Breaking the Cornucopian Paradigm: Towards Moderate Internet Use in Everyday Life

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ABSTRACT

The Internet and digital devices are increasingly embedded in our everyday lives. The hidden environmental impacts of this infrastructure are substantial and quietly growing at an increasing rate. Our collective Internet use is following a 'Cornucopian paradigm', which is unsustainable. And yet, while intentionally limiting our online connectivity might be seen negatively as a retrograde step, in this paper, we offer ways in which users might welcome attempts to moderate their Internet use through improving four aspects of our digitally-mediated lives: relationships, digital wellbeing, productivity at work, and online privacy. Given these areas, we discuss how our research agenda may realistically be facilitated and what challenges we may face in moving from the reinforcement of 'business as usual' trends. By investigating and developing user-centred, moderate Internet use, we can 'break' the Cornucopian paradigm.

KEYWORDS

Internet use, data demand, sustainability, everyday life, Cornucopian paradigm, Internet moderations, digital wellbeing, relationships, work productivity, online privacy

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1 INTRODUCTION

The Internet is increasingly written into everything we do in European society: from the entertainment of yet another Netflix video, to interacting socially, controlling our homes via IoT, to the nebulous Cloud infrastructure that keeps our data safe and computes behind the scenes as we drive our cars. The Internet has become the seemingly irreplaceable mirror to our modern personal and professional lives. As a consequence, the demand for Internet data has grown, and continues to grow, year on year. To put this growth into perspective: globally the Internet carried an estimated 100 GB of data per day back in 1992; this increased to 2,000 GB *per second* by 2007, 46,600 GB per second by 2017, and is estimated *to triple* by 2022 to 150,700 GB per second [17, Table 1]. A significant portion of this traffic is streaming of video content (58% of global downstream traffic) with web, gaming and social media also being top contributors [74].

The growth in "data demand" and "online services" [50] has implications for the environment due to the subsequent growth in the underlying Internet infrastructure (data centres, communication networks, end-user devices). Estimates of the actual environmental footprint of this vary massively; and there is certainly much dispute as to how significant the problem of data demand actually is [3, 52, 76]. However, it has been argued that by 2030, 21% of our global electricity use is expected to be due to ICT [1]; and by 2040, ICT may even exceed *half* the global greenhouse gas emissions of the current transport sector today [9].

The relation of data demand to the environmental impacts of the Internet infrastructure has been described through the "Cornucopian paradigm" [67]. In simple terms, users' and businesses' explicit, or even unintentional, demand for data and services pushes the need for an expansion in the Internet infrastructure to cater for this demand. This expansion of the global network then allows for the innovation of Internet services, providing more bandwidth-intensive applications (such as video-on-demand, 8K definition video, live streaming, and cooperative gaming). These new applications offered by service providers are soon adopted by society and become the 'new norm'; this leads to another increase in demand, and hence the infrastructure growth cycle continues to revolve.

Given that continuous improvements to energy efficiency are made in the Internet infrastructure to keep up with its ever-rising growth, surely these efficiency gains must outweigh the growth in demand? Unfortunately not–current growth of the Internet is seemingly outgrowing efficiency gains [67]–and we will no doubt see further growth with the rise of the Internet of Things (IoT) and technologies that necessitate energy intensive computation, such as Bitcoin [20] and 5G connected cars.

In this paper we ask, *can we 'break' this Cornucopian paradigm* and avoid the unsustainable growth in footprint of the Internet? We focus on everyday users, and propose that their Internet and device use *could indeed be limited in ways that positively affect users* whilst also escaping the continuous growth cycle of the Cornucopian paradigm. Through designing for such *moderate use*, we envision a 'win-win' scenario for both users and sustainability: we offer four aspects of life that Human Computer Interaction (HCI) is currently already working towards improving where opportunity lies for *more sustainable* Internet use to be developed. We then detail how moderate Internet use *ideally should* and *practically could* be approached in today's Internet-fuelled society, and how we may make these idealised approaches practical through future work.

