected in a CAGR of 55% for gaming-related data traffic (Carbon Trust, 2021). Data intensity can differ greatly between games and their level of complexity.

Examples: Steam, Origin, Google play store, candy crush, Call of Duty, FiFa

Social media

Next to entertainment the internet also allows people to get in touch with each other and fulfill a more social need. Social media facilitate this need by allowing people to put personal content online in various formats to be viewed by others. Data traffic is mostly caused by sharing pictures and short media or videos. Storage is also allocated to tracking personal data and providing personalisation.

Data intensity

Transfer	Storage	Computing
High - very High	High	Low- Medium

	>8%

Share in total data traffic

Examples: Facebook, Instagram, TikTok, Snapchat, LinkedIn

Data intensity

Transfer	Storage	Computing
Medium - very High	Medium - very High	Medium - very High

	<5%

Share in total data traffic

Left: Social media app Facebook, Right: Xbox gaming controller

Communication services

Another category that allows people to stay in touch is that of communication. Many messenger services facilitate in this need along with calling through internet connections and more recently also video conferencing. The impact of this category various widely as data volumes depend on the format (text vs. video).

Data intensity

Transfer	Storage	Computing
very Low - very High	Low	Low

Share in total data traffic

n/a

Examples: WhatsApp, Signal, Telegram, Zoom, FaceTime, Outlook, Gmail

Video conferencing through Zoom

Browsing & Information services

The internet provides access to an incredible amount of information which is acquired through browsing or other information services. Websites, maps and news articles all reach our devices through browsers and apps. Viewing this information causes data to be transferred and stored and search aids like Google's search bar make use of computing to provide search suggestions and collect relevant information. To generate these, user data is also collected and stored.

Data intensity

Transfer	Storage	Computing
Medium	Medium	Medium

Share in total data traffic

>10%

Examples: Chrome, FireFox, Edge, Safari, NOS, Nu.nl

File handling (Cloud storage & file transfer)

Storing and sharing information also happens on a smaller scale directly by individual users. They can choose to store their personal files on their own devices but also upload them to data centers so they are always accessible to all devices. Data is mostly consumed by transferring files and storing them in these cloud facilities.

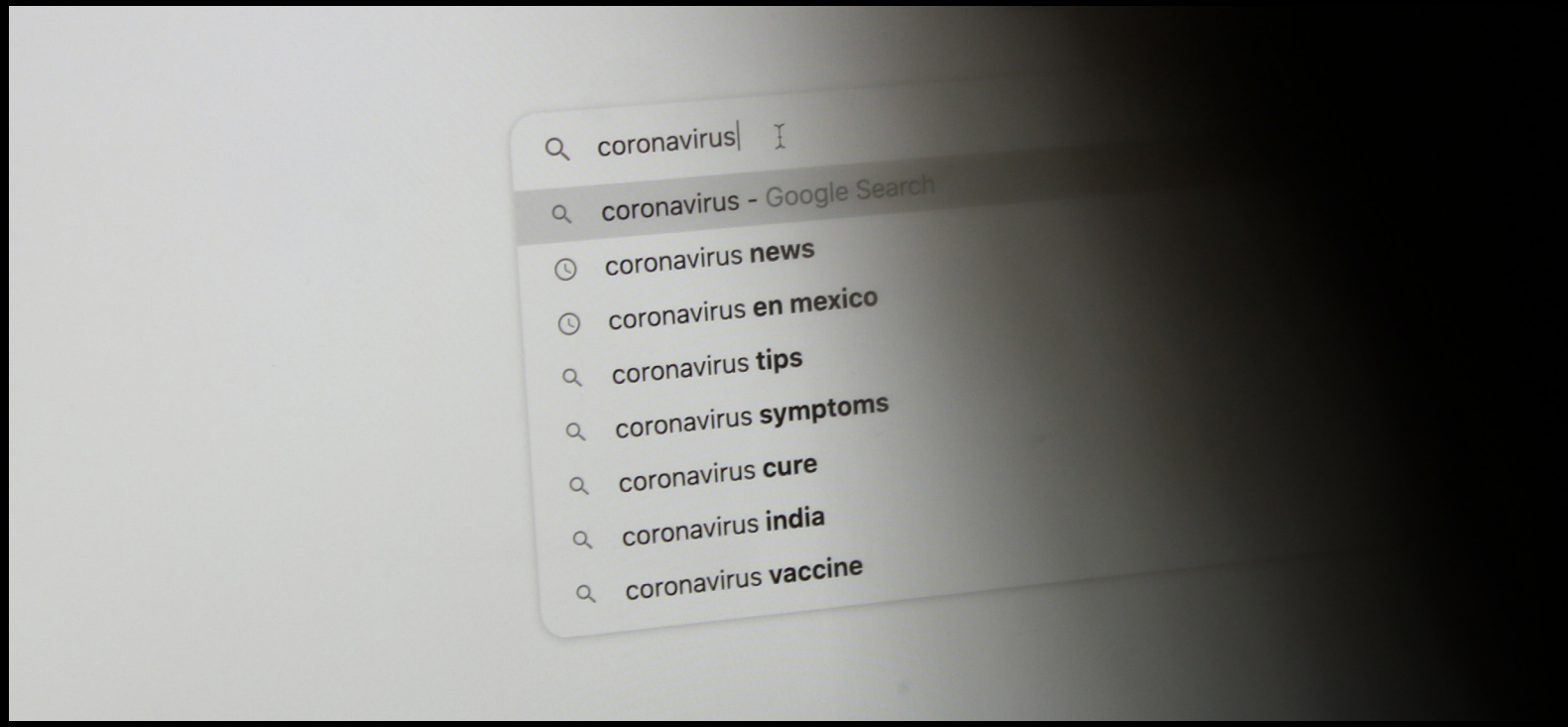
Examples: Google drive, Onedrive, iCloud, Wetransfer, Dropbox

Data intensity

Transfer	Storage	Computing
Medium - very High	Medium - very High	very Low

	<5%

Share in total data traffic



The Google search bar computing search terms while you type

SERVICES

Format: visual

One of the first things that becomes clear when looking at these services is that they are becoming increasingly visual. Bits of text on a website are almost always accompanied by pictures and also text messages have evolved from short letter combinations to animated Gif's. Social media stand at the top of this trend offering an almost continuous stream of pictures and videos. It's easy to understand why this is happening; visual content simply appeals more to people than plain text. If you want your blog post or website to be viewed you need to tap into these channels (Mad fish digital, n.d.). Digital services encourage this by creating strict formats to adhere to such as the short-video format of social medium TikTok. Predetermined formats like these force users into adding visual features even when this is not necessary, leading to unintentional data handling. A recent evaluation of a "listen-only" mode in YouTube, where normally audio content is supplemented with video footage to meet platform standards, showed that up to 5% of carbon emission could be saved by allowing more flexible formats (Preist et al., 2019). Besides more data handling, additional graphic content also leaves a bigger burden on devices. This so called 'bloat' slows down websites and can lead to buffering or a sluggish user experience (A3.20), also draining the battery (Apica Systems, 2013).

"Less data on your device makes it less sluggish"
- Blake

Battle for attention

If you want people's attention you need to address visual channels, and attention is what it's all about in the world of digital entertainment. Social media, streaming services and gaming platforms are all in a constant battle to claim a bit valuable time from their users. The height of this fierce competition takes place at 19:15 every evening, a time which Netflix refers to as "the moment of truth" as this will determine how many viewers they will get that evening (Netflix investors, 2021). To make sure that they win people over, entertainment services go further than just making their content appealing. To keep people hooked they need to keep the content coming, and lots of it. Game developers add new content via updates to their games so regularly that in order to keep competing with new game releases, they push their own studios to extremes. 100-hour work weeks have become a standard as a week without new content can lead to a serious drop in players (Jody Macgregor, 2019). A similar trend can be noticed in Video-on-demand services where platform exclusive content is developed at a rapid pace in order to have an edge on the competition. To help with constantly feeding users this new content, digital services have also adopted Artificial intelligence in their applications. This technology can provide user with custom personalised interfaces that help them get to the content they like the fastest. Combined with features such as AutoPlay in YouTube, which automatically plays content without any explicit action by the user, episodes and social media posts are literally spoon-fed to the user. In some cases this process reaches levels of automation where users don't even register what is being displayed and engage in a form of 'brainless' activity (A3.25). Resulting from this are addictions to these services along with a self-centred worldview due to personalised suggestions (A3.7). This also becomes clear from search engines where identical search terms can create different results across user profiles. When information is acquired through these means there is always a bias that colours users' opinions and beliefs (A3.15). In all their zeal to grab people's attention, the increasing amount of digital content adopted by DSPs is pushing the consumption of data to higher levels.

"Sometimes you've been scrolling for an hour or so and you think, what have I been doing?"
– Logan

"I'm triggered to think about something that was suggested to me"
– Charlie

Next paragraph in **3**...**2**...**1**...

Business models

These developments are also strengthened by the way that DSPs make money off their services. Moving away from traditional sales per item such as buying a game or renting a movie, new services tend to charge based on monthly subscriptions or other forms of ongoing payments like in-game purchases, season passes and placing advertisements. Because of this new business model it becomes increasingly important that consumers are retained for a longer period of time. As information consumes attention, the users' attention becomes a form of currency that is worth fighting for. Besides the temptation of various forms of content, DSPs also try to bind users to them by forming monopolies. Large technology oriented companies often referred to as 'big tech' combine multiple services in package deals or forcefully install their apps on devices that run their operating software. When they have reached a large user base it becomes even more difficult for users to switch to a competitor as they will no longer be able to interact with friends and family that have not yet made the switch (A3.10). They provide users with an offer they quite literally can't refuse or they will have to seriously compromise user experience.

"When you decide to leave Facebook you isolate yourself" – Cameron

But in order to retain users they must be interested in the offering to begin with. To make their services appealing, DSPs use subscription based payments to lower initial buy-in costs and often offer free trial periods or decide to run their products free of charge with in-app advertisements (Amazon Inc., n.d.). This hooks customer in thinking that they got a good offer but they might end up paying for services they will rarely use (A3.36). To add to that, digital applications are generally downloaded for free as no physical production or shipping is needed. Along with much information being freely accessible online, this has earned the internet a somewhat cheap reputation. The response of internet users to the monetization of digital applications is then also to refuse payment and download illegally or block advertisements with plugins like adblocker (Kulche, 2022). With current subscription models

users often end up sharing accounts between relatives bringing the cost down even further (A3.13).

"I pay for Videoland and Prime but I don't actually use them"
- Charlie

Combined, the monopolies and low buy-in of digital services make for an expansionist business model that covers ground quickly only for it to be impossible to be reclaimed by competitors (Mensing, n.d.). With the expansion of these services data consumption also expands at rapid pace and is difficult to reverse.

Data reduction

Despite this difficulty some services have also released data saving features or 'Lite' versions of their applications. These functionalities are aimed at reducing costs of data plans at the users' side and improve performance on old devices. In most cases these features automatically turn off when connected to WiFi or fixed access internet as these plans are often unlimited and have a fixed price. They are clearly not designed with sustainability in mind but do hold serious implications for the environment. When comparing the regular facebook app to the respective 'Lite' version, data transfer decreases by almost 90% (A2). Biggest contributors to this reduction are lowered video resolution and turning off AutoPlay, underlining the impact of this technology on consumption behavior.

Highest measured data traffic "Heavy" Facebook app vs. Lite app

Along with data saving features aimed at reducing costs, certain applications have also been developed to improve wellbeing by cutting usage. Prime examples are the wellbeing apps by the android OS and iOS for Apple (Apple, n.d.; Google LLC, n.d.-a). In these apps users can gain insight into how often they use their smartphones and set some targets to restrict their usage. Whilst these apps are a good step forward, the notifications that people receive when they reach their limits are easily ignored and without any real incentive there is little reason to use them (A3.39). Another limitation lies within the fact that they only work on smartphones whilst the real usage is spread out across many devices.

"Reminders of wellbeing apps are easily ignored and they don't work anymore after a while"
– Nicky

CONTEXT FACTORS

- Most data is used through long-form video streaming
- Rich/visual media attract our attention because they appeal to our senses and are more easily digested
- Many media such as music/podcasts are given a visual format to meet platform standards
- "heavy" applications with lots of bloat decrease the device's performance

- With a lot of services competing for the user's (limited) attention they engage in a fierce competition
- A period where no new content is generated results in loss of users/viewers/subscribers
- Digital applications are updated very frequently as new features or security measures are released
- The ever increasing demand for content put creators under a lot of pressure to keep delivering
- Most people use streaming services during the evening
- AI personalization narrows down your suggestions to what you already like
- AutoPlay features play content automatically even when the user isn't paying attention

- Services are made part of platforms owned by one DSP that offer all-in-one solutions
- Big tech companies create monopolies through unique user bases and features or buying out the competition
- Advertisements monetise digital content making it free to use, only paying with your attention
- Digital services are often offered for free or on monthly plans with a low entry fee making them affordable
- We see digital content as a free resource and refuse to pay for it if possible

- Data saving features in apps do not apply when connected to Wi-Fi (fixed networks)

3.3 HUMAN VALUES

This final part of the chapter focuses on the people that make use of the internet. What drives them to behave in the way they do and what implications does this have for the values they uphold? During the research 4 major gains have been identified along with 3 pains that all come forth from the use of internet applications.

GAINS

Digital cravings

How products and services attempt to force-feed people their content also teaches us a bit about them. Not only do we accept whatever is thrown at us, we also long for new episodes of our favorite series or that notification that signifies a news update. Information in general seems to be something that humans inherently crave, it can provide us with more certainty about what will happen next or entertain our desire for stimulation (A3.18). The need for staying 'up to date' has people glued to their phones and some even suffer from a self-proclaimed addiction to news, constantly waiting for that next update (A3.18). These addictions can affect people greatly as consuming too much news aggravates symptoms of depression (Potts & Sanchez, 2009).

"Information gives you security and something to hold onto, you know what's ahead of you"
– Nicky

"I would say I'm a little addicted to news"
– Sam

What makes these short updates so desirable is the way that nature rewards us for finding yet another piece of information. Short bursts of dopamine are released in our brains every time we click on a cat video that provide us with a pleasant sensation. In pursuit of happiness and pleasure these small doses are like tempting snacks but stand in the way of the healthy meals we need in order to sustain ourselves. Choosing these immediate rewards over long term benefits is called instant-gratification and is key to understanding why digital services are so addictive (Courtney E. Ackerman, 2022; Medical Association, 2020). Biggest suppliers of dopamine are social media which keep the updates coming only to leave a feeling emptiness as soon as users close the app (A3.24). Content creators play into this by creating 'clickbait', digital content that is disguised as the quick rewards we are looking for but lead to immediate disappointment when viewed (Lischka & Garz, 2021).

"It's entertainment but the happiness is short-lived"
- Logan

But the quest for pleasurable moments on the web does not only stand in the way of meaningful activities, it also leads to some very questionable ones. Across the internet people engage in weird or immoral behavior that they rather keep to themselves. Examples of these 'guilty' pleasures range from strange yet satisfying audio content (ASMR) (Media Nest, n.d.) to adultery and pornographic content (Catherine McNally, 2018). Information like this can accessed in relative anonymity as everything happens on the user devices and features like incognito modes of browsers make it even easier to hide guilty pleasures from peers. Pleasure seeking also happens through the consumption of these devices themselves. Many see technology as a hobby and buy newer devices out of curiosity or interest (A3.32). Keeping up to date with the newest technologies is considered both useful and fun.

Crossing boundaries

These guilty pleasures are just the top of the iceberg when it comes to what the internet has to offer. Possibilities are effectively endless as the internet contains far more information than one could ever dare to consume. This vastness is also part of the appeal of the digital world, access to the internet broadens horizons and gives people the autonomy to do whatever they want, when they want. Online there is always some place that has what you are looking for as the web is not bound by physical restrictions like the time of day or geographical borders (A3.35). This also means that the internet can connect people, communities and cultures which has greatly enriched our lives.

"Internet is freedom, you can go anywhere"
- Jordan

Social desires

Connecting people with each other is also regarded as one of the main uses for the internet. Humans are very social animals and this new technology promises to make us more social than ever. And it's true that the internet does allow for this to happen, it is now easier than ever to get in touch with faraway friends and arrange meetings (A3.23). This is also reflected in the data that we store online as photo albums are full of memories to social encounters and moments that are of significance to us (A3.26). This also means that we try to cling on all this data because it has won over a place in our hearts.

"I think the main goal of the internet is connecting people"
– Cameron

"I tend to turn on series when I'm alone, when I have company I don't need it"
- Charlie

The internet is also host to countless of online communities that form over common interests or other ways of like-mindedness. These communities develop their own customs and cultures and also referred to as subcultures (Plant, 2004). Social medium reddit gives these communities a platform on which they share countless of posts, often containing 'memes' that refer to inside-jokes or other internet related customs. Communities also form around individuals who aggravate a following and become popular role models.

But at the same time interactions over the internet are also seen as less personal and do not fulfill our needs for social contact in quite the same way as meeting up in person. Although digital interactions do come in various degrees, with calling being more personal than simple texting (A3.16), this doesn't distract from the fact that the integration of digital services in real-world interactions leads to less social behavior. Distracting devices disrupt conversations and the ability to look up everything with the blink of an eye can stand in the way of a healthy discussion (A3.16). Along with that, social desires also feed our addictions to information. In order to be able to join in on the 'talk of the day' we need to stay up to date with the most recent developments which sometimes means binge-watching entire series in a matter of days (Matrix, 2014). This 'Fear of missing out' also occurs when activity of others is displayed in social media, making users feel the urge to engage in similar activities.

"Sometimes I feel bad when I visit them <the kids> and they only look at their screens"
- Taylor

Comfortable living

One more value represented by digital products and services is that of comfort. SMART devices and other forms computing, automation and optimization all cater to ease of use and a higher standard of living. Tasks that would normally require effort from the user are now seamlessly integrated in interactions which offers a lot practicality. For many, the internet therefore also symbolises practicality and usability (A3.28). The higher quality of life that it enables has become a new standard and is difficult to let go off. High speed internet is seen as a requirement and it should never be limited, even if that means paying a little extra (A3.30).

"There just needs to be enough <...> otherwise I'll just get a bigger plan"
- Alex

Another way the internet provides us with comfort is by offering a range of services that help to unwind and relax. Especially audio-visual media seem to fulfill this need as watching series or listening to music is a great way to switch off at the end of the day (A3.37).

"It can be nice to switch the your mind off, but not too often"
- Logan

CONTEXT FACTORS

- Humans are hard wired to learn seek out new information in order for them to adapt and survive
- Instant gratification of quick accessible content gives people a dopamine rush that makes them happy for a short moment
- Continuous streams of information are addictive and it's hard to stop
- Dopamine rush of digital service use does not lead to longer-lasting happiness and stands in the way of meaningful activities
- Clickbait articles grab your interest by tricking you that there is more to them than there really is
- The relative anonymity of the internet allows people to seek out 'guilty pleasures'
- Many tech savvy people crave technological advancements, new gadgets and gimmicks

- Access to unlimited sources of information opens up your world to many new things
- The internet has connected us with people all over the world allowing for communities and families to stretch beyond borders

- Humans are social animals and long for interaction with others
- Through digital apps it's easier to get in touch with people you affiliate with no matter the distance or other boundaries
- People form attachments to personal data containing memories making it difficult to remove them
- Groups of people get together on the internet and establish digital communities with their own customs and cultures
- By connecting many the internet allows people to create a following of people that admire or respect them
- Digital services lack qualities of real humans and can stand in the way of meaningful interactions
- We want to belong to social groups and be able to join in on 'the talk of the day' so we need to stay up to date

- Bombarding the brain with information can have numbing effect that is desirable
- SMART systems give you more control to exercise your preferences/values in your living situation
- Computing/automation decreases the amount of effort required from the user and allows things to happen 'seamlessly', without even being noticed
- Updating and other data handling happens in the background unbeknownst to the user
- (Like water,) Internet is an essential resource and should not be limited

PAINS

Declining health

However the desire to unwind is not all about relaxation. By binge-watching series people also try to escape from the real world where they face stress and feelings of unhappiness (Potts & Sanchez, 2009). Fully immersing in the different worlds that are created by directors and actors serves as a moment to get away from it all. But bombarding our brains with more stimuli when we actually seek rest does not actually help our cause. The internet keeps us entertained and engaged 24/7 but what we actually need is some time doing nothing. Being bored every once in a while is considered a very healthy practice as this truly helps our minds to reset (Rensselaer Polytechnic Institute, 2020).

And whilst our mind moves around different worlds our body does not. The versatility and freedom of the internet is not reflected in the devices that run it causing various health issues. 'Whatsapp-finger' and 'mouse arm' (RSI) are just a few of the long list of internet related complications that arise from constantly using devices and their peripherals (Steijaert, 2018). Digital well-being apps and other interventions already try to raise awareness about the complications that arise from the excessive use of digital applications and advocate a moderation in usage. At the same time, parents are now setting fixed amounts of screen time for their children to do the same (Ouders van nu, n.d.). The goals of these interventions go hand in hand with a more sustainable use of the internet.

Information abundance

Combining addictive stimuli, an endless stream of information, great accessibility and high ease of use it becomes clear why consumption is skyrocketing so quickly. Add to that subscriptions to internet that offer limitless transfer and the incentive to use more only increases (A3.3). This so called rebound effect explains why new technologies that are more efficient by design can sometimes nullify any gains with increased usage (Coulombel et al., 2019; Walnum & Andrae, 2016). In the case of the internet this is abundantly clear. Great amounts of storage space on cloud servers make for less selective photographing and sending emails or pictures with the press of a button leads to inboxes being filled to the brim (A3.19). Viewers are subscribed to more streaming services than they realise and when they do watch its often because they are bored rather than explicitly choosing to watch a series (A3.36). Together with 'watching' a series younger audiences will almost certainly also be engaged in other activities on their phone as multitasking several digital applications at once is common practice (Dreier, 2017). A final example emphasizing the extent to which this rebound effect encourages consumption concerns the existence of 'dark data'. Dark data is all data stored on cloud servers by organizations and is not being used or analysed. Estimates of how much of our total data stack is considered dark range from a staggering 54% to a mind-blowing 99.5% (Corbett, 2018).

"Cloud storage is like water from the tap, it's always nice to have" – Cameron

Stored data used vs. stored data 'dark' (worst-case scenario)

But as has become clear from previous examples, people are not made to deal with these amounts of information. Too many incoming messages make it impossible to reply to everyone which can be frustrating and lead to feelings of anxiety and stress (A3.19). Along with that, the abundance of different types of information we take in also causes our attention spans to decrease (Technical University of Denmark, 2019). "A wealth of information creates a poverty of attention and a need to allocate that attention efficiently among the overabundance of information sources that might consume it" (Corbett, 2018). We keep seeking new information at an increasingly fast rate and find it difficult to deal with moments where the supply stops. To fill this void, audio-visual content has earned an almost permanent presence in our lives, playing in the background keeping us company (A3.22). More responsible and deliberate usage could do wonders for both environment and people.

