Extended Abstract
6th PLATE 2025 Conference
Aalborg, Denmark, 2-4 July 2025

From Clicks to Circular Behavior: A Smart City Mobile Application Leveraging AI and Gamification

Julia Beatrix Reinhard[(a)], Imke Schmidt[(a)]
a) Wuppertal Institute for Climate, Environment and Energy, Research Group Circular Economy, Doeppersberg 19, Wuppertal, Germany

Keywords: Circular Economy; Behavior Change; Gamification; Artificial Intelligence; Smart City Mobile Application.

Introduction

To address today's environmental risks, the circular economy can help to establish new economic models that conserve resources and contribute to climate protection (EC 2020). While efforts often focus on production, consumption patterns are equally crucial for circular transformation (ibid). Fostering circular behaviors remains challenging, as behavior change requires overcoming entrenched routines and societal norms (Muranko et al., 2018).

Digital solutions have increasingly gained attention as tools to encourage more sustainable consumption behaviors (e.g., Berger et al., 2022; Hedin et al., 2019). However, two challenges remain: first, most tools address only isolated phases of the consumption cycle—such as product scanning tools that support information acquisition—without supporting users holistically across acquisition, use, and return or disposal. Second, the growing number of separate apps and platforms risks overwhelming users, making it difficult to navigate and engage meaningfully with circular practices.

From a circular consumption perspective, however, it is important to consider all phases of the product lifecycle to extend product lifespans, recover materials, and reduce emissions (Ellen MacArthur Foundation 2013).

Against this background, this research explores how digital tools can engage users comprehensively across the entire circular customer journey. Employing a design science research (DSR) approach (van Aken & Romme, 2009), it proposes a mobile app that integrates circular strategies across several lifecycle stages. Further, the app seeks to bundle key functionalities within one platform and reach users at a critical touchpoint—when they are already considering disposal and thus more receptive to reuse, repair, or conscious acquisition alternatives.

Theoretical Background

A Circular Perspective on the Customer Journey

The traditional customer journey—typically divided into pre-purchase, purchase, and post-purchase phases (Lemon & Verhoef, 2016)—offers useful insights into consumer behavior but overlooks key aspects of circular consumption. It often fails to capture the complexity of circular models, such as feedback loops, iterative decisions, and rebound effects (Lange et al., 2023). Moreover, it does not consider continued product use by others—a central strategy for closing material loops and extending product lifespans (Kirchherr et al., 2023). This research adopts a circular perspective on the customer journey, combining lifecycle-focused approaches with consumer decision-making by incorporating the R-strategies of the circular economy, such as refuse, reduce, reuse, repair, and recycle (Murakami et al., 2010; Potting et al., 2017).

Digital Tools for Circular Behavior Change

Digital tools for fostering circular behavior span various technologies, including software, platforms, and applications, and are categorized here by main purpose: promoting behavior change or enhancing awareness and knowledge.

Many behavior change tools target specific consumption phases. Examples include apps or platforms providing sustainable product suggestions, waste reduction tips, or repair and recycling guidance—often supported by AI or chatbots (Behrendt, Henseling & Sievi, 2024).

Tools for education and knowledge-building raise awareness and promote circular thinking through interactive serious games,

gamification, and immersive augmented or mixed reality applications (Jääskä, Aaltonen, & Kujala, 2021; Katika et al., 2022; Whalen et al., 2018).

Methodology

This study employs a DSR approach to foster circular behavior through the development of a multifunctional mobile app for a pilot city. DSR addresses practical challenges by iteratively designing and testing interventions in real-world contexts (van Aken & Romme, 2009). Figure 1 depicts the DSR cycle for this study (adapted from Brown et al., 2021; Coffay & Bocken, 2023).

Identification of Problem and Definition of Objectives for Solution

The DSR cycle began with a problem and objective definition, informed by literature and existing tool analysis. These revealed a lack of integrated digital solutions supporting circular behavior across the full consumption cycle. Expert and practitioner input clarified user needs and behavioral barriers, highlighting the value of a multifunctional tool that reaches users at key moments of the circular customer journey. The app builds on an existing municipal waste app and engages users when they are already considering disposal, opening a potential window of opportunity for reuse, repair, or sustainable purchase. The goal is to offer actionable support within a familiar infrastructure.

Design and Development

The tool was developed iteratively, guided by literature and practice. Initial concepts were shaped in team workshops, followed by Figma-based screens and a click dummy. The first functional prototype is currently being implemented by an external developer; a second iteration will follow user testing.