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2 BACKGROUND

There has been considerable focus in the literature about sustainability and the role Internet and digital technologies play in it. This work has included: potential limits (e.g. time) and significant drivers (e.g. machine-to-machine communication from IoT) of data traffic growth [39]; the need for both efficiencies in technology and user behaviour change for more sustainable Internet use [68]; and how networking technologies and associated software or hardware may cope in (or should be implemented for) futures of scarcity and collapse [42, 66, 69–71]. This can all seem quite daunting (and even pessimistic) for environmentally-conscious researchers who aim to promote more sustainable Internet use, particularly when the Internet crosses so many aspects of our lives.

In 2018, Mann et al. argued for a positive framing on issues of sustainability through "regenerative computing"–ensuring researchers in this field become "ambassadors of hope" [53]. Whilst Mann et al. believe the '(ACM) LIMITS community' provide the critical lens that computing needs for a sustainable future, they also argue that a more positive framing is needed to avoid defeatism and galvanise the community [53], e.g.: assuming our path towards a more sustainable society will filled with feelings of pain and guilt [45]; predictions of, and preparing for, "bleak futures" [65]; and viewing technological futures such as the sustainable smart city as potentially impossible [73]. To make Limits more 'positive', Mann et al. link to Gui and Nardi's argument of transitioning our focus on "less" for sustainable computing (e.g. less energy), towards the "mores" it can bring (e.g. empowerment, sustainable morals) [38]. With this framing, we aim to find positivity in Limits [53] by positioning that we can moderate users' Internet use and break the Cornucopian paradigm in ways that users might actually want.

To move HCI designs away from the Cornucopian paradigm, a number of ideas have already been proposed for promoting more sustainable use of digital services and technologies. These have included: designing for non-reliance on Internet services [5]; turning off network connectivity on mobile devices when screens are off [50]; and encouraging breaks from technology [89]. But how would these work in practice, and how would users react to designs like these? Blevis et al. have discussed the potential of a "Digital Day of Rest" [12] to create energy savings on one day of the week–however, this has limited utility. What happens if we don't access the Internet on each Sunday (reducing our data demand 'by one seventh'), but continue our trajectory of significant Internet growth every other day of the week? Or even cause a rebound effect of 'making up for lost data' on other days?

Preist et al. [67] provide a "Rubric for Infrastructural Effects" (extending the "Rubric for Material Effects" proposed by Blevis [11]) which provides a number of design considerations for service providers. Whilst they provide some specific recommendations (e.g. defaulting video streams to standard definition instead of HD, Ultra HD or 8K), their rubric while well intentioned, is relatively difficult for the HCI community to interpret and action. For example: "Does the service encourage a healthy relationship with digital technology, and avoid promoting inappropriate dependency on the digital infrastructure?" [67] - what relationship could be classified as 'healthy' and what dependency is 'inappropriate'?

With a pessimistic attitude, it seems that people without strong sustainability motivations will not do what is 'right by sustainability' unless it is also 'right by them'. If we asked you, the reader, to make significant changes to moderate your Internet use starting right now - would you? Even as authors and researchers in this area, we admittedly rely on the Internet 'too much' (e.g. author 1 streamed all 62 episodes of TV hit 'Breaking Bad' on Netflix in less than 2 months, despite just writing a paper about unsustainable streaming patterns [90]). However, if we can align users' goals with those regarding sustainability [91], it will become a lot easier to attain more sustainable Internet use whilst addressing 'other' problems at the same time. As a result, we present a new initiative in this paper to break the Cornucopian paradigm by creating more moderate and meaningful Internet use. We envision that we can build on other areas of HCI that aim to halt the negative effects of ubiquitous connectivity whilst promoting sustainability, making a positive and holistic research agenda that is worthwhile for HCI researchers and practitioners regardless of whether they want to better society or the environment. We provide a more detailed example of how we imagine this, in the next section.

3 BREAKING THE CORNUCOPIAN PARADIGM

What do we mean by *'moderate' Internet use* (and therefore data demand) which positively affects users? In this section we highlight four aspects of life that are actively being researched that we think could be improved by intentionally moderating Internet use: promoting better relationships, digital wellbeing, work productivity, and online privacy. Whilst we envision other research avenues can and will align with this problem, we have chosen to detail these particular four concepts as our empirical work investigating data demand has started to link to these [90, 91]. Through more holistically working across these research fields, we envision interventions to data demand that can be incorporated into HCI designs which help or positively affect the user. This will help avoid the constant increases in demand which are pushing unsustainable Internet infrastructure expansion, and move to 'break' the Cornucopian paradigm.

