

Ewa Duda et al.

Promoting pro-environmental behaviours among urban dwellers

A study of the interdisciplinary Greencoin project



MARIA GRZEGORZEWSKA UNIVERSITY PRESS

**Promoting pro-environmental behaviours
among urban dwellers**
A study of the interdisciplinary Greencoin project

Ewa Duda et al.

**Promoting pro-environmental behaviours
among urban dwellers
A study of the interdisciplinary Greencoin project**



MARIA GRZEGORZEWSKA UNIVERSITY PRESS

Scientific reviewers:

Professor Dr. Juho Mäkiö

Professor Dr. Flávio de São Pedro Filho

Funding information:

This publication was funded by Iceland, Liechtenstein and Norway under the EEA Funds and the state budget of Poland through the National Centre for Research and Development under grant agreement no NOR/IdeaLab/GC/0003/2020, awarded to Ewa Duda.

Editor:

Ewa Duda

Cover:

Grażyna Adamska, Ewa Duda

Composition:

Grafini DTP

Publisher:

Maria Grzegorzewska University Press



CC BY-NC-ND 4.0 PL

Copyright © by Maria Grzegorzewska University Press

Warsaw 2024

ISBN: 978-83-67721-53-0

ISBN: 978-83-67721-54-7 (e-book)

Maria Grzegorzewska University Press

40 Szczęśliwicka St.

02-353 Warsaw, Poland

Tel. 22 5893645

e-mail: wydawnictwo@aps.edu.pl

Promoting pro-environmental behaviours among urban dwellers. A study of the interdisciplinary Greecoin project

Ewa Duda ORCID 0000-0003-4535-6388

Helena Anacka ORCID 0000-0001-7483-2844

Jakub Bojanowski ORCID 0000-0002-5829-9725

Hanne Cecilie Geirbo ORCID 0009-0009-8760-4440

Ayda Joudavi ORCID 0000-0002-9727-0706

Zbigniew M. Karaczun ORCID 0000-0001-6971-275X

Jolanta Kowal ORCID 0000-0002-6241-9603

Igor Niemczyk ORCID 0009-0000-2833-481X

Iwona Nowakowska ORCID 0000-0001-7701-5612

Hanna Obracht-Prondzyńska ORCID 0000-0003-0621-1020

Chandra Prakash Paneru ORCID 0000-0002-7118-5941

Iga Perzyna ORCID 0000-0002-0341-0465

Jana Pieriegud ORCID 0000-0003-1774-5220

Małgorzata Romanowska ORCID 0009-0003-6024-4453

Ari K. M. Tarigan ORCID 0000-0002-1578-5125

Cristian Toşa ORCID 0000-0003-0986-4131

Danuta Uryga ORCID 0000-0003-1113-3346

Aleksandra Wyciszekiewicz ORCID 0000-0003-4908-1422

*We do not inherit the Earth from our ancestors;
we borrow it from our children.*

proverb

Table of contents

Preface	11
Introduction: Harnessing technology for urban sustainability	17
Step 1. Research background	27
Approach to the Greencoin project and the PULA design	29
Analysis of projects based on alternative currency	33
Step 2. Development of the social feasibility of the Greencoin system	36
The course of the task	36
Step 3. Identification and selection of pro-ecological actions	56
Literature review: Pro-environmental actions	59
Choice of actions	63
Step 4. Quantification model	68
Methodological approach for the quantification model	69
Conclusions	76
Step 5. The application	78
Application functionalities	78
Users' feedback on functionalities	86

Step 6. Testing phase	96
Background	96
Timeline	98
Strategic partners	98
Local partners	100
Early adopters	101
PULA application – acting and earning	102
Partners – networking meetings and communication	105
Promotion and communication	106
PULA in numbers	109
Step 7. Key findings and insights gained from the implementation of the project	114
Recommendations	120
Conclusions	123
References	127
Figures	141
Tables	143
Biographical notes	145

Preface

The publication presented to the reader is more than a typical academic monograph. It is my hope that it will attract the interest of a broad range of academics and individuals who do not necessarily identify with the scholarly community but are concerned with our planet's future. The unconventional character of this publication is related to the uniqueness of the project within which it was created. Therefore, to understand the form of this monograph and the adopted research approach, it is necessary to know the context in which it was developed, the goals that accompanied its creation, and the implications thereof.

The monograph was conceived to scientifically summarise a unique project in which we participated and shared the knowledge and experience gained over four years of collaborative work. The project proved valuable, but the international team forming the project consortium is a precious resource. Within this framework, many innovative ideas for exciting research, scientific publications, and the implementation of developed tools emerged, aimed at initiating and shaping pro-environmental behaviours among the residents of Gdańsk. I am convinced that it is precisely this group of outstanding individuals and fantastic researchers who contributed to our shared success, the realisation of a project that was recognised by the European

Commission, awarding the Greencoin project second place in the Education for Climate Coalition competition, in the Lifelong Learning category.

Let me start at the beginning. The Greencoin project presented to the reader was developed in response to an invitation for proposals within the unique IdeaLab pathway, which aimed to generate creative ideas during interactive and intensive five-day workshops involving participants from various disciplines and backgrounds, supported by a team of external experts and stakeholders. The programme was created, and within its framework, workshops were organised to introduce new approaches to research challenges concerning the issue of “*Cities of the Future – Services and Solutions*”. We met for the first time during the workshops organised in Otwock, near Warsaw, in March 2020. We spent five intensive days together, contributing to creating a fantastic project team and developing the Greencoin idea, which utilises the mechanism of a common currency to stimulate pro-environmental behaviours among urban residents.



FIGURE 1. Initial Greencoin team, formed during the IdeaLab workshops in March 2020

The core of the project consortium was formed by the following individuals (Figure 1, from left): Hanne Cecilie Geirbo, representing Oslo Metropolitan University; Ewa Duda, representing the Maria Grzegorzewska University; Małgorzata Romanowska, representing the City Initiative Association; Jakub Zawieska, representing the SGH Warsaw School of Economics; Ari K. M. Tariqan, representing the University of Stavanger; and Kacper Radziszewski, representing the Gdańsk University of Technology, who successfully undertook the role of project leader.

After returning from the workshops, we had two and a half months to develop and submit the full proposal. Upon its acceptance, we began the project in March 2021. The project's nature and logistical assumptions required cooperation among partners on the one hand and a certain degree of autonomy on the other, allowing each team to develop the educational tool's assumptions independently, reflecting their respective scientific disciplines or areas of activity.

The Greencoin project aimed to use new technologies and social innovations to develop a tool for environmental education, ecological skills, and shaping or stimulating pro-environmental behaviours among urban residents. To achieve this, we designed and implemented a tool as a mobile application based on gamification mechanisms and a rewards system. The application rewarded users with points for environmentally friendly actions, and the accumulated points could be used to purchase eco-friendly products.

The Greencoin project was tailored to the context of Central Europe, where the society of this dynamic region requires a significant shift in pro-environmental behaviours. Given the project's logistical context and the leader's location in Poland, we chose the Tricity area (Gdańsk, Gdynia, Sopot) as the site for our living laboratory, where we tested the developed application. In the first testing phase, users earned points (called Good Coins) by reading articles on environmental and climate topics and then completing quizzes based on the acquired knowledge. The application offered various features, such as eco-tips, interactive educational games, and access to information about local environmental initiatives. Participants were rewarded with coins for using public transportation, cycling to work/school, purchasing local products, sorting waste, and collecting litter from public places. The application thus motivated users to act against the climate crisis.

The urgent need to counteract climate change, promote sustainable urban development, and transform communities towards prosperity in harmony with the environment drove our research efforts. In the context of

growing environmental concerns and advancements in mobile technology, we aimed to assess the transformative potential of the application in shaping environmentally friendly behaviours and mitigating the adverse effects of urbanisation. The monograph presented to readers provides new or expanded knowledge on the Greencoin system, offering a review of scientific articles and recommendations regarding an alternative mechanism for policymakers to encourage residents towards pro-environmental behaviours. This promotes adult learning for green transformation.

