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ICT practices in smart sustainable cities

In the intersection of technological solutions and practices of everyday life

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Abstract— *ICT, information and communications technology, has radically transformed our world and is now an inextricable part of what it means to live a normal life as a citizen, at least in high-income countries. This has led to a situation where ICT has become so taken for granted that it has lost its visibility. While this development to a large extent has been driven by business opportunities, there is now also an increasing recognition of ICT as a possible solution to sustainability problems. There are however two major pitfalls of using ICT as a tool for sustainability that need to be addressed for its potentials to be realized. The first pitfall is environmental impacts of ICT, as well as the risk of lock-in effects and an increasing vulnerability. The second pitfall concerns the understanding of ICT as a neutral solution, rather than recognizing that ICT, as all technology, carries implicit values. Taken together, these two pitfalls imply a need for replacing the atomized and techno-biased understandings of ICT with an approach that recognize the larger socio-material, political and economic structure in which ICT is (thought to be) part. With the aim of contributing to such a shift, this paper proposes a practice-oriented perspective in order to explore the potential of ICT to contribute to sustainability, using the smart sustainable city discourse as our example. We define the concept ICT practices and discuss it from an interdisciplinary perspective and in relation to the sustainable smart city. We argue that by using ICT practices as a conceptual starting-point for analysis, both the technological and the socio-cultural components of the smart sustainable city discourse can become elicited, enabling a more explicit analysis of what assumptions this discourse rests on.*

Keywords—Social Practice Theory; ICT practices; Sustainability; Sustainable Smart Cities; HCI; Sustainable practices

I. INTRODUCTION

In 2013, the UN reported that there now are more people with access to mobile phones than clean toilets [1]. The same year, Business Insider estimated that by the end of that year, global smartphone penetration would have gone from 5% of the global population in 2009, to 22% - an increase of nearly 1.3 billion smartphones in four years. Information and Communication Technologies (ICT) has become one of the fundament of modern society, an interwoven part [2] of what it means to live a normal life as a citizen, especially in high-income countries. But more than substituting older ways of exchanging information and communication, ICT are causing fundamental changes to the organisation of society and everyday life, for example "In 2015, Uber, the world's largest taxi company owns no vehicles, Facebook the world's most popular media owner creates no content, Alibaba, the most valuable retailer has no inventory and AirBnb the world's largest accommodation provider owns no real estate." [3]Today, we do not only use ICT to get and stay in touch with friends and family, but also for playing games, shopping, planning trips, paying bills, dating, keeping track of our bodies, and to find and participate in communities of all sorts. Through smart metering, sensors in household appliances and vehicles, we also use ICT to monitor and control environment - but also to be controlled, or persuaded.

Besides being an inescapable component of modern life as we know it, ICT is also increasingly put forth as a possible remedy to predicaments related to sustainability, including ICT-enabled solutions to reduce greenhouse gas emissions in areas such as the power sector, transportation, agriculture and land use, buildings, manufacturing and in the consumer and service sector [4]. Through the concept of automation, ICT is framed as a way to do more with less, and through the concept of persuasion, ICT is framed as a way to do away with the deficits in knowledge and motivation that are seen as hindering the adoption of more sustainable lifestyles.

Within this emerging field of ICT for sustainability (ICT4S), there is an increasing interest in using ICT to make urban areas more sustainable. This interest is not surprising. The ongoing concentration of the global population to urban areas implies that these are of increasing importance for sustainable development at large – including both ecological and social aspects; "there can be no global environmental sustainability without urban environmental sustainability" [5:173]. Moreover, ICT has a recognised potential of

improving the environmental performance of the built environment without the need for more extensive changes of the urban fabric [6]. Using ICT in the operation of urban infrasystems is however not any novelty. ICT supported systems for making transport systems run smoother, to make buildings more energy efficient or for planning snow ploughing has been around for many years. What is new is the way these previously isolated ICT interventions are framed as being 'smart', as well as the way the concept of 'smart' has travelled from being associated with household appliances to become a concept attachable to entire cities. While the discourse of smart cities - or smart sustainable cities - is positive in that it urges the transcendence of previously siloed infrasystems, it does so from a technocratic point of view, implying that both the intended users of the ICT solutions, as well as the people needed to implement, install and manage these, are portrayed according to what is needed for the technology to function, if addressed at all.

This paper aims to 'socialize' the techno-biased discourse of smart sustainable cities. . Firstly, after a fuller introduction to the concept of smart sustainable cities, the paper explores the arguments for using a social practice point of departure when conceptualising how ICT can support more sustainable lifestyles. Secondly, the paper proposes ICT practices as a possible concept to be used to analyse the intersection of technological solutions in the smart sustainable cities, and practices of everyday life.