3.1 Relationships

Our digital lives unquestionably affect our relationships with others, including family, friends and even people with whom we have "weak ties" [31] with, e.g. acquaintances. We increasingly turn to digital devices, and expect more from technology than each other [85]. Device use in the presence of others can cause frustrations for couples and family members [62], tensions can build between families when devices are used during mealtimes [61], and parent-child relationships can be challenged through parents' managing their children's 'screen time' [30, 40]. A partner's psychological reliance or need to be constantly connected with their smartphone can lead to lower satisfaction in romantic relationships [49].

To encourage people to spend less time on their phones and more time together, different businesses and places have begun to 'ban' or ask users to put away smartphones e.g. at restaurants [8], schools [36], and even for discounts on hotels [41]. These non-technological approaches show how users may in fact want, or

even need, to have their connectivity and device use managed on their behalf to maintain or improve their relationships. HCI and technology could be designed in which 'ground rules' for the use of Internet-connected devices are implemented for all our relationships (personal or professional) in different places and times (home, workplace, holidays, etc.); helping ameliorate our reliance on, and demand for, Internet services and data traffic.

3.2 Digital Wellbeing

Our wellbeing is another aspect of our lives impacted by digital devices and online activity. Whilst technology may be utilised for maintaining well-being (e.g. promoting mindfulness [93], or self-tracking [4]), the devices and services *themselves* can be problematic to users' wellbeing. There are often stories in popular media reflecting genuine concerns about how technology is impacting us negatively (e.g. through gaming addictions [7]), with an emphasis on social media and the young [37]. To create better relationships for users and their devices, social media users have been known to take breaks from such services to enhance their well-being [79]; this 'unplugging' from "computer-mediated-communication" can create positive outcomes for users if adopted temporarily [83]. Research in this space has also investigated what negatively impacts users in their digital lives; e.g. alerts and notifications can reduce user attention span [48], and addiction is often associated with social and communication mobile app use [21]. To promote health, researchers have begun exploring software designs for reducing time spent in applications [64], avoiding "mindless forms of interaction" [18], and more broadly designing for digital wellbeing[1].

Digital wellbeing designs have started to emerge in the popular operating systems and services of tech giants Apple [2], Google[2] and Facebook[3]. This is clearly a response to demand from users for technologies to help enhance their wellbeing through moderating use of technology. For example, Apple's iOS 'Downtime' design allows users to specify periods of time at which only certain apps are accessible [2], aiming for users to spend time away from their mobile device screen. We see designs like these as prime opportunities to leverage breaking the Cornucopian paradigm. For example, background data demand could be avoided by turning Internet connectivity off during downtime periods, and downtime sessions could be actively promoted and extended through designs aiming to avoid user-initiated data demand.

3.3 Work Productivity

Our working lives have been transformed by email and other digital systems that make communication easier and encourage productivity. This has led to a number of research projects investigating the impact of HCI at work, including: how email affects employees and their work [47, 56]; how devices and their software allow workers to take "micro-breaks" [81]; examining the effect of "sleep debt" on students' Facebook use and work productivity [55]; how employees' constant connectivity is used as an economic service [58]; how 'nomophobia' (the anxiety of being unable to use your smartphone) can both positively and negatively affect work productivity [87]; and creating and exploring the effects of productivity tools [44, 54]. Productivity tools (e.g. StayFocusd[4], Forest[5]) for managing work focus are publicly available and are being adopted.

Taking an example 'closer to home', University 'writing retreats' in academia [60] provide opportunities for researchers to physically leave the usual office environment with a group of academics to concentrate on writing papers, grants or other tasks. Given our experience of these, writing retreats are a great way to be productive and get work done; this is because disconnecting from email and the Internet is usually a requirement or is encouraged, and writers are held accountable by each other to ensure they write 'enough' in focused time periods (e.g. using the Pomodoro technique [16]). This is another example of how we attempt to 'disconnect' in everyday life, but for means of work productivity. By implementing moderate Internet use into working lives, we could potentially benefit users by enabling them to be more productive whilst reducing our demand for data that influences the Cornucopian paradigm.