The project comprised the following main stages we sought to elucidate in greater detail in subsequent monograph chapters. (1) Research background. A comprehensive review of projects analogous to Greencoin was conducted, focusing on the efficacy of currency systems in influencing pro-environmental behaviours; (2) The social feasibility of Greencoin was then developed. This entailed the identification of potential community stakeholders and the delineation of engagement opportunities; the execution of studies to ascertain the needs of prospective application users; and the investigation of partnership strategies to establish productive collaborations with diverse entities for the advancement of sustainable development under the Greencoin project; (3) Preparation of the quantification model. Appropriate actions were identified, their value quantified, and the effectiveness of the Greencoin system in promoting environmentally friendly behaviours was examined. Subsequently, a selection process was conducted for actions, whereby specific pro-environmental activities were identified and chosen for inclusion in the Greencoin project; (4) Technical feasibility. A further area of investigation was the technological aspects of implementing the Greencoin project in the Tricity area. This was followed by (5) Pilot testing of the mobile application and (6) User feedback analyses and function validation in the evaluation, refinement, and up-scaling task.

The project brought together three main participant groups. The first group was the project team, which not only developed the application but also conducted research to advance knowledge on the practical implementation of innovations tailored to changing societal needs. The second group comprised application users who, through active use of the application, deepened their knowledge and developed their skills in improving environmental quality. The third group consisted of city authorities and local stakeholders, who were made aware of the importance of their role in the green transformation process. The overall elements of the project, comprising its entirety, are depicted in Figure 2.

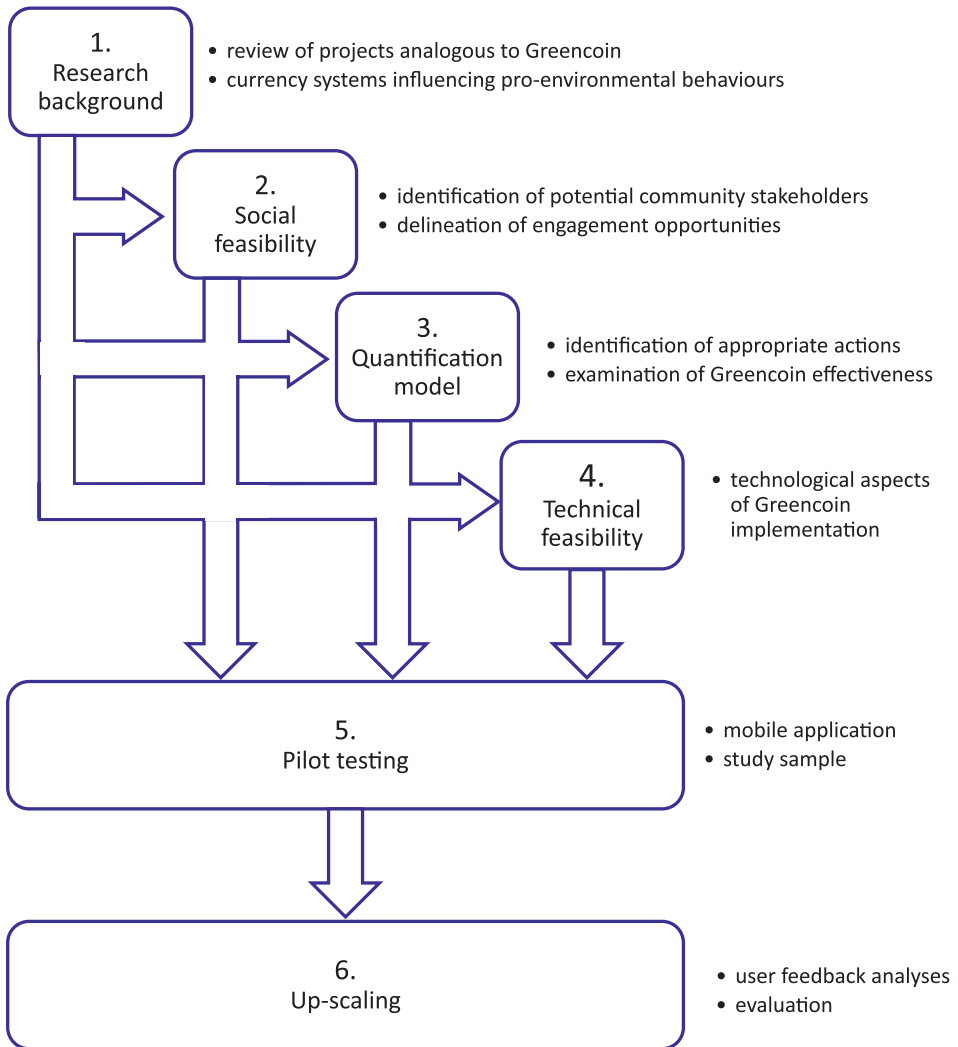


FIGURE 2. Tasks and community that make up the Greencoin project environment

The diverse tasks undertaken in the project required different skills or expert knowledge; hence, our team was interdisciplinary. The Gdańsk University of Technology was responsible for project management and developing and implementing the application, leading Task 4. The SGH Warsaw School of Economics managed Task 1, preparing the research background for the project. Oslo Metropolitan University led Task 2, developing the social feasibility of the Greencoin system. The University of Stavanger was responsible for

Task 3, developing the quantification model. The City Initiative Association coordinated Task 5, the pilot study. The Maria Grzegorzewska University led the research task of evaluating, refining and upscaling the developed educational tool.

The presented monograph outlines the course of the project activities and their outcomes. Due to the distinct nature of each task and the fact that they were coordinated by the various partners, who bring their own unique perspectives to the table, I endeavoured to present them in the monograph in a way that reflects this diversity. Each section was developed by individuals responsible and engaged in their execution. This approach aims to reflect the project's inherent complexity, which is multi-stage and non-linear, with project tasks occurring concurrently over time. It also considers the diverse theoretical assumptions and perspectives, as well as the project team members' respective modes of action and tools. Conducting interdisciplinary research in large, often international teams involving people from outside the scientific community is essential if we want to solve environmental problems together, as the climate crisis is not a one-dimensional phenomenon.

I want to thank the entire Greencoin team for their excellent collaboration, the research adventure during the project's execution, and the relationships formed, which will undoubtedly continue our chosen research path. I also extend my gratitude to those of you who decided to contribute to the final task of co-creating this monograph. Only through this collaboration was it possible to take shape in its current form, presenting our shared winding journey from the workshops in Otwock to the reporting period of project outcomes.

Ewa Duda

Introduction:

Harnessing technology for urban sustainability

In the current era characterised by accelerated urbanisation and intensifying environmental crises, the urgency to promote sustainable living practices has reached an unprecedented level. The extensive ramifications of climate change and ecological degradation necessitate the development of innovative solutions that can seamlessly integrate into the daily lives of urban residents. These residents, located in densely populated environments and engaged in intensive social and economic activities, often face significant challenges, particularly about the spectre of climate crisis (Palanivel, 2017; Weiskopf et al., 2020).

A comprehensive review of urban ecosystem services underscores the crucial role of cities in climate mitigation through sustainable practices and the incorporation of green infrastructure to enhance resilience and mitigate environmental impact (Palanivel, 2017; Weiskopf et al., 2020). The United Nations Development Programme (UNDP) report explains the dual nature of rapid urbanisation, highlighting its potential to drive economic growth and development while posing challenges such as increased pollution, inadequate infrastructure, and heightened vulnerability to natural disasters (Palanivel, 2017; Weiskopf et al., 2020; Zhang et al., 2020).

It can be demonstrated that regular participation in pro-environmental activities by members of urban populations can contribute to the advancement of sustainable urban development. As evidenced by Steg et al. (2014), the collective engagement of citizens in pro-environmental behaviours can drive transformational change through a collective effort towards sustainability. Furthermore, as highlighted by de Jesus et al. (2019), the pursuit of sustainability can be achieved through a collaborative approach, with the collective actions of citizens playing a vital role. The necessity for a sustainable future is a global concern, as evidenced by the findings of Merz et al. (2023) which indicate that climate change, resource depletion and pollution are significant challenges that require urgent attention.