II. SMART SUSTAINABLE CITIES

Neirotti et al. [7] trace the roots of the concept of smart cities to what they call the "cybernetically planned cities" from the 60's, further developed in proposals for networked or computable cities in urban development plans from the 1980s onwards. An overview of the smart city literature reveals that most of it focuses on either specific types of technologies, specific opportunities and challenges, or specific domains of application [8]. According to de Jong et al. [9] the focus on 'smart' rather diverts from the environmental conceptions of the city and focusses on the infrastructure and information use [9]. Neirotti et al. instead points to "various urban domains" and "help[ing] cities making better use of their resources." [7:25]. Outside the academic body of literature, smart cities are also the focus of an increasing number of policy or policy-directed documents, developed by actors such as the European Union, the British Standard Institute, and the International Telecommunication Union [10]. Common to the definitions of smart cities proposed in these policy documents is a strong focus on citizens as the key beneficiaries of ICT investments.

Publications looking at smart cities from a more overarching or conceptual point of view include e.g. Townsend [11], Caragliu et al. [12], Neirotti et al. [7] and Piro et al. [13]. Common to all of these studies is that they define smart cities as places where ICT is used to improve the city, in one way or another. Key differences between definitions revolve around what parts of cities that is to be improved, for what purpose, as well as the relative emphasis on parts and purposes. For example Caragliu et al. [12] and Piro et al. [13] emphasises increased quality of life as a key purpose of smart cities, while Townsend [11] mentions both social, economic and environmental concerns, but without expressing any priorities.

Another difference concerns whether 'smart' is seen as normative concept, or as an instrumental concept which can be attached to a variety of other normative concepts such as sustainable, just or attractive [8].

Separating the concept 'smart' from the concept 'sustainable' implies that a city can be smart without being sustainable, and vice versa. Separating these two concepts also makes it evident that depending on how a sustainable city is defined, different ICT solutions will come across as relevant. As with 'smart cities' there is a plethora of understandings of what a sustainable city is. One reason for this is that sustainability is an inherently ambiguous, contested [14] and "dangerously vague" [15] concept. Sustainable can mean anything from a relative "better than the rest" to an absolute understanding of impact or performance levels. Sustainable can imply harm-reduction, zero-impact or net-positive contributions [16]. Sustainable can focus on the city as a living environment (internal sustainability) or the impact of the city on its environment (external sustainability) [17]. A second reason for the ambiguity is that also the concept of a "city" can be understood in a variety of ways. For some, the city is defined as being the built environment only, i.e. the buildings and infrastructures. For others, the city is understood to include also the resource flows in these infrastructures - electricity, heating, cooling, water, sewage and waste - and, in rare cases, consumption goods such as food, clothing and furniture. A third layer of variability emerges from the way environmental (and social) impacts are assessed and allocated, which can be done based on either the production or the consumption in a city [18]. Today, most proclaimed examples of sustainable cities use a relative definition of sustainability, focusing on harm-reduction of the built environment and a few selected consumption categories: direct energy use (kWh/m2 and year), waste (percent that are source separated), water (volume used per person and year) and local transport (percent made by other means than car). This implies that a large share of the environmental impact of the citizens is unaccounted for at the local scale. Looking for example at food and aviation, which seldom are included in sustainability profiling of urban areas, for an average Swede these two consumption categories alone stand for about 3 ton of CO_2(e) emissions per year [19]. Acknowledging the importance of urban areas as regards sustainability at large, not accounting for such large parts of the environmental footprint is a fundamentally unsustainable strategy. Another reason for including consumption in the definition of sustainable is the fact that the 'human factor', i.e. 'behaviour' or in other words the lifestyle of citizens, in many cases is as important as the environmental performance of technology when it comes to explaining levels of resource use (see e.g. [20]).

Using a clearly instrumental understanding of the concept 'smart', Townsend [11] defines smart cities "as places where information technology is combined with infrastructure, architecture, everyday objects, and even our bodies to address social, economic, and environmental problems". Similarly, ITU's Focus Group on Smart Sustainable Cities defines a smart sustainable city as "an innovative city that uses information and communication technologies (ICTs) and other means to improve quality of life, efficiency of urban operation and services, and competitiveness, while ensuring that it meets the needs of present and future generations with respect to economic, social and environmental aspects". [10]. In a similar line, Höjer and Wangel (2015) defines a smart sustainable city as "a city that 1) meets the needs of its present inhabitants; 2) without compromising the ability for other people or future generations to meet their needs; 3) and thus, does not exceed local or planetary environmental limitations; 4) and where this is supported by ICT." [8]. The ITU definition and the definition provided by Höjer and Wangel both bear obvious connections to the Brundtland definition of sustainable development as "development that meets the needs of the present without compromising the needs of future generations." [21]. However, the ITU definition is weaker in that it does not say anything about the intergenerational distribution of environmental goods and bads. Here, the definition by Höjer and Wangel is clearer, and comes quite close to how Girardet [22] defines a sustainable city as being "organised so as to enable all its citizens to meet their own needs and to enhance their well-being without damaging the natural world or endangering the living conditions of other people, now or in the future." [22:13]. This definition points to an understanding of sustainable as an absolute level of impact/pressure, and rejects atomized approaches to sustainability as something internal to the city. By way of including also impacts from consumption, this definition of a sustainable city implies an increased relevance for exploring how ICT can promote more sustainable lifestyles.