3.4 Online Privacy

Our consumption of online data, through the use of digital technologies, has implications for the data collected about us. Data privacy and awareness has received a lot of attention by the HCI research community in recent years, including work on: understanding users' behaviours for protecting their privacy online [29, 46, 51, 75]; highlighting the role of personalisation and information transparency in interfaces for user trust and experience [15]; using comics to facilitate better understanding of service agreements [82]; applying game-based methods to discover how families want their "Family Civic Data" to be managed [13]; discovering reactions to controversies of shared data by social media and communication services [26]; uncovering the explanations behind targeted adverts to users [25]; and exploring the privacy issues and perceptions of voice-driven technology [28, 59]. Concerns of privacy and trust have also lead researchers to develop tools which help users better protect their privacy [92] and expose the data collected about them [86]. In terms of policy, the General Data Protection Regulation has been introduced to better protect users' and the privacy of their data[6]. In the media, our online privacy has come under scrutiny given the Cambridge Analytica scandal [35]–leading to Facebook being involved in a lawsuit for their breach of users' data [34].

Guidelines have been positioned to help users take steps to protect their online privacy (e.g. by The Guardian [33], TNW [88]). These strategies include emphasising to users that they should be aware of the data that they share online and how this is used. With this in mind: could the avoidance of data sharing, or even the resistance of online service use, be the best way to minimise personal data being accessed via the Internet? Limiting data this way would protect users from potential, or significantly detrimental, data breaches. By promoting moderate Internet use, we can encourage users to carry out fewer personal data transmissions online and therefore reduce the data demand that is impacting our environment.

[1] **https://digitalwellbeingworkshop.wordpress.com/**
[2] **https://wellbeing.google/**
[3] **https://www.facebook.com/safety/wellbeing**
[4] **https://chrome.google.com/webstore/detail/stayfocusd/laankejkbhbdhmipfmgcngdelahlfoji?hl=en**
[5] **https://www.forestapp.cc/**
[6] **https://www.gov.uk/government/publications/guide-to-the-general-data-protection-regulation**

4 ACTIONING MODERATE INTERNET USE

We now discuss how to take the core idea of positive framing of limiting data demand forward in two ways. Firstly, we outline the ways in which designs that attempt to moderate Internet use should 'ideally' be incorporated, implemented and evaluated in everyday life. Secondly, and drawing upon our previous work to date investigating this topic, as well as the inherent barriers we anticipate to our proposals, we highlight the realistic constraints that may resist our proposals within our current society. There are obvious conflicts with business models; in terms of balancing control between machine and user; and in actually implementing or evaluating designs due to technical issues or problems that will need to be addressed. As a result, we discuss how such designs could practically be introduced and popularised given society's current expectations and tools.

4.1 Incorporating Moderate Internet Use into Business Models

4.1.1 Idealistic Approach. In our idealised world, service providers should design applications and services that help users limit their Internet use. They should create responsible, ethical and sustainable designs—utilising these aspects as a deliberative selling point to keep customers and profit. Moderate Internet use would be especially relevant for bandwidth-intensive activities such as streaming content (watching, listening), social networking and online gaming [74, 89]. Moderation would need to be implemented across a range of devices (smartphones, tablets, smart TVs, IoT etc.) to work completely in today's multi-device and multimodal society. A good place to start in this area would be the social issues in recent media as discussed in the previous section. For example, companies could explicitly address binge watching [19] or gaming disorders[7] to design more moderate and meaningful user experiences that protect both the user and the environment.

