ABSTRACT

Real-World Labs (RWLs) hold the promise of directly involving citizens in shared shaping of research with the goal of societal transformation. However, particularly in the case of technology-centric RWLs, this is associated with unique challenges with respect to the way technology-based intervention is negotiated particularly with respect to accessibility and understanding of emerging technologies. In this position paper, we reflect upon these challenges on the basis of three RWLs, "Accessibility", "Artificial Intelligence and Robotics", and "Cooperative Autonomous Mobility". We close with guiding principles for technology-centric RWLs that we wish to discuss with the research community in an effort to ensure that the introduction of technological intervention does not threaten the democratic notion of the concept.

KEYWORDS
Emerging Technologies, Participation, Real-World Lab Research

1 INTRODUCTION AND BACKGROUND

Real-World Labs (RWLs) are transdisciplinary efforts in which researchers engage in structured participatory research with citizens and other stakeholders [4]. Originally rooted in sustainability research, such labs seek to achieve transformation by means of direct engagement with society [3]. For example, RWLs have been employed to explore transformation to carbon neutrality in campus settings [6], in the context of aging societies [20], and in a range of other settings across Europe [23]. An important characteristic of RWLs is that research teams and citizens engage in collaborative shaping of research projects, jointly defining research questions, and openly discussing desirable research objectives and project outcomes. As such, RWLs share many of the characteristics of Participatory Design (PD) [21] – in particular, the aspiration to share power with participants [7] – and apply a similar set of methods (e.g., interviews and focus groups). However, they also carry an element of intervention [12], i.e., through employment of technology, they seek to produce change in citizen behaviour that is in alignment with overarching societal values such as sustainability [5]. Recently, there has been a push toward the application of RWLs in other domains, e.g., sport and exercise [33], and autonomous mobility [16], which has demonstrated the feasibility of the concept beyond sustainability research.

Particularly in the context of technology-centric RWLs, this opens up exciting research opportunities to create products that are aligned with citizens’ needs and preferences while also taking into account values that should guide the design. From the perspective of Computer Science and Engineering Sciences, we see potential in these RWLs as transdisciplinary research efforts that include the design, development and deployment of technological artifacts in shared spaces (rather than dedicated research labs), with the goal of iteratively designing and evaluating emerging technologies in conjunction with end-users, striving to devise artifacts that meet societal needs. Here, Computer Science and Engineering Sciences could in particular benefit from medium- and long-term studies that also account for overarching societal values. However, from the perspective of researchers in technological domains, we argue that under consideration of these distinct characteristics, technology-centric RWLs are associated with unique challenges for our own domains of research, as well as for the Real-World Lab as a method of scientific enquiry. In the remainder of our paper, we discuss these challenges on the basis of three RWLs at Karlsruhe Institute of Technology (KIT), and
reflect upon guiding principles for technology-centric Real-World Lab research.

2 CASE STUDIES: KIT REAL-WORLD LABS ON ACCESSIBILITY, AI AND ROBOTICS, AND COOPERATIVE AUTONOMOUS MOBILITY

The goal of the technology-centric RWLs at KIT is to facilitate technology development that takes place in conjunction with society, encompassing the human perspective and the desire to positively impact society, as well as the intention to advance technology and related research.

2.1 Case Study 1: Real-World Lab “Accessibility”

This RWL is concerned with the role that technology can play to improve inclusion of disabled people in society. The RWL takes a two-pronged approach that examines the potential of assistive technology for disabled people on the one hand, and interventions that target non-disabled people on the other hand. One challenge here is that existing RWL research has not yet engaged with the privilege of participation [10], i.e., it is unclear how the method supports meaningful participation of disabled individuals, and there is a need to develop accessible formats of participation that also address inaccessibilities of emerging technologies (e.g., see [11, 13]) that often prevent hands-on exploration otherwise readily available to non-disabled individuals. Likewise, the lab is situated within the tension of clearly defined overarching societal values – access and inclusion – which are rooted in law (e.g., the UN Convention on the Rights of Persons With Disabilities [22]), but often poorly implemented. Here, a challenge for the lab is to mitigate the risk of technosolutionism [14], carefully telling apart instances in which technology can contribute to inclusion, and those where wider societal change must happen first [32], technology may not even be needed [2], or is not affordable [1]. Likewise, we are interested in trade-offs between new technologies (e.g., vision-based systems) and privacy concerns for users and bystanders, and want to engage in societal dialogue surrounding these.