III. Social Practice Theory

In order to 'socialize' the discourse of smart sustainable cities, this paper uses social practice theory as a basis for conceptualising how ICT can support a more sustainable lifestyle. The practice turn within social and philosophical theory has given rise to an entire ecology of practice approaches and theories [23-25] with a common trait in seeing practices as arrays of human activity, which are embodied, mediated by materials and organized around shared practical understanding [24]. Within this field of thought, social practice theory distinguishes itself by its focus on understanding how practices and norms are established and changed. Rather than seeing norms as mainly stemming from the mind, social practice theory highlights how norms are enacted, rationalized and institutionalized through social practices. Drawing on Shove et al. [26] social practices are constituted by a variety of 'elements' that are integrated when the practices are enacted. Practices thus emerge, persist and disappear as their defining elements are made and broken [27]. The elements that make up a practice are typically conceptualized as three categories: material, competence and meaning. A practice is the interplay between material(s), knowledge of how to manoeuvre the material and the images and meanings attached to this. Another important feature of a social practice is its performative dimension. This means that practice only exists when being performed, because it is then and only then that the three types of elements become interrelated, thus constituting the practice in question. A social practice is thus dependent on its practitioners and can only continue to exist if it can, if not attract new, than at least retain practitioners. A third aspect that distinguishes the social practice approach from other strands of practice theory is the emphasis on the material elements. This is also what makes social practice theory such an interesting point of departure for exploring what role ICT can play in the formation of everyday life [28]. As aforementioned, it is when the links between elements are altered or new links or elements appear that a practice can change. This means that for ICT to become part of a social practice it has to be accompanied by or connected to both image and meaning, and competence and skill.

Practice theory poses other questions than the traditional deficit-based explanatory models of why people do as they do. These deficit-based models typically point at a lack of knowledge, engagement or moral as the explanation for unwanted behaviour. Practice theory opposes narrow and top-down definitions of rationality and instead takes as starting point that people do what makes sense for them to do. This, in turn, makes it possible to explore why this way of doing makes sense. A practice-based approach turns the tables from top-down to bottom-up, thus facilitating exploring how ICT can be used to make cities more sustainable as regards the practices of its citizens.

IV. ICT practices

With a starting point in social practice theory, we argue there is a need to focus on a particular set of practices connected to ICT. By shifting the focus from practices in general, to what we here have chosen to call ICT practices we seek to highlight the material element of the social practice and show the role ICT plays in constituting different practices. This is very much in line with Shove and Walker [29] who argue that we, in order to make energy use visible, need to recognize energy as an element of social practice. Hence, in order to make ICT visible, ICT must be used as the defining element of the practice. Indeed, since all practices are constituted by a number of element, one and the same practice will always be possible to organise into other conceptual categories as well, e.g. energy practices highlights the material element of energy and practices of cleanliness highlights the image element of being clean [27].

A. Defining ICT practices

How, then, can we conceptually define what constitutes an ICT practice? A first, quite fundamental question to address is

what kind role or influence ICT should have in a practice for it to count as an ICT practice? We do not argue that there is a clear demarcation; rather the prerequisites for being an ICT practice can be viewed as a continuum.

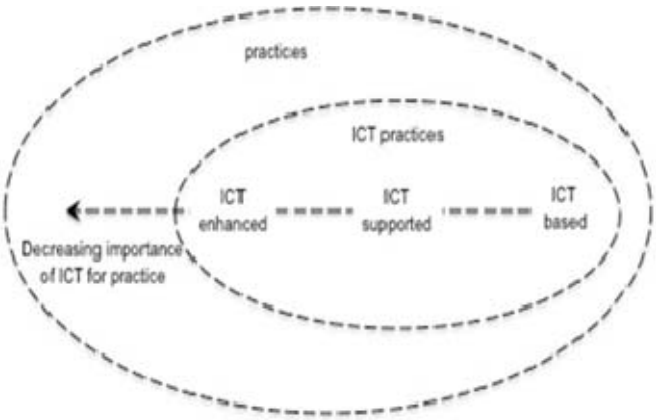

Figure 1. ICT practices are understood as a continuum and a subset of practices. The direction of the arrow shows a decreasing importance of ICT for performing the practice.