"Sometimes everything that I receive drives me crazy, it's like a panic attack"
– Nicky

Digital dangers

The openness and freedom of the internet also attracts people with bad intentions. Scammers are on the lookout for digitally illiterate people who form an easy prey. They are mainly on the hunt to steal money but with information becoming an increasingly valuable resource data about users also becomes a target. This has not gone unnoticed by companies who also try to collect data from their users in order for it to be sold or used in other lucrative endeavours. Prime example is the scandal around Cambridge Analytica, where user data from Facebook was used without consent to feed political campaigns (The New York Times, n.d.). The vulnerability of personal information on the web has become a serious concern for its users as their feeling of privacy could be undermined (A3.21). This endangers inherent feelings of autonomy and self-actualization, the idea that you are in charge of your own person (Nagle, 2020). For some users this concern is large enough to adjust their behaviour and make use of different browsers or regularly delete tracked user data (A3.21).

“I think they know in Peking when I leave the house” <when using Chinese devices>
– Alex

Dangers also lie within other internet users. People not only seek out guilty pleasures for themselves, they also behave themselves in immoral ways towards others or create malicious content. Children cyberbully each other online, so called ‘trolls’ intentionally seek out fights with people to cause hate and in the dark places of the web things happen that due not stand the light of day (A3.29). Early 2022, former moderators of TikTok, the safeguards filtering out ‘bad’ content before it goes public, sued their previous employer for the horrible things they had to watch claiming it had left severe psychological trauma (DeGeurin, 2022). As another article rightly points out, the way we behave online has similarities with that of prehistoric hunter-gatherers only for them to be the more civilised of the two (Vince, 2018). There is an apparent need for social norms online and institutions that regulate them. Breaking the virtual barrier and reminding users that real people with real emotions are on the receiving end of abusive content can already work magic (Vince, 2018).

Technology and design also play their part in this process. Against the contrary belief that digital systems are logical and therefore objective, they are far from impartial. Just like how consumers are being spoon-fed information by AI systems, humans train AI models feeding them information. If this information is biased than so is the model and this can lead to programs actively discriminating groups of people (Bender et al., 2021). Apart from that, technology and design can also play an important role in spreading and mitigating false information or ‘fake news’. By using technology like deepfake, trolls can make fake information look incredibly convincing (Vaccari & Chadwick, 2020). At the same time, better verification of sources by digital services can help user to separate fake from real (A3.8). Together with data consumption, online behaviour calls for more regulation and a form of digital civilization.

KPN VALUES

The values that KPN upholds are generally well represented in the findings of this research specified to data consumption. One important value however, that of sustainability, was not mentioned by the participants and is also rarely touched upon by literature. This does not mean however that this value is not present in KPN customers and internet users. On the contrary, a large majority of KPN’s customers care about the environment and want the company to take action (kpn, 2021). From the interviews performed in this study however, it becomes clear that currently sustainability is not being linked with internet usage or data consumption. This is further substantiated by the fact that another majority of KPN customers does not actually know how sustainable their provider really is (kpn, 2021). Some awareness does exist on the usage of devices and the consumed electricity. This also caused some consumers to change their behaviour to a certain extent and they indicated to be willing to do more.

CONTEXT FACTORS

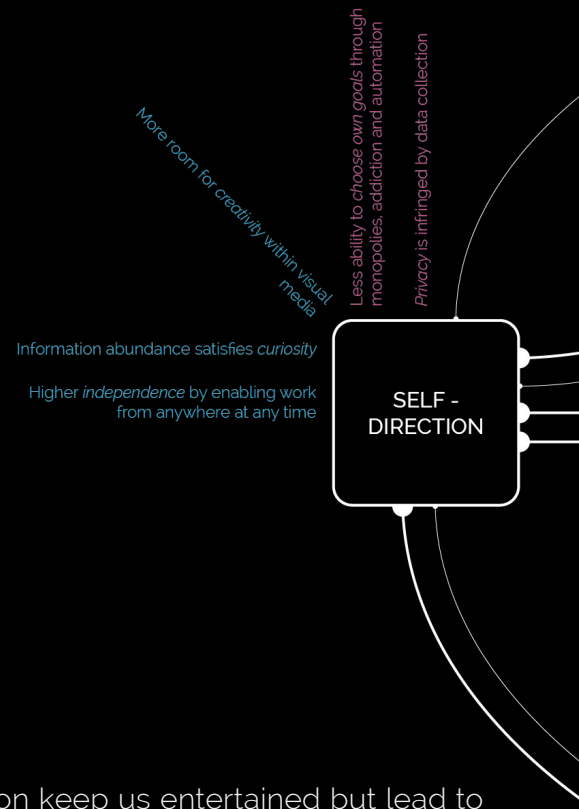
- High stress levels result in an increasing desire to unwind and 'escape' from the real world
- Lack of variation in the movements we perform due to using similar digital interfaces leads to a growing amount of complications
- Being bored and doing nothing is good for your mental health and development
- Parents are concerned about the amount of screen time their children should have as they believe it is bad for their development

- Unlimited fixed wire internet becomes the standard, increasing the incentive to use more
- When we use resources more efficiently we also use them more extensively keeping it in balance (rebound effect)
- There is a limit to the amount of information we can digest
- The attention span of humans is decreasing due to the information age
- 99% of young adults multitask while streaming and use multiple digital services at once
- People have difficulty dealing with a void of stimuli

- Digitally illiterate people are vulnerable to online scammers
- Personal information has become a valuable resource to big tech companies and criminals
- People have an in-born need to keep certain information private as it underlies autonomy and self-actualization
- There are no social norms or rules on the internet resulting in misbehaviour of people (trolling/'toxic' behaviour)
- Social media do not show the consequences of abusive behaviour
- Machine learning programs can discriminate if allowed to operate without intervention of humans
- With more fake information being spread it becomes hard to verify information as true or false

VALUES AND CONFLICTS

The pains and gains discussed contain various values which all have interrelations. To visualise these values they are categorised using the theory on values developed by Schwartz (Schwartz, 2012) and put into an overview. This overview also contains 2 types of relationships between the value categories indicated by the different lines. Thin lines with arrows embody one-way effects where one value endangers another and thick lines represent two-way dependencies where two values are in a direct conflict with each other. Figure 7 provides an overview of all the values and the connections. The value conflicts that the figure refers to are listed below.



Self-direction

a. Collecting personal information can give us insurance but also infringes other's privacy
b. We want dopamine to stay happy without becoming dependent on the services that provide it
c. Automation requires less effort but makes choices for us decreasing self-direction
d. We want to satisfy our curiosity but not give in to perverse pleasure seeking

Hedonism

e. In a search for dopamine and happiness we us lose our ability to discipline our own behaviour
f. Instant gratification does not amount to longer lasting wellbeing
g. Automation and IoT applications heighten comfort but decrease physical movement and therefore physical health
h. Pleasure that is easily attained through digital services does not lead to meaningful activities
i. Digital applications that grab attention by fulfilling desires for pleasure do not make the world more beautiful

Security

j. In an effort to become successful we work overtime which negatively impact our health
k. Continuous streams of information keep us entertained but lead to restlessness and stress

Stimulation

l. Information technologies make us more capable but overloads of information slow us down
m. Variety of content is exciting but leads to a lack of focus on things that really matter

n. Social media fulfil our desire for social recognition but can stand in the way of building deeper relationships

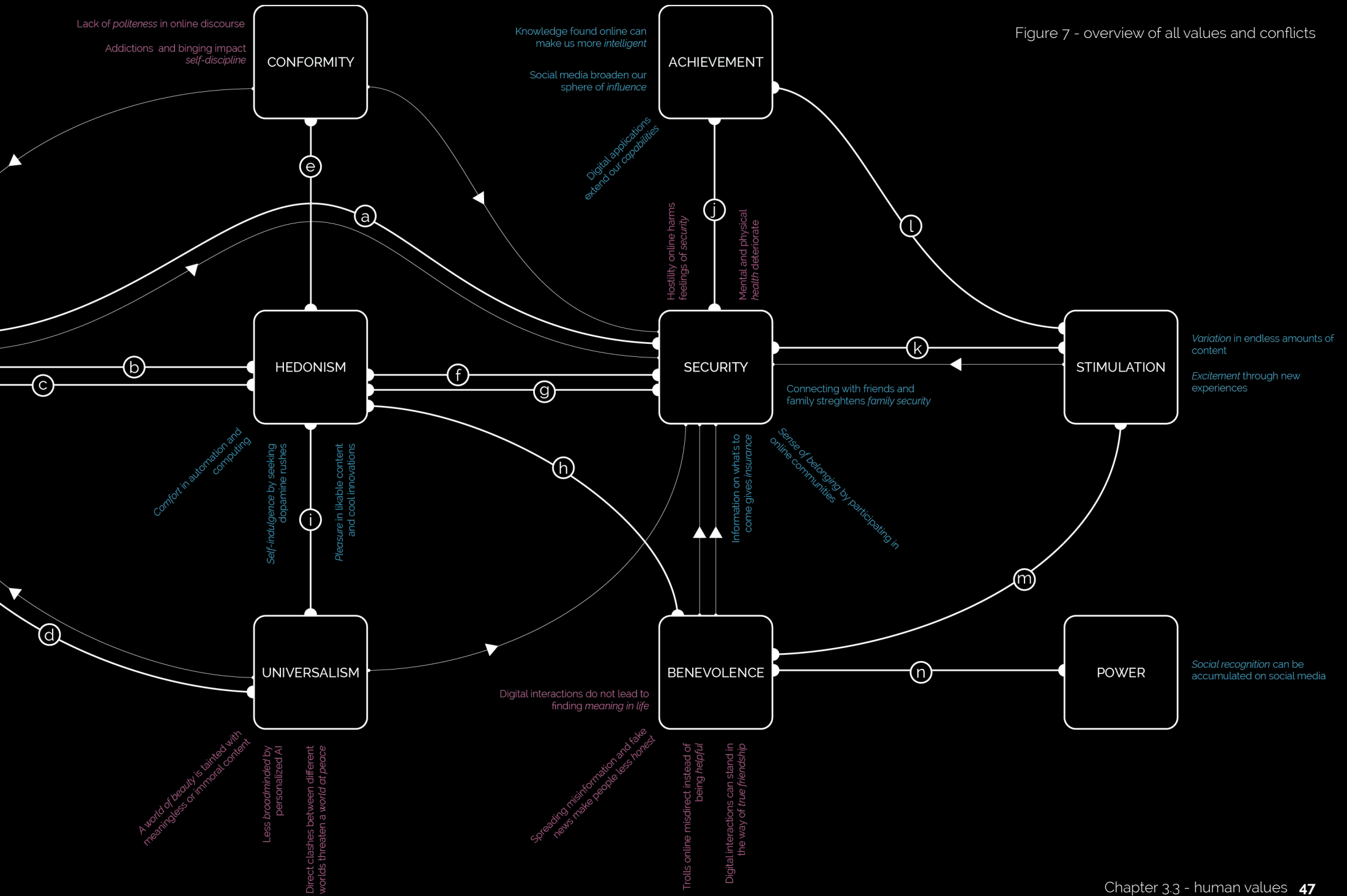


Figure 7 - overview of all values and conflicts

Ch. 04
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DATA CONSUMPTION IN SOCIETY

In this final chapter of the research phase all developments and findings are approached from a broader perspective in order to see how they influence environmental impact by data consumption on a more systemic level. To identify these broader contexts, previous findings are further researched in literature and additional findings from the user study are introduced. As this chapter concludes the research phase it also contains a discussion of the validity of the study.

4.1 SYSTEMIC VIEWS

THE ENERGY TRANSITION

Looking at the impact data consumption has on the environment, it becomes clear that the biggest impact is caused by the vast demands for electricity. Electricity is still mostly sourced through fossil energy sources which causes GHG-emissions. An obvious solution to the problem is to increase the amount sustainably produced electricity that is used to power all ICT infrastructure and end user devices. This approach to minimalizing climate impact is widely adopted by big tech companies like Google, Meta and also KPN (Google LLC, n.d.-b; Meta, n.d.). But whilst this helps to lower emissions from this sector and incentivises the construction of renewable power sites the pressure on our energy infrastructure keeps rising.

To enable all sectors to reduce their carbon output it is necessary to approach the problem from a systemic view. After all, energy used by one sector cannot be used by another and there is only so much renewable energy available, even if this number is rising. The energy will need to be divided centrally and various industries must work together. The Dutch government is therefore making plans to distribute data centres across the Netherlands in the most efficient way possible, making sure that their impact remains to a minimum and goes hand in hand with neighbouring industries or households (R.E.O.S, 2019). But more can be done, for many years already suppliers of energy operate night tariffs to incentivise the use of electricity outside of peak times to avoid congestion. As data infrastructure works in a similar fashion they could too use this 'peak shaving' method to lower network infrastructure requirements (Costenaro & Duer, 2012).

ATTITUDES

As became clear in the previous chapter, sustainability is not linked to the internet by the general public. When they think of requirements for their connectivity they show a general lack of interest, it just needs to be fast and plentiful (kpn, n.d.). This ignorance also stretches out to politics as there are little to no rules for ICT products and services, especially when it comes to their energy demands. Prime example is the exemption made for SMART devices in energy labelling. Almost all in-home appliances are rated by their power efficiency but computers, phones and peripherals are nowhere to be found (Milieu centraal, n.d.). This is not because their energy demands are negligible though, on the contrary; a recent study showed that the efficiency between TV set-top-boxes of competing providers differed by a factor of 10 which could amount to 262 kWh per year. Households could save up to 145 euros a year just by switching provider but for years no one seemed to notice (Radar, 2022).

What feeds this apathetic attitude is the fact that the internet is very intangible. Infrastructure runs under the ground or at the bottom of the sea and most people would not be able to recognise a data centre when they see it. The bits that do enter our houses like routers are often placed in closets and nooks keeping them far out of sight. What we do see of the internet are depictions in sci-fi movies where it is presented as a different universe (A3.4). The digital world is shown as a virtual world with infinite space dominated by logic which is represented in its geometric shapes. But from the research in this study it has become clear that it is neither of those things and that this attitude can have a negative influence on how we behave.

"I was never told to worry about my internet usage"
- Blake

Sci-fi movie TRON, source: https://www.looper.com/194749/the-untold-truth-of-tron/

A Wi-Fi router photohraphed during the user study

PRODUCTIVE SOCIETY

That the internet is seen as a different universe might also explain why so many try to 'escape' to this world when they are stressed and seek comfort. The 'real' world has become hectic and busy as our societies are more productive than ever. We can work from anywhere using our portable devices and connection to the internet which results in late nights working. In this performance culture employees can feel pressured to work these extra hours and gives them less time to do other meaningful activities. With time being scarce, we try to optimise our activities as much as possible with information technologies. Resulting is a wave of burnouts and psychological issues (Pfauth et al., 2016) partly facilitated by digitalization.

DIGITAL DETERMINISM

A last development on a societal level concerns the rigidity of the whole system. DSPs have not just formed monopolies but the internet has become an unmissable part of our lives. It provides value to us in a way that nothing else can and in many cases alternatives have even disappeared (A3.1). Internet infrastructure even underlies so many of our daily activities that a quarter of the GDP of the Netherlands relies on it (R.E.O.S, 2019). But what is most surprising about this is the fact that digital products and services are so easily accepted and welcomed into people's lives. Even when we learn about the downsides like addiction and compromised privacy they are regarded as a 'fact of life' (A3.21 & A3.33). The way forward for society is digital, no questions asked. The way we consume is therefore not something we control but rather a given which could stand in the way of realizing any changes in behaviour.

"We shouldn't be so gullible to think there's any privacy left"
- Alex

CONTEXT FACTORS

- There is a finite amount of energy available on earth that can be shared between customers

- 45% of KPN customers does not know how fast their internet is as they simple want it to be fast enough
- There are no energy labels for IoT devices
- The ecological impact of ICT takes place far out of sight of the user
- There is no 'normal' for internet use, so people cannot compare their behaviour to others
- As portrayed in movies and language, the internet is seen as a virtual place, another universe somewhere other than on earth
- We don't see the internet as something unsustainable

- In the performance culture we always challenge ourselves and continue to work far beyond office hours as we can easily performs our tasks form home
- Time has become one of our most valued resources
- Data tracking in digital services and applications quantifies values in order for them to be optimised
- Despite rises in productivity we still work more hours every year

- 25% of the GDP in the Netherlands is reliant on ICT infrastructure
- There is no alternative for internet in many use cases
- Some people have accepted that they can be tracked everywhere in the internet

4.2 DISCUSSION

Findings of this study need also to be put in perspective by the limitations of the study itself. In this research phase of the project practices around consumption of data have been studied and analyzed. The duration of this research phase was approximately 2,5 months meaning that the scope had to be limited in order to make it manageable. In reality, more practices around data exist and if analyzed could lead to additional findings or bring more nuance to the statements made. The findings are therefore not definitive but rather give a glimpse of how data is consumed in order to serve as input for design explorations.

A second point of discussion regards the size of the impact of data consumption. As already mentioned it is very difficult to separate data streams and assign weight to individual contributors. This also holds for individual services and the service categories discussed in Chapter 3.1 which is why a personal inquiry was set up. It is important to note that these findings are based on one user only and should be verified on a much larger scale. In this study they mainly serve as an indication and means to explain how services impact data consumption. Numbers about energy usage of the total network are also subject to uncertainties and findings vary from study to study. Apart from that the impact has now been determined by focusing on the ICT sector itself but the use of digital products also replaces other activities. To get a better understanding of how much extra impact ICT has on the environment it also needs to be compared to the services it replaces. For example, the impact of all email could be compared to regular mail whilst also weighing in rebound effects caused by this disruptive technology. Studies like these are hard to find however and it is difficult to precisely measure rebound effects in a society that's constantly changing. The goal of this project however is not to evaluate digital services compared to others but rather to investigate how they could be used more responsibly.

Finally, the user study that was conducted with some of KPN's customers also holds some biases. Participants were recruited in KPN's up to data panel and supplemented with familiars of the researcher. This resulted in the majority of the participants to be both highly educated and interested in data technology. This position could have allowed them to contribute more during the interviews but also limits the amount of perspectives that was gathered. At the same time, the fact that participants were well informed could have made them more resilient to the identified problems caused by data consumption. The findings are therefore closer to a 'best-case-scenario' and aggravate when less informed consumers are interviewed.
Apart from that the second group could have been more inclined to give answers that they thought were in line with expected findings to 'help' the researcher. Two more contextual factors also could have influenced the participants. At the time of the study a lot of propaganda was spread by the 2022 Russian-Ukraine war which got a lot of media attention. This might have heightened concerns about misinformation. The final factor concerns the general opinion on information technology, which is becoming more negative around the time of the study. Many news articles warn about the dangers of overconsuming apps like TikTok and participants could have voiced concerns more strongly too comply with the general opinion.

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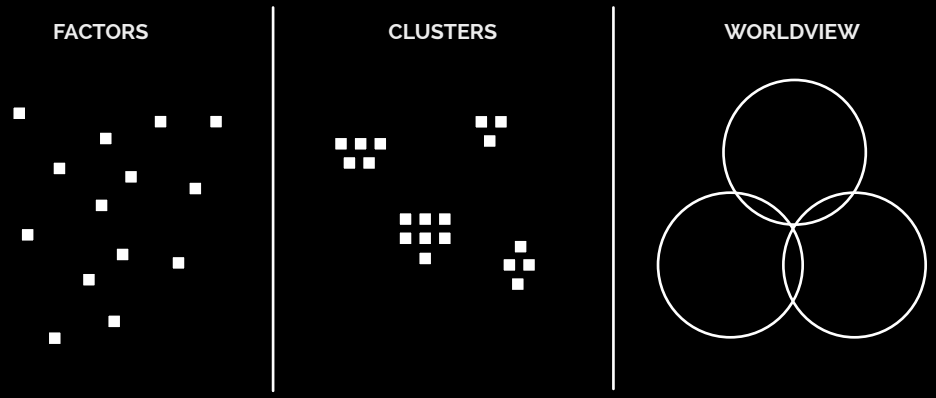
PROJECT DIRECTION

In this chapter the findings from the various activities in the research phase are combined to develop a broad understanding of the project domain. From this understanding will follow a vision that embodies the desired change that is needed. This vision is worked out in concrete design directions that can be explored in the next phase of the project.

WORLDVIEW

At the end of every chapter the research findings were summarised in the context factor pages. The context factors touch upon many different disciplines and have as aim to create a comprehensive understanding of the entire context around the consumption of data. In order to do this, they are first bundled in clusters that cover important topics or drivers within the current situation. Together, the clusters are be combined into the worldview that is a depiction of this situation from the viewpoint of the researcher.

The worldview created within this project calls for a new form of digital civilization. In the current situation, the internet is considered a lawless place, a free and limitless playground with little norms, morals, ethics or individual responsibility. This situation is not sustainable in the broadest sense of the word as it puts both humans and the environment under a huge amount of stress. Core to this line of thinking are the values related to internet use that we wish to uphold but are currently in conflict with the way we behave online. Within the worldview three pillars are identified around the¬se value conflicts, that when designed for will also contribute to more sustainable online interactions for both planet and people. An Illustration containing these three 'value synergies' is represented in figure 8. Within the pillars the corresponding clusters are also listed, all clusters and their individual factors can be found in appendix 4.



From factors to worldview following the ViP process

I Norms & regulation

This pillar concerns the lack of social norms and regulation on the internet. Perverse pleasure seeking, deceptive technologies and social misbehaviour threaten the individual on the web. Whilst the internet promises more social interactions it actually leads to a lack of meaning and immoral practices. Introduction of new norms and rules could lead to more responsible and meaningful interactions including interactions that value sustainability.

II Moderation & modesty

The second pillar tackles the superfluous consumption of the internet. Constant distractions and the acceleration at which we increase productivity lead to an overload of information that humans are not capable of handling. This decadent and greedy way of using digital resources puts enormous pressure on our own health and we are reaching our biological limits. By moderating use we can alleviate the pressure we put on ourselves and the environment.

III Active involvement

The third and final pillar comes forth from the ignorant attitude that people now have towards the internet. The lack of physicality of data infrastructure combined with a generally apathetic mindset makes us extra vulnerable to big tech companies and their expansionist business models. The internet is a free and open space for everyone that can facilitate sustainable practices and we should get actively involved to preserve that.