4.1.2 Practical Approach. The idealised situation clearly challenges businesses and core business drivers head on. Use and engagement is linked to revenue either directly, or by marketising users' attention for advertising. It's difficult to believe that such service providers would welcome designs that encourage limiting this. Currently, in HCI, it's no secret that companies follow design patterns which intentionally facilitate 'persuasive' behaviours, e.g. the 'Fogg Behaviour Model' (FBM) suggests designs should: 1) motivate users to use the service; 2) simplify the design to make it as easy to use as possible; and 3) introduce 'triggers' that push users to perform a specific behaviour in the moment [27]. These designs encourage users to spend *more* time on their devices, carry out more actions on the service, and hence may lead to behaviours which are more 'profitable' for the company. By way of example, Amazon sends regular emails to customers that provide 'one click' buttons to items the customer might like or has previously viewed; these are intended to get users back on the site to purchase those items. This design encourages Internet use and may contravene users' moderation goals e.g. if a user wants to spend less money.

Designs that aim to moderate users' Internet use would enable more responsible and sustainable business motives and therefore can be posed as a potential ethical selling point. However, such designs may hinder business profitability. For example, if Amazon were to avoid sending these 'one click' product emails, users are less likely to visit the site to purchase these items and therefore Amazon could potentially lose out on custom. Even more so, if their competitors (such as eBay) were still sending these emails, it may be more likely that users would transition to using their competitors and hence further damage profit gain.

4.2 Implementing Users' Freedom of Choice

4.2.1 Idealistic Approach. Moderations of users' Internet use should only affect users in positive ways, i.e. adapt Internet uses when users are happy for their Internet uses to be adapted. This requires sophisticated contextual awareness, meaning that Internet use should only be facilitated, if: 1) at a time suitable for the users; 2) at a place where users can cope with Internet limits; and 3) for services that do not disrupt their necessary uses of the Internet [91]. When a user begins to moderate their use, they could be involved in a setup process (e.g. a baseline study, or survey) to help the design 'understand' the user and define the initial characteristics of the Internet usage limit. To update users' patterns of moderate Internet use as they develop, designs could take advantage of learning algorithms (as like other sustainable HCI research [43, 80]) to predict users' routines and feelings towards Internet use over time. Designs could also encourage user reflections surrounding their goals towards moderate Internet use; users should always believe that technologies and services are helping them, and should never feel as though they are being controlled.

4.2.2 Practical Approach. This is a notoriously difficult balance to achieve in practice! Finding the balance between helping users and acting on their behalf (e.g. limiting their use) is going to be challenging. Taking tools for productivity as an example, there are variations of how much control users have for operating such software. 'Cold Turkey', a software tool to block "time-wasting websites, games and applications"[8] (e.g. at specific times or after a certain time limit has passed), cannot be deactivated; StayFocusd, a Chrome browser extension that blocks access to certain sites however, can easily be bypassed (e.g. by disabling the extension, or using an alternative browser such as Safari). Here lies a tension between the user being controlled, or being in control.

We do not necessarily think allowing technologies to take total control away from users is the way forward—this is too close to questions of censorship that limits users' freedom of choice. However, leaving moderate Internet use fully in the control of users is also counter-intuitive: if the moderating design is too easily ignored, it will be too easy for participants to revert to their usage norms (e.g. as like users (re)lapsing from aims of reducing or removing their Facebook use [6]). Hence the user-benefits of moderating Internet use will not be achieved. It could be that there's only 'so much' that HCI researchers can do, with the success of moderate Internet use relying upon the user. Ensuring success is especially difficult as users' routines of, and feelings surrounding, Internet usage change over time. How do we ensure that designs do not fall into the trap of the 'novelty effect' for users, and how much control

[7] `https://www.who.int/features/qa/gaming-disorder/en/`

[8] `https://getcoldturkey.com/`

can be given to machines if users have provided consent? We see that methodologies to create balance between being *controlled* and being *in control* is an important avenue to explore further in HCI.

4.3 Evaluating Moderate Internet Use Designs

4.3.1 Idealistic Approach. Any design proposals must clearly be tested and evaluated with end-users to determine their efficiency, ideally for a sufficiently long time to understand genuine adoption (e.g. a year) [72]. For example, Okeke et al. developed an intervention with 68 users' whereby their smartphone vibrated after a user had spent 'too much time' using Facebook [64]. Ideas like this could clearly be programmed into such applications and deployed via app stores. Moderate Internet use tools could also gather useful interaction and quantitative data to aid in its evaluation (e.g. the number of times a user interacts with the tool features, the data demanded by device, the data demanded by the app in which it is affecting) and advertise calls for users to participate in feedback surveys. This qualitative data would uncover more detail about the utility and acceptability of the positively-moderated Internet design, and help uncover nuance that the quantitative data alone could not provide; for this data, we suggest effort should be made to recruit types of users who would appreciate help in moderating their Internet use and those who would not.