An ICT practice can be anything from being so strongly connected to ICT that it cannot be performed without it (such as sharing pictures globally and instantly as is made possible by the app Instagram), to being ICT supported (such as planning a journey, paying bills or booking tickets) or enhanced by ICT (through for example gamification such as going for a run with the app Zombies, Run![30]. In all these examples, ICT is present as a material element; an artefact that mediates the activity. However, the level of integration of ICT in a practice must be understood in relation to not only its material aspect, but also the other two elements constituting practices: competence and meaning.

The purpose of placing ICT practices on a continuum is that it not only helps capture 'pure' ICT practices (such as Instagram-ing or playing videogames) but also helps to illustrate the way ICT have become integrated in our everyday lives. Røpke and Christensen [31] note that although ICT is being 'used' in a variety of consumer products, such as cars and washing machines, the dominating areas of ICT related practices are entertainment, social communication and mundane administrative tasks of private and work life. Indeed, whether an ICT practice is enacted and understood as ICT based, supported or enhanced varies across cultures and individuals. What is an ICT based practice for some, might for others be a practice in which ICT is not used at all. Yet, integrating ICT in everyday life is at the core of the vision of a smart sustainable city. In order to realize this vision, more and more practices will need to include ICT as material elements. And more and more people will need to adopt these practices.

In order to further develop the conceptual definition of ICT practices we chose to look to systems theory. Within this field, Churchman [32] uses an action-oriented approach when delimiting a system from its surroundings and bases this on two questions:

1. Does it matter to my objectives?
2. Can I do anything about it?

If the answer to both questions is yes, then it belongs to the system. If the answer to question 1 is yes and the answer to question 2 is no, then it belongs to the system's surroundings.

When developing a definition of ICT practices these questions can help provide a useful delimitation, but only if the issue of agency is taken into consideration. Translated to an ICT practice setting and thus opening up for more distributed versions of agency these questions and the interpretation of answers could be specified as follows:

1. Does it (a specific ICT) matter to the objectives of the practice?

If there is no ICT that matters to the practice I am about to perform, then it is not an ICT practice.

2. Can the performers of the practice (at least theoretically) do anything about it (the specific ICT)?

If the performers of a practice cannot make use of the ICT in performing a practice, then it is not an ICT practice. One example of such an ICT could be a device for automated control of ventilation without any possibility for interaction. (We do however wish to point out that automated control of ventilation of course also could be seen as part of social practice in the sense that the shared notions of what is considered an ideal indoor temperature have evolved over time together with technologies to achieve it.)

Taken together this means that it is the meaningful use of ICT that is needed to constitute an ICT practice. This leads us to the following definition:

An ICT practice is a recurrent situated action where ICT is experienced as a meaningful material element for performing that action.

The abovementioned definition of what could constitute an ICT practice is not only to be used in order to define whether a practice could be seen as an ICT practice or not. By using a social practice theoretical lens, this definition could also play an important role in understanding how, and in what way already existing practices can be changed. That is, how can existing ICT practices be made more sustainable, and how can existing practices be made more sustainable through ICT? A social practice theoretical lens implies that for an ICT to become part of a practice it needs to be related to existing or created images with attractive connotations, but also to a set of skills needed to perform the practice (with ICT). In some communities of practice these skills are already in place, in others they need to be developed (cf. the digital divide).

V. Discussion

We have thus presented a definition of ICT practices and will now go on discussing the concept in relation to ICT development, sustainability and sustainable smart cities.

A. ICT practices and ICT development

Turning to the field of Human-Computer Interaction (HCI), where the design, development and use of computer technology comprise the main foci, we argue that the concept of ICT practices can particularly strengthen and expand an emerging focus on practice within the field, and hence contribute to a richer understanding of the use, and correspondingly the design and development of technology.

Within the field of HCI, it is argued that the main and dominant focus long has been the interaction between individuals and computer systems, what is called the 'interaction paradigm' [33]. The focus on interaction has led to a rather ahistorical and momentary type of research, where for example the context of use and work practice has been included, but still is seen as a separate variables influencing interaction [33]. Furthermore, the research has mostly been concerned with observing work, and from that attaining implication for design for work life [34]. ICT practices could in this context open up the research topics to include other areas of life and to include other elements of development than the interactional aspects of ICT. However, the HCI field has gone through a number of developmental phases or waves, where practice already has become more prominent. But it is not until the allegedly third wave of HCI research that practices have been addressed to a higher degree [35]. The third wave engages in a life world where computers are widely dispersed and used in everyday life. It should be noted though that practice oriented research within HCI predominantly have focused on work practice rather than the practice in general, where the prominent body of work practice research within the Scandinavian school of participatory design is one clear example [36]. It could be argued that the distinction between work practice and the practice of lived life is dissolving, not the least through the pervasiveness and mobility of technology use enabled by advances in ICT [37]. One example of HCI research aimed at addressing everyday practices is the work by Lehtimäki and Rajanti [38] who promote co-design with local stakeholders through local handcrafts in order to address users everyday practices.