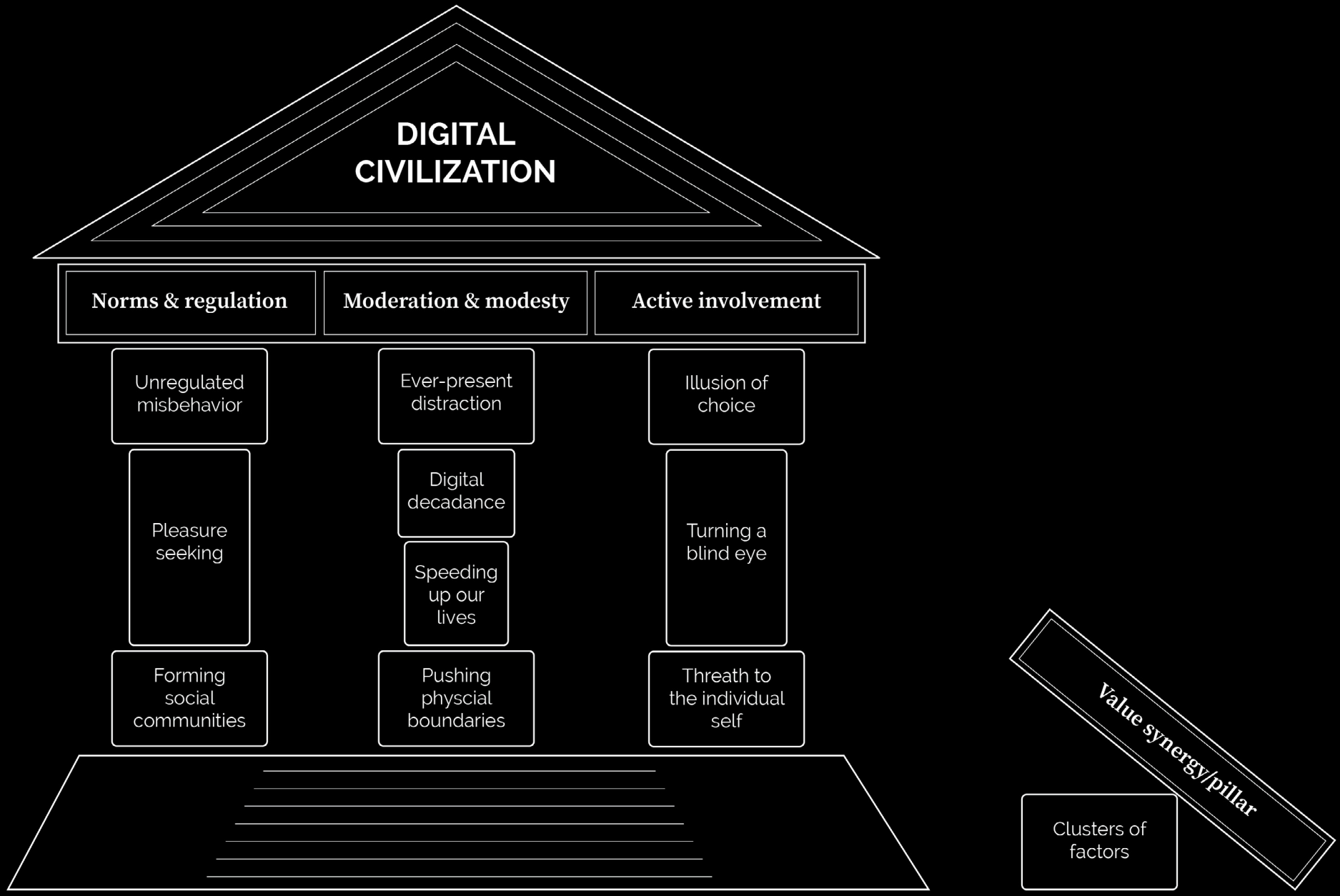


Figure 8 - worldview with three pillars consisting of the clusters

STATEMENT

Based on the newly created worldview a direction can be formed for the creation of design interventions. This direction is formulated in the form of a statement that explains the desired effect, the desired behavioural change and introduces an appropriate way to make it happen. Already concluded in the worldview is the observation that behaviour on the internet is somewhat uncivilised and this could improve by intervening along the three 'pillars'. The third pillar about active involvement however can be seen as prerequisite of the other two. To give shape to rules, new forms of regulation or any type of moderation of our behaviour we firstly have to be able to talk about the topic of data consumption and discuss as a civilization what action is necessary. The focus for the remainder of this project will therefore lie on making the consumption of data more tangible and understandable in a way that facilitates this discussion and conversation. The completed statement then becomes:

"To reduce the burden on people and environment caused by data consumption I want KPN customers to use the internet in a more civilised manner by making their usage explicit in a social context"

VISION

In the upcoming phase this statement will manifest itself in various ideas and concepts. To make sure these ideas are in line with the statement and approach the desired behavioural change in an appropriate manner, a design vision is formulated. This vision contains a metaphor for the wanted interaction from which certain quality criteria can be derived. The metaphor for a more civilised interaction with digital products and services concerns the layout of a specific piece of Dutch urban form giving; the so-called woonerf. These liveable streets connect neighbourhoods by creating safe spaces for children to play and adults to get together. All traffic traveling to or from these streets are considered 'guests' and should behave accordingly, resulting in civilised traffic flows. Daredevils and speed demons are tamed through a strong social construct and clever design. When applied to the context of data consumption a similar approach could lead to more responsible usage. Coming forth from this metaphor are four interaction qualities that should be touched upon by the designed intervention.

Controlled

When driving though a woonerf, drivers are always made sufficiently aware of the fact that they are entering a shared space. A sense of urgency is installed into the drivers mind by making clear what hazards they might face such as playing children and what potential consequences dangerous driving could have. Drivers going though one of these streets will be more alert and in control of their vehicle through a heightened awareness. In a similar sense, internet users might be alerted about the pains of overconsuming data.

Deliberate

Next to road signs, the woonerf contains various other cues that try to motivate drivers to act more responsibly. The entire design of the streets is centred around this principle along with creating an area that is suitable for other activities than transportation. There is a clear sense of purpose to all actions undertaken in these areas and the artefacts that are placed within. This feeling of purpose is currently missing from digital interactions, leaving a void after each and every use.

source: https://mensenstraat.nl/inspiratie/woonerven/

Inconvenient

In the perception of the driver, the crooked and narrow streets can be quite difficult to manoeuvre and a bit of a pain. This designed inconvenience is exactly what makes these streets such a success. Uncomfortable pavement and speed bumps discourage fast driving and make traveling from point a to b slower yet safer. It raises the question whether 'digital speed bumps' could also make the digital world a better space, given that this benefit is clearly communicated. For the inhabitants of the woonerf, the inconvenience is a small price to pay for the reward they get in return: a safe neighbourhood.

Communal

Perhaps the most important aspect to this metaphor is the fact that most traffic passing through either lives in or visits the neighbourhood itself. Drivers therefore share in the benefits of their own behaviour and see them materialise in their own vicinity. Because these benefits are shared and the behaviour takes place in a public space, it also opens up the possibility for debate. A debate that is clearly lacking when it comes to the intangible interactions that occur online. When one of the inhabitants behaves in a way harmful to others or themselves they might be corrected by the caring community that surrounds them. In order to care for others online, we need to open up about our data consumption.


source: https://www.youtube.com/watch?v=bSBdshn2tUM&ab_channel=Streetfilms

source: https://vvn.nl/actie/vvn-stickeractie


Experia Box v10
myKPN
Dashboard
My devices
My usage
My family
My TV
My Data Diet
Limits | Tips | Info
Digital Services
Set limit
Instagram
Time limit:
Share savings
post
Tips to help saving data
KPN Offers
KPN Magazine
1 Month Disney+
WiFi Repeater
My Family
Henkie
Roos
Coins
2.5Gb
Monthly
Weekly
Daily
Limit Reached
Returning Gbs for discount
Network Traffic
Phone
Laptop
TV
IoT
Mathijs
Henk
Roos
5.4Gb
11.5Gb
Power
Eco
Sleep
Average

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INTERVENTION

In this chapter the approaches and design directions emerging from the research are put into practice through the creation of possible interventions. To support this creative process, strategies for behaviour change are first analysed followed by the creation of various prototypes that manifest the statement and vision. All prototypes are briefly evaluated by their appropriateness and effectiveness to formulate a final concept at the end of the chapter.

6.1 IDEATION

DESIGNING FOR BEHAVIOUR

Mentioned already in the project outlines, there is a distinct body of literature that studies the design of behavioural changes to positively impact social benefits. The many theories discuss cognitive processes inside the brain that eventually lead to the behaviours we perform, be it consciously or unconsciously. With that comes also the study of all types of external factors influencing how and what we perceive. Next to individual behaviours that are displayed incidentally, the theories also concern behaviours that occur in patterns, so called habits. Most behaviours related to the use of digital products and services mapped in this research also fall in this category. Habits often contain behaviours that are performed with little cognitive effort and more often occur unconsciously rather than consciously. As they are so ingrained, they require more effort over a longer period of time to adjust or let go off. Bhamra et al. explain how changing these rusted patterns requires three distinct elements or stages (Bhamra et al., 2011). First, consumers need to be guided into formulating an intention to make a change in their own behaviour. Mere motivation is not enough however as consumers may face many barriers when putting their intentions into practice. In this next phase another level of interventions is needed to help consumers to maintain the desired behaviour in order to start forming habits. Repetition of these new habits is key to ensure that will eventually stick and the behaviour becomes fully integrated into daily activities. This forms the third level of intervention: control. Looking at the consumption of data, there seems be limited to no momentum on either of these levels. Consumers mostly do not intent to reduce their data intake nor are they enabled or nudged to do so by current designs. Instead, a trend can be identified in the current design of digital products and services that influences people to consume more. The interventions that do exist are not commonly used and are often insufficient. The concept resulting from the ideation process must therefore try to touch upon all these levels to start making an impact. Most important is shaping the intention in consumers to break with current habits as this can be considered to be the first step of the process.

To apply this knowledge in the ideation process, DfBC theories often formulate certain strategies. These strategies are defined across all the levels of habit formation and are proposed in various pieces of literature. To guide the creation of ideas, the strategies of three frameworks for designing sustainable interactions are combined and categorised by the levels of habit formation in figure 8 (Bhamra et al., 2011; Klaniecki et al., 2019; White et al., 2019).

Linking these strategies to the interaction qualities that come forth form the vision, six concrete design goals can be formulated:

Controlled

1. Installing awareness by educating and framing

To create the heightened sense of awareness that makes us feel in control, consumer must look at the internet in a different way. Just like new drivers taking to the streets, they must develop a basic understanding of how the paths they are traversing work. In addition to that, the risks and consequences must be brought to the attention sufficiently to make sure people can make their own considerations. Information about the workings of the internet should be understandable and framed in a way that highlight the potential dangers.

2. Making it standard

To guide consumers into changing their consumption habits the desired behaviour can be integrated into their routines. Making the desired behaviour the standard in digital products and services will pave the way for anyone who intends to change their habits.

	Core strategies	Sub-strategies
CONTROL	Default settings	
	Automated behavior	
	Sustainable by design	Changes in physical environment
	Changing systems	Legislation
HABIT	Prompting	Lowering effort/ barriers to desired behavior
	Afford & constrain	
	Incentivise & penalise	Price mechanisms Hedonic benefits
INTENTION	Choice	
	Commitment	Explicit choices Goal setting
	Feedback	Showing the impact Confront (subtly) Comminicate impact in the direct environment Show the benefits Materialise future benefits Relating to other (sustainable) behavior Cherishing desired behaviors
	Educate & Inform	Framing information (to evoke emotion) Framing of information (to comply with identity) Simplify information Verify information
	Eliciting social norms	Shaping social desirability Establishing groups / communities
	Avoiding negative connotations	Address groups differently Letting go of unsustainable sentiments

figure 8 - Categorization of behaviour change strategies

Deliberate

3. Committing to purposeful decisions

After making considerations on the consequences of data consumption, it is important that internet users start making more explicit choices. Motivated by a clear sense of purpose they can choose to navigate wherever they please without the risk becoming distracted and going of track. Commitments like these can be difficult to make and the concept should support users in this effort.

Inconvenient

4. Affording inconvenience

The increasing speed of data consumption can be halted by raising barriers that force people to slow down. By designing digital speed bumps the effort required to perform existing internet behaviour is raised making it less appealing. Along with that it also breaks the current habit and could lead to more conscious decisions. These digital speed bumps must be materialised in the concept.

5. Materialise the benefits

To mitigate the friction caused by inconveniences and the discomfort caused by changes in behaviour there needs to be a clear motivation. Benefits of desired behaviour have to be materialised in the direct vicinity of the consumer. By keeping the benefits close to home it will be more clear to the consumer how they themselves or people they care for might be positively affected by the change in habits. The concept must clearly communicated the benefits and their relation to the consumer.

Communal

6. Elicit a social frame of reference

Establishing social communities with shared interests can create a reference frame for people to behave in. This requires the behaviour to be public within a group of people that they consider part of their social circle. To establish this the way we consume data has to be shared in a way that allows consumers to compare it with their peers.

PAPER PROTOTYPING

Intervention areas

To explore initial ideas that can start to embody the design goals formulated, I crafted series of paper prototypes. To provide feedback all these prototypes were evaluated informally with peers and experts within the project team. To give the ideation process more focus and ensure that the resulting outcomes of this project remain relevant to KPN, two existing interactions within the project scope are selected for the intervention. As the scope is centred around in-home networks and personal data plans, the interaction with internet peripherals is chosen as a first area for intervention. More specifically, current interactions with the router, or lack thereof, will be reimagined to facilitate new features and scenarios that could decrease data consumption. From the research can be concluded that this device is currently hidden away and is only rarely interacted with, contributing to the lack of knowledge and awareness around internet practices. This interaction therefore holds interesting possibilities for making a change. The second intervention area resides within the digital offerings of KPN. Through the Mijn KPN app and KPN Home app, the ISP currently communicates with their consumers and aims to rely more on this communication in the future. By interacting with these apps users can also access information about their plans, peripherals and network. This is currently the main source of information for KPN customers about how they consume data making it an interesting opportunity for possible interventions. Along with that, the design of digital services is more flexible than that of hardware which makes implementation easier and faster. This area of intervention therefore holds larger potential for making an impact on a short term.

Prototypes

During the ideation process many ideas have been generated which were condensed into six paper prototypes in total. All prototypes will be shorty discussed by introducing their features, the design goals they aim to fulfil as well some feedback on how well they managed to do this.

1. *Power switch*

The first prototype of a series of redesigned routers is one that offers the user a choice in speed. Through turning a dial on the front the user can select between 3 modes:

- Deep sleep mode

Internet bandwidth is limited to a minimum and non-essential devices listed by the user are disconnected from the internet. This mode saves energy and lowers chances of malicious parties entering the network

- Eco mode

Internet bandwidth is lowered meaning that video's might play in lower quality and pages load more slowly. Basic functionalities remain active.

- Power mode

No restrictions, business as usual

On the bottom left LEDs display which devices are connected to the internet and above that another LED indicates the current peak on the network. If many users are stressing the network capacity the light turns from green to red.

Design goals

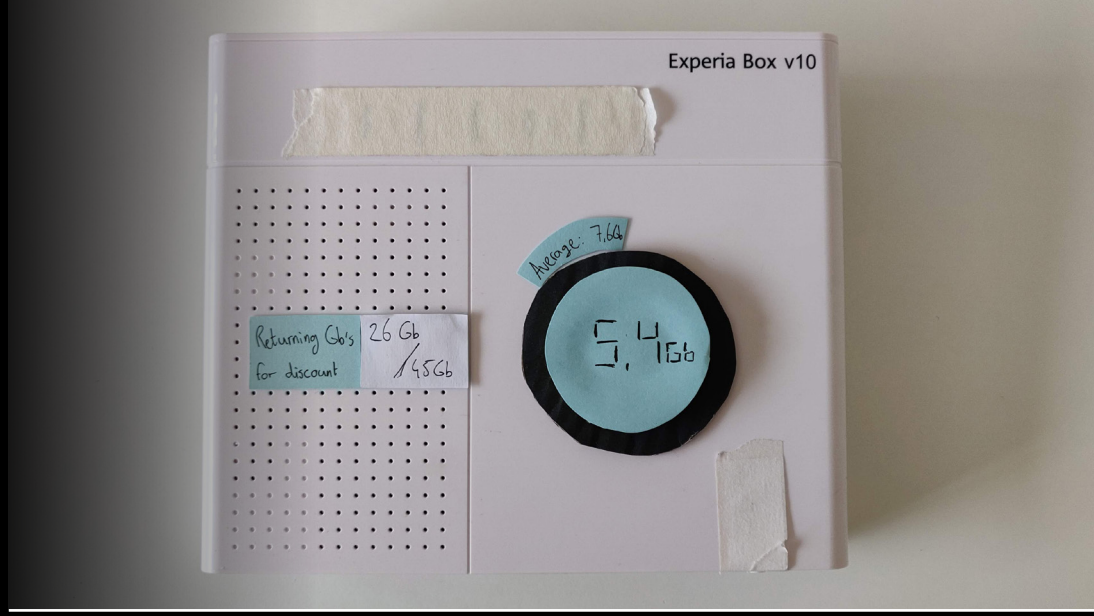
This prototype allows people to make more explicit choices and aims to raise more awareness by materializing some of the workings of the internet. Devices can be managed more actively as well as what's happening on the network. Making people aware of the total stress on the network could serve as a nudge to use less when the community needs more. Framing the modes as sustainable and secure hints to the benefits that different behaviour will have.

Evaluation

More choice and control over what devices are connected were considered a good feature and in general the prototype gives some more control. Implications of the actions are not immediately clear however and there is little incentive to not put the router on power mode and leave it there. It could be made more appealing by switching between the modes on a handheld device as no physical movement is required. This inconvenience enlarges the boundary to use less instead of promoting it. The network traffic indication was not perceived as a significant argument for lowering bandwidth as there was no way to determine whether others on the network needed it more than them.

2. *Displaying usage*

The second router design features a circular display showing the amount of data used during the day. Two versions of the prototype were tested, a meter that simply measures the amount of data and fills if more data is used and a countdown system that depletes after a certain amount of data has been set as a limit. The limits can be set with the black rotary dial surrounding the display. As additional nudges the average use is displayed above the display to influence the limit that is set and a discount on the internet plan is offered when the user remains under a certain budget. The display can show the usage expressed in both Gb and hours.



Design goals

By showing the usage on the display the prototype aims to make the user more aware of the data volumes they consume. By counting down it also plays around with inconveniences as users must go to the router repeatedly to add 'budget'. By showing an average and displaying the usage publicly the concept also tries to create a reference frame and take the subject of data consumption more into the public domain. Lastly, the prototype also speculates about possible rewards in the form of discounts to incentivise decreasing usage.

Evaluation

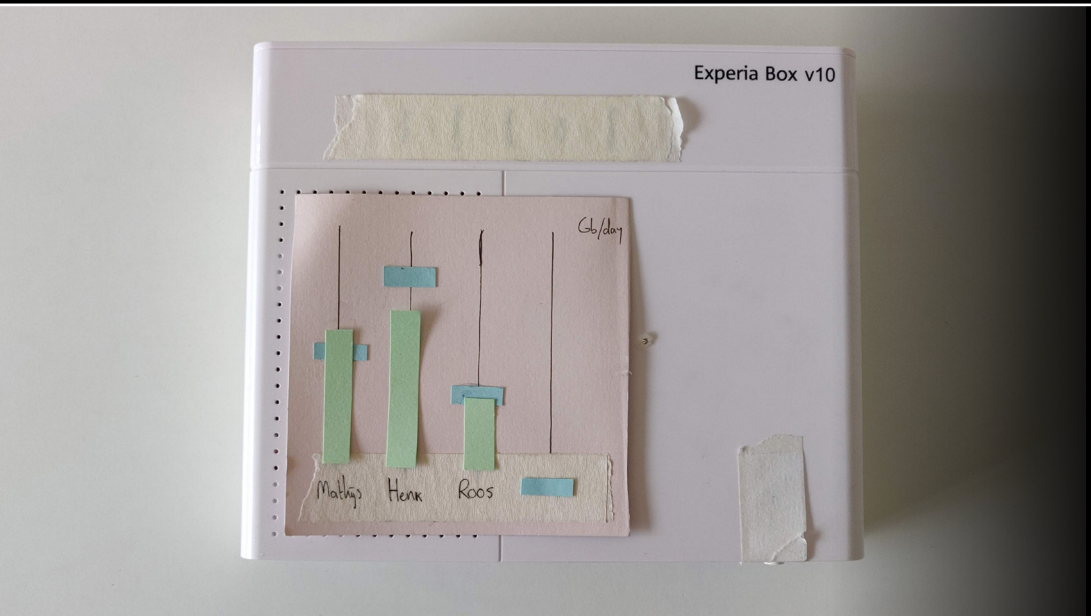
Viewing the usage on the display was considered confronting especially when displayed in hours, Gigabytes were too vague and did not really amount to anything. Like the previous prototype, setting the budget on the router was considered an inconvenience but the ability to set limits could also allow for competition and discourage data use. This is especially the case when additional incentives like the monetary reward come into play. Showing the average user was estimated to have less effect as it is impersonal and users would go higher than average to be sure they had enough. Making usage public got mixed reviews as some saw as a good way to discuss with others in the household but also indicated they would probably try to hide it when having people over for a visit.

3. *Social comparison*

The last physical prototype displays individual settings for all users centrally on the router. Every user is able to view their usage during the day (in green) and set a daily limit with the sliders.

Design goals

This prototype aims to create social comparison amongst the people in a household and in this influence them to base their decisions on the behaviour of others. Moderate consumers can then set a standard for others to also lower their data intake.



Evaluation

Comparing to others was estimated to bring an element of challenge and competition incentivizing lower data consumption. Important however is the behaviour of the person one is compared to, if their behaviour differs too heavily from that of the user it becomes irrelevant. Along with this the prototype also raised the question of who to attribute usage to if multiple people make use the same service or product.

4. *Quantified feedback*

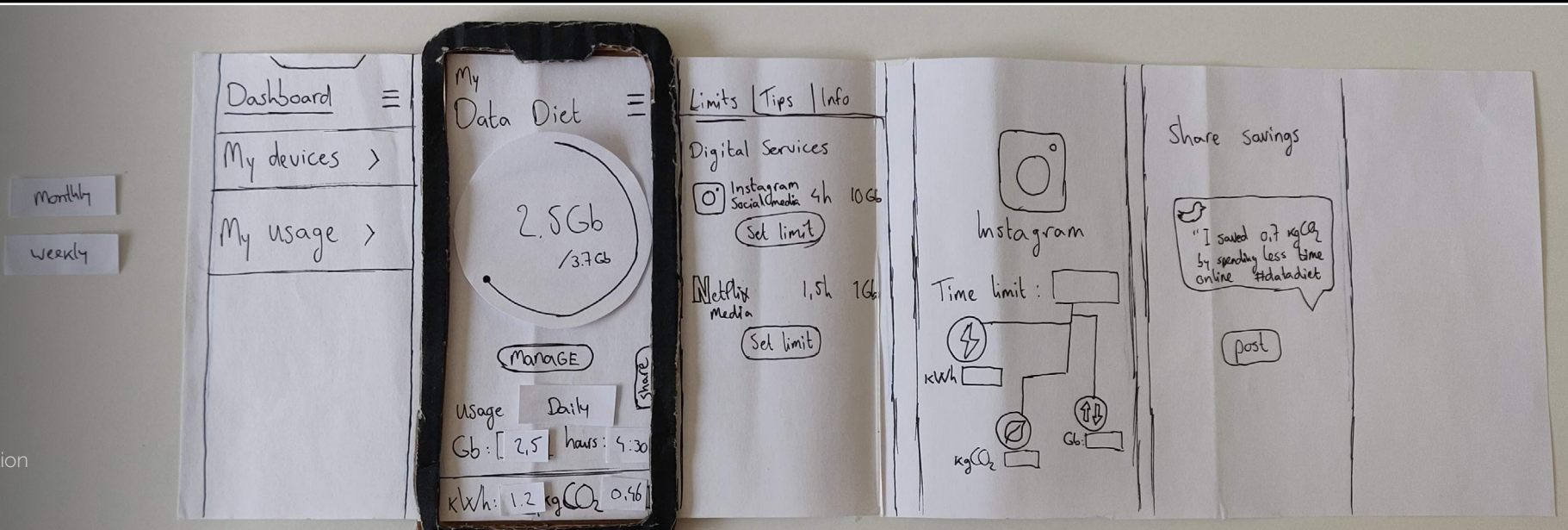
In this app KPN customers can view their usage expressed in the various parameters that it influences and set limits accordingly. Usage is expressed in hours, kWh, kgCO2 and GB and can be views per app and in total. When setting a limit for a specific app the parameters will show the potential impact of the limit on the screen. Progress towards a more general target concerning overall usage is shown on the home screen. Progress towards this goal can also be shared with friends on social media.