4.3.2 Practical Approach. Software based interventions such as this are a potentially effective way of gathering longitudinal, large scale data from a wide audience. However, current restraints that mobile operating systems place to preserve energy, ensure inter-application security and the privacy of user data, are making these types of 'background' software increasingly difficult to implement. For example, only specific types of apps can run continuously in the background (e.g. music players, location trackers) on Apple's iOS[9], so logging device actions and data demand in real-time is no longer possible unless 'disguised' as a permitted background-execution app (which would then be subsequently rejected from the App Store). Furthermore, to the best of our knowledge, access and control of certain device settings (e.g. turning off mobile data and Wi-Fi) to save upstream network demand is restricted on Android and iOS without breaking the standard operating systems protections (such as jailbreaking the devices). Without access to these controls, any design would not be able to make a difference to data demand. More control of Wi-Fi access could be provided at the home-router level (e.g. using OpenWrt routers[10]), yet this clearly places a significant deployment burden–most likely leading to a much smaller number of participants.

There are also challenges in measuring the effectiveness of these designs, since the data logged for its evaluation may even be difficult to analyse. For example, just to associate data demand to Android apps, the app names on Android would need to be mapped to names which are contextualised and understandable by humans (e.g. 'com.facebook.katana' is Facebook, 'com.facebook.orca' is Facebook Messenger). This is similar to if a design was created at the router level, as services would have to be parsed from domain names (e.g. YouTube is at least associated with the domains 'youtube.com' and 'googlevideo.com'); this becomes increasingly difficult when content is provided by Content Delivery Networks (CDNs e.g. Akamai) which host a variety of services' data. Manual mapping processes have been taken in previous research [89, 90], but these would not be appropriate for large-scale deployments.

5 MAKING THE IDEAL APPROACHES PRACTICAL

How can we overcome the barriers we have discussed regarding incorporating, implementing and evaluating HCI designs that focus on moderate Internet use? We propose that there are a number of avenues in which this research community could explore in future work to address these barriers, and ensure that our more idealistic approaches to moderate Internet use designs become practical opportunities. We discuss these in turn below.

5.1 Seek Virtuous Synergies

We should seek to explore what moderate Internet uses users may actually want that simultaneously provide opportunities to decrease data demand and reliance on the Internet. A valid starting point for this exploration would be to carry out a meta-review of HCI research to create a plethora of 'moderate-ready' research areas (adding to the four aspects we have already identified); these could then be more tightly linked to data demand, enabling researchers to easily factor sustainability-motivated amendments into designs already likely to find acceptability by communities of users. Possible areas of research could include health, social justice or fairness. Another route for exploring moderate Internet use could investigate how user-engaging interactions (e.g. 'dark design patterns' [32]) could be 'flipped' into moderate Internet designs (e.g. using BJ Fogg's model for "prevention" [27]), and evaluating these designs with users themselves.

Furthermore, we see great need for conducting studies to understand feelings towards Internet use in everyday life and what exactly 'moderate' Internet use may look like for different users e.g. through qualitative data capture. This could involve actively seeking and learning from users who: 1) already moderate their Internet and device use, whether through technical means (e.g. productivity tools such as Cold Turkey) or by non-technical solutions (e.g. digital detoxes[11],[12]); and 2) would be actively against moderate Internet use. Co-designing solutions with users would also be useful to uncover the right balance between users' freedom of choice and moderating their Internet use, and we see utility in encouraging reflection on how other people's use of the Internet affects users. Users may think there's nothing 'wrong' with how they use the Internet and devices, yet their family, friends or co-workers may feel differently–putting strain on relationships. Here an etiquette of Internet use may be established to positively affect relationships, and help users moderate their Internet use in ways which they may not have initially seen as necessary.