Since the aim of this paper is to address sustainability issues, we argue that we need to broaden the perspective of practice to encompass all of our life, both working life and private life. There are already calls to do this within HCI sustainability research, for example Tomlinson et al. [39] who argue for addressing the practices of lived life in order to inform the research on collapse informatics, how to plan and prepare for a future of scarcity. Another example is the arguments made by Brynjarsdottir et al. [40], who criticizes the use of persuasive technologies in sustainability research, and calls for replacing behaviours as the analytical foci to practices. Another example is the special issue of TOCHI (Transaction of CHI (Computer-Human Interaction)) on "Practice-Oriented Approaches to Sustainable HCI", where the including papers are a "set of works which approach sustainability by shifting the primary unit of analysis from individual action to everyday practice" [41].

More recently Kuutti and Bannon [33] have argued for defining a paradigm of research on practice, opposing the earlier mentioned interaction paradigm. Furthermore, Kuutti and Bannon implicitly, and sometimes explicitly argue that what the HCI field should research (within the practice paradigm) is computer-supported practices [33], however, without providing any definition of what computer-supported practices could be. The concept of ICT practices could provide such a definition, in this way contributing to the development of the emerging practice research program within HCI. ICT practices could also broaden the discourse of ICT in design and development of technology, especially in relation to smart solutions for sustainability.

B. The role of ICT practices in smart sustainable cities

As aforementioned, the definition of 'sustainable' provides a cognitive frame for understanding of which smart solutions are relevant. If, on the one hand, a sustainable city is defined as an urban area in which the built environment is resource efficient, then 'smart' will comprise ICT solutions for automation. If, on the other hand, a sustainable city is defined as an urban area in which the footprint of consumption does not exceed a certain level, then 'smart' will imply ICT solutions addressing also consumption habits, by way of information, persuasion and gamification. The contemporary smart sustainable city discourse aspires to address both infrasystems and lifestyles, but is strongly techno-biased [42, 43]. While there are well-elaborated proposals for technological solutions, and to some extent how these are intended to be used, [44] the heterogeneity and complexity of everyday life is remarkably often neglected. Moreover, the solutions are typically aimed an ideal type of human being, emerging from the male-biased technocratic dreaming of engineers and policy-makers. The idea of this individual and rational "resource man" [43] is however not unique for the smart sustainable city discourse, but is a recurring character in many sustainable development agendas addressing consumption, behaviour or lifestyles [45, 46]. While "resource man" might be an appealing understanding of how people function, this simplification is a problematic shortcut. Numerous studies have shown that to understand patterns of consumption (and how to change them), it does not suffice to focus the logics of (bounded) economic rationality. Social, cultural and institutional dimensions also need to be taken into consideration [47-50]. Additional criticism against contemporary smart city agendas is lifted by [51], who argues that the smart city agenda is underpinned with ideas of authoritarianism instead of harnessing the reality of urban life.

Subsequently, there is a need to address the smart sustainable city, not only from the technological possibilities of ICT - building smarter solutions because we can - but from a practice point of view, taking into account the lived life in the city in order to plan for a smart sustainable city. Focusing on practices rather than the agents or the technology per se also leads to "new means to investigate the dynamics of

(un)sustainability" [41]. According to Pink et al. [52] practice theory "has enabled a critical departure from notions of the individual rational actor that underpin some understandings of behavior change" [52]. Shove & Walker [29] point out, that present practices are taken for granted and assumed implicitly to not change in policy documents and scenarios, thus leading to the focus being to become more efficient with the help of technological solutions and more consumer awareness. A social practice based point of departure could also help in addressing second order effects of ICT, such as rebound [53].

C. Sustainable practices?

Social practices can be more or less sustainable and even unsustainable. Social practices can also differ in how many people share and perform it, which in turn also has implications for environmental sustainability. If sustainable practices are able to recruit practitioners on a larger scale there is a lot to be gained, but for this to happen sustainable practices need to be facilitated through all of its integrative elements and in this article we are stressing the material element in the form of ICT.