Design goals

The app tries to educate about the potential consequences and benefits of online behaviour. Along with that it also gives the user handles to set limits and make their intentions explicit. To add a social dimension and potential reward in the form of recognition, the realised benefits can be shared.

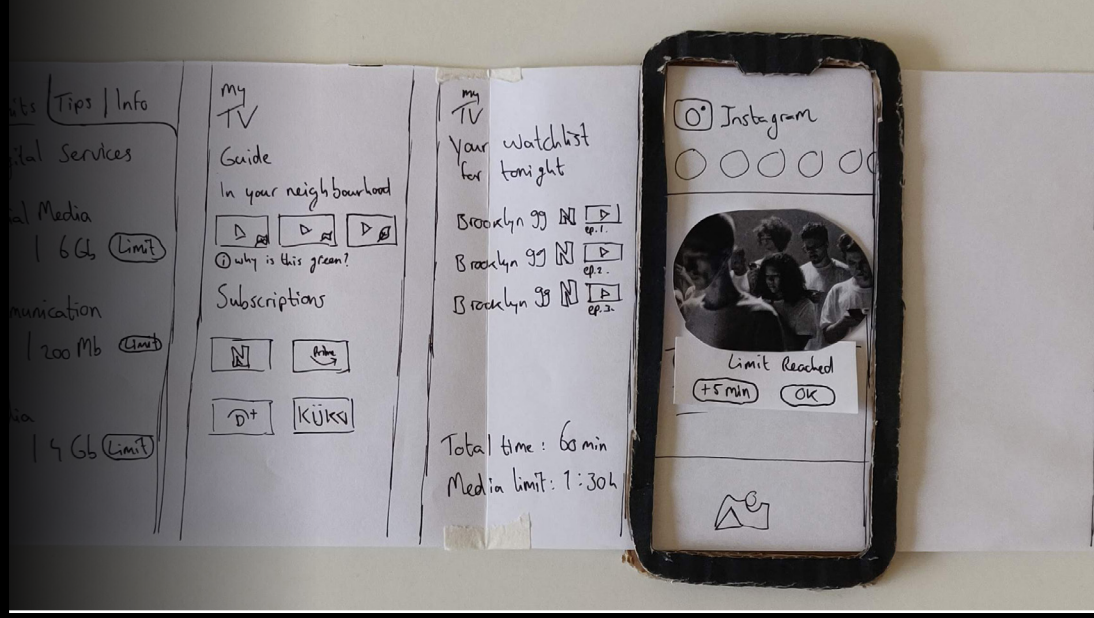
Evaluation

The parameters introduced remained vague during tests and did not make a lot of sense other than hours used. Without real comparison or other forms of concrete examples the information remains meaningless. The limits could be helpful but do not add any value compared to existing wellbeing apps installed on most smartphones. Sharing would be interesting but only in circles of likeminded peers and not publicly.



5. *Green framing*

The second app prototype frames the data usage as a data diet and takes goal setting a step further with concrete targets formulated in kgCO2. It stresses the importance of sustainability and shows a bar that balances 'eco' with 'power'. It also gives the possibility to set limits for app categories and displays a deterring message when the limit is breached in the form of pictures. A second part of the app explores the design of a TV guide for KPN's streaming offerings. Instead of listing popular shows on a national level or personalised offerings it shows what is popular in the neighbourhood and allows to stream these via more efficient peer-to-peer connections. Users can also pre-select all the episodes they wish to view that evening and see whether this fits within the limits they set out.

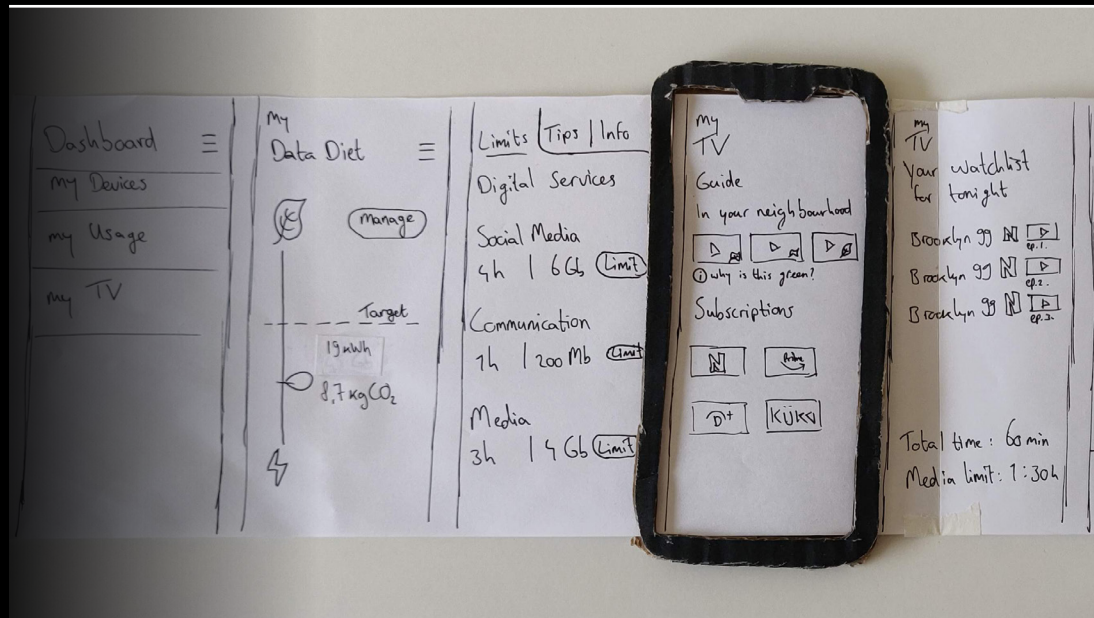


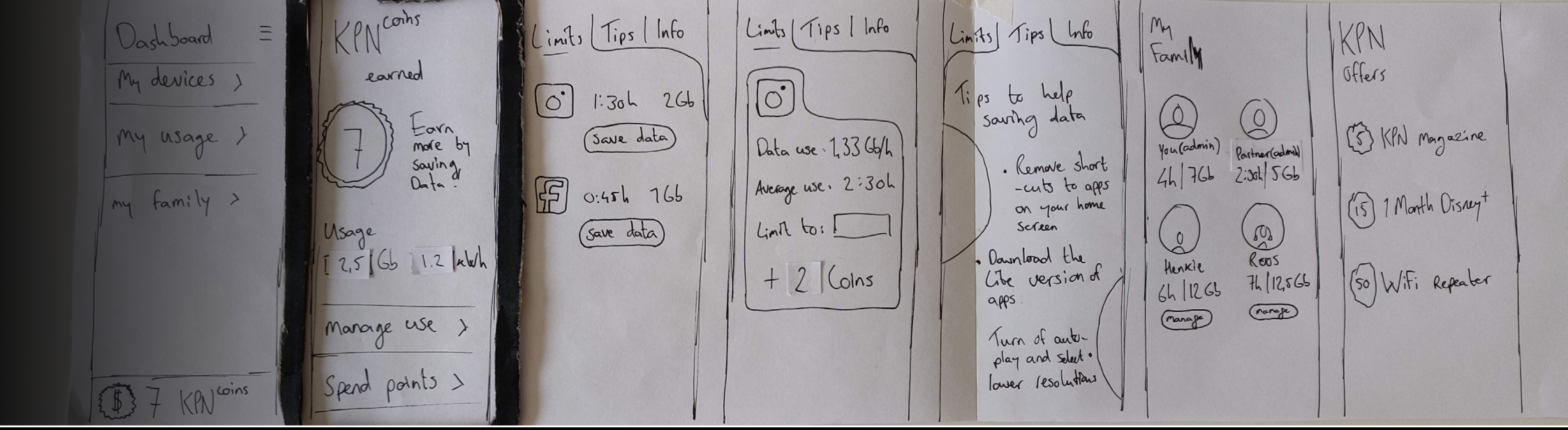
Design goals

Information is strongly framed from an environmental viewpoint and features are also centred around sustainable choices to raise awareness. By setting limits, targets and selecting media upfront the prototype also tries to guide the user to make more purposeful decisions. The deterring messages should install a sense of urgency and remind user of the consequences of their actions.

Evaluation

The sustainable branding can be seen as too pedantic, pushing users to behave more responsibly too obviously. The same was said about the deterring messages, which could work better if framed more positively. Again, the information in kgCo2 was too vague to understand. Limiting usage with app categories was not preferred over individual apps as it lacked meaningful insights into one's own use patterns. The TV guide feature was appreciated however as it provides the user with easy, sustainable suggestions.





6. *Coin system*

The final prototype introduces a coin reward system on top setting limitation for individual apps. For every Gb saved coins are awarded which can be traded in for rewards in a KPN store, such as discounted tickets to events. Together with that the app also has a 'family' tab where usage information of the entire household can be viewed and parents can set limits for their kids.

Design goals

Through gamification and rewards this prototype aims to create concrete benefits and incentivise users to limit their data usage. It also offer some social comparison by making behaviour of people in household more public.

Evaluation

The coin system was rated as a promising way to motivate users to use less internet but this is also highly dependent on the rewards that can be purchased. These rewards effectively create a trade-off between data consumption and consumption of other items which is not always beneficial to either environment or wellbeing. The family tab is recognised as a useful feature especially when the household includes kids.

Reflection on statement

As the design process is iterative rather than linear, the statement and design goals mentioned earlier in this report were developed alongside the prototyping activities. By experimenting with a variety of intentions and designs the vision for the concept could be further refined and adjusted to what is truly essential to create the desired effect. Coming forth from the prototypes and evaluations was the understanding that the topic of data consumption is still so new that a conversation about it is already a meaningful activity in itself. Encouraging this conversation by making data usage more public and concrete through comparison is one the very first steps to making a change in this domain. To stimulate a change in behaviour even further some of the features introduced by the prototypes can be realised as long as a good balance between inconvenience and benefits is upheld.

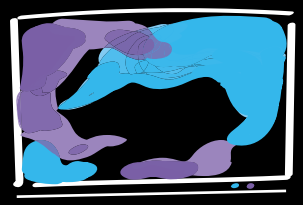
6.2 CONCEPTING

In a second round of ideation, the learnings from the prototypes are combined into a final concept that is centred around making data consumption more concrete and provoking discussion around the subject.

CONCEPT STORYBOARD

Final concept of the ideation process is a new kind of internet plan that offers customers a variable rate and allows them to regulate their behaviour using a custom router and app. KPNcare is designed around informing customers about the implications of their online behaviour by materialising the usage within a household. Though monetary and aesthetical rewards future benefits and consequences are made concrete in the present. By intervening on the level of a household these effects are made comparable and can spark conversation were user explore the implication of their own consumption. As members of a household are familiar to each other sharing information about data usage becomes less privacy sensitive and comparison are also more likely to be relevant. The concept is further detailed in the storyboard on the next pages where the functionalities of the router and app are explained. Before the user receives these they must first make the decisions to sign up.

Care app

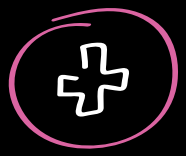


Frame of reference router

KPNcare would be one of the options when signing up for a new data plan with KPN. The plan offers various benefits for the user in terms of lifestyle that are categorised in three values; wellbeing, sustainability & online security. These values are in line with existing communication by KPN about their core values, with sustainability and online safety already part of their profile. Wellbeing is added as an additional value and can be directly linked to the social wellbeing in current communication. Through these lifestyle topics the impact of data consumption on personal values is brought to the attention of KPN's customers.

As part of a far-reaching corporate responsibility campaign this information is incorporated in the communication of KPN on their website and not only linked to the new plan. KPN will take up a leading role in spreading awareness about the dangers of data consumption and start a dialogue with their customer base on how they can improve, together. Information about the lifestyle topics is also available when viewing the plan so consumers can read up on all the benefits that the plan has to offer.

Besides this the new plan also propagates a new type of membership where using less is preferred over using intensively, contradictory to current communication and the movement towards limitless. Customers can rest assured that they stay connected through KPN's advanced network but a more moderate way of consuming is encouraged. The plan rewards moderate use by offering discounts on monthly fares when less GB is used, similar to how energy contracts are structured.



Wellbeing

Environment

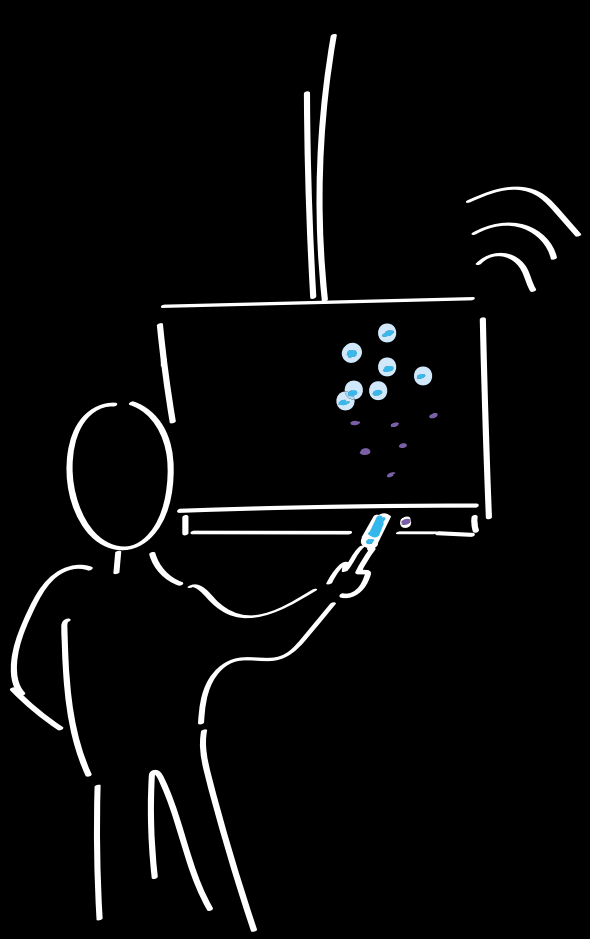
Security

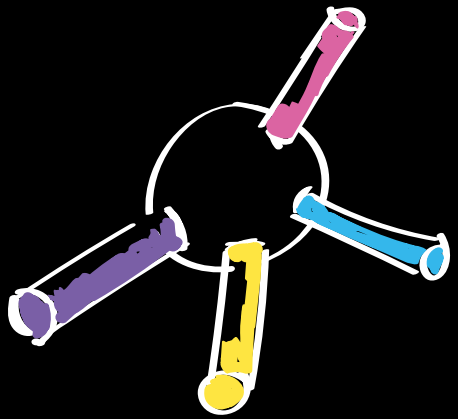
- Always connected
- Control your online behavior
- Fast only when it needs to be
- Only pay for what you use

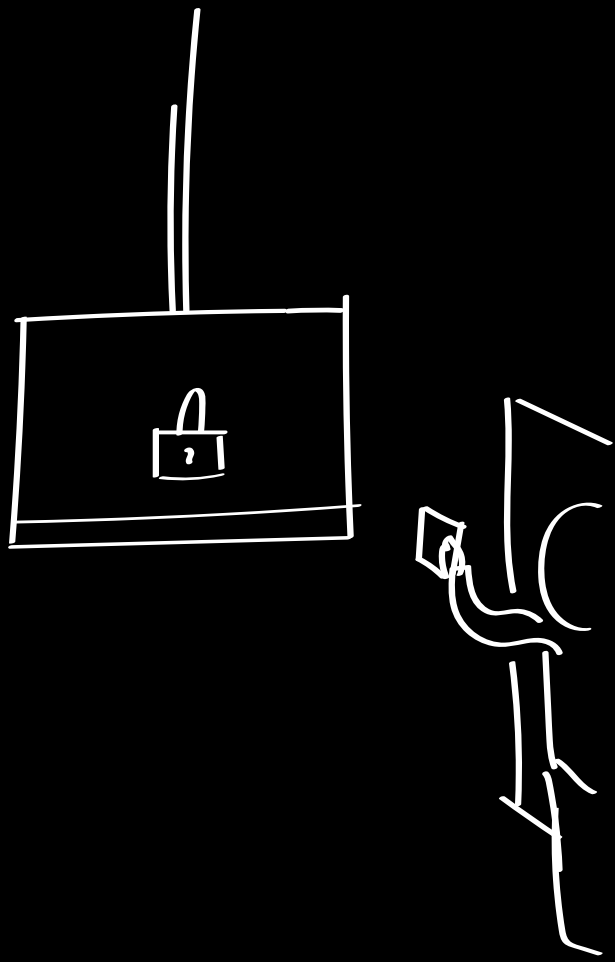
When signed up customers receive the router and can download the app. To encourage them to give their internet source a prominent spot in the house, the router is designed as a decorative painting that can be placed in a common area. The interface features a series of slots in which keys can be inserted to (dis)connect the devices of a specific user, for example when coming home.

Each member of the household has a unique key and can link it to their devices in the app. Devices that need to remain connected permanently can also be set. All keys have a distinctive colour that matches one of the colours in the painting. Keys feature an easy clip-on/off ring to easily attach them to keychains or clothing so they won't be forgotten.

When leaving the house or going to sleep, the key can be taken out of the router meaning that the selected devices no longer receive internet. This offers the user some rest, protects devices from being hacked into and when all user are logged out the router itself can go on stand-by reducing energy costs. This process of logging in and out is interwoven with existing rhythms such as leaving and entering the house to make the interaction more habitual.



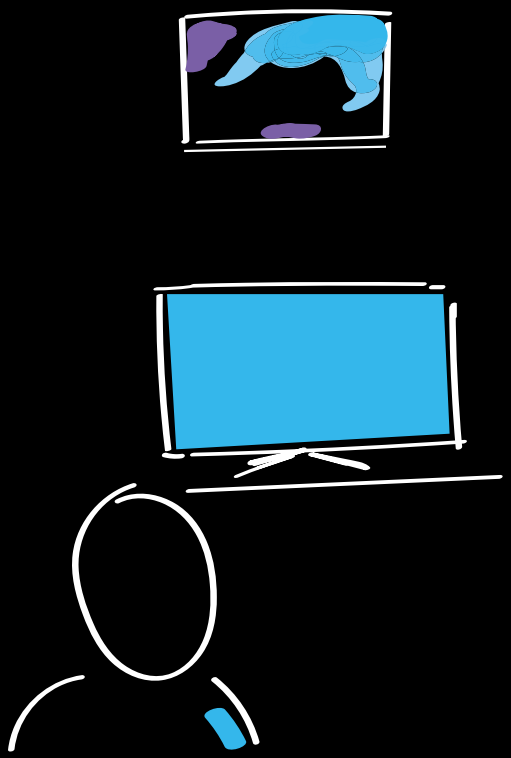


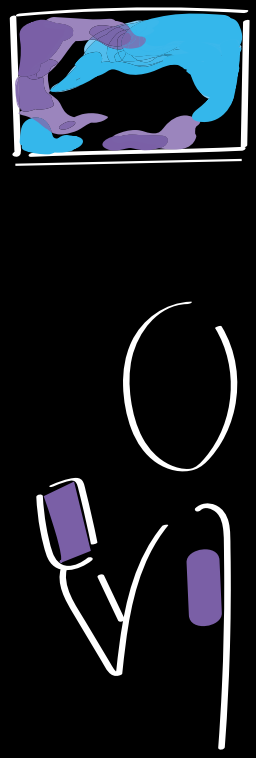


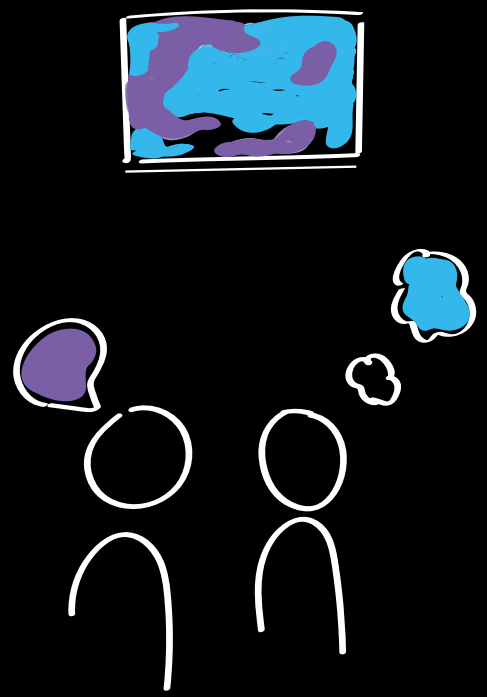
To provide feedback on online behaviour data usage is visualised in the router by making the painting interactive. When a member of the household uses a digital service their colour start to slowly dominate the painting. The higher the intensity of the data stream, the faster the colour will take over. When no internet is used, the colour slowly decays.

When others in the household also start using they will join in the effort of filling the picture frame with colour. When everyone in the household uses a lot of internet the colours flow rapidly making the painting turbulent and less appealing. When the usage is moderate, the painting is more balanced and has a nicer aesthetic.

When logging out at the end of the day or when the household comes together the interface also offers a moment of reflection. The visualisation aims to trigger users to think about their data consumption that day and by putting it in a shared location it could be the starting point of new inquiries into online behaviour together with others.