These behaviours have been demonstrated to reduce environmental degradation and promote sustainability (Prati et al., 2017). Furthermore, they have been shown to promote social cohesion, community ties, sustainable norms, and environmental benefits (Miller et al., 2022). Implementing sustainable practices has been demonstrated to result in economic benefits, improved resource utilisation, and enhanced environmental performance (Piwowar-Sulej & Kołodziej, 2022). Furthermore, a healthier environment is conducive to improved mental and physical health (Hadavi, 2017). Implementing sustainability practices, such as recycling and energy conservation, has been shown to enhance personal satisfaction and the quality of life (Klug & Niemand, 2021).

These practices help achieve the United Nations Sustainable Development Goals (SDGs), such as sustainable energy, responsible consumption, and community growth (Guang-Wen et al., 2023). Pro-environmental actions can help marginalised communities address their disproportionate ecological impacts and create a society where everyone benefits from a clean, unpolluted environment (Fuller & Brugge, 2020).

Understanding and using key variables helps promote and integrate pro-environmental behaviours (Miller et al., 2022). These behaviours shape environmental awareness, social norms, institutional support, and education. Syncing norms and policies can create a sustainable environment (Zhang et al., 2022). Educational programmes spread knowledge, motivate people, and encourage environmentally conscious behaviour (Mendoza et al., 2019). Mendoza and colleagues (2019) state that incentives and rewards can influence motivation for pro-environmental behaviour. Marketing uses financial and non-financial schemes to build product loyalty. Incentives motivate users.

International initiatives aim to achieve sustainability and address human-caused impacts. Currently, considerable research efforts are dedicated to promoting healthy behaviours, addressing self-sufficiency in rural areas, and promoting environmentally friendly production and consumption in urban areas (Lawhon, 2013; Obracht-Prondzyńska et al., 2022; Puska et al., 2016; Šauer et al., 2021). Several initiatives have been launched to encourage pro-environmental behaviour through rewards or incentives (Bolderdijk et al., 2018). They also suggest that reward-based mechanisms can encourage sustainable behaviour in Eastern European cities.

This monograph presents the Greencoin project, initially conceived as a currency system designed to reward environmentally friendly actions, and within it, the development process of the educational mobile application PULA as a tool to promote pro-environmental behaviours among city residents, contributing to a broader discourse on sustainable urban development. The project's progression is outlined through successive steps, constituting individual monograph chapters.

The Greencoin project is an innovative educational information system designed to support eco-integration and strengthen city adaptive capacities (Obracht-Prondzyńska et al., 2021). Utilising interdisciplinary cybernetic principles, the system integrates data, methods, information and communication technologies, organisation, and people, creating comprehensive frameworks for promoting sustainable urban living. Greencoin (GC) incentivises pro-environmental behaviours through a reward system where users earn green points for environmentally friendly actions. These points are then tracked and managed within the system. This approach aims to motivate individuals and communities to adopt sustainable practices by providing tangible rewards for their efforts.

The self-learning and recursive nature of the system ensure continuous adaptation and improvement, adapting to the dynamic needs of urban environments. By employing gamification, behavioural economics, and goal-framing theory, Greencoin educates and actively engages users in striving for sustainable environmental development. A schematic representation of Greencoin as an information system is illustrated in Figure 3. The developed diagram illustrates the Greencoin information system, emphasising data flow and interactions between various components. The system begins with data collection influenced by public relations and social communication methods, processes information to assign green coins, and utilises feedback loops to reinforce and perpetuate pro-environmental behaviours.

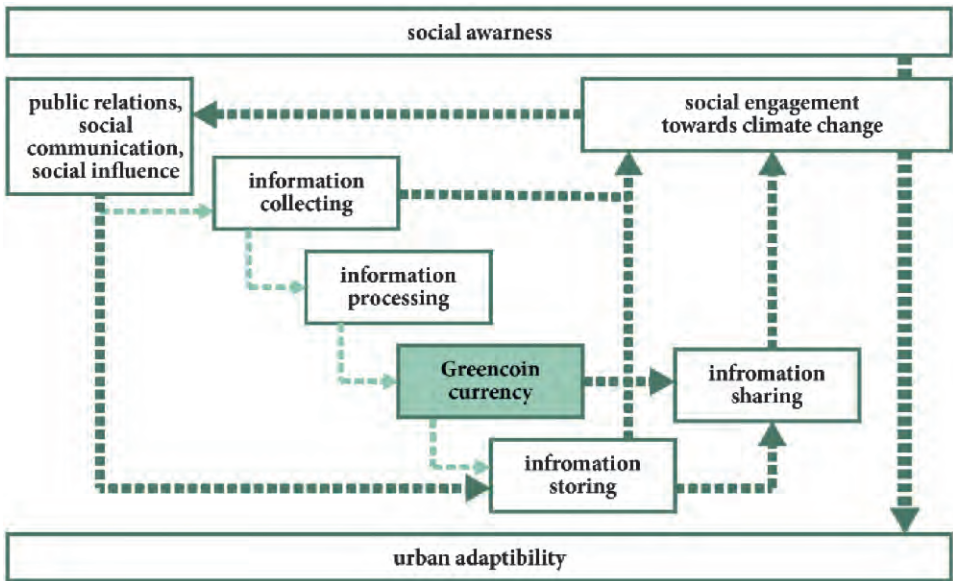


FIGURE 3. Algorithm of information system (IS) as a basis for research format.
Source: Obracht-Prondzyńska et al. (2021, p. 4)

Research, however, has shown that emphasising the “green” aspect can deter potential users (Uryga et al., 2024). Therefore, our project application was developed with a broader emphasis on promoting sustainable behaviours that enhance local environments and community well-being. This innovative approach aims to engage a wider audience by making environmental actions satisfying, accessible, and integrated into daily life, thereby driving significant positive changes in sustainable urban development (Obracht-Prondzyńska et al., 2021; Duda et al., 2023a).

The PULA application is a comprehensive digital tool designed to enhance sustainable urban environmental development by promoting environmentally friendly behaviours (see Figure 4). It serves various user groups, including general users, administrators, and supervisors, each accessing the system via mobile devices. General users can register and track their environmental actions, earning points contributing to their overall environmental impact. Administrators manage the application ecosystem, including user data, partner integrations, and the reward system. Supervisors ensure smooth application operations and handle operational issues. The application utilises advanced data management features and quick-response codes to streamline

user interactions and enhance engagement. The system project emphasises user-friendliness and adaptability, aiming to support environmentally conscious communities (Duda et al., 2023b).

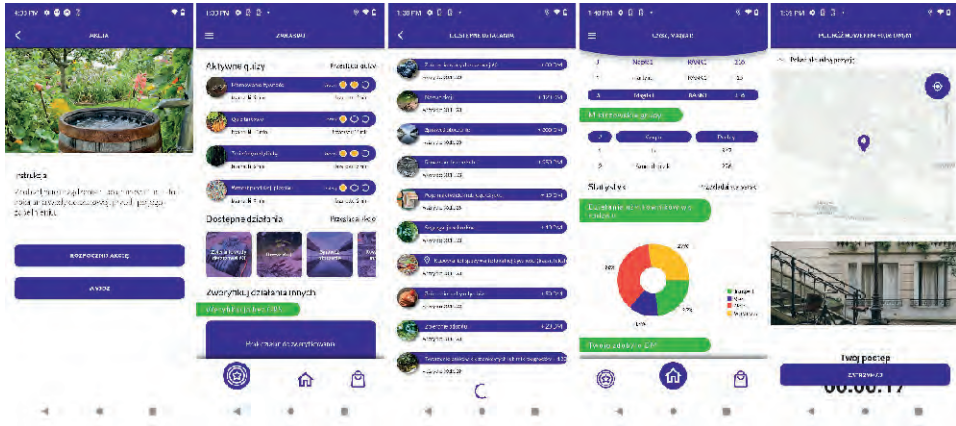


FIGURE 4. PULA screenshot. Source: Duda et al. (2023b, p. 68)

Pro-environmental behaviours refer to actions taken by individuals or communities to protect the natural environment or mitigating their negative impact on it. These behaviours include waste segregation, reducing energy and water consumption, using public transport or bicycles, and promoting sustainable consumer practices. Encouraging these behaviours involves environmental education, promoting conscious choices of environmentally friendly products, organising social campaigns, or initiating projects aimed at environmental protection (Kollmuss & Agyeman, 2002; Khatibi et al., 2021; Salvador Costa et al., 2022; Carmen et al., 2023). The convergence of technology and ecological awareness offers a new era of opportunities embodied by the transformative potential of applications created for environmental literacy.