So, what does it mean for a practice to be sustainable? From a social practice point of view a sustainable practice can be interpreted as a practice in which (parts of) the image element is sustainability. Thus, eating vegetarian food in order to lose weight would not count as a sustainable practice, while doing the same in order to save the planet from carbon dioxide emissions would. Based on this, a sustainable ICT practice could thus be defined as a practice in which ICT as a material element is meaningful in relation to the image element of sustainability. The drawback of this understanding is that it does not say anything about the actual sustainability of the practice at hand. Thus, it might be better to denote such practices as sustainability practices, rather than sustainable. Examples of ICT practices that falls into this category could be reading a digital magazine in order to save trees, shopping online in order to avoid going by car to the supermarket, or using smart metering to control the energy use at home. While all of these practices have clear sustainability connotations, there actual contributions in terms of decreased energy use and pollution are rarely assessed. .

A sustainable practice can however also be understood from an impact point of departure, i.e. based on whether the practice at hand actually can be said to be sustainable or not. From this point of view, and using the example of vegetarian food again, a practice of eating vegetarian food in order to save the planet, in which meat is replaced by dairy products (which, unfortunately has an almost as large CO_2(e) footprint as red meat), would not be sustainable. Since the climate system (unfortunately) does not react on ambitions but only to actual (cuts in) emissions, the impact point of departure might seem as the most feasible way to define what a sustainable practice is. However, for such an approach to be valid, it would have to take into account not only one but all practices of a person, which in turn would result in that what would count as a sustainable way to perform a specific practice would depend on in what ways other practices are performed. Indeed there is a possibility to use approximations by which estimations of approvable average impacts of practices could be used to benchmark what 'versions' of practices are to be considered as sustainable or not.

Another way to frame this is to instead talk about promising and problematic practices, respectively. From a sustainability point of view, promising practices would then imply practices that can be seen as being more sustainable than the business-as-usual, while problematic practices would be understood as practices, which are inherently unsustainable.

One example of a promising ICT practice could be the possibility for citizens to be able to work at a distance from their workplace. Not having to go to your workplace every day can be a way to reduce travel and transportation, especially if you go by public transportation or car to work and hence reduce both greenhouse gas emissions and reduce congestion in the city. Problematic ICT practices are perhaps easier to spot than promising since ICT in itself is environmentally problematic due to its energy consumption, short lifespan and the materials that ICT is made of. The mere fact that ICTs now are so integrated into our daily lives and thus leading to an increased energy demand, makes this a crucial issue to deal with. In a Danish report on young people's ICT practices it is however concluded that the ambivalence and interpretive flexibility noted among the young people about their usage of ICTs (being meaningful and important as well as waste of time) could form the basis for promoting more 'reflexive' and environmentally sustainable ICT practices [54]. What remains to be explored is how such sustainable ICT practices would look like, and how and to what extent such a development could and should be promoted, and by whom.

VI. Concluding Remarks

In this paper we have strived to explore and define the concept of ICT practices to link the technological perspective with the everyday practices in urban settings. We argue that ICT practice need to be viewed as a continuum, from practices that are so strongly connected to ICT that it cannot be performed without it, to practices being ICT supported or enhanced. Common to all these examples and thus demarcating the continuum is the function of ICT as a material element in the practice. Using systems thinking as the notion of meaning as tools for further demarcating ICT practices from other practices resulted in a definition of the concept that highlights the role of ICT as a meaningful artefact:

An ICT practice is a recurrent situated action where ICT is experienced as a meaningful material element for performing that action.

The concept of ICT practice is a strategy to move away from the techno-biased concept of ICT solutions. ICT solutions, or smart solutions, are a commonly used concept in the smart cities discourse is techno-biased since the denomination of an ICT as a solution is based solely on its technological potential. This means that the concept of ICT solutions fail to address

the social dimension of urban life, and even less so the complexity of socio-material entanglements. Thus, citizen and the practices of their lived life are excluded from the planning, development and implementation of ICT. In this paper, we argue that there is a need to address the smart sustainable city, not only from the technological possibilities of ICT but by also taking into account the lived life in the city.

An exception to this is policy or policy-directed documents on smart cities where a strong focus on citizens as the key beneficiaries of ICT investments can be found. However, in these document citizens as beneficiaries are mainly assigned a role as passive receivers of benefits. This points to yet another problem with the notion of ICT solutions as it only highlights deliberate use of ICT to address a problem, and not the way ICT have become a fundamental part of everyday life.

Social practice theory, which premises our concept of ICT practice, poses other questions than the traditional explanatory models of why people do as they do and opposes narrow and top-down definitions of rationality by instead starting out in what people do and makes sense for them to do. Social Practice theory aims at answering questions revolving around how norms are established and changed. This, in turn, makes it possible to explore why this way of doing makes sense. Furthermore, in using social practice theory in exploring the concept of ICT practices, we open up for addressing issues around skills/competence and meaning in practices with ICT, which can have profound effect on understanding change processes.