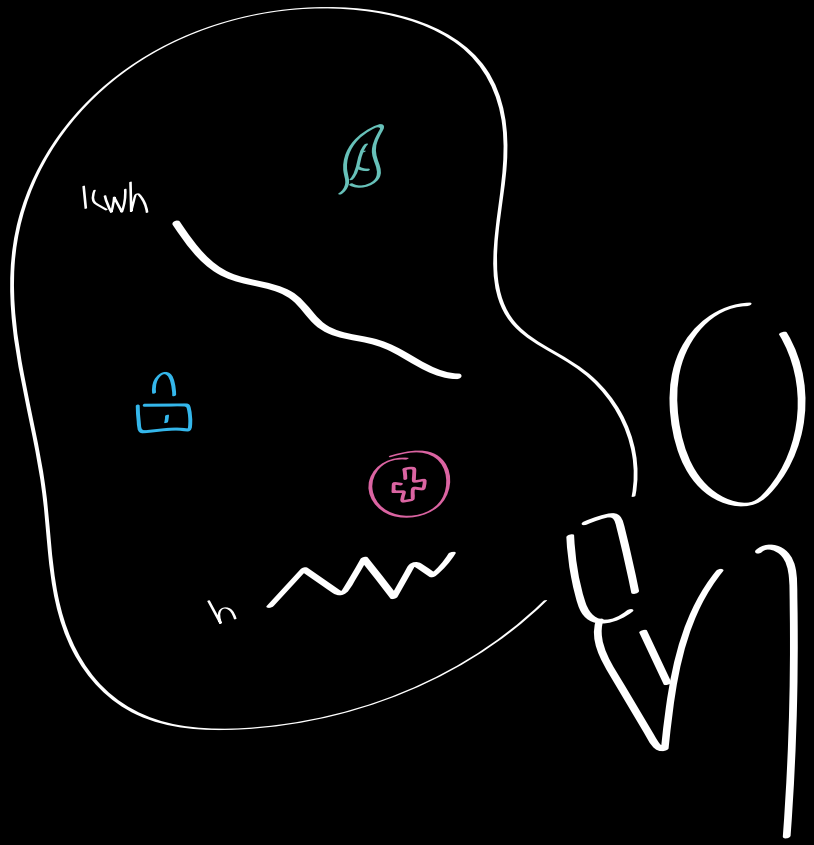


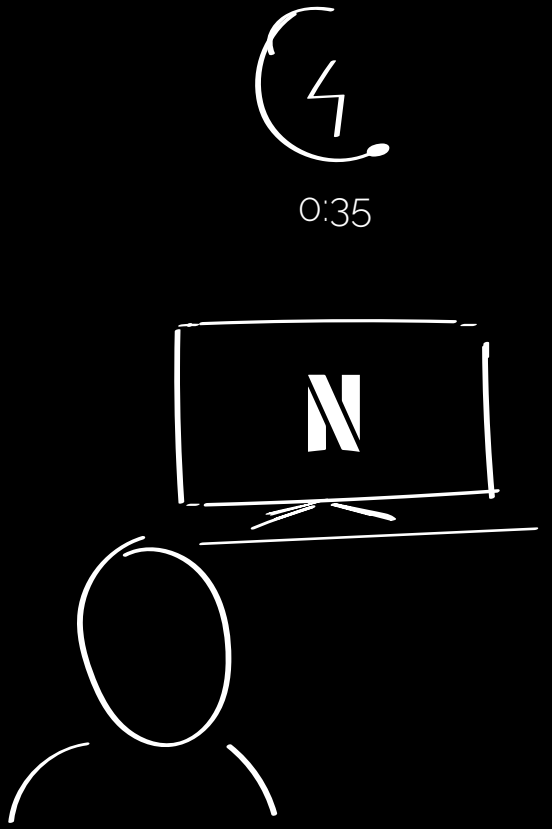




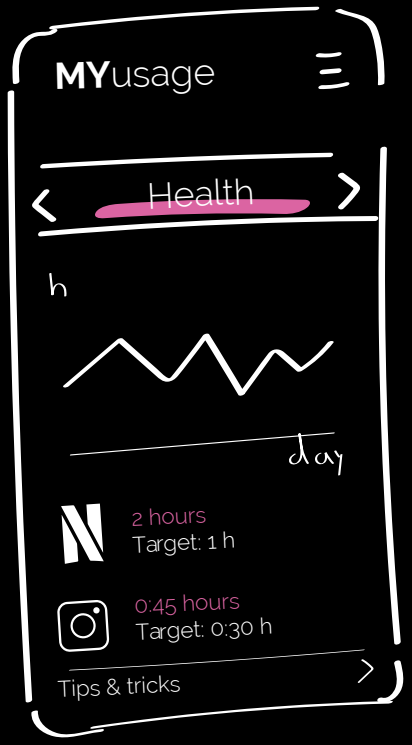
A more detailed version of the feedback provided by the router can be accessed in the usage tab of the app. Framed in the lifestyle lenses, users can view how much they have used that day and over longer periods of time. With these deeper insights into their own usage they can now take action to change their behaviour and directly see the effect.

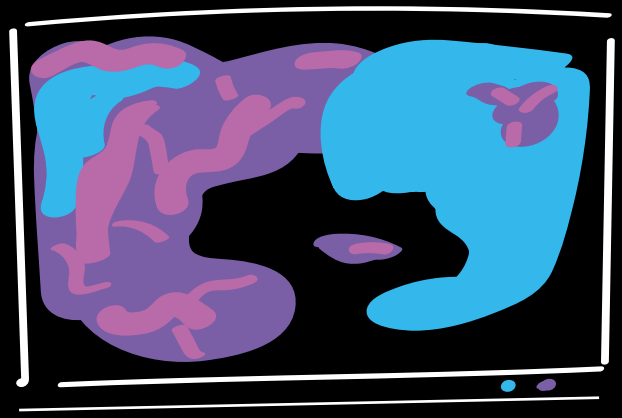
Along with the feedback, KPNcare also encourages people to make more explicit decisions. The plan offers a basic speed at which the network normally operates, enough for every user to comfortably use communication services or other essentials. When heavier applications are opened they will be slower or forced to run in lower resolutions. To dial up the speed users can temporarily set a 'boost' through the app on their smartphone. This requires them to set a duration for the boost meaning that they will consciously decide for how long they want to consume.





In the light of wellbeing users can also set targets for the amount of time they wish to use certain services. When users set these targets in the app their performance is also linked back to the picture frame. Not only will they see whether they have reached their targets in the app but when they reach their targets the beauty of the painting is also enhanced by smoothening visuals. If targets are exceeded the painting will undergo a different transformation and become more erratic.



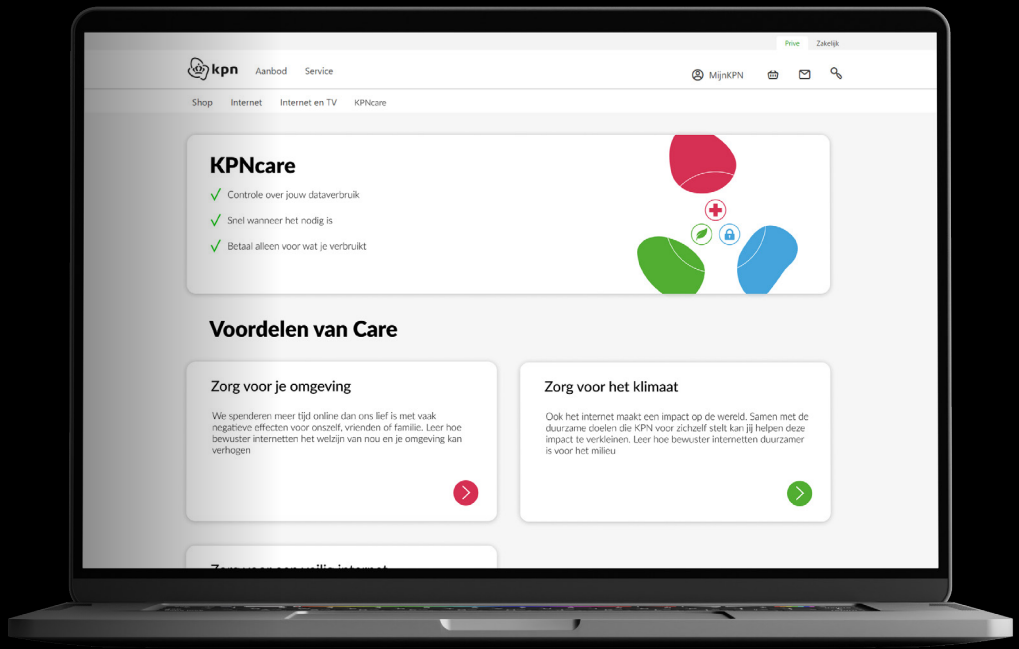


THE DESIGN

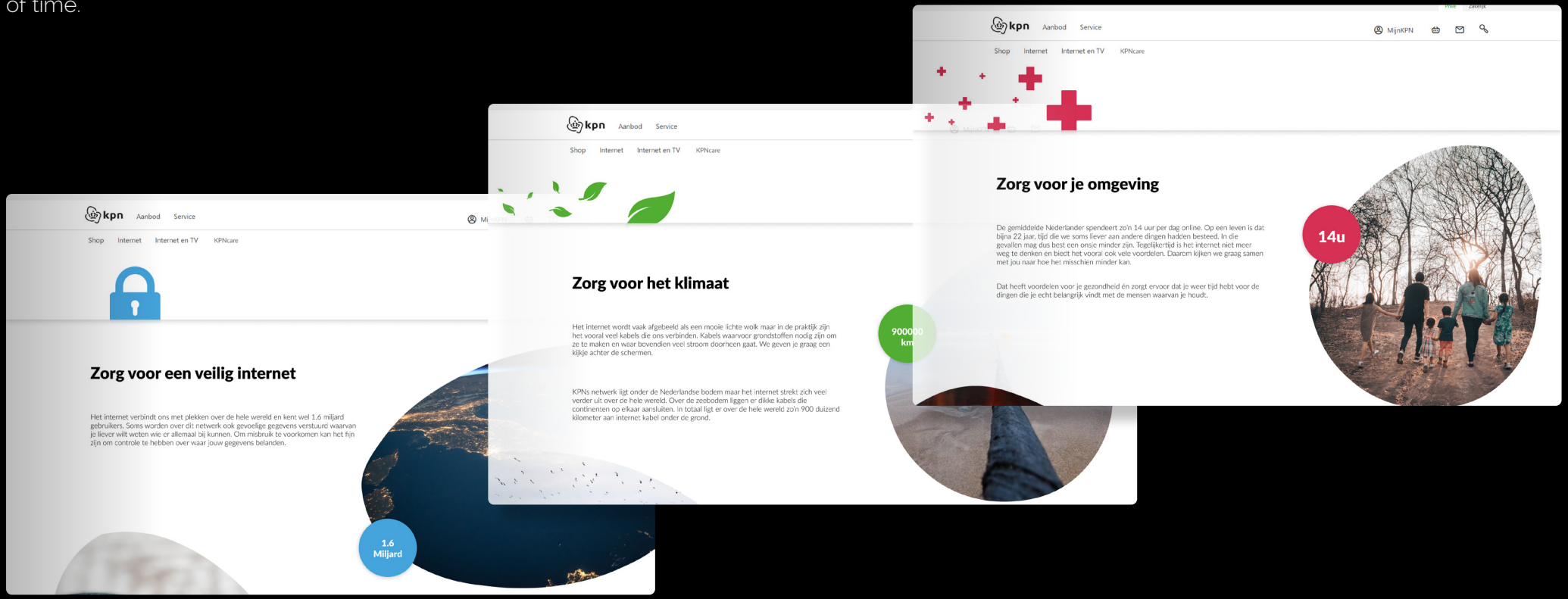
How these features take shape in the design of the individual interventions within the concept needs to be in line with the design goals. Within the concept three distinct interventions can be distinguished that are given form.

The website

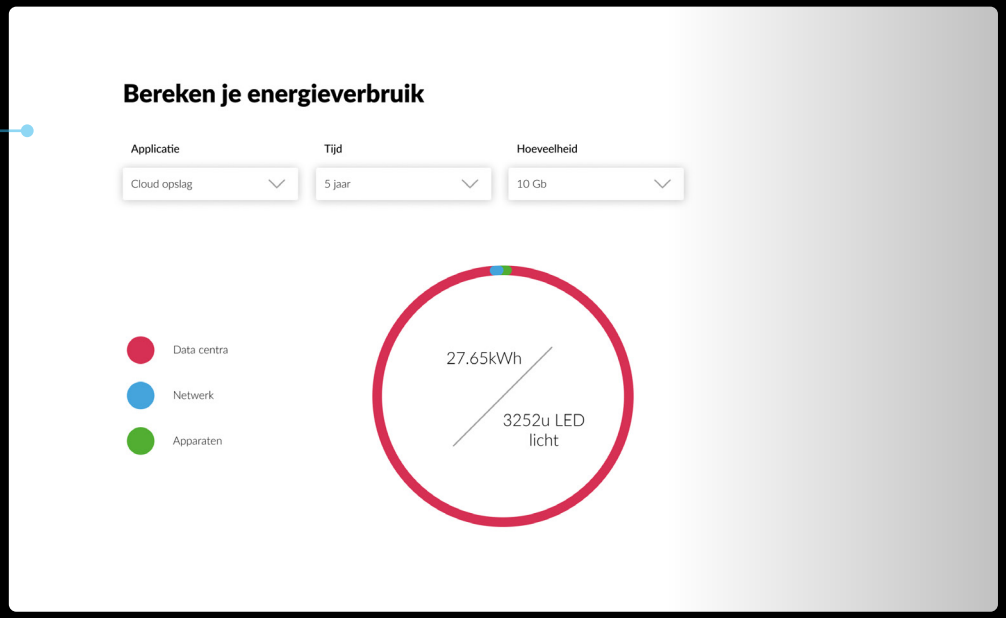
The first touchpoint within the concept is the web page where the KPNcare plan can be viewed and the benefits are explained. Viewers can delve deeper into the value that the plan wants to offer and read up on the features like the boost and flexible payment plan. All information on the website is phrased in a narrative where KPN approaches their customers as partners and want to collaborate with them in this new endeavour. This way consumers are invited to participate by the company so that they may get actively involved in reducing their data intake.



Information on the values that the KPNcare plan represents should become integrated in current KPN communication on the website. Existing KPN values are combined with the lifestyle lenses on the corporate identity page of the KPN website which is linked to the new plan. The values are made concrete and easy to understand by using relevant examples and comparisons. The value conflicts identified earlier in the research of the project form the backbone of these pages. Dilemmas such as the construction of large scale data centres are used as well as relatable real life scenarios such as the addiction to digital services and overload of information. With short pieces of text and confronting statistics the viewer should be triggered to continue reading and inform themselves about the impact of data consumption. Overall, the messaging is visual and easy to digest within a limited amount of time.

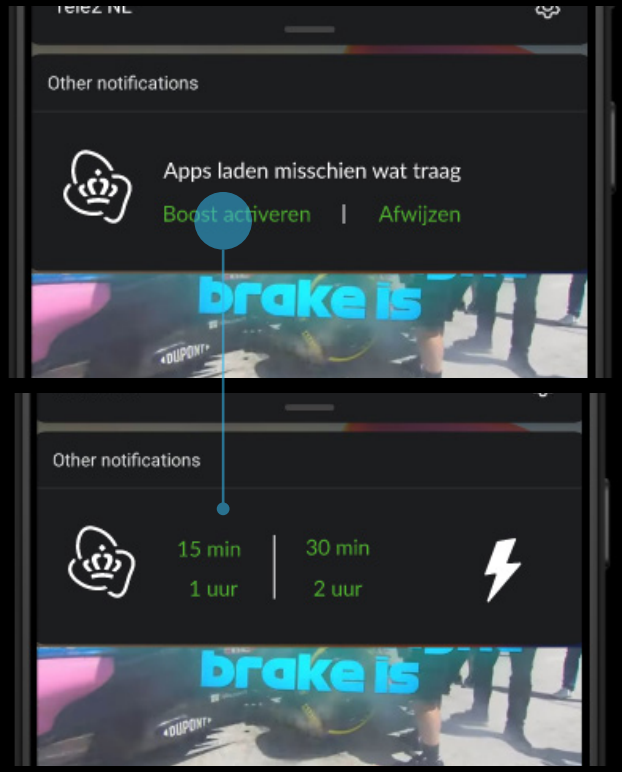


To further materialise the power consumption of ICT products and services the viewer can also interact with a custom tool on the environment page. For every category of digital service viewers are able to calculate how much energy is consumed for a given scenario. Next to kWh the energy is also expressed in terms of other practices that are more insightful such as the power used by lighting. This way the viewer is able to see how big their individual impact is and can estimate the potential benefit in case they change their behaviour. Visualised is also the share in the energy consumption of all parts in the network. This provides additional insight into the basic workings of the internet and can give direction to possible actions that consumers can undertake such as using WiFi instead of mobile data.



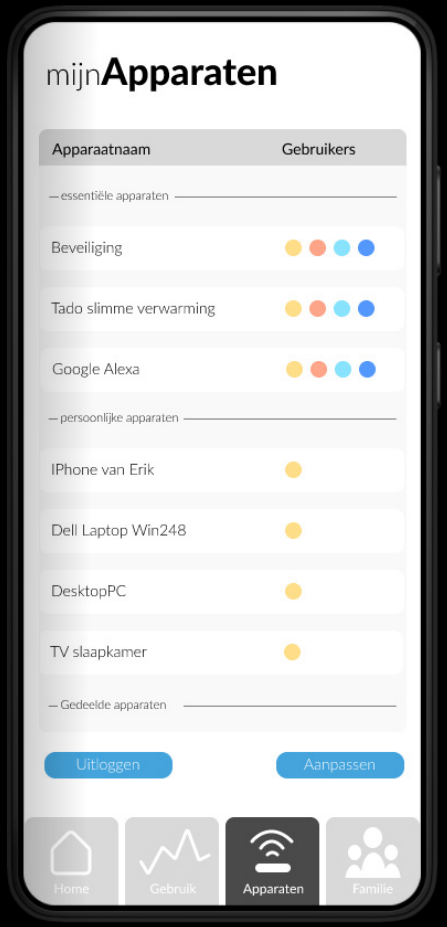
The app

The appearance of the app is similar to existing KPN apps but is more basic to comply with the low data philosophy. Users first arrive at the start screen which is centred around the main boost functionality so that it may be accessed quickly. Along with that the boost is also featured as an app overlay within the operating software so the app does not need to be opened. When bandwidth is running out, the overlay will pop up with the option to boost. To make selecting a duration quicker, standard durations are presented along with the option to enter a custom time. Along with the boost the home screen also shows the current speed at which the network operates, total amount of used data in the current billing cycle and an overview of the goals for that day. From here, users can also navigate to the various tabs that show information about personal usage, devices on the network and an overview of the household.

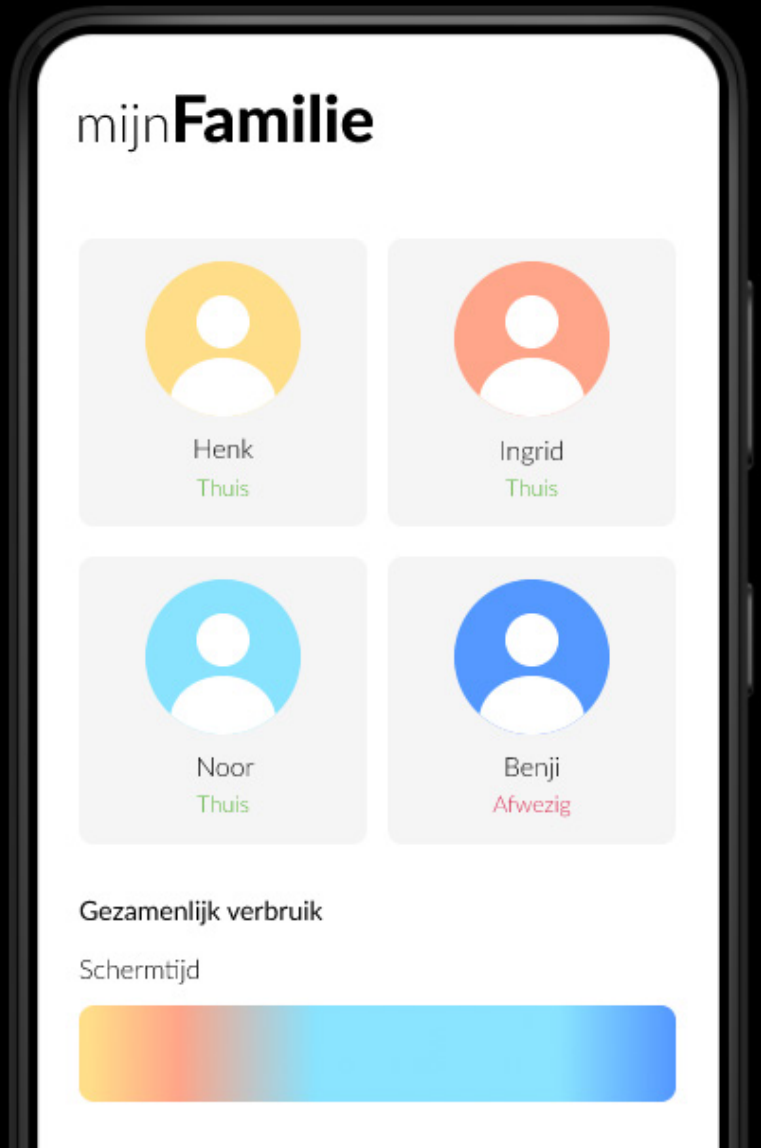


App overlay in the Android OS

In the device overview a clear separation is made between essential devices that must remain connected, personal devices and shared devices. This will give user more insight into all devices connected as this number will likely increase by the rise of IoT products. By selecting certain devices as essential users can avoid SMART home applications such thermostats and security systems to remain online even when nobody is home. Throughout the app the same colours of the keys in the router are used to attribute devices and usage to household members.



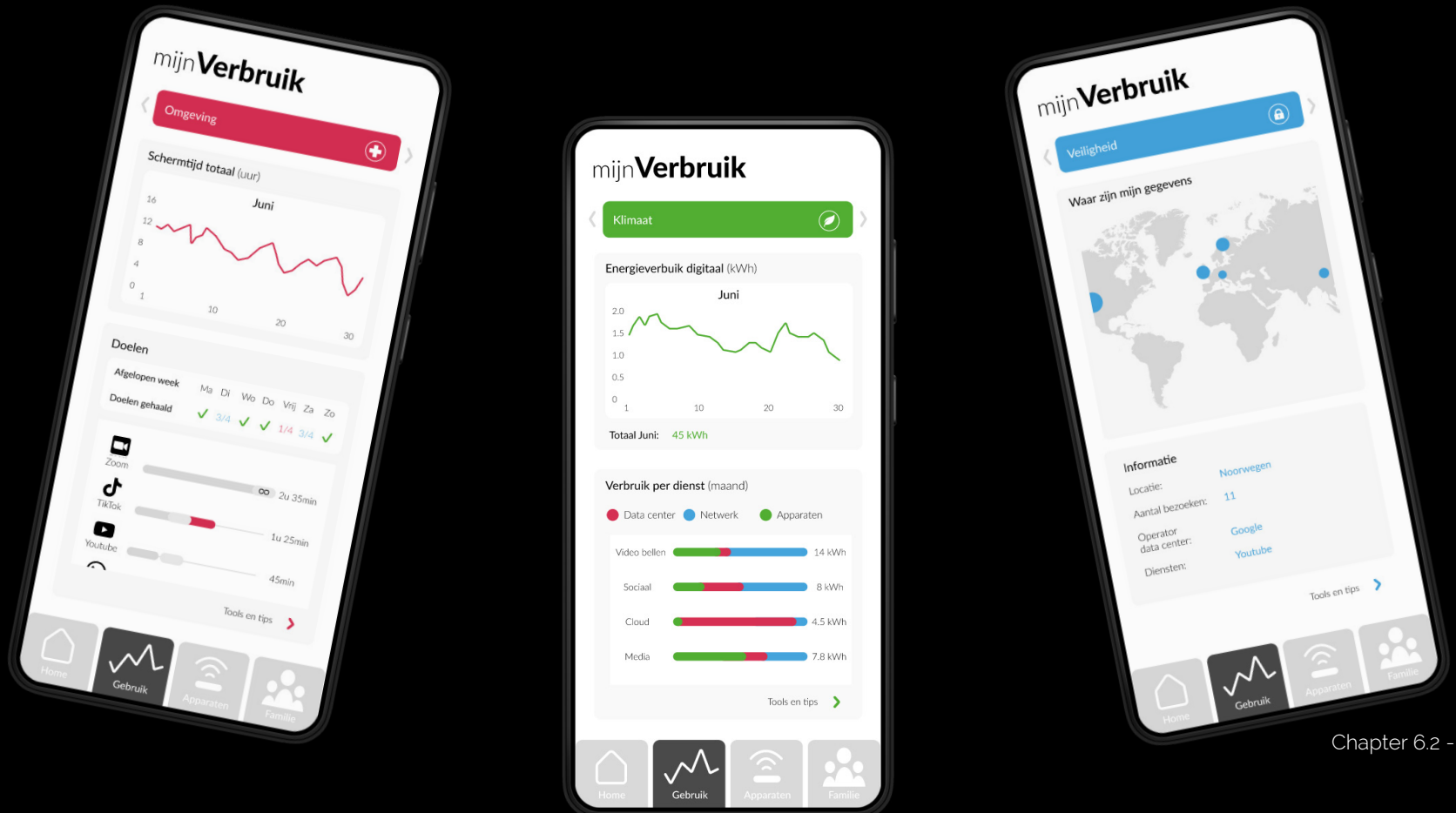
In the family tab a digital representation of the information provided by the router is displayed so that users may check up on members of the household even when not in the vicinity of the router.