2.2 Case Study 2: Real-World Lab “Artificial Intelligence and Robotics”

The RWL Robotics AI has been established with the goal of making AI tangible and debatable for society through humanoid robots. Real-world experiments in public space of the city of Karlsruhe --- from kindergarten, childcare centers, and schools to museums, city libraries, retirement homes, and hospitals --- are conducted with several humanoid robots to raise awareness of robotics AI technology by individuals and to gain new insights into the research and development of future AI robots. Through continuous interactions in real-world settings with different user groups, society and science come together on an equal footing to hand-in-hand co-develop embodied AI robot systems that align with users’ needs and expectations. The goal is to reduce or close the knowledge gap between what is scientifically possible, and technologically feasible and what is expected by society through the co-development of these systems. Specifically, we address the following research questions, which also relate to the main challenges: (i) What is the attitude of different user groups towards robotics AI? How do people behave and feel when dealing with humanoid robots? What fears and expectations prevail, and in how far are they rooted in characteristics of the technology, or in people’s ideas informed by media? (ii) How robust are current methods of AI-enabled humanoid robots for real-world applications? Which requirements for the robots result from practical use in long-term and weakly-controlled experiments with diverse users? and (iii) how can the suggestions and wishes of the user groups be incorporated and implemented in the design of new AI robot technologies?

2.3 Case Study 3: Real-World Lab “Cooperative Autonomous Mobility”

The RWL is dealing with the adoption of cooperative autonomous mobility as a part of future urban transportation systems with the overarching societal goal being the road safety. In comparison to existing testbeds, which mostly aim at the collection of the data enabling autonomous driving [26] or at the public demonstration of the specific use-cases [25], the RWL targets at understanding the user behavior changes when cooperative autonomous transport is in place. One challenge here is the low trust in the safety of autonomous systems [19], which might negatively impact the participation of end users. Another challenge closely related to the previous one comes from the level of technical maturity of urban autonomous mobility which limits its sustainability and increases the risks of insufficient user satisfaction [18]. For cooperative transport systems, the participation of a plethora of different stakeholders (e.g., automotive and telecommunication industries, respective authorities and regulators) is crucial. There is a non-stopping heated debate on the standardization of vehicular communications and related business incentives [30], which slows down the deployment of cooperative vehicles. The RWL provides such a participation platform. Reaching consensus among different players is especially important here since the cooperation between the vehicles is a technical enabler for making ethical decisions in autonomous driving [28].

3 GUIDING PRINCIPLES FOR TECHNOLOGY-CENTRIC RWLS

Reflecting upon these challenges and viewing them across three technology-centric RWLS, we believe that there is value for our community to define guiding principles for such research in an effort to ensure that they do in fact align with the aspiration of participation and democratization, outlining characteristics of RWLS that contradict traditional approaches in Computer Science research and Engineering Sciences.

- **Shared shaping of research and open-ended technology deployment.** Traditionally, our domains engage in technology-driven research where there is emphasis on development and deployment of a specific system that is only evaluated, but not shaped with end-users. In technology-centric RWLS, our domains need to take a step back and develop research approaches in which projects are defined and developed with end-users and stakeholders to align with the democratic notion of RWLs (e.g., see [4]). Likewise, technology-centric RWLS need to be open to the notion that
a given technology is not accepted in a given setting, or that non-technical solutions are preferred.

- Understanding of technology. When involving citizens in the envisioning of new systems, their understanding of underlying technologies and system capabilities becomes highly relevant to root the discourse in a realistic understanding of resulting artifacts, both in terms of individual expectations [17] and potential risks, challenges, and capabilities of technology, avoiding the reliance on folk theories [24]. Here, RWLs need to build on and expand existing research approaches that help create understanding of what future systems could look like, e.g., speculation [29] or careful construction of digital twinning studies [31] that could serve as intermediate step to foster understanding and create common ground for further conversation.

- Inclusive and safe research sites and methods. Computer and Engineering Sciences are faced with a twofold methodological research challenge in the context of Real-World Lab research: We systematically struggle with the inclusion of minoritized groups in research endeavours (e.g., see [15]), and many of the methods we employ are not accessible (e.g., see [9, 27]). Likewise, we traditionally engage in laboratory research particularly when new technology is deployed, allowing us to control the research setting and ensure safety of participants. In a RWL setting, we give up on that control, increasing the requirements for our systems with respect to their reliability. Particularly when working in sensitive settings, we anticipate that these two challenges will need to be addressed in conjunction.

4 OUTLOOK AND CONCLUSION

Real-World Labs offer the opportunity of engaging in shared research with society, thereby holding the promise of participation and citizen empowerment. However, particularly when considering technology-centric RWLs, barriers to true and inclusive participation remain, and our domains need to re-think established approaches to technology research. Here, the guiding principles discussed in our position paper provide a starting point, but are by no means comprehensive, and should therefore be subject to discussion within our research community. In this context, we define the benchmark for success of technology-centric RWLs for our domain as twofold: On the one hand, such labs must ultimately facilitate informed technology adoption (or rejection) within the population while aligning with overarching societal values in an effort to facilitate transformation, and avoiding a superficial operationalization of the concept of the RWL that has previously been considered a weakness of technology-centric RWLs [8]. On the other hand, technology-centric RWLs must provide Computer Science researchers and others with tangible tools to build such technology, and must serve as a space that helps our communities operationalize overarching values for technology integration in society in conjunction with relevant stakeholders and in a way that provides practical guidance that is mindful of technical dependences and the dynamics that emerge when humans interact with technical systems.

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