By using a social practice theoretical lens, the definition could also play an important role in understanding how, and in what way already existing (ICT) practices can be changed. This is important as it provides an entry point to understanding what role ICT can play in the transition to more sustainable cities. ICT does hold potential for making cities more resource efficient but for this potential to be realized rebound-effects resulting from increased volumes of ICT consumption and the third wave of household electrification must be abated. Energy is a finite and precious resource, especially if considering the need to replace fossil fuels with renewable sources of energy. Thus decreasing energy use is a prerequisite to achieve climate targets. To do so, ICT4S research and social practice research have an important task to fill, together with ICT companies, urban planners and other stakeholders engaged in planning and developing our cities.

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REFERENCES

[1] Deputy UN chief calls for urgent action to tackle global sanitation crisis. 2013 [cited 2015 March 27]; Available from: http://www.un.org/apps/news/story.asp?NewsID=44452&Cr=sanitation&Cr1=#.VRqtBXvKcvW.

[2] Weiser, M., The computer for the 21st century. Scientific american, 1991. 265(3): p. 94-104.

[3] Goodwin, T. The Battle Is For The Customer Interface. 2015 [cited 2015 March 27]; Available from: http://feed.hypervocal.com/frame/6366392.

[4] GeSI, SMARTer 2020: The Role of ICT in Driving a Sustainable Future.

[5] Perlman, J.E., O'Meara Sheenan, M., Fighting poverty and environmental injustice in cities, in Worldwatch Institute 2007 state of the world: our urban future., L. Starke, Editor. 2007, The Worldwatch Institute: New York.

[6] Wangel, J., Løbner, K., Sølgaard Bang, M. . ICT as Motor for Transition: towards a Low Energy, Low Carbon City. in ICT4S. 2013. Zürich: ETH Zürich.

[7] Neirotti, P., et al., Current trends in Smart City initiatives: Some stylised facts. Cities, 2014. 38: p. 25-36.

[8] Höjer, M. and J. Wangel, Smart sustainable cities: definition and challenges, in ICT Innovations for Sustainability. 2015, Springer. p. 333-349.

[9] de Jong, M., et al., Sustainable–smart–resilient–low carbon–eco–knowledge cities; making sense of a multitude of concepts promoting sustainable urbanization. Journal of Cleaner Production, 2015.

[10] Kondepudi, S.N., Smart sustainable cities: An analysis of definitions 2014, ITU-T Focus Group on Smart Sustainable Cities.

[11] Townsend, A., Smart cities - big data, civic hackers and the quest for a New Utopia. 2013, New York: Norton & Company.

[12] Caragliu, A., C. Del Bo, and P. Nijkamp, Smart cities in Europe. Journal of urban technology, 2011. 18(2): p. 65-82.

[13] Piro, G., et al., Information centric services in smart cities. Journal of Systems and Software, 2014. 88: p. 169-188.

[14] Connelly, S., Mapping sustainable development as a contested concept. Local Environment, 2007. 12(3): p. 259-278.

[15] Daly, H.E., Beyond growth: the economics of sustainable development. 1997: Beacon Press.

[16] Robinson, J. and R.J. Cole, Theoretical underpinnings of regenerative sustainability. Building Research & Information, 2014. 43(2): p. 133-143.

[17] Zhou, C., Dai, X., Wang, R.,Huang, J., Indicators for evaluating sustainable communities: A review. Shengtai Xuebao/ Acta Ecologica Sinica 2011. 31(16): p. 133-143.

[18] Kramers, A., et al., Smart sustainable cities–Exploring ICT solutions for reduced energy use in cities. Environmental Modelling & Software, 2014. 56: p. 52-62.

[19] Larsson, J., Hållbara konsumtionsmönster: Analyser av maten, flyget och den totala konsumtionens klimatpåverkan idag och 2050. 2015, Naturvårdsverket.

[20] Gram-Hanssen, K., Efficient technologies or user behaviour, which is the more important when reducing households' energy consumption? Energy Efficiency, 2013. 6(3): p. 447-457.

[21] Brundtland, G.H., Report of the World Commission on environment and development:" our common future.". 1987: United Nations.

[22] Girardet, H., Creating sustainable cities. 1999: Resurgence Books.

[23] Schatzki, T.R., Practices and actions a Wittgensteinian critique of Bourdieu and Giddens. Philosophy of the social sciences, 1997. 27(3): p. 283-308.

[24] Knorr-Cetina, K., E. von Savigny, and T.R. Schatzki, The practice turn in contemporary theory. 2000: Routledge.

[25] Reckwitz, A., Toward a theory of social practices a development in culturalist theorizing. European journal of social theory, 2002. 5(2): p. 243-263.

[26] Shove, E., M. Pantzar, and M. Watson, The dynamics of social practice: everyday life and how it changes. 2012: Sage Publications.