The app also contains an overview of the individual usage per family member under the usage tab. This feedback is offered through the three lifestyle lenses to educate about the impacts of data consumption. Through the health lens the usage per service is given in hours along with the ability to set targets for the services that are used. Targets are set with sliders and for apps that need to stay available the slider can be set to unlimited. For every day of the week the user can see whether they have reached their targets as seeing their achievements from previous days can motivate them to keep up momentum and reduce their data intake. A graph shows a more zoomed out view of the usage across longer time spans to show the result of any changes in behaviour.

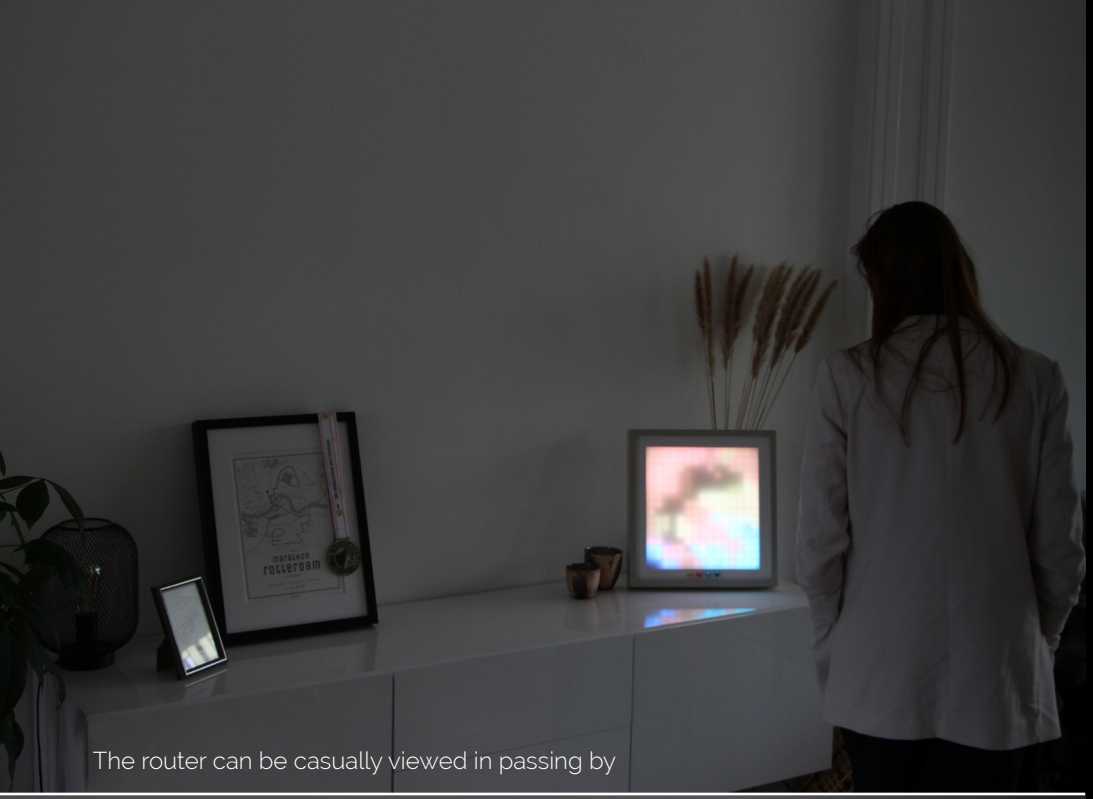
In the environment screen the usage is displayed in kWh so a start is made in educating people about power costs of online services. The usage is linked to the devices as a big part of energy consumption is caused by them. With device types listed in the app, estimates are calculated on how much energy is used. An hour of Netflix on a big TV will therefore result into different usage then when viewed on a phone which calls for a more nuanced action. Instead of streaming less, users could also switch to a smaller screen to reduce their impact. Again, a graph shows the total usage over time to visualise any progress made by new behaviour.

The third lens of security is centred around data storage and identification of internet connections. To create more awareness about the variety of servers that the user visits throughout the day these connections are visualised on a globe. Along with the location, details about the owner of the server are also displayed along with a safety rating.



The router

The design of the picture frame that is the router is a balance between a technological and homely aesthetic. It invites users to bring a piece of hardware into their living spaces without hiding it from sight. This way the omnipresent-role that digital services and devices have in our daily lives is made material and can't be ignored. Next to bits of hardware inside, the casing of the router is made of wood rather than plastic. Not only is this more sustainable, it also expresses this quality clearly to the user making the product appear in line with the sustainable benefits of lower data consumption.



The router can be casually viewed in passing by

Exceeding limits saturates colours (orange)

The interface is made interactive by using light that generates the flowing colours. By using a grid of LEDs and minimal diffusion the light appears slightly pixelated and adds to the technological aesthetic. The colours used are soft and unsaturated so that they blend nicely into the room yet are distinctive enough so that users can distinguish their own usage. When a user has reached one of their limits and continues to use data, their colour becomes more saturated and becomes an attention grabbing light source that breaks the theme of the other colours. Light effects are generated based on live consumption but never the same so that they remain interesting and trigger users to have a look. In the bottom part of the frame the four keys can be inserted and turned to log in or out.

DESIGNED INTENTION

The concept tries to move towards a more civilised interaction with the internet by going back to the very fundament of what makes a civilization. As anthropologist Margaret Mead discovered long ago by studying the healed bones of one of the very early humans to walk this earth; we only came this far because we cared for each other. It is the fact that we were able to look after each other that allowed humans to thrive and survive. To establish a civilised internet, we have to start actively caring about what impact it has on ourselves, on others and on the planet. That way we can protect our societies from overconsuming data and online misbehaviour.

Besides adhering to this philosophy, the combination of different interventions tries to embody all the design goals mentioned at the start of this chapter. In various ways, awareness about the potential impacts of data consumption is being raised. To make the information matter to consumers it is framed from the lifestyle lenses and feedback is given in relation to members of the household. The concept also aims to make a start at creating a more universal language around power consumption to educate consumers about the energy requirements of their daily practices. The messaging is simple and easy to understand but also gives deeper insights for those interested. In the end, user should not have to rely on data and numbers to estimate their device's energy usage but rather understand the basic principles of what types of practices are power hungry and make trade-offs autonomously.

Next to educating and framing consumers should also be enabled to make more purposeful decisions. The boost functionality might be perceived as an annoying inconvenience but at the same time will disrupt automated behaviour and provide users with a moment to make a decision consciously. As to not bother users to the point that they will refrain from using KPNcare, this hurdle is made as small as possible. Consumption that normally happens out of sight of the user such as devices left on when not in use is also made explicit to highlight the presence of digital products and services. With the key system and insights into data usage, KPN's customers should feel more in control of their own consumption behaviour.
Benefits of these new practices should be apparent due to the newly created awareness but are also highlighted in the concept. With additional rewards in the form of a decorative painting the user is incentivised to perform more desirable behaviour. Whilst the painting and monetary incentive try to materialise benefits in the short term, other incentives such as improved wellbeing will realise in the long run. In the end, this concept should educate consumers in a more playful way without being pedantic. Users are given the tools to reflect together with peers on their behaviour and draw their own conclusions. If they decide to take action the means are there for them to start making a change in their habits.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EVALUATION

The newly generated concept is put to the test in a user evaluation with higher fidelity prototypes. This chapter reports on the setup used, prototypes that have been build and the outcomes of the evaluation. After presenting the results they are also discussed in order to determine their relevance.

TEST SETUP

By means of a qualitative evaluation the concept of KPNcare is put to the test to determined whether it meets the design goals it sets out to fulfil. Over the course of two days semi-structured interviews are held with participants whilst they interact with prototypes of the three interventions. In order for the concept to be evaluated properly the real use scenario is enacted, participants are sourced close to the target audience and prototypes are build that simulate the workings of the concept.

The scenario

The router and app are meant to be used within a household and can be used in two different ways. Users can either interact with them individually and reflect on their data consumption by themselves or they can do this together with other members of the household. The evaluation therefore test the prototypes both with individual participants, were the usage of other house members is simulated without them being present, and with a focus group of four participants each representing a household member. All test are conducted within KPN's experience lab facilities where a living room situation is simulated to allow for user studies to be done.

In the individual test participants are first introduced to the topic and their current knowledge and attitudes towards data consumption is discussed to set a benchmark. Afterwards they will engage in several interactions with the prototypes with a short series of interview questions after each round. The questions aim to evaluate the prototypes on the previously formulated design goals and to what extent these are met. In the end the overall concept is discussed in a similar fashion and the participant's attitudes to the topic of data consumption is gauged once more to see if they have changed opposed to their previous statements.

A similar sequence is set up for the focus group where the participants are introduced to the topic more elaborately through open discussions and an association exercise that will encourage them to share personal experiences and thoughts on online behaviour. To test the prototypes of digital interventions the group will split in two so that they have more freedom to interact with them and experiences are discussed plenary afterwards. The router prototype is tested by reenacting a household scenario instead of simulating other household members. Each participant is given a profile based on what kind of internet user they see themselves as and acts as this type of user during the roleplay. They will engage in watching an episode of a series whilst some participants also perform additional activities matching their profile such as multitasking with their smartphone. Whilst the participants engage in the activity the router simulates the workings of the concept which will be evaluated afterwards with the group. This is done to ensure that different use patterns take place within the evaluation which makes it possible to compare these and discuss them. The exact sequences and interview guides can be found in appendix 5.

During the activities described in these sequences observations are made by the researcher to capture first impressions and video footage is captured to review the test more thoroughly afterwards.

Setup for the individual test with the figma prototypes on the laptop left and the router on the right

Prototypes

To simulate the workings of the concept three prototypes have been crafted for the evaluation. These do not work fully but rather give an impression of how the real interventions would look like and simulate the interaction. For the router a working LED panel is made and inserted into a custom frame. Coloured keys can be inserted in the bottom of the frame which activate buttons to log in and out. Visuals on the LEDs do not respond to actual data consumption but are activated by the researcher to simulate visuals in the scenarios discussed. This prototype is given a spot within the test facilities for the duration of the study.

The app and website are build up to a wireframe level using Figma, a prototyping tool made for creating digital experiences. Through a laptop participants are able to click and scroll through several screens and evaluate the general experience of viewing the website and using the app.

Participant interacting with the router prototype

Participants

From the study conducted in the research phase of the project it became clear that not all internet users are ready to change their habits and are therefore less susceptible to interventions than others. The concept is designed around the consumers that are open to the idea of consuming less and value either sustainability, digital wellbeing, online safety or a combination of these. The type of consumer that does not wish to be bothered with information regarding their own behaviour lies outside of the target audience and can be considered out of reach at the time of this project. They might be addressed in the future if the topic becomes more widespread and accepted. Along with an interest in the aforementioned topics the participants are also selected based on their age, with 2/3 of them ranging from 20 to 40 and the latter 40-60. This spread ensures that the young audience which is more likely to frequently use digital services is well-represented in the evaluation whilst also including older audiences to see whether the concept still holds relevant for them. In total 5 people were recruited for the individual test and 4 participated in the focus group. All participants were recruited through external agency Norstat.

Participants

Order	Pseudonym	Age
1	Kennedy	34
2	Avery	39
3	Ryan	30
4	Ezra	65
5	Austin	35
6	Rory	50
7	Tash	21
8	Robin	77
9	Elliot	62

RESULTS

Outcomes from the test are derived from the footage captured and notes taken at the time of the interviews. As the evaluation aims to validate the design goals formulated earlier, the results are structured along these criteria in six sections. A detailed overview of all quotes, findings and observations can be found in appendix 6.

Installing awareness by educating and framing

The first goal tries to educate consumers on the social impacts of data consumption and the general workings of the internet to make them more aware. Especially the website and app provided participants with lots of information that has been collected during the research of this study. The information was generally well understood by the participants and was sufficiently concrete for them to understand what it meant for their own usage. Calculating costs with the tool on the webpage and comparisons with other forms of energy use were considered very helpful to achieve this.

"If you make it concrete in other forms of usage than you compare it to something"
– Elliot

"It gives a lot of insight and makes you aware of what you do on a daily basis"
– Rory

The first goal tries to educate consumers on the social impacts of data consumption and the general workings of the internet to make them more aware. Especially the website and app provided participants with lots of information that has been collected during the research of this study. The information was generally well understood by the participants and was sufficiently concrete for them to understand what it meant for their own usage. Calculating costs with the tool on the webpage and comparisons with other forms of energy use were considered very helpful to achieve this.

"You hear about it sometimes but now you can view things on an individual level"
– Kennedy

But besides providing interesting insights, the concept also evoked many emotional responses with participants exclaiming their disbelief at the facts they were confronted with. Despite claiming to be knowledgeable on the topic concrete figures about social impacts of data use and visualizations of their own behaviour visibly affected the participants. Even those who had already actively sought ways to reduce climate impact or increase their own wellbeing were caught by surprise when informed about their digital footprint. Many considered the newly gained information as 'mind-blowing' and 'an eye opener' with total screen time and electricity costs in kWh as the biggest triggers.

"I am a member of green choice and vegatarian but I never thought of this"
– Austin

"14 hours a day online!! That's nuts"
– Kennedy, Ezra, Austin

These figures seemed to offend deeply rooted values in people that helped to relate the goal of reducing data consumption to personal goals. What figures appealed to whom differed greatly however and so did levels of engagement across the lifestyle topics. The safety topic seemed to the least valuable to the participants interviewed and sustainability was regarded as most valuable. This underlines the importance of the broader set of values that is incorporated in the concept as it shows how they can be used to appeal to a greater audience. When combined, these values clearly motivated

people to change habits and some of the participants already showed forms of commitment to start doing things differently.

"With this information I can already start doing things at home to reduce"
– Ezra

"At first I thought I want as fast as possible but when I read about these values then it makes sense"
– Kennedy

Participant engaged in learning about the lifestyle lenses

Committing to purposeful decisions

There was also a strong indication that the interventions within the concept can help with committing to a change in behaviour. The boost was regarded as a handy tool to avoid needless consumption especially if specific times could be set. These small commitments could break up long periods of use into more manageable chunks which could seriously benefit wellbeing goals. Along with that the information on usage in the app and logging on/off can help by making actions more visible for users to make informed decisions.

"It allows you to make a conscious decisions and that's not a barrier but something desirable"
– Kennedy

"Sometimes I might think hey if I do this, then the usage goes up and I might question whether it is necessary"
– Avery

Setting goals in the app and keeping track of them appealed to fewer of the participants as it required more intensive monitoring of their own behaviour. Although completing the goals can provide users with some reward by gamification, this type of functionality is not for everyone.

"It's a bit like the fitbit, I'm personally not a big fan of that"
– Avery

Affording inconvenience

Besides making decisions more visible, the boost function also requires users to put in a little bit of extra effort before they can make use of their digital services. As already mentioned, this inconvenience was not a problem for some but other participants expressed their considerations when having to use the boost. The benefits gained from fulfilling social values were mentioned as something that could outweigh the inconvenience as well as the possible monetary benefits. For some, the prospect of also paying more when using more did not seem to bother them but rather functioned as additional incentive to do better.

"I might be a bit scared that it would cost me more time but I think you will have more gains from the social benefits"
– Kennedy

"If I end up paying more it's a simple consequence and it would drive me to use more consciously, like calling used to be"
– Ezra

This monetary incentive was a clear motivator amongst all the participants and even outweighed all the other benefits that the concept had to offer. For some it was a hard requirement that the service would be cheaper than competing plans if less data is used. When asked about the amount of reimbursement they expected a single participant indicated to expect the price to be halved whilst others simply wanted to see some sort of compensation for their troubles.

"Now I don't have a reason to put away my phone, but if it saves me money I would"
– Ryan

"It would have to be a lower price than the other plans, maybe just at the start and then see"
– Kennedy

Another form of inconvenience was caused by the visualisation on the router as it displays intensive usage publicly as something ugly. Participants expressed how it made them feel bad about their own behaviour and how they wanted to hide the router in case they used a lot of data. This confrontation was also strongly related to the community aspect brought about by the fact that data usage was brought into a social setting.

"This looks pretty confronting, I push away the others and hoard all the data <...> it should be the natural response of anyone when you see this, too use less"
– Kennedy

Materialise the benefits

Along with monetary and aesthetical benefits the concept also touched upon many other desires kept by the participants. It provides a lot of insight into usage and information to dive into. Paradoxically, this plays into the cravings for information and curiosity that people inherently have and inquiries into their own usage seemed to fulfil that need. Comparisons were made with SMART home applications like the TADO (smart thermostat) and raised the question whether this intervention could become another data-driven gadget reinforcing the addiction to data.

"I would like to find out what I could win by pre-downloading things"
– Austin

"My girlfriend would find this amazing, she is into the SMART home and has a TADO"
– Ryan

But as the responses to the new information showed, the concept also appeals to the values that are currently being violated by digital products and services. Participants were not only able to relate to the lifestyle topics but also expressed their growing concerns about the impact of information technologies and confirmed many of the findings presented earlier in the study. Being able to limit the negative impact that they have was considered valuable and a reason to get started with a new plan like KPNcare.

"It's shocking, I know about it from experience with people and loneliness"
– Ezra

"It would probably make you more aware, that's a good thing in itself"
– Kennedy

Many participants also expressed their concerns with the current relationship they had with their provider. The excess data caused by unlimited data plans and free bundles did not resonate with their needs and many expressed a desire for more tailored offerings. The newly presented plan gave them the feeling that KPN was actually thinking along with them and that they were not forced into a consumption pattern. A more tailored approach could pave the way for a better customer relationship were the customer is given the autonomy to actively decide how they want to use consume.

"It feels like somebody is thinking along with me"
– Ryan

"I get so much more than I need, fine if that's how you want to keep me as a customer but I could do with less"
– Avery

"I think there's demand for this, it allows me to take action myself"
– Kennedy

The extent to which this new kind of relationship between provider and user can add value can be considered significant. Providing transparent information on the website, helping users adhere to personal values through app and router and giving them a flexible plan that tailors to their needs can be a game changer that gives KPN a competitive advantage. A majority of the participants indicated that if implemented, the newly presented concept would be reason for them to leave their current providers behind and make the switch for KPN.

"Right now KPN doesn't have anything that Ziggo doesn't have, this would be different"
– Austin

"If my current subscription with Ziggo was ending I would go for this"
– Ryan

Focus group enacting the scenario with the router displaying usage on the left

v a social frame of reference

Interactions with the router and the visualisations of data use in the household triggered participants to think about the potential scenarios that would play out. Some imagined themselves bringing it up at the dinner table to discuss usage with the family whilst others saw it as a useful tool to confront loved ones about their unhealthy habits. Also in the focus group the router sparked discussion and led to participants comparing their roles to find out what profiles matched with the visual on the display. For some this even went so far that they would hold others accountable for excessive use and divide costs of the plan accordingly but in general people responded in a lighthearted way and shared a smile. In lesser terms the same can be said about the family tab in the app but it was less successful in provoking a response.

"Now I can say to her, hey blue what are you doing?!"
– Elliot

"I would use it to provoke my girlfriend; 'hey honey, you are using a lot today'"
– Ryan

This light-heartedness, along with playful aspects of the router and app like the goal setting and visuals, also brought a sense of fun into the interaction. The interface of the router could become a central point in the house where users can see who is home and this way add to the existing interactions in the household. Discussions about data use do not only serve a functional purpose by motivating reductions in use but can be an enjoyable activity in itself that can be more meaningful than other interactions online. The relevance of the concept within a family setting was further confirmed by almost all participants as the lifestyle topics related to data consumption were considered as an essential part of the upbringing.

"I can really see the added value for a family, to see 'hey dad is home'"
– Austin

Within this dependency on a family setting lies also a weakness of the concept. As many of the participants currently lived by themselves they did not deem the functionalities of the router and family tab relevant and felt somewhat discriminated by the concept. These features did not add enough value when used by only one user despite the fact that some functionalities such as the data visualisations still worked in a single user scenario. Another

potential drawback of the communal setup that was discovered concerns the consent of everybody in the household. For the concept to function properly it needs everyone in the household to agree with sharing their usage and committing to this new plan. In case of a household with children the parents could make this decision for their kids but if they refuse to cooperate this would most likely only create friction. Users must therefore enter in some form of social agreement when opting for the new plan and this could form a barrier for individuals who do not live with likeminded peers.

"I understand that for a family I could be useful but I don't have kids I could address"
– Ezra

"If my son would agree to use it, it would be helpful but I think not all teenagers would like that"
– Rory

Making it standard

When asked about the potential for the concept to be adopted in their daily lives the participants responded with some hesitation. Main features that would impact daily activities are embedded in either the app or the router in the form of activating boosts, logging on/off and checking up on usage. The app was considered a useful tool for this that is not too intrusive and only to be accessed weekly or monthly. To the relief of some of the participants activating boosts through the interface of the phone enables the app to be accessed less frequently and mitigated some of the inconvenience.

"If it's in the phone interface than it's not a barrier, only two clicks right?"
– Kennedy

"It's good to have a moment in the week to evaluate"
– Kennedy

The design of the router faced more criticism as it is a lot more intrusive than the app. Despite the more homely look and feel it was still seen as something that forces itself into living areas and is not necessarily desirable. A smaller, less 'in your face' version would have mitigated most concerns and could persuade participants to not hide it in one of their cabinets. Regardless of these aesthetical concerns however the added value of bringing the visualisation of data use into the daily rhythm still resonated with most of the participants. The physical format could complement the more subtle role of the app by reminding users of their intentions in a quick and intuitive way as opposed to the rather detailed graphs and figures.

"In a different format it could definitely add value"
– Rory, Tash, Elliot

"If I put it in the hallway I could look at it sometimes and that's fine"
– Austin

DISCUSSION

Before a final recommendation for the design can be proposed the concept needs be discussed more extensively within its corresponding context. Combining the results from the qualitative evaluation with a critical analysis of the concept and possible implementation thereof, this discussion will identify both strong and weak points on the level of the idea's appropriateness, effectiveness, and feasibility.