[9] **https://developer.apple.com/library/archive/documentation/iPhone/Conceptual/iPhoneOSProgrammingGuide/BackgroundExecution/BackgroundExecution.html**
[10] **https://openwrt.org/**
[11] **http://digitaldetox.org/**
[12] **https://www.itstimetologoff.com/**

5.2 Collaborate through Business Partnerships

It is important that researchers developing moderate Internet use discover how they could be made practical for businesses and how they might be incorporated into the services that are provided today. For example, how do companies create Internet services that encourage users to 'do business' with them, yet promote moderate Internet use and ensure users' do not become 'hooked' on their service? We suggest that collaborations and partnerships may be required to find the nexus between maintaining business needs and catering for users' needs. Yet, we posit that this collaboration is likely only possible with established businesses; start-ups with no existing customer base may be too vulnerable for advocating moderate Internet use whilst stabilising themselves in the market.

Business collaborations would also be significant in regards to actually testing and evaluating designs. Given the constraints that some operating systems place on controlling other applications, collaborating with major service providers would enable a variety of designs to be Beta tested more easily with a large group of their customers. Partnerships would also make it easier for gathering and analysing the data required to monitor the effectiveness of moderate Internet use designs. If permissions were granted, designers could gain a detailed understanding of the service providers' backend servers and data transmissions, therefore making it easier to categorise and calculate the traffic volumes of different application areas (e.g. video, communication). This is similar to how researchers have teamed up with the BBC [77] and Guardian News and Media Ltd [78] to measure the environmental impact of these online services.

5.3 Broadening Research Scope and Engagement

As some businesses may be reluctant to introduce moderate Internet use within the design of their technologies, researchers could engage with policy (as called for by other sustainable HCI researchers [14, 22, 23, 84, 90]) to ensure businesses comply with important changes or designs which form from this ethical and sustainable agenda. Recent developments in social media have called for such services to be better policed in the UK [37], therefore there may be opportunity to engage with policy makers in efforts to ensure these services specifically incorporate moderate Internet use designs. For moderate Internet use in other types of services (e.g. for music streaming, online shopping), more persuasion may be required. Economic benefits are often argued to be linked to Internet growth (e.g. broadband adoption leading to an average 0.3% rise in GDP per annum across the OECD region [63]), meaning moderate Internet use designs may just be too unrealistic to promote from a financially-strategic perspective of a company or country.

However, researchers in this area could investigate, and draw upon, how other places or countries (specifically developing countries) live or work with less reliance on Internet connectivity and online services (similar to studies investigating Internet adoption in Cuba [24], mobile data practices in South Africa [57], or Internet disconnections in Bangladesh [10]). This includes understanding the users of, and business model designs for, 'Lite' versions of services which are purposely made to demand less data, for example: Facebook Lite which strives to work for "2G networks and areas with slow or unstable Internet connections"[13]; Twitter Lite which has a "data saver mode to download only the images or videos you want to see"[14]; Spotify Lite which has a control screen to help users manage and limit their mobile data use for music streaming[15]; and YouTube Go that lets users choose the amount of data they use per video they watch[16]. Internet growth is only going to become more problematic with new norms of online service use and emerging technologies (e.g. IoT, cryptocurrencies), meaning we will need to build a "robust evidence base for policy makers" [90]; by drawing upon the experience and practices of countries or places less reliant on connectivity, we can better propose alternative futures for our use of Internet technologies and services to policy makers.

6 CONCLUSION

In this paper, we have begun to outline a research agenda to create more moderate and less data demanding use of the Internet to benefit both users and the environment, and move away from the Cornucopian Paradigm of increasingly data intensive design. Relationships, digital wellbeing, work productivity, and online privacy are all aspects of our digitally-mediated lives that could be improved by introducing more moderate Internet use. Yet, as we have discussed, this research agenda does not come without its challenges in regard to incorporating moderate Internet use into dominant business models, preserving users' freedom of choice, and evaluating such designs in HCI. Through the future work we have outlined, we hope that the HCI and sustainability community will make the ideal approach for facilitating moderate Internet use more practical in our current society, and help create better, more sustainable uses of the Internet in everyday life.

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