[27] Shove, E., Comfort, cleanliness and convenience: The social organization of normality. 2003: Berg Oxford.

[28] Christensen, T.H. and I. Røpke, Can Practice Theory Inspire Studies of ICTs in Everyday Life?, in Theorising media and practice, B. Bräuchler and J. Postill, Editors. 2010, Berghahn Books: New York.

[29] Shove, E. and G. Walker, What is energy for? Social practice and energy demand. Theory, Culture & Society, 2014. 31(5): p. 41-58.

[30] Zombies, Run! ; Available from: www.zombiesrungame.com.

[31] Røpke, I. and T.H. Christensen, Energy impacts of ICT–Insights from an everyday life perspective. Telematics and Informatics, 2012. 29(4): p. 348-361.

[32] Churchman, C.W., The systems approach. 1968, New York: Dell Publishing.

[33] Kuutti, K. and L.J. Bannon. The turn to practice in HCI: Towards a research agenda. in Proceedings of the 32nd annual ACM conference on Human factors in computing systems. 2014. ACM.

[34] Dourish, P., Implications for design, in Proceedings of the SIGCHI Conference on Human Factors in Computing Systems. 2006, ACM: Montréal, Québec, Canada. p. 541-550.

[35] Bødker, S., When second wave HCI meets third wave challenges, in Proceedings of the 4th Nordic conference on Human-computer interaction: changing roles. 2006, ACM: Oslo, Norway. p. 1-8.

[36] Bannon, L., Constructing utopia (s) in situ-Daring to be different. Re) Searching The Digital Bauhaus, 2009: p. 61-77.

[37] Bødker, S. and Y. Sundblad, Usability and interaction design-new challenges for the Scandinavian tradition. Behav. Inf. Technol., 2008. 27(4): p. 293-300.

[38] Lehtimäki, K. and T. Rajanti, Local voice in a global world–User-centered design in support of everyday practices, in Universal Acess in Human Computer Interaction. Coping with Diversity. 2007, Springer. p. 197-206.

[39] Tomlinson, B., et al., Collapse informatics and practice: Theory, method, and design. ACM Transactions on Computer-Human Interaction (TOCHI), 2013. 20(4): p. 24.

[40] Brynjarsdottir, H., et al. Sustainably unpersuaded: how persuasion narrows our vision of sustainability. in Proceedings of the SIGCHI Conference on Human Factors in Computing Systems. 2012. ACM.

[41] Pierce, J., et al., Introduction to the special issue on practice-oriented approaches to sustainable HCI. ACM Transactions on Computer-Human Interaction (TOCHI), 2013. 20(4): p. 20.

[42] Katzeff, C. and J. Wangel, Social practices, households, and design in the smart grid, in ICT Innovations for Sustainability. 2015, Springer. p. 351-365.

[43] Strengers, Y., Smart energy in everyday life: are you designing for resource man? interactions, 2014. 21(4): p. 24-31.

[44] Streitz, N.A., Smart cities, ambient intelligence and universal access, in Universal Access in Human-Computer Interaction. Context Diversity. 2011, Springer. p. 425-432.

[45] Gyberg, P. and J. Palm, Influencing households' energy behaviour—how is this done and on what premises? Energy Policy, 2009. 37(7): p. 2807-2813.

[46] Shove, E., Gaps, barriers and conceptual chasms: theories of technology transfer and energy in buildings. Energy Policy, 1998. 26(15): p. 1105-1112.

[47] Owens, S. and L. Driffill, How to change attitudes and behaviours in the context of energy. Energy Policy, 2008. 36(12): p. 4412-4418.

[48] Mont, O. and A. Plepys, Sustainable consumption progress: should we be proud or alarmed? Journal of Cleaner Production, 2008. 16(4): p. 531-537.

[49] Tukker, A., et al., Fostering change to sustainable consumption and production: an evidence based view. Journal of cleaner production, 2008. 16(11): p. 1218-1225.

[50] Robinson, J.B., The proof of the pudding: Making energy efficiency work. Energy policy, 1991. 19(7): p. 631-645.

[51] Greenfield, A., Against the smart city (The city is here for you to use, part I). 2013, New York City: Do Projects.

[52] Pink, S., et al., Applying the lens of sensory ethnography to sustainable HCI. ACM Transactions on Computer-Human Interaction (TOCHI), 2013. 20(4): p. 25.

[53] Rivera, M.B., et al., Including second order effects in environmental assessments of ICT. Environmental Modelling & Software, 2014. 56: p. 105-115.

[54] Christensen, T.H., Young people, ICT and energy-status and trends in young people's use and understanding of ICT and energy consumption: D2. 1 Technical Report on the Organisation and Outcomes of Focus Groups and the Mapping Exercise. 2014, Intelligent Energy Europe.