The motivation behind this monograph is multifaceted. At its core lies the urgent need to combat climate change and promote sustainable development in urban areas. Urban areas significantly contribute to environmental issues and offer unique opportunities for implementing large-scale sustainable practices (Bulkeley & Betsill, 2005). Integrating digital tools to promote pro-environmental behaviours represents a promising path towards catalysing this transformation. By leveraging mobile applications, we can reach

a broad audience and facilitate behaviour change on a scale that traditional methods may not achieve (Evans & Karvonen, 2010). Recent studies have demonstrated the effectiveness of digital interventions in promoting sustainable behaviours, underscoring the role of mobile applications in increasing environmental awareness and encouraging ecological practices (Boncu, 2022; Jones et al., 2017; Balińska et al., 2021; Zulkepeli et al., 2024).

Several research questions guide our study. Due to the monograph's specific nature, these questions are addressed in individual chapters dedicated to the successive stages of project implementation. The research questions aligned with the research objectives arise from the needs of executing specific project tasks.

Our methodology adopts a comprehensive approach, integrating systematic literature reviews, case study analyses, participatory co-design workshops, and qualitative research methodologies such as focused group interviews. This multifaceted approach enables us to offer a robust insight into the dynamics of promoting pro-environmental behaviours. Systematic literature reviews thoroughly analyse existing research and exemplary practices related to currency systems and digital technologies in the field of climate change (Bamberg & Möser, 2007; Hargreaves, 2011). Case study analyses of various projects offer valuable insights into the effectiveness of these systems in promoting pro-environmental behaviours and their potential to achieve climate neutrality in the context of smart cities (Bulkeley & Betsill, 2005). Participatory co-design workshops engage stakeholders, including residents, environmental organisations, and municipal authorities, to identify community needs and prioritise ecological initiatives.

Qualitative research methodologies through focused group and individual interviews provide a deep understanding of the ecological attitudes and behaviours of urban residents and potential application users (Patton, 2023). This integrated approach allows us to comprehensively explore the complexities of promoting sustainable practices and developing effective strategies within urban environments, contributing to a nuanced understanding of environmental initiatives and their impact on community engagement and behaviour change.

Our research results offer a compelling insight into the effectiveness of currency-based systems, the potential of digital tools in shaping climate awareness, and the efficacy of participatory co-design methods. From highlighting the impact of environmentally friendly local actions to explaining

the application's functionality developed by the project team, our findings pave the way for informed interventions supporting sustainable urban living. Our contribution to the discourse on sustainable urban development includes providing insights into the design and implementation of environmentally friendly initiatives, informing policy, practice, and research to promote ecological awareness, and supporting collective action.

Furthermore, our exploration of the transformative potential of digital tools underscores the importance of technology in enhancing both environmental and societal outcomes. The impact of our research extends beyond academia, offering practical implications for decision-makers, practitioners, and technology developers. By elucidating effective strategies for promoting pro-environmental behaviours and shaping climate awareness, we aim to catalyse positive changes in urban communities and contribute to the broader goal of building resilient and sustainable cities.

In the first phase of our research, we delve into a comprehensive review of projects like Greencoin, focusing on the effectiveness of currency systems in influencing pro-environmental behaviours. This chapter examines the potential of artificial intelligence solutions in supporting smart cities towards achieving climate neutrality and the role of digital tools in mitigating climate change. By analysing these initiatives, we highlight innovative approaches and provide valuable insights into how digital interventions, particularly those utilising social currencies and information systems, can drive efforts towards sustainable development.

In the second phase of our research, we propose systematic frameworks for identifying and quantifying pro-environmental actions and products within the Greencoin system. This chapter identifies appropriate actions, quantifies their environmental value, and examines the system's effectiveness in promoting environmentally friendly behaviours. Through developing a quantification model, this chapter provides essential tools for measuring the impact of pro-environmental behaviours and ensuring that incentives are appropriately aligned with environmental benefits. These frameworks are innovative as they integrate comprehensive evaluation methods and reward mechanisms, making them valuable reading for those interested in data-driven approaches to supporting sustainable urban living.

The third phase of our research meticulously analyses identifying and selecting pro-environmental actions to be included in the Greencoin project. Emphasising stakeholder engagement and empirical research, this chapter

underscores the importance of a participatory approach in environmental planning and the role of community input in shaping effective initiatives for sustainable development. By considering diverse perspectives from local authorities, activists, and residents, this chapter presents robust frameworks for selecting effective actions. This innovative approach ensures that chosen actions are beneficial for the environment, socially acceptable, and technically feasible, making it essential reading for those interested in community-led sustainable development.

The fourth phase of our research focuses on establishing effective collaboration with various stakeholders to promote sustainable development within the Greencoin project. It delves into identifying potential partners, understanding their needs, and supporting strategic communication channels. By analysing similar initiatives, this chapter highlights the crucial role of multisectoral partnerships in achieving sustainable development goals and expanding the reach and impact of environmental projects. Emphasising a collaborative approach, it outlines how strategic partnerships with local authorities, businesses, and NGOs can enhance project impact. Readers gain valuable insights into building a solid network of partners and motivating users to participate, making it an engaging read for those interested in community-driven sustainable projects.

In the fifth stage of our research, we conducted a qualitative study to understand the environmental attitudes and behaviours of residents of Gdańsk. This chapter aims to identify potential users of an application that rewards environmentally friendly behaviours and explores the application's branding strategy. It provides insight into user-centred design and the importance of aligning branding strategies with user values and environmental goals (Norman, 2013). By detailing the application's functionalities, such as user actions, progress tracking, community engagement, and urban partnerships, this chapter highlights innovative approaches to supporting sustainable behaviours. Readers will find practical strategies for engaging users through intuitive design and significant incentives, making it essential for those interested in effective environmental applications.

The sixth stage meticulously describes the features of the PULA application, designed to facilitate user engagement in environmentally friendly actions. Drawing on user feedback and application parameter validation, this chapter focuses on the "Transport" action as an example. Emphasising the iterative process of technology refinement based on user feedback, this

chapter demonstrates the practical application of digital tools in promoting sustainable development (Rogers et al., 2014). It underscores the importance of user-centred design and continuous improvement, providing valuable insights into how pilot projects can enhance application effectiveness. This chapter is crucial for understanding the dynamics of developing and testing environmentally friendly digital solutions, making it an attractive read for those interested in sustainable technological initiatives.

This monograph employs diverse methodologies, from literature reviews to qualitative research, to unravel the complexities of promoting pro-environmental behaviours. The research findings contribute valuable insights to the broader discourse on sustainable urban development, offering practical implications for decision-makers, practitioners, and technology developers. This monograph aims to pave the way towards a more sustainable future through collaborative efforts and a nuanced understanding of human behaviours.

Step 1.

Research background

To maximise chances for successful design and implementation of the Greencoin project, we have conducted a thorough analysis of similar projects to identify challenges, best practices, and lessons learned from systematic literature reviews and case studies.

As a first step, we conducted a systematic literature review to identify existing projects like Greencoin. We have found that currency-based systems have effectively influenced behavioural change towards environmental issues. Participants in such initiatives were motivated by reward systems or service exchanges, leading to a transformation in their attitudes towards pro-environmental issues. For example, Akin and colleagues (2021) found that in local currency-based systems, participants prioritised trust and neighbourly solidarity over traditional payment methods, deepening their knowledge of pro-environmental activities (Akin et al., 2021; Dini & Kioupkiolis, 2014). Below, we present an overview of articles that show the results of the studies that were conducted.

In Obracht-Prondzyńska et al. (2021), we focus on the systematic literature and case studies summary and the implementation of innovative solutions based on community currencies (CCs) and information systems (ISs) us-

ing gamification techniques to raise environmental awareness and encourage environmentally friendly behaviours. Based on the lessons learned from the initial research, Duda et al. (2022) outline the development of the Greencoin cybernetic system as an educational tool to foster pro-environmental attitudes and behaviours among urban residents.