Appropriateness

The first point of discussion addresses the extent to which the concept is appropriate for the project context and whether it addresses the challenge formulated at the beginning of the project in a suitable way. Using the ViP methodology, a worldview and statement were created to give direction to the ideation process and coming forth from that six concrete design criteria have been brought into life to help evaluate the concept. The results of the qualitative study show that the concept adheres to all of the design criteria and proved especially suitable for making users more aware and framing data reduction as a beneficial endeavour for consumers. KPNcare also gives users useful handles to start changing their behaviour. It seems plausible that they could flow into daily use patterns, given that some adjustments to the design of the router are made so that it is less conspicuous.
The introduction of the household as a social context has also proven its value however strongly leans on households containing more than one person. For people living alone the feature is less valuable but the overall concept still encourages user to reflect on their personal behaviour and remains a promising tool to create behavioural change. At the same time, a small addition to the concept where befriended small households can connect in the same 'family' and are displayed on each other's routers could also partially bypass this problem and create additional value for this type of consumer. This would also be in line with strategies of KPN where customers invite others to join the network and share in benefits such sharing left over data in their plans.

Besides the design criteria, the concept must also be in line with the worldview and contribute towards a civilised interaction with the digital world. From the user evaluation became clear that talking about data usage and comparing one's usage to that of others can be a good start to creating social norms and rules. Families imagined themselves setting targets together and making it part of the upbringing can educate new generations that will give shape to new standards. But whilst pleasure seeking is currently being covered by the lifestyle topics, online misbehaviour is still badly represented and could be included to also establish a broader set of ethical guidelines.
The information provided also makes a start at educating people on the physical limits of their own bodies and the world around them related to data consumption. To help them achieve a more moderate and modest use pattern the boost functionality and target setting can support users in resisting the ever-present distraction of the online world. By setting the basic speed lower, a slower and more thoughtful way of using the internet can be realised where the user is in control.
This flows directly into the last tenet of active involvement. To be able to shape our digital civilization, internet users must first understand their role within the network and actively reflect on how they would like to fulfil this role. Although the concept made consumers aware of their own impact and motivated them to change it, the concept could've supported them even more if it had given them concrete and tailored advice on how they could improve their digital habits. This next step is a vital one in paving the road for individual consumers to actively participate in forming digital interactions. Shifting the focus from detailed information to concrete actions might also prevent users from diving too deeply into these numbers and figures. Whilst the concept uses data to function, it does so to help users fulfil other values than the craving for information that is currently satisfied with many IoT applications.

Some reflection is also necessary on whether the concept is in line with the context that has been defined earlier in the project. By designing for households the scope of personal consumption on in-house and mobile networks is sufficiently targeted and by monitoring a great diversity of digital practices it does so in a comprehensive way. At the same time the target

audience of this intervention is also narrowed down to consumers that have affinity with the lifestyle benefits. From earlier studies within KPN however, it becomes clear that this group is considerably large. Overall, 73% precent of KPN's user base wants to take action to become more sustainable and more than half considers it an important factor when choosing their provider (kpn, 2021). Users also start to open up towards interventions that help them with achieving personal goals: 51% already uses IoT products that help them reduce energy or is highly interested at least, 31% does so to be more secure and 14% uses them to benefit their health (kpn, 2022). All these percentages are rising and it is probable that in the upcoming 5 years a large part of KPN's private customer base can be considered appropriate target users for a plan like KPNcare as it addresses the aforementioned values. During all the studies conducted during the project the level of interest did not differ across age groups. Although younger people are generally more intensive data consumers, older age groups were surprisingly digital and should be included in this group of target users.

But the end user is just one of the many stakeholders that have been identified. Along with them the interventions must also be desirable for KPN, DSPs, energy suppliers, data centres and governments. Whilst the gains for individual users have been discussed more extensively the relation of other stakeholders to the concept need some clarification. For the ISP, in this case KPN, the concept holds clear benefits in the form of improved customer relationships, potential growth in market share and reduced demand on their network. This reduced load could also benefit other parts of the infrastructure such as the energy suppliers and data centres who are currently under pressure to expand their capacities at a rapid pace. For governments the interventions can bring about social benefits for their inhabitants whilst alleviating the infrastructure that they govern. Additionally, the implications for GHG-emissions can help governments to achieve climate targets and make progress towards sustainable societies. A last stakeholder that might not benefit immediately from the proposed concept are the DSP's. Decreasing the use of digital products and services means they will lose part of their customers, albeit that a decrease in use does not necessarily have to lead to consumers cancelling their memberships. But in the long run the DSP's might also gain from a more civilised approach to data consumption. As mentioned, the overconsumption of digital products and services also takes its toll on the employees of DPS's and their customer's values are an important factor in the experience that they provide through their products. In the end, the concept only aims to reduce data consumption and this way make interactions with digital products more pleasant and meaningful instead of banning them from our daily lives.

Effectiveness

Other than approaching the challenge from the right angle, the concept should also do this in a way that actually creates the desired effect. The initial goal of this project was to reduce climate impact through a change in behaviour around digital products and services. KPNcare should therefore be evaluated on the likeliness that the behavioural change will actually occur and how much climate impact could be reduced as a result. Starting with the behaviour, the framework introduced earlier can be consulted once more. The concept touches upon all three levels required to facilitate a change in habits but does so differently for each one, which can also be concluded from the fact that the design goals are not evenly spread out across the levels. Given the fact that the topic of data consumption is still very new and only a handful of people is aware about the impact of their usage, this is also the first step that many consumers will have to make. That makes shaping the intention a vital requirement if a change in behaviour is to be made and an important hurdle for the concept to overcome. From the evaluation it seems likely that the concept is successful at shaping the attitude of the user and opening them up to start making a change. A potential barrier here could be the fact that the chosen lifestyle lenses can come with some negative connotations. Although it is getting more socially accepted, being an aware individual that champions other values than is currently the standard can lead to criticism and mockery, as is the case with changing diets. Being a conscious internet user could therefore also lead to demotivating criticism counteracting the progress made by the intervention. However, during the studies conducted in this project there was no indication that these sentiments exist around data consumption and neither did participants express any concerns related to this matter.

When it comes to shaping new habits KPNcare also seems suitable and offers some features that were well-received. It seems plausible then that the intervention can actually urge users to adopt new practices, however a big reason for this is the fact that the concept currently offers a monetary incentive. Although more incentives are provided, the prospect of saving money remains important and a hard requirement for some. While the intervention speculates with a variable tariff, it is still difficult to estimate how large the actual savings would be and it's likely that it will not be a large amount of money. To get a better estimation of how effective the concept would be, a realistic estimate needs to be derived and tested with customers to verify the current results. This is not to say that many will back out if savings turn out to be negligible as some even indicated that they are willing to pay more.

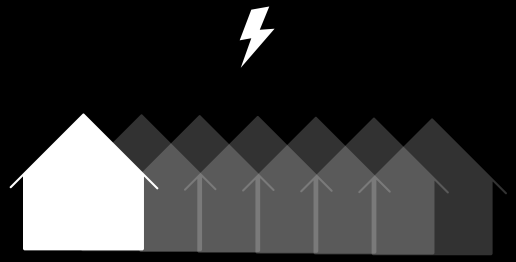
The last level requires consumers to control the new habit and make it stick. Again, various features of the concept support users in this endeavour and during evaluations they indicated that these features could become integrated into their daily practices. Whether this is really the case, even in moments were users are under significant cognitive load, remains to be seen as these features require additional effort from the user. The designed inconveniences walk a fine line between helpful barriers and frustrating ones and a change in mood could already tip the scales. This mainly concerns the boost and logging on features and underlines the importance of making these easily accessible. In the current setup, integrating the boost functionality into the smartphone interface through a pop-up was not estimated to be a serious inconvenience by the participants and neither was logging on or off with the router or in the app. To further avoid frustrations pop-ups like these could also become integrated in the interfaces of TV guides, laptops and PCs. Automating them through time-based events (i.e. logging in always at 7am) should be avoided however as users must still be urged to take conscious action. To give a decisive answer on whether the new habits will really be adopted additional tests in real life scenarios with higher fidelity prototypes are necessary.

Given the fact that the concept is at least somewhat effective at changing behaviour a rough calculation can be made estimating the potential benefits of the intervention. As the main goal of the project focuses on sustainability and the largest impact of the ICT sector is through its energy consumption, an estimate is given for the potential energy savings in kWh.

As was previously discussed, a fair amount of customers would be interested in an offering like this. To be more conservative we could say that about 10% will actually opt for the new plan and actively make use of it features. Levels of engagement will most likely differ across users but for the actual data saved we will use an average. Since it's difficult to give an exact measure of this average I will use my personal experience as a guideline. Over the course of this project I was able to track my data use through Glasswire

and by paying more attention to my usage and setting limits in the android wellbeing app I was able to half my monthly data intake, amounting to 20 Gb for my smartphone only. Before the start of the project I had already set some limits for myself and tried to reduce so the real amount for new users that use similar services is likely to be higher. If we add computers and TVs, the number will increase even more. For the purpose of this calculation we can say that the average potential savings lie around 30Gb per month for transfer of data. To that we must add the savings made by decreasing storage space and operating devices. In this scenario users of KPNcare will turn off their peripherals for an average of 12 hours a day (night time and some time during the day) and a reduction in use means they will use their devices less. Again this is being conservative as some examples showed that additional reductions in device use can be realised, such as swapping TVs for small speakers when listening to music. Lastly reductions in online storage can be realised. Exact numbers on total storage used per person are hard to find as it is usually spread out across multiple services but let's say the average person can delete 5000 emails and another 500 photos from their cloud if motivated to do so. From a back of the envelope calculation we then find that across all of the KPNcare user serious savings can be realised. The total amount, which comes close 240 GWh, is the equivalent of the electricity demand of almost 100.000 Dutch households. Savings that are realised by 350.000 users. These numbers are indicative only and should be taken with a grain of salt but at the same time illustrate that the immense potential of the interventions introduced. And next to saving electricity there are numerous other benefits to reducing our data consumption that add to the potential gains.

100.000x



Calculations

Transfer (including peripherals and user devices)
12 months * 30 Gb * 1,8 kWh/Gb = 648 kWh

Devices not in use
365 days * 12 hours * (4,5 W power router + 3,6W power tv box) = 35,5 kWh

Cloud storage freed
5000 *0,01 gCO_2 / 427 gCO_2 per kWh = 0,1 kWh
500 * 1 gCO_2 / 427 gCO_2 per kWh = 1,1 kWh

Total kWh per year saved: 684,7*

Total energy saved across KPNcare users
10% of 3.500.000 customers * 684,7 = 239,5 GWh

* this amount is highly speculative and for illustration purposes only. The average power required per Gb does not reflect the complexity of how energy is distributed across the whole internet as depicted in figure 3. In a real life scenario, numerous factors are of influence and can greatly affect the outcomes.

Sources:

- Average power use per Gb (Andrae & Edler, 2015; Greenwood, 2020).
- Power saved by turning of router (Mills, 2021)
- Power reduced when TV box is in ECO mode (kpn, 2021)
- Emissions of storing email and photos (Vodafone, 2018)
- Emissions per kWh (CO_2 emissiefactoren, 2022)
- KPN customer base (Hulshoff Pol, 2022)

In the current setup however, the prototype of the router used an disproportional amount of energy to generate this effect. Rated at almost 50W, this physical intervention will need to be redesigned in a way that it uses a considerably smaller amount of energy or it will counteract all progress made.

Feasibility

The concept of KPNcare is initially brought into life to provide an alternative view on the current interaction with data consumption and scope out possible opportunities to make a change in the dominant mindset. To asses these opportunities the feasibility of the proposed interventions needs to be discussed as well.

A first challenge in the implementation concerns the plan itself and the flexible payment system. While this type of subscription is standard for water and energy it is new to the telecommunications sector. Given the fact that the amount of reimbursement that can be given might not be large, the plan could not be competitive enough when current subscriptions offering higher speeds and unlimited data are still available. At the same time, the more tailored approach to data plans can be a unique selling point in itself because of the added social value. Still, to give a subscription like this a fighting chance, campaigns and regulations could be implemented on a national level that discourage the use of 'abundant' plans and favour moderate use. This can go hand in hand with the corporate social responsibility initiatives that the concept proposes for the KPN website.

A second challenge lies within the features of the app. To provide the insights displayed in the usage tab a lot of information needs to be tracked and calculations need to be made similar to the one that estimates the effectiveness. Tracking this data itself seems to be possible as various apps already do this like the Glasswire app and digital wellbeing apps of android and iOS. But whilst using the Glasswire app I did run into some problems; Apple products often do not allow access to data about app usage, usage can hardly be tracked whilst operating from a VPN and for these apps to work the software needs to be installed on all devices that the user wants to track. But this is also where part of the potential for KPN lies as all this information already passes through their network and the router should be able to log this information given that some modifications to the device and software are made. To track usage on mobile networks or other wireless networks that are not in the home of the user the app still relies on access to the devices and some software needs to be installed. Since this will only be the case for mobile devices such as smartphones, which will already have the app, and laptops, this shouldn't be tedious or complicated to set up. VPN connections remain a concern however but they are mostly used for work related activities. For many participants in the evaluation, work related data consumption was not something they wanted to reduce as it is often unavoidable.

Another important aspect concerns the storage of all this data. As this information can be considered privacy sensitive KPN needs to make sure that it is kept securely and is not used for any other purposes than providing feedback to consumers. Along with that all the extra data should not take up too much space as it will otherwise mitigate some of the energy saving. Timely deletion of older data and the use of sustainable data centres are paramount to preventing this.

To make the calculations that provide the user with insights, the industry will have to establish some averages like the kWh/Gb figure shown earlier. These include averages for devices' power use per hour and averages for power consumed per Gb, which varies between the type of application (i.e. streaming vs. cloud storage). Since the network is so complex these numbers will never be really precise but for the purpose of educating consumers and providing insights they should suffice. As KPN has a lot of information about the network already and partners that can supply them with additional insights, they can have an important role in this process.

A final point of discussion is the design of the new router. Opposed to the website and app, this piece of hardware comes with greater costs and technical challenges. To facilitate the boost functionality the router must be able to artificially limit bandwidth to user devices. This is already possible on the mobile network of KPN as their fair use policy sets back users to a lower speed if they exceed the limit of 8Gb per day. Not yet a possibility in current software, this should also be possible for Wi-Fi networks. A second concern might be that turning of the router at night will interfere with the rising amount of SMART home appliances such as security cameras. In the proposed design users are able to select 'essential devices' that are always connected but what implications this has for energy saving is still unclear. As of yet there is no energy saving mode that only allows these essential devices to be connected whilst still operating at lower power. Besides that, logging off might not have the desired wellbeing effects due to the fact that mobile network still operate at night. Users will have to turn these off at night too if they wish not to have any connection. Luckily this can easily be done via so-called 'bedtime modes' that automatically turn off mobile data at a given time.

Lastly, the current design features many LEDs and rotary encoders to create the desired interaction. Whilst this works for the prototype and allowed the hypotheses underlying the concept to be tested the final design needs to feature a more simple interface with fewer parts. This will keep costs low but also prevent a lot of GHG-emissions from being emitted as the production of digital products counts for a large share of the total emissions caused by the ICT sector.

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CONCLUSIONS

Based on the earlier research and findings from the valuation this chapter will summarise the main outcomes of the project by proposing a final design and identifying implications for the stakeholders within the project context.

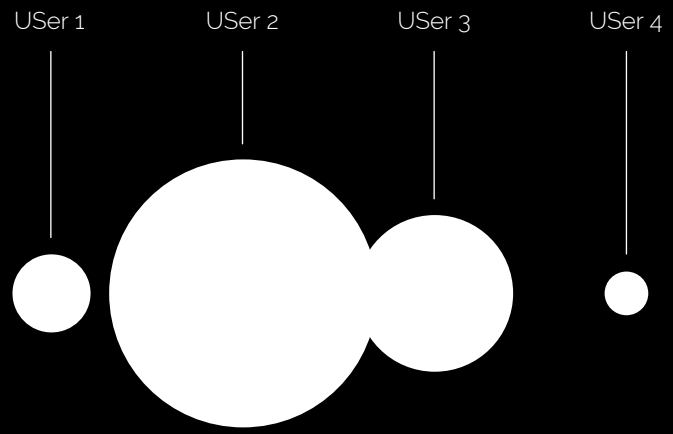
FINAL DESIGN

The evaluation made clear that the current concept and it's design need to be modified in order to be successful. In this final iteration the router is redesigned and some suggestions are proposed for the website and app.

In order for the router to be a feasible product the amount of additional hardware needs to be reduced. Along with that the overall look and feel needs to be less prominent for user to actually embrace it into their living spaces. The original grid of 240 LEDs is therefore reduced to smaller LED spots consisting of 3 to 4 LEDs. These spots are placed behind a mesh of fabric where the harsh light is softened into smooth circles. Instead of the colour in the painting, the circles grow when more data is consumed and eat away at each other's space while doing so. The circles correspond to the buttons on the top which still feature the colours of the members in the household. By using bigger push buttons that are either up or down depending on their position, it can be easily seen who is logged in or out. Because the buttons are now integrated in the device itself the 'keys' can no longer be lost or forgotten. The overall shape of the router resembles that of the most recent router, the KPN Box 12, so that most of the current parts can be transferred into the new. To add to the homely aesthetic, wooden legs are added and the front is covered in a soft fabric.

With these changes an attempt is made to make the design blend in more yet retain the qualities of the original prototype. Despite it being smaller and less provoking the circles still give a simple and low key visualization of the usage in comparison to that of others. Because the circles intersect, the feeling of 'hoarding' the bandwidth by taking it from others is still there and serves as a deterrent for using too much. The changes should also lead to significantly lower energy costs, both in use as well as in production. With four users the white-only LEDs will use no more than 4 Watts, keeping the additional operating energy to a minimum. This will still mitigate any savings made by turning the device off when not in use but all other savings still make for significant gains in energy consumption.

For the website and app two additional features are proposed. The wellbeing page on the website needs to be expanded to also cover the topics around online misbehaviour. Examples from the often harsh discourse by trolls, other forms of cyberbullying and perverse activities can be utilised to make it relatable and impactful. The app needs to better accommodate the actual use scenario where it is only accessed once a week or month to check up on the progress. The current graphs and figures provide a lot of depth but need too much interpretation before any action can be undertaken. In the final design, the app will give users an weekly overview containing the progress on their goals, a comparison with the usage from the previous week and a tailored tip based on the data of that week. If in a given week the user has streamed a lot of video or music on their mobile data, the overview could propose the idea of pre-downloading playlists and series on the home network to save energy. That way the app educates on concrete steps that consumers can take in an unintrusive manner and gives them time to actually do it. If any progress is made, the results will be visible in the overview of the following week.



IMPLICATIONS

Next to the proposed intervention the design and research activities have led to a number of insights. Based on the findings new areas of research can be identified as well as concrete steps that need to be undertaken to ensure that the global demand for data does not negatively impact people and planet. In this overview these outcomes are laid out from the perspective the physical network, service providers (ISP and DSP), people and politics.

The network

The total amount factors that influence the energy that flows into the internet is extremely large and makes assessing the impact on the environment infinitely complex. When looking at the sector as a whole however, it is clear that this impact is far from small and that we should look critically at the digitalisation of our societies. Current trends move towards an omni-present internet that provides us with unlimited opportunities but looking forward a more moderate use scenario holds great promises for both users and environment. This project has identified three main areas of opportunity where the physical network that makes up the internet can accommodate energy savings by finetuning it to suit real use scenarios.

1. Peak shaving

Because the network is built to facilitate peaks of usage, it demands more power when demand is low, and more hardware is required. If usage can be spread out across the day by downloading in advance or using at a different time, this could reduce the total energy and material costs of the network. Syncing this interaction between user and network could lead to serious savings.

2. Limiting uptimes

The network is always on, even when parts of it might not be used. A photo in the cloud needs to be always accessible, even when it's only viewed once per year. Through technological advancements these low use phases are made more efficient but it is also worth exploring how parts of the internet could be turned off all together. If clearer distinctions are made between dark data and data that is frequently accessed, a large part of total server space could be shut off over long periods. Further investigations could also look into downtime of websites during the night when they get fewer visitors.

3. Slowness

The proposed concept pushed forward the idea that higher speeds are not always necessary. Currently, advancements in technology lead to higher demands because of improved efficiency and increased speeds. If speeds are limited for scenarios where this is not a necessity this will partly discourage the rebound effects of updated technologies and holds serious potential for energy saving. Not only is it interesting to delve into use scenarios where speeds could be limited but also the role of hardware requires further investigation. How the network can accommodate these variations in speed and distribute the available bandwidth across internet connections in a smarter way is an interesting direction for new research.

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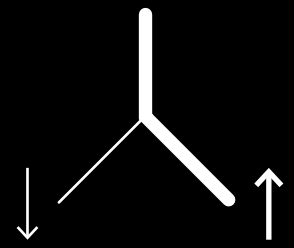
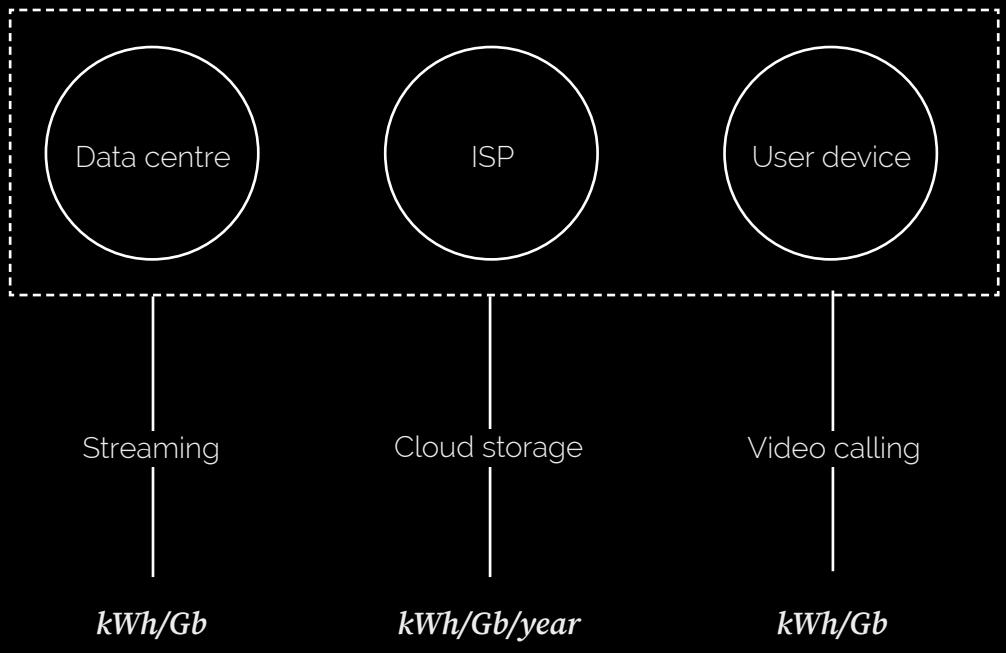


During the project also became clear that estimations on the energy use of individuals are hard to come by. In order to understand how individual users impact environmental factors and give shape to interventions that minimise this impact, a set of averages for given use scenarios should be established. It is important that these averages paint a complete picture by using wide system boundaries and include energy used across the whole network, also in the production phase of infrastructure and devices. With all their knowledge, KPN could take up a leading role in this process.