Demonstration, Evaluation, and Communication

The demonstration and evaluation follow a two-stage process combining expert input and user feedback. In 2024, the concept was tested through expert interviews and workshops with AI, gamification, and waste experts, alongside focus groups with residents of the German pilot city, a mid-sized urban area with an existing municipal waste management app, providing an ideal context for real-world testing and integration. A Figma-based click dummy supported early usability testing.

In 2025, the functional prototype is being tested through interviews and focus groups. These results will be presented at the PLATE Conference 2025.

A second prototype iteration will broaden testing through additional interviews and surveys beyond the pilot city and explore how the app functionalities interact. Insights will inform further refinements before public release in 2026.

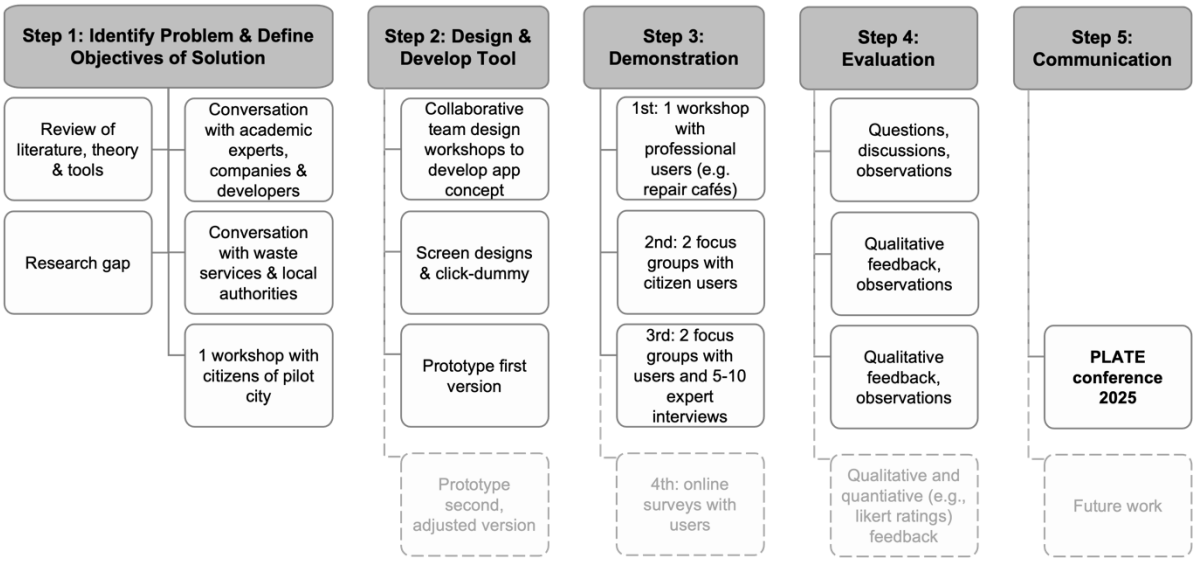

Figure 1. DSR cycle

Preliminary Results

The app integrates AI (module 1) and gamification (module 2) to support circularity across multiple stages of the consumer lifecycle. The AI module targets electronics, textiles, and furniture, primarily supporting mid-level R-strategies like reuse, repair, and refurbish, while also offering tailored guidance on disposal and recycling. The gamification module focuses on organic waste, especially food, aiming to improve sorting, and resource-saving behaviors. Both modules promote early-stage R-strategies such as refuse, rethink, and reduce through shopping tips and product information.

Module 1 leverages AI to support sustainable consumption decisions. Using image recognition or text input, it identifies products, assesses product conditions via follow-up questions, and delivers recommendations. Users are connected to local services like repair shops, resale platforms, or recycling centers through a map interface with location-based matching and contact options.

Module 2 uses gamification to enhance bio-waste sorting through interactive challenges, point-based rewards, and real-time feedback from sensor-equipped waste trucks. Users progress through learning levels on topics such as correct sorting, compost use, and the broader relevance of organic waste.

Together, both modules form a multifunctional system combining interactive engagement with data-driven insights, empowering residents to contribute to circular economy goals. By integrating the tool into an existing municipal waste app, it reaches users at a key moment, that is, when they are already thinking about disposal and potentially open to circular alternatives.

While implementation is currently limited to a single pilot city, future research should explore its broader applicability, long-term behavioral impact, and whether a single digital touchpoint can sustainably foster circular practices. The app is designed to be scalable and adaptable for other smart cities, offering a replicable solution to promote circular behavior.

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