

Exploring the Challenges and Opportunities for the Physicalization of Household Consumption Data to Encourage Sustainable Practices in Wales

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Physicalization design for household consumption data often overlooks how the situated context such as household collaboration, user engagement, and individual preferences, play an important role when designing a physicalization. To better understand these contextual factors, we conducted a survey which received 22 responses, and follow-up interviews with 13 households in Wales to gain deeper insights into their practices and preferences toward physicalizations of consumption data. Our findings revealed that households generally prefer physical artefacts and images that generate empathy, and that unobtrusive design for shared spaces in the home is highly valued. We believe that there is an opportunity to design physicalizations of consumption data that blend seamlessly into the home environment, fostering collaboration and enhancing user engagement, thus not only increasing the opportunities to enhance households' awareness of their consumption patterns but also suggesting new design possibilities to promote household's sustainable efforts to reduce them.

CCS Concepts: • **Human-centered computing** → **Information visualisation**; **Collaborative and social computing devices**.

Additional Key Words and Phrases: Data physicalization, Climate Change Communication, Sustainable HCI, Household consumption

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1 INTRODUCTION

Climate change is an intangible and invisible phenomenon [20] and has become a global concern over the last decades. In particular, research shows that 72% of carbon emissions are caused by household consumption [31] (e.g., electricity, gas, fuel, water, etc.) which have an effect on the climate [9]. Various strategies are adopted for promoting sustainable household practices, which include some forms of visualisation to provide feedback [5–7, 14, 19, 27, 30, 31, 34] aiming to increase awareness about household activities and their impact on the climate [4, 13]. However, most visualisations are found to not be compelling enough to motivate people to reduce consumption through awareness or persuasion alone [4] and designing visualisations for the long-term consumption behaviour change is often overlooked [33]. Data physicalizations [8] integrate data into the physical environment and daily routines to help people become more aware of their consumption data [17, 22, 30, 31]. This often creates a link between the people and the information presented by the artefact on a more intimate level [18] which could lead to a better user experience [28] and greater awareness to reshape current household actions. Unlike screen-based visualisations that demand visual attention [3, 18], data physicalization could provide a basic, abstract representation of data in the periphery of attention [10], which makes them a useful tool to be integrated into busy human lifestyles and practices [29]. We believe that there is an opportunity

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53 to further investigate the design of home-based data physicalizations of people’s consumption patterns. This may lead
54 to better awareness of climate change and the adoption of more sustainable practices at home.
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56 2 CASE STUDY: METHODS AND FINDINGS

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58 We engaged in an exploratory study through an online survey (22 responses from households) followed by 13 semi-
59 structured household interviews (1 to 6 people per home) conducted in Wales, UK, to investigate households’ everyday
60 practices and preferences for the design of physicalizations of consumption data. This study was conducted between
61 July and October 2022. Six interviews were conducted in each participant’s home while seven were done online. We
62 explored participants’ opinions on six physicalizations from the literature [12, 15, 22, 26, 30, 31] and two design probes
63 [32] that we created. Our empirical data was transcribed using NVivo (1.7.1) and analysed following a reflexive thematic
64 analysis approach [23].
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66 We found that households prefer data physicalizations more than screen-based visualisations. While households
67 attached meanings to images, objects, and places in the home, they mentioned that the design probes aid in bonding
68 with household members. Participants felt comfortable with looking at physicalizations that evoke empathy in them as
69 opposed to those that elicited revulsion. Participants emphasised on designing an unobtrusive physicalization for a
70 shared space in the home. Participants suggested places in the house where the physical artefacts could be kept (e.g.,
71 the dining room, hallway, and children’s bedrooms) to enhance engagement and foster household collaboration in
72 curtailing consumption. We found that families prefer to involve their children to engage with the physical artefact
73 and collectively attempt to reduce consumption. Households preferred to be accurately informed of their consumption
74 data through positive reinforcement and mentioned how the change of shape of a physical artefact could be a pleasant
75 strategy that could be interpreted as a reward.
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80 3 DISCUSSION AND FUTURE WORK

81 Aligned with previous research [16, 25, 27], our findings suggest that a physicalization designed with aesthetically
82 pleasing and empathetic features is mostly preferred by households. Indeed, people are more likely to join environmental
83 conservation initiatives if they have an emotional attachment to the problem [11]. Researchers should better understand
84 the meanings people attach to objects around the home [1, 21] and design physicalizations for a shared space in the
85 household that may become a focal point in the home [24] which encourages collaboration among the occupants.
86 Physicalization design needs to blend into the home environment and functions in the user’s periphery of attention and
87 shift back and forth to the center of attention when relevant [2] so that it is not disruptive. Designing shape-changing
88 physicalizations [28] could consider depicting a sense of reward for reduced household consumption to motivate people
89 to take pro-environmental actions.
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91 While most visualisations related to household consumption have focused on providing technical information to
92 users, our research suggests that a deeper understanding of the user experience and engagement is necessary to
93 produce more effective home-based physicalization designs. To achieve this, we need to account for all the contextual
94 dynamics that are part of a household and explore designing physicalizations for shared living spaces that function in
95 the periphery but still provide accurate consumption data. However, determining the appropriate level of consumption
96 information, the structure and interactions and how to meaningfully map consumption data to the physical properties
97 of the physicalization can be challenging and must be carefully considered to avoid confusion and intrusiveness. To
98 support long-term household consumption behaviour change, future research should aim to identify parameters for
99 physicalizations that can maintain user engagement and provide a better user experience at home.
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