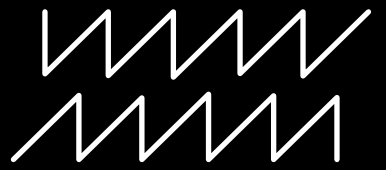


Service providers

Businesses offering digital services and products also play a big role in the current surge for data. Besides connecting people with all the benefits that the internet has to offer and providing users with valuable applications, they also stimulate addictions and propagate the idea that the internet is infinite. This limitless mindset is pushing the boundaries of both material resources as well as the biological limits of humans. By breaking with this way of thinking the project proposes four concrete guidelines for service providers to adhere to.

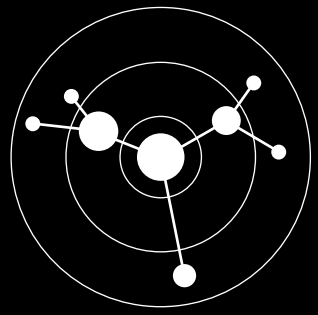
1. Allow for friction

The design of modern-day digital products is centred around the idea of seamless interactions where work is done for users through automation. Changing the perspective to one where the interaction is seen as a cooperation between users and technology will give back some of the control consumers and help them act in line with their personal goals. As opposed to seamless solutions, this calls for the (re)introduction of a certain level of friction in digital interactions where users are required to make an effort and work together with the product or service to achieve their goals.



2. Extending corporate responsibility

The costs of running these products and services are not evenly distributed across the stakeholders. Consumers are forced to place routers and other devices in their homes that use electricity and digital service providers like Netflix rely on both user devices and infrastructure for their products to work. Although it is difficult to attribute these costs to individual businesses it is important that service providers take up responsibility for the impact they cause at the other stakeholders. With KPN already taking initiative with efficient set-top-boxes, all service providers must make sure that the hardware and software their products make use of across the entire network also adhere to company policy.

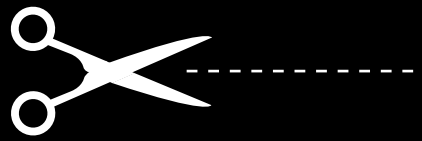


3. Integrating sustainability in UX design

Over the years UX design has become increasingly visual and therefore also more energy intensive. Despite the fact that batteries have increased in size, mobile devices' battery life has not. Bloat in websites and apps could be reduced to benefit the environment and decrease the required computing power necessary to operate them. By designing in a leaner way, sustainability can become integrated in the design of digital products and services.

4. Tailoring the offering

By moving to subscription models service providers are increasingly offering limitless use plans. For many consumers, limitless is far more than they need and leads to either harmful overconsumption or users that pay more than necessary. Taking into account social values like wellbeing and sustainability, it is in the interest of both parties that the offering is tailored to the needs of the consumer.



Politics

Online interactions have partly become harmful because of a lack of regulation. The speed at which the ICT sector advances has outpaced governments and unions in making policies and has resulted into an absence of rules and guidelines. During the project several areas have been identified where policy makers could intervene.

First of all, standards should be introduced to more accurately measure the social impact of digital products and services. Already mentioned are averages that allow us to estimate environmental impact. An international legislative body could verify these averages and make sure that a standard protocol is setup for measuring them. Along with that, rating systems such as energy labels should start to include IoT products and additional labels can be setup that inform about other social harms (i.e. warnings about addiction when downloading social media apps).

Secondly, governing bodies should see to it that the guidelines for service providers are adhered to. By introducing international rules all businesses will have to change at the same time which will prevent individual businesses from losing customers to the competition when they stop employing addictive features. To change an industry that is so competitive it cannot be expected from individual players to take the lead.

A last point concerns the overseeing of data infrastructure. Recently the Dutch government has started to regulate the construction of data centres on a national level but the internet goes further than a country's borders. To prevent big tech companies from simply moving their business to the cheapest plot of land, the construction of this kind of infrastructure should be overseen from an international perspective to make sure that it is done in a way that is desirable for our society as a whole and does not stress energy infrastructure.

People

Besides the impact on our planet, the superfluous consumption of digital services hits consumers the most. The current way of interacting with the internet can be categorised as unregulated and careless and despite the fact that many are negatively impacted the general attitude towards digitalisation is deterministic. As users we should embrace the digital future and all its promises. The research suggest that a counter-movement should be established where internet users become actively involved in shaping digital interactions.

A first step in getting involved could be to make decisions in daily use scenarios more explicit. In many cases users act out of habit but do not really want to consume more data. Breaking these habits and informing people about the impact of the internet can lead to more conscious decisions that benefit the consumer.

Next to making conscious decisions these trade-offs need to be brought into the public domain. Internet usage generally goes unnoticed as the web is very immaterial but this hides our behaviour from others. This stands in the way of an open dialogue about how we would like to use the internet and how much usage is desirable. Re-establishing the connection between our virtual behaviour and the real humans that cause it could help us to be more thoughtful in online interactions and introduce social norms to the digital world that help us care for others and ourselves.

Lastly, the education on the social impact of excessive internet use should become integral in the upbringing of children. Growing up in an era where information technologies are already present and will most likely become even more dominant in the future, children should be taught how to deal with the omni-presence and abundance of information. If the current trend where more digital products and services lead to increases in mental and physical illnesses continues, the negative impact of IoT systems and 5G technologies could have disastrous consequences for our wellbeing, let alone the environment.

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EPILOGUE

REFLECTION ON THE PROJECT

At the start of the project I set out with a clear ambition; to give an alternative for the cornucopian thinking that is so dominant in the technological industry. But by delving into personal experiences with the technological products that I love and learning about those of others, the project has become a lot more than that. It became clear that the technology is not only regarded as a solution for everything but this solution is forced upon users, often without them even knowing. The logic of the digital world strips users from ethics and morals and makes us behave in ways that we would not want others to know about. With the proposed way of thinking that emerges from this project I hope to empower those who feel helpless in the face of the digitalisation and bring these human values to the digital world. Because digital applications also come with a great set of benefits, as has also become abundantly clear during the research. Connected with the rest of the world, we are now part of a network that holds an infinite amount of opportunities and literally broadens our horizon, we just need to learn how to use it. As evolution does not happen in a matter of decennia, this will take more time than the current advancements give us.

This balance between technology and human values is something that intrigues me deeply and I now know that I wish to continue working on bringing value to technological innovations. But designing for this balance proved quite challenging, especially whilst also respecting the interest of a service provider like KPN. To champion human values in a world of efficiency and optimization requires a idealistic mindset, but to translate this into a design that also makes sense in such a competitive industry has given me quite some headaches. In the end, the ViP approach has really helped to boil down my research into a workable statement and after some iterations the final design has come quite close to a realistic design whilst still embodying the radical thinking of the worldview. Along with that, the coaching has also helped me to stay close to my own research and remain ambitious with my ideas and concepts.

Next to employing these radical and speculative approaches to design I also wanted to work on my storytelling and visualisation skills. Taking inspiration from journalists and writers of non-fiction, I have tried to craft a moving and relatable narrative that convincingly presents the research. The narrative really helped me to not only communicate my work to others but also immersive myself into the world of complexity around data consumption and come out with a concrete set of goals. The narrative is personal and shows a subjective interpretation of the data which means that it is merely one way of looking at the current context. By comparing multiple views on the topic, I hope that my work can contribute to a more universal and nuanced set of goals and guidelines for online behaviour.

To conclude, there is one paradox underlying the concept that still needs to addressed. By using data to reduce data, the intervention can be seen as 'a gadget against gadgets', something that only reinforces the dominant position of data-driven design. I have encountered this problem more often in projects and it has often left me dissatisfied with the end result. At the start of the project I wanted to avoid data-driven solutions like this but now I have come to a different conclusion. Although I still believe there is some truth to this and we should be very mindful when using data in designs, I also think it is not the means that is the issue here but rather what the design aims to achieve. By centring the design around real world value conflicts and translating the data into accessible, low-key visuals I hope that the concept will educate people and empower them to take back control, rather than fulfilling our cravings for information.

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REFERENCE

A

Amazon Inc. (n.d.). Welcome to Prime Video. Retrieved April 16, 2022, from https://www.primevideo.com/?ref_=dvm_pds_amz_NL_lb_s_g_mkw_slKDXRpp6-dc_pcrid_518127078430&mrntrk=slid__pgrid_123814849384_pgeo_9064516_x__ptid_kwd-296879212490

Andrae, A., & Edler, T. (2015). On Global Electricity Usage of Communication Technology: Trends to 2030. Challenges, 6(1), 117–157. https://doi.org/10.3390/challe6010117

Apica Systems. (2013, December 10). Page Bloat: What Should We Do About It? https://www.apica.io/page-bloat-what-should-we-do-about-it/

Apple. (n.d.). Use Screen Time on your iPhone, iPad, or iPod touch - Apple Support. Retrieved July 13, 2022, from https://support.apple.com/en-us/HT208982

B

Belkhir, L., & Elmeligi, A. (2018). Assessing ICT global emissions footprint: Trends to 2040 & recommendations. Journal of Cleaner Production, 177, 448–463. https://doi.org/10.1016/j.jclepro.2017.12.239

Bender, E. M., Gebru, T., McMillan-Major, A., & Shmitchell, S. (2021). On the dangers of stochastic parrots: Can language models be too big? FAccT 2021 - Proceedings of the 2021 ACM Conference on Fairness, Accountability, and Transparency, 610–623. https://doi.org/10.1145/3442188.3445922

Bhamra, T., Lilley, D., & Tang, T. (2011). Design for Sustainable Behaviour: Using products to change consumer behaviour. Design Journal, 14(4), 427–445. https://doi.org/10.2752/175630611X13091688930453

C

Carbon Trust. (2021). Carbon impact of video streaming.

Catherine McNally. (2018, July 9). The World's Guiltiest Online Pleasures Revealed | Reviews.org. https://www.reviews.org/trends/worlds-guiltiest-online-pleasures/

CO2 emissiefactoren. (2022, January 14). Lijst emissiefactoren | CO2 emissiefactoren. https://www.co2emissiefactoren.nl/lijst-emissiefactoren/

Corbett, C. J. (2018). How Sustainable Is Big Data? Production and Operations Management, 27(9), 1685–1695. https://doi.org/10.1111/poms.12837

Costenaro, D., & Duer, A. (2012). The Megawatts behind Your Megabytes: Going from Data-Center to Desktop.

Coulombel, N., Boutueil, V., Liu, L., Viguié, V., & Yin, B. (2019). Substantial rebound effects in urban ridesharing: Simulating travel decisions in Paris, France. Transportation Research Part D: Transport and Environment, 71, 110–126. https://doi.org/10.1016/J.TRD.2018.12.006

Courtney E. Ackerman. (2022, March 25). What is Instant Gratification? A Definition + 16 Examples and Quotes. https://positivepsychology.com/instant-gratification/

CSS Insight. (n.d.). Mobile Phone Sales Are in Decline – CCS Insight. Retrieved April 9, 2022, from https://www.ccsinsight.com/press/company-news/mobile-phone-sales-are-in-decline/

D

DeGeurin, M. (2022, March 25). TikTok Ex Moderators Sue Over On the Job Trauma. https://gizmodo.com/tiktok-ex-moderators-sue-over-on-the-job-trauma-1848704856

Dreier, T. (2017, March 22). 73% Binge Watch, 99% of Young Adults Multitask While Viewing. https://www.streamingmedia.com/Articles/News/Online-Video-News/73-Binge-Watch-99-of-Young-Adults-Multitask-While-Viewing-117132.aspx?CategoryID=430

E

European environment agency. (2021, March 9). Europe's consumption in a circular economy: the benefits of longer-lasting electronics — European Environment Agency. https://www.eea.europa.eu/publications/europe2019s-consumption-in-a-circular/benefits-of-longer-lasting-electronics

G

Gonny van der Zwaag. (2020, May 15). Netflix gaat weer normale streamingkwaliteit aanbieden in Europa. ICulture. https://www.iculture.nl/nieuws/netflix-normale-streamingkwaliteit-europa/

Google LLC. (n.d.-a). Digitaal welzijn - Apps op Google Play. Retrieved July 13, 2022, from https://play.google.com/store/apps/details?id=com.google.android.apps.wellbeing&hl=nl&gl=US

Google LLC. (n.d.-b). Our Commitment to Sustainability | Google Sustainability. Retrieved April 16, 2022, from https://sustainability.google/commitments/

Greenwood, T. (2020, August 26). Why do estimates for internet energy consumption vary so drastically? https://www.wholegraindigital.com/blog/website-energy-consumption/

H

Heleen Ekker, & Nando Kasteleijn. (2021, December 15). Megadatacenter Facebook zet extra druk op al grote energievraag | NOS. https://nos.nl/artikel/2409557-megadatacenter-facebook-zet-extra-druk-op-al-grote-energievraag

Hulshoff Pol, F. (2022, February 21). Omzet en klantenaantal KPN stabiel in lastig 2021 - Techzine.nl. Techzine. https://www.techzine.nl/nieuws/infrastructure/478610/omzet-en-klantenaantal-kpn-stabiel-in-lastig-2021/

J

Jody Macgregor. (2019, May 7). The pressure to constantly update games is pushing the industry to a breaking point | PC Gamer. https://www.pcgamer.com/the-pressure-to-constantly-update-games-is-pushing-the-industry-to-a-breaking-point/

K

Kate Crawford, & Vladan Joler. (2018). Anatomy of an AI System: The Amazon Echo As An Anatomical Map of Human Labor, Data and Planetary Resources. In AI Now Institute and Share Lab. AI Now Institute and Share Lab. https://anatomyof.ai/

Klaniecki, K., Wuropulos, K., & Hager, C. P. (2019). Behaviour Change for Sustainable Development. In Encyclopedia of Sustainability in Higher Education (pp. 1–10). Springer International Publishing. https://doi.org/10.1007/978-3-319-63951-2_161-1

Koomey, J. G., Berard, S., Sanchez, M., & Wong, H. (2011). Implications of historical trends in the electrical efficiency of computing. IEEE Annals of the History of Computing, 33(3), 46–54. https://doi.org/10.1109/MAHC.2010.28

Kulche, P. (2022, March 1). Wat is een adblocker? | Consumentenbond. De Consumentenbond. https://www.consumentenbond.nl/internet-privacy/wat-is-een-adblocker

KPN (2021). Internal report by Nordkamp, H. & Genuchten van, R.

KPN n.d. Internal report by van de Berg K.

KPN (2022). Market intelligence report by Martens, C.

L

Lischka, J. A., & Garz, M. (2021). Clickbait news and algorithmic curation: A game theory framework of the relation between journalism, users, and platforms. New Media and Society. https://doi.org/10.1177/14614448211027174

M

Mad fish digital. (n.d.). Capture & Engage Your Audience with Visual Content. Retrieved April 11, 2022, from https://www.madfishdigital.com/blog/engage-your-audience-with-visual-content/
Marsden, M., Hazas, M., & Broadbent, M. (2020). From One Edge to the Other: Exploring Gaming's Rising Presence on the Network. ACM International Conference Proceeding Series, 247–254. https://doi.org/10.1145/3401335.3401366
Matrix, S. (2014). The Netflix Effect: Teens, Binge Watching, and On-Demand Digital Media Trends. Jeunesse: Young People, Texts, Cultures, 6(1), 119–138. https://doi.org/10.1353/jeu.2014.0002
Media Nest. (n.d.). Wat is ASMR? En zijn ASMR video's wel zo onschuldig? | MediaNest. Retrieved April 12, 2022, from https://www.medianest.be/wat-asmr-en-zijn-asmr-videos-wel-zo-onschuldig
Medical Association, A. (2020). Steroid Shots and the Culture of Instant Gratification. https://doi.org/10.1001/jamaoto.2020.3413
Mensing, G. (n.d.). Uber - an exponential business model. Business Models Inc. Retrieved April 16, 2022, from https://www.businessmodelsinc.com/exponential-business-model/uber-an-exponential-business-model/
Meta. (n.d.). Data Centers - Meta Sustainability. Retrieved April 16, 2022, from https://sustainability.fb.com/data-centers/
Microsoft. (2017, September 22). A cable stretching 4,000 miles between the US and Spain is the key to a high-speed future. Microsoft News. https://news.microsoft.com/europe/2017/09/22/a-cable-stretching-4000-miles-between-the-us-and-spain-is-the-key-to-a-high-speed-future/
Milieu centraal. (n.d.). Energielabel apparaten. Retrieved April 15, 2022, from https://energielabel.nl/apparaten/
Mills, M. (2021, June 23). Verbruik van een router die altijd aan staat: ontdek het jaarlijkse verbruik | ITIGISCH. https://itigic.com/nl/consumption-of-a-router-always-on-discover-the-annual-consumption/
Morley, J., Widdicks, K., & Hazas, M. (2018). Digitalisation, energy and data demand: The impact of Internet traffic on overall and peak electricity consumption. Energy Research and Social Science, 38, 128–137. https://doi.org/10.1016/j.erss.2018.01.018

N

Nagle, Y. K. (2020). Encyclopedia of Personality and Individual Differences. In Encyclopedia of Personality and Individual Differences. Springer International Publishing. https://doi.org/10.1007/978-3-319-24612-3
Netflix investors. (2021, July 20). Netflix - Overview - Long-Term View. https://ir.netflix.net/ir-overview/long-term-view/default.aspx
Ning, Z., Kong, X., Xia, F., Hou, W., & Wang, X. (2019). Green and Sustainable Cloud of Things: Enabling Collaborative Edge Computing. IEEE Communications Magazine, 57(1), 72–78. https://doi.org/10.1109/MCOM.2018.1700895

O

Ouders van nu. (n.d.). Beeldschermtijd: hoe lang computeren en tv-kijken? | Ouders van Nu. Retrieved April 13, 2022, from https://www.oudersvannu.nl/kind/spelen/beeldschermtijd/

P

Petit, V., Carlini, S., & Avelar, V. (2021). A bottom-up forecast of the IT sector energy consumption and carbon footprint Digital economy and climate impact Introducing our Sustainability Research Institute.
Pfauth, E., Verkade, T., & Hofstede, B. (2016, April 21). Prestatiemaatschappij - Gelukkig zijn in een wereld die draait om succes - De Correspondent. De Correspondent. https://decorrespondent.nl/10001/prestatiemaatschappij-gelukkig-zijn-in-een-wereld-die-draait-om-succes/28396958021861-a36175b2
Plant, R. (2004). Online communities. Technology in Society, 26(1), 51–65. https://doi.org/10.1016/J.TECHSOC.2003.10.005
Potts, R., & Sanchez, D. (2009). Television viewing and depression: No news is good news. Https://Doi.Org/10.1080/08838159409364247, 38(1), 79–90. https://doi.org/10.1080/08838159409364247
Preist, C., Schien, D., & Shabajee, P. (2019, May 2). Evaluating sustainable interaction design of digital services: The case of YouTube. Conference on Human Factors in Computing Systems - Proceedings. https://doi.org/10.1145/3290605.3300627

R

Radar. (2022, March 21). Veel Ziggo-klanten hebben stroomslurpend tv-kastje in huis | Radar Checkt! - Radar - het consumentenprogramma van AVROTROS. https://radar.avrotros.nl/uitzendingen/gemist/item/veel-ziggo-klanten-hebben-stroomslurpend-tv-kastje-in-huis-radar-checkt/
Rensselaer Polytechnic Institute. (2020, August 20). Let Your Brain Rest: Boredom Can Be Good For Your Health. https://www.newswise.com/articles/let-your-brain-rest-boredom-can-be-good-for-your-health
R.E.O.S. (2019). Ruimtelijke Strategie Datacenters.
Ring. (n.d.). Collecties – Ring. Retrieved April 16, 2022, from https://nl-nl.ring.com/collections
Ristic, B., Madani, K., & Makuch, Z. (2015). The water footprint of data centers. Sustainability (Switzerland), 7(8), 11260–11284. https://doi.org/10.3390/su70811260
Samsung. (n.d.). Samsung Family HubTM | Samsung US | Samsung USA. Retrieved April 16, 2022, from https://www.samsung.com/us/explore/family-hub-refrigerator/overview/
Schofield, S. (2020, January 21). How much data do Netflix, YouTube and Spotify use? How streaming affects your mobile internet allowance. INews. https://inews.co.uk/news/technology/data-netflix-youtube-spotify-how-much-streaming-video-music-mobile-internet-allowance-388089
Schwartz, S. H. (2012). Unit 2 Theoretical and Methodological Issues Subunit 1 Conceptual Issues in. Psychology and Culture Article, 11, 12–13. https://doi.org/10.9707/2307-0919.1116
Steijaert, M. (2018, January 19). Een ode aan de verveling: waarom het goed is af en toe niets te doen te hebben. De Volkskrant. https://www.volkskrant.nl/wetenschap/een-ode-

aan-de-verveling-waarom-het-goed-is-af-en-toe-niets-te-doen-te-hebben~bf054bd6/

T

Technical University of Denmark. (2019, April 15). Abundance of information narrows our collective attention span. Journal of Nature Communications. https://www.eurekalert.org/news-releases/490177

The New York Times. (n.d.). Cambridge Analytica and Facebook: The Scandal and the Fallout So Far. The New York Times. Retrieved April 13, 2022, from https://www.nytimes.com/2018/04/04/us/politics/cambridge-analytica-scandal-fallout.html

V

Vaccari, C., & Chadwick, A. (2020). Deepfakes and Disinformation: Exploring the Impact of Synthetic Political Video on Deception, Uncertainty, and Trust in News: Https://Doi.Org/10.1177/2056305120903408, 6(1). https://doi.org/10.1177/2056305120903408

Vince, G. (2018, April 3). Evolution explains why we act differently online. BBC Future. https://www.bbc.com/future/article/20180403-why-do-people-become-trolls-online-and-in-social-media

Vodafone. (2018, April 21). Trenn Dich von Deinem Datenmüll – der Umwelt zuliebe. https://www.vodafone.de/featured/inside-vodafone/trenn-dich-von-deinem-datenmuell-der-umwelt-zuliebe/?b_id=1416&c_id=Content_cba_A01:fq0_G_gen_sta_non_Awa_featured_trenn-dich-von-deinem-datenmuell-der-umwelt-zuliebe&j_id=ConConAwaA01G|NonNon000|fq0genstanon

W

Walnum, H. J., & Andrae, A. S. G. (2016). The internet: Explaining ICT service demand in light of cloud computing technologies. Rethinking Climate and Energy Policies: New Perspectives on the Rebound Phenomenon, 227–241. https://doi.org/10.1007/978-3-319-38807-6_13/TABLES/1

White, K., Habib, R., & Hardisty, D. J. (2019). How to SHIFT Consumer Behaviors to be More Sustainable: A Literature Review and Guiding Framework: Https://Doi.Org/10.1177/0022242919825649, 83(3), 22–49. https://doi.org/10.1177/0022242919825649

Widdicks, K., & Pargman, D. (2019, June 10). Breaking the cornucopian paradigm: Towards moderate internet use in everyday life. ACM International Conference Proceeding Series. https://doi.org/10.1145/3338103.3338105