The following article, Obracht-Prondzyńska et al. (2022), explores the potential of AI-based solutions in supporting smart cities to achieve climate neutrality, mainly focusing on the Greencoin framework. We have approached the design of Greencoin activities by conducting a systematic literature review and using Kamrowska-Załużska's approach (2021) for evaluating AI-based solutions in urban planning. We aimed to introduce solutions supporting an implementation process of net-zero policies benefiting from the single actions of urban dwellers. The research narrowed down to educational and economic aspects of smart cities, proposing AI-based solutions to address various needs such as shaping pro-environmental behaviours, reinforcing urban management, supporting bottom-up initiatives, enhancing smart mobility, shaping local economies, and improving communication with residents (Obracht-Prondzyńska et al., 2022).

In the research titled "Greencoin as AI-based solution shaping climate awareness", we have utilised Kitchenham's methodology and the PRISMA approach for model creation, focusing on a systematic literature review and case studies (Kitchenham & Brereton, 2013; Page et al., 2021). We have identified AI-based tools embedded in the smart city concept that could support climate change mitigation, climate neutrality awareness, and pro-ecological behaviours. Challenges in the process included defining selection criteria, data extraction and analysis, and building a theoretical model based on the extracted variables. One difficulty was the limited number of studies explicitly addressing climate-related research using digital tools within the smart city context, which made it challenging to find relevant strategies to develop the design of the Greencoin project activities.

The following article extensively analyses existing community currencies and applications to promote pro-ecological behaviours to mitigate climate change (Obracht-Prondzyńska et al., 2023). For instance, such projects as Makkie and Brixton Pound demonstrated a broad inclusivity of target social groups and regional strengths. These and similar community currency projects involve stakeholders such as households, businesses, tourists, and local authorities. These projects recognise the potential of digital currencies and

applications to foster climate awareness and stimulate bottom-up initiatives for environmental actions (Paneru & Tarigan, 2023). Various initiatives aim to utilise digital tools and participatory approaches to promote pro-environmental behaviours and enhance social engagement in climate change mitigation efforts. All the above studies allow one to gain a holistic view of how to build a viable digital tool, such as the PULA mobile application, focused on stimulating pro-ecological attitudes and habits among city residents.

Approach to the Greencoin project and the PULA design

After an initial phase of the Greencoin project, based on theoretical framing and socio-technical requirements formulation, in the next phase of the project, a PULA application – designed and tailored specifically for the Gdańsk city area and targeting Gdańsk urban dwellers with pro-environmental educational gamification means – has been created. We have adopted a participatory co-design methodology, engaging various stakeholders, including academics, representatives from the private and business sectors, urban movements, municipal institutions, and residents, in group workshops (Duda et al., 2022). While this approach ensured diverse perspectives, it posed challenges such as reaching a shared understanding and overcoming barriers in the co-design process related to the successful pro-environmental application framework creation and its further implementation. One difficulty was integrating existing technological solutions into the Greencoin system while addressing concerns about security and authenticity, some of which were contradicting or not relevant in terms of the scope and aims of the Greencoin project. Despite these challenges, the participatory nature of the workshops we conducted facilitated the identification of existing challenges, good practices, and potential solutions for shaping pro-ecological behaviours.

We approached the design of the Greencoin project by consulting literature on Information and Communications Technologies for Development (ICT4D), looking for examples of how to promote environmentally friendly behaviours (Dearden & Kleine, 2021). We found that the importance of feedback mechanisms, social participation, and the involvement of public authorities and stakeholders stands out in these examples. However, we also noted that implementing these elements posed challenges such as time constraints,

financial concerns and additional efforts among developers, operators, and system users that could go beyond research project frames. Based on this research (Chen et al., 2015; França et al., 2020), we decided to incorporate activities like news, tips and hints, quizzes, and challenges to enhance user engagement. After piloting, we decided to continue with these activities in the application.

Our literature study revealed that while there are many examples of collaborative projects across academia and the public sector that aim to engage citizens in environmental action through ICT solutions, there are few examples of this in Eastern European cities. While other initiatives do exist, the specificity of Greencoin lies in its focus on shaping urban green behaviours through integrating educational modules and an alternative community currency through digital means. This distinctive combination sets Greencoin apart from similar projects and positions it as a pioneering solution in the Eastern European region.

Moreover, based on the literature review, we have found that digital tools for mitigating climate change and shaping climate awareness within the smart city context are underdeveloped and require further investigation (Obracht-Prondzyńska et al., 2022). While existing digital tools are discussed in the implementation of smart city policies, a limited number of studies explicitly focus on climate-related research using gamification-based applications. For example, we have found more case studies related to using digital solutions in shaping smart mobility compared to other areas. This indicates that initiatives that, similarly to the Greencoin project, aim to use digital tools and gamification to shape pro-environmental behaviours and promote climate awareness are relatively rare (Obracht-Prondzyńska et al., 2022).

We have adopted a systematic approach to the requirements gathering and further systematic analysis on which functionalities should be integrated into the Greencoin system, consisting of several key steps: Empathise, Define, Ideate, Prototype, Test, and Implement (Obracht-Prondzyńska et al., 2023, see Figure 5). During the Empathise phase, we analysed more than 120 case studies describing various approaches to using social or community currencies and applications supporting climate change mitigation activities. During the Define phase, workshops and dialogue sessions involving various stakeholders were conducted to shape the project direction and engage potential users. These sessions revealed that key actors readily participated in socially important processes that directly affected them.

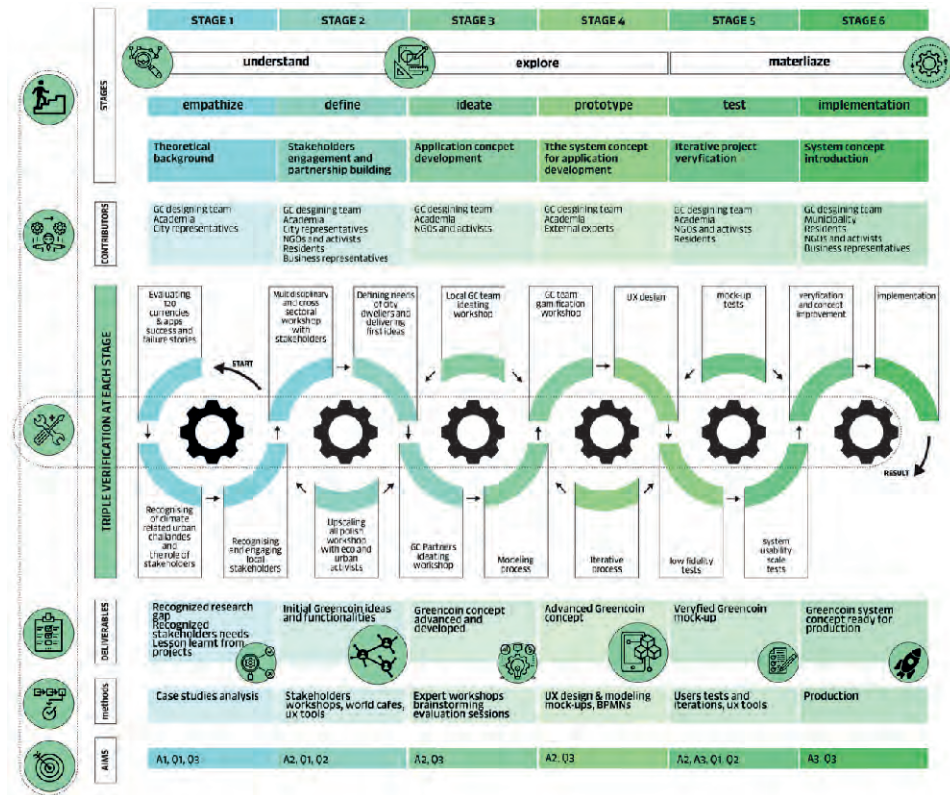


FIGURE 5. Research design: steps, contributors, methods, aims, and deliverables. Authors’ own elaboration, firstly presented in (Obracht-Prondzyńska et al., 2023, p. 5)

The Ideate phase involved iterative brainstorming sessions, resulting in developing and evaluating multiple concept versions of the GC system. We have leveraged multidisciplinary collaboration and user feedback to refine the functionalities and design of the developed application. The Prototype phase utilised graphical user interface prototypes, Business Process Models, and Notation diagrams to visualise system interactions and processes. Usability testing (the Test phase) was conducted to gather user feedback and refine the system design iteratively. The Implementation phase involved preparing the system specification and collaborating with IT companies to develop the GC system based on the finalised design and requirements. The analysis highlighted the role of digital technologies in promoting climate awareness and facilitating bottom-up initiatives for environmental action.

A detailed study was designed to understand the Greencoin project better and situate it within a broader context. The project authors employed well-established and well-known methods and techniques to guarantee that the study was conducted following the most recent research and best practices within the field. In particular, to ascertain the social feasibility of Greencoin, a series of workshops were conducted to gather insights from relevant stakeholders, understand the system's potential applications, and establish a network of potential participants. The workshop yielded a wealth of qualitative data on stakeholder perspectives and facilitated interaction and feedback. Another research method employed was SWOT (strengths, weaknesses, opportunities, and threats) analysis, which evaluated the strengths, weaknesses, opportunities, and threats associated with potential project partners. This analysis informed the decision on which stakeholders should be involved in the pilot programme.

To conduct direct qualitative research, we employed the focus group interviews. We used them to gauge environmental awareness, identify factors influencing sustainable behaviour, assess the usability of a Greencoin application, and develop user personas representing different target groups (students and office workers). Additionally, we performed a quantitative survey to investigate Tricity residents' attitudes and practices regarding waste segregation and assess their knowledge about waste management policies. We also used some marketing strategies, such as value proposition analysis, including personas, customer journey maps, and business models, which can elucidate the system's unique benefits to both partners and users. Such an approach makes it possible to better understand the connections between Greencoin, its users, and other stakeholders.

Based on the above outcomes, we have adopted a tailored approach to design and implement environmentally friendly local actions. We have utilised the Diffusion of Innovation Theory to analyse data provided by early adopters of the application, evaluating its impact on ecological awareness and environmentally friendly activities among urban dwellers (Rogers, 2003). One proven aspect of the application approach was employing innovative technological solutions and data-driven methodologies to promote sustainable behaviour.

Analysis of projects based on alternative currency

To better understand and lay the groundwork for the project, a crucial part of Greencoin's early days was analysing similar projects already undertaken. The analysis focused on various digital tools using gamification-based applications that increase public involvement in mitigating climate change by encouraging potential users to engage in ecological behaviour (Zawieska et al., 2022). The project's principal objective was to develop a system that was as similar as possible to the intended one, namely the concept of an alternative currency. Two major factors needed to be considered during the selection process of the projects to be analysed. Firstly, the given currency had to be related to sustainability issues. Secondly, sufficient information about the currencies had to be available. The analysis was based on differentiated sources, such as reports, scientific papers, newspapers, Internet articles, or project websites. The aim of the research process emphasised the need to find answers to two groups of questions, regarding stakeholders and consumers. The questions from the first group were aimed at finding answers to how stakeholders co-create currencies, what their contribution may be, and what potential benefits they can obtain from them. The latter group of questions were more customer-oriented, emphasising things like incentives to use the Greencoin currency. The main projects analysed are presented in Table 1.

Regarding the stakeholders, even while information on their roles and contributions was available, it was uncommon to discuss how their cooperation within the project would benefit them, mainly when it came to private partners. Most public institutions and authorities at various levels carried out their environmental and social policies, which included strengthening social cohesion, encouraging sustainable behaviour, increasing environmental awareness, accomplishing social goals, and lowering social problems. The benefits to the private sector were mainly in the form of promotion, such as displaying the variety of sustainable products in stores (NU Spaarpas) or participating in the system, which aligns with a critical concept of entity philosophy (Bristol Pound). In Torekes' case, the city of Ghent compensated store owners for goods that Torekes purchased. In specific plans, the third sector was also involved (Torekes). Their mission was to promote volunteerism and local, sustainable, and economic development.

TABLE 1. List of projects analysed in the research process

Currency/project name	Country and city (or region)	Aims
Zet op de Kaart	Netherlands, Limburg	to support and reward pro-environmental behaviours of Limburg city residents
NU-Spaarpas	Netherlands, Rotterdam	to support sustainable behaviour and sustainable consumption
SOL	France, 3 regions	to contribute to the development of the social and solidarity economy and contribute towards sustainable development
Torekes	Belgium, Ghent	to address the issues of poverty, labour market exclusion, and deterioration of public spaces in the neighbourhood
Bristol Pound	United Kingdom, Bristol	to support the local market

As for the project users, the findings were more comprehensive. They have been grouped according to each of the analysed projects:

Zet op de Kaart

Users of the system earned points for engaging in pro-environmental activities such as installing radiator foil, participating in litter campaigns, composting at home, joining climate neighbourhoods, and placing anti-advertising stickers on letterboxes. One euro was worth one hundred points scored from the activities given above. There was a closed list of goods and services that customers could purchase with their points on the available expenses side. Among the items on the list, there were things such as energy-efficient lights, compost bins and vats, energy metres, pool tickets, rentals of DVDs, thrift store purchases, football and cultural passes, wind-up radios, and coupons for nearby businesses (Niemegeers, 2009).

NU-Spaarpas

Each cardholder who purchased from a store participating in the NU savings programme was awarded NU points. Points equivalent to a predetermined

percentage (such as 1%) of the retail value were awarded for purchases made at these stores. Environmentally friendly products were awarded four times as many points. Sorting rubbish for disposal and dropping off used items at Roteb's municipal amenity sites were two other significant ways that cardholders could accrue points. Among the rewards were day passes for public transport, art library subscriptions and free entry to nearby museums and attractions (Joachain & Klopfert, 2012).

Torekes

Working for the Rabot-Blaisantvest district enabled obtaining currency Torekes. These acts were especially important and rewarded, as they expressed care for the neighbourhood. These activities included planting flower boxes, creating a green roof garden, and participating in neighbourhood improvement initiatives like reading to kids in schools, providing free sports instruction, picking up litter, and maintaining parks and public spaces. For each hour that they worked, volunteers were paid 25 Torekes. The Torekes that were obtained were redeemable at several establishments within and occasionally beyond the neighbourhood, including food stores, bakeries, pharmacies, pubs, restaurants, and clothing stores. Products like bread, line cards, movie tickets, trash bags, school supplies, toys, stamps, flower boxes, and bird boxes were available for purchase with Torekes. Only merchants were permitted to directly swap their received Torekes for euros, as the goal was to encourage local exchange circles (Schiltermans, 2019).

Bristol Pound

The value of a Bristol pound in sterling was exactly £1. Bristol Pound could exchange any kind of goods or services within the network. The Bristol Pound Scheme comprised more than 650 company members and more than 2,000 individual members. When consumers paid in Bristol Pounds, several establishments gave them a discount. Bristol Pounds were allowed to be used to pay electricity bills and local taxes. The network was open to individuals and commercial partners in the city (Marshall & O'Neill, 2018).

Step 2.

Development of the social feasibility of the Greencoin system

This chapter will briefly explain each of the applied methods, along with placing them in the appropriate context regarding the Greencoin project. The results of the appliance of each technique in the preparatory process for launching the Greencoin test phase will also be explained.

The course of the task

The specific objectives of this phase of the project were to (1) gain insight into user needs and behaviours about sustainable practices, (2) identify potential partners and evaluate their suitability for the Greencoin project, (3) develop a user-centric value proposition for the application, and (4) establish a network of stakeholders for the Greencoin project.

During this phase of the project, we were interested to find answers to the following specific questions:

SQ1: What are residents' current environmental awareness levels and concerns?

- SQ2: What factors motivate or discourage residents from adopting sustainable behaviours?
- SQ3: What features would users find most valuable in a sustainability-focused mobile application?
- SQ4: What are residents' current waste segregation practices and knowledge levels?
- SQ5: What are the most significant challenges residents face when it comes to waste segregation?
- SQ6: What potential applications do stakeholders see for the Greencoin project?
- SQ7: What are the strengths and weaknesses of different potential partner organisations?
- SQ8: How can the Greencoin project build a network of engaged stakeholders?

As previously stated, the decision was taken to employ various research methods, techniques. The following section will provide a concise overview of the implementation of these methods within the research and design activities. Furthermore, we encourage readers to peruse the referenced scientific articles, wherein we have detailed the findings of our study.

Workshops

This section will demonstrate the significance of stakeholder engagement as a vital component in acquiring essential insights into the individuals within the Greencoin ecosystem. In this context, the term “environment” is defined as “institutions or forces outside an organisation that potentially affect the organisation’s performance, operations, and resources” (Robbins et al., 2013, p. 412). This section focuses on stakeholders who are involved with or affected by Greencoin’s activities.

The preparation for the meeting involved communication with stakeholders and promotion, including creating a joint list of potential stakeholders, crafting an official invitation email, preparing promotional materials, promoting the event on Facebook, and providing information on the website registration form. Stakeholder communication included email correspondence, follow-up phone calls, and confirmation emails.

The workshop's goals included introducing representatives of institutions and informal groups to Greencoin's potential, fostering networking among potential stakeholders, and imparting knowledge about potential beneficiaries, actions eligible for Greencoin rewards, available rewards, and promoting an understanding of simple collaboration schemes between entities. The workshop aimed to equip participants to envision potential collaborations and grasp opportunities for their respective entities or industries to participate in the Greencoin system. The workshop was designed for the project's needs (Duda, 2022; Duda et al., 2022). The working materials were prepared, and the boards were developed so that the participants first defined the problems and challenges, then the ways to solve them, and then designed simplified currency functions and combined them into a currency model that could function in Gdańsk.

The main events for gathering this knowledge were conducted twice through workshops. The first workshop, with regular stakeholders, was conducted in Gdańsk on 22 October 2021 (see Figure 6 and Figure 7), and the second one, for urban activists, was carried out in an online version on 20 November 2021. The first workshop aimed to educate relevant stakeholders



FIGURE 6. Workshop conducted in Gdańsk. Photo by Monika Krzemińska



FIGURE 7. Determining environmental challenges and possible solutions during a workshop in Gdańsk. Photo by Monika Krzemińska

on the Greencoin project and its possibilities, investigate the chances that Greencoin could offer to various organisations, and create a network of possible participants. The participants in this workshop were representatives of different stakeholders: business startups, big companies, municipal institutions, companies and departments, education centres, and non-governmental organisations.

Environmental challenges in Gdańsk that have been considered include low awareness, waste segregation issues, transport problems, and climate change impacts. Participants suggested solutions like workshops, green marketing, and corporate social responsibility campaigns. Anticipated gains and opportunities for Greencoin involvement were discussed. The City of Gdańsk could benefit from legitimacy, contributions to sustainability policies, a positive public image, and potential financial benefits. Stores and restaurants could enhance their brand through eco-friendly offerings, while large corporate partners could gain positive public relations (PR) through sponsorship and corporate social responsibility. Citizens stand to benefit from local au-

thorities and businesses, potential habit changes, and increased knowledge about environmental practices.

On 30 November 2021, urban activists from Polish cities participated in the second online workshop. The attendees were to be introduced to the concept of alternative currencies and the Greencoin initiative. In this workshop, three main topics were discussed: challenges and problems, good practices, and suggestions for the development of Greencoin. The workshops were conducted according to a pre-established planned structure, which is schematically presented in Figure 8.

The first topic, problems, can again be subdivided into three parts: the first problem is the impact of climate change on the city and the pollution already present in the town, with particular emphasis on the problem of smog. Secondly, the concentration of towns on cars remains problematic, leading to traffic jams and car-centric urban solutions. Thirdly, concerns about how urban space is used were highlighted. This reflection included issues such as the migration of social activities to peripheral shopping malls, disruption of the vitality of city centres and the increasing imbalance between mass tourism and the local life of residents in recent years.

In addition to the aforementioned points, there are also other aspects of the discussed problems. Based on participants' opinions, massive development of urban space, which does not consider the psychological discomfort of residents, leads to the erosion of neighbourly relations. Excessive use of concrete in construction works instead of alternative building materials. Ageing public infrastructure, primarily in the provision of water and heating, requires an urgent need to apply the basic requirements effectively.

Regarding the second part of the study, namely good practices, participants expressed their views by grouping them into three categories. The first group was related to the natural environment, the second to the social sphere, urban planning and management, and the last to the economy. In the realm of the natural environment, the approaches included things like making incentives for garbage collection through rewards like free canoe rides and tree seedlings, implementing rainwater collection programmes, encouraging people commuting to work to use the bike as a primary mode of transport through company rewards, and ultimately utilising air monitoring technologies. Within the second social sphere, urban development and management, good practices involved hosting competitions for beautiful gardens, providing mini-grants to neighbourhoods, implementing mi-

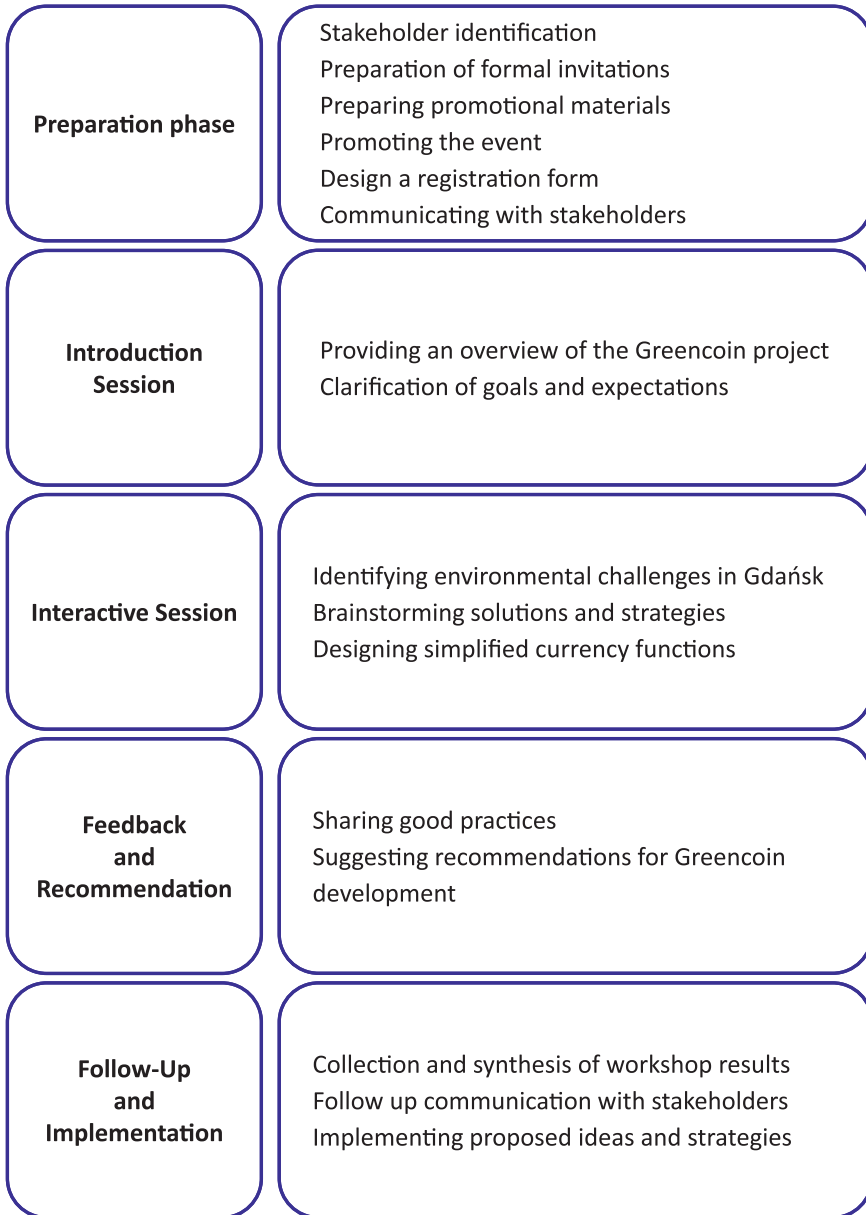


FIGURE 8. Structure of conducted workshops

cro-strategies at the district level, or creating community gardens. The last part, regarding good economic practices, is related to debt relief systems and programmes.

The last part of the workshop was connected to the participants' recommendations towards Greencoin development. They argued that this project should pursue the goals of making the city greener, saving water, promoting environmental education, and providing debt relief for citizens, as the last economic argument stated. Residents could be awarded for using rainwater, supporting insects, and using municipal springs. Proposed rewards included tickets to the Philharmonic Hall, cultural events, ecological workshops, and access to many different events.

SWOT analysis

Collaboration with stakeholders in the fall of 2021 served as the basis for determining which stakeholder groups should be recognised as strategic partners. A strategic partner is defined as one who offers Greencoin, early adopters, promotes the initiative, and contributes content for the application. A SWOT analysis of many possible partners was carried out in January 2022 to assess that. The name of this method stems from an acronym for the words Strengths, Weaknesses, Opportunities and Threats. By definition, this tool may be used in the analysis process, which involves identifying the internal and external elements influencing the business and its performance (Gurel & Tat, 2017). Strengths are a company's internal capabilities and favourable aspects that are important for achieving goals and providing effective customer service. Internal issues or limitations that could impair an organisation's functioning are known as weaknesses. As a result, internal factors comprise the strengths and weaknesses of the business. Opportunities are characteristics or elements that, when combined with relationships with other organisations, can help or support businesses. These are outside variables that companies can use to their advantage. Threats pertain to adverse external elements that may impede or postpone the company's attainable objectives. Opportunities and risks are therefore considered environmental elements.

The Greencoin team chose to include university students and company employees in the pilot programme based on the SWOT analysis results. The decision regarding the first group, i.e. students, results from the benefits of partnership with universities, strengthened by the organisational base. The crucial support of the deans and rector might potentially lead to the general dissemination of the app among university members. This might enormously facilitate Greencoin's implementation across an entire institution.

As future workers, students present a valuable demographic in instilling the practice of using Greencoin, which, in the long run, might be transferred to their professional life after graduation. Additionally, the relatively homogeneous needs of this group make it easier to adjust content and offers during the application pilot phase.

When choosing the second group, company employees, deciding which business centre to choose was necessary. Two candidates for a partnership appeared. The final decision was to select the Olivia Centre as the pilot partner. This was influenced by the fact that Olivia Centre had previous contact with the project, and the team members also had experience in contact with it.

In addition to these two groups, selecting a university association and a business centre allows expanding the reach of potential Greencoin users to people working in both places in positions other than those indicated above, e.g. maintenance staff. This will extend the participant diversity beyond business professionals and students, enriching the testing population. Many potential users are needed to draw in businesses that will give Greencoin users discounts and other benefits. This is assumed to be provided by the university's union and Olivia Centre.

Despite the benefits, working with multiple universities and a business centre poses challenges, such as the need for extensive communication and negotiation activities. This requires significant resources but mitigates risk by diversifying collaborations. Significant is the fact that the potential failure of the pilot programme in one community does not mean the overall failure of the project, as it can still work in the other community.

Summing up, based on the SWOT analysis, collaborating with university students and company employees presents significant advantages like diversity, financial resources, invention, and a broad audience. This approach taps into a large and diverse community with various backgrounds and perspectives, providing richer data and a wider understanding of user needs. Both groups have established structures (universities and companies) that can facilitate communication, project management, and dissemination of information. Students and employees directly represent the intended user base, offering valuable insights and ensuring the project caters to their specific needs and interests. Companies often possess resources and budget flexibility, while students bring fresh ideas and potential for long-term project involvement (e.g. post-graduation). We assumed that students and

employees could act as early adopters, providing initial feedback before a broader public launch. In this scenario, the project can offer non-financial benefits to students (e.g. linking it to a university subject) while addressing companies' growing need for an eco-friendly image.

Focus Group Interviews

Focus Group Interview (FGI) is a technique of conducting an in-depth interview with participants selected based on a purposive but non-representative sampling of a specific demographic group. Such a group is “focused” on a particular issue. Therefore, the criteria used when selecting participants for this type of research are as follows: they would feel comfortable talking to the interviewer and each other, have something to say on a given topic, and fit into a specific age range (Rabiee, 2004).

Two research studies were conducted using this method. The first was carried out in exploratory research, while the latter was an experimental study. Four focus group talks that belonged to the first part were conducted in November 2021. Each group consisted of eight inhabitants of Gdańsk (four men and four women, ages twenty to sixty). Participants were chosen to discuss their viewpoints on environmental issues based on segmentation. Individuals with “moderately ecological” views – defined as a broad knowledge of environmental problems – were represented by two groups (FGI 1 and FGI 4). They don't think the situation is urgent enough to warrant drastic actions, and there is still time for action. The members of the other two groups (FGI 2 and FGI 3) held “decidedly ecological” viewpoints. These participants agree that environmental problems are serious, and that human activity is primarily to blame. They have already implemented actions like trash segregation and water/energy saving, indicating a willingness to modify their habits.

The interviews were conducted based on the interview scenario developed by the project team. All interviews were conducted face-to-face by the selected research institute. The interview scenario consisted of three main thematic blocks (1) the issues of environmental protection; (2) Gdańsk ecological activities and initiatives; (3) potential ecological application, its usability and usefulness.

The duration of each interview was up to two hours. The study suggested growing environmental awareness among Gdańsk residents. It highlighted demotivators like deforestation and contradictory decisions by authorities.

The lack of external motivation and agency experience inhibits action, while incentives, education, and reliable urban initiatives can promote a sustainable lifestyle. Urban programmes, including public transport, cycling facilities, and outdoor activities, can encourage a healthy and ecological lifestyle. A mobile application involving officials and authorities could positively contribute to these efforts.

The second part of FGI, conducted in March 2022, was an experimental study. The main goal of this part of the FGI was to serve as a foundation for creating “personas” that would be utilised in the advancement of Greencoin. A technique creating an imagined representative of the target group is called a “persona” (further explanation will be provided in the next part of this chapter). “Persona” in the FGI was interpreted as a standard representation of one of the environments under study, such as office workers or students.

Four theme blocks comprised this Focus Group Interview: (1) Questions about general persona activity; (2) Influence on the persona’s attitude; (3) Day-by-day analysis of ecological behaviour; (4) Other personas at work or the university, depending on interview’s respondents.

This part involved three FGIs. Eight people attended each part, representing Tricity residents studying at universities or doing office work.

FGI 1 – The student cohort comprises four female and four male students from the Gdańsk University of Technology (telecommunications), the University of Gdańsk (management and journalism) and the Medical University of Gdańsk (medical).

FGI 2 – The sample consisted of four women and four men in various professional roles, including office-based positions in the shipping industry, event organisation, data analysis, finance, and customer service.

FGI 3 – The sample consisted of four women and four men employed in a variety of professional roles, including debt collection, human resources, railway investment management, accounting and finance, data analysis, and customer service.

The results of this qualitative study shed some light on the ecological aspects of the lives of the two groups. Students face time constraints, balancing university classes and work. They use practical solutions, like thermoses, to save time. Office workers experienced a shift to remote work, resulting in a less hectic schedule but weaker workplace relationships. Re-

garding media habits, people selectively engage with content, favouring apps that track progress and foster competition among friends or companies (Duda, 2023). Lofty environmental slogans may backfire, with individual local initiatives seen as more effective than large campaigns. Awareness of environmental issues is growing, leading to adopting eco-friendly practices, such as reducing excessive consumption and supporting local producers. Economic burdens and a perceived lack of action from corporations and governments can discourage individual efforts despite a rise in pro-environmental behaviours.

Quantitative research

The next method applied was a regular quantitative survey. It was conducted from June to September 2022. In the October 2021 stakeholder workshop, waste segregation was considered a significant environmental concern in Gdańsk. A decision has been made to investigate Tricity residents' thoughts regarding the municipal garbage sorting and collecting policy to learn more about this and the relationship between knowledge and practices. Questions about a range of topics were posed to the respondents, such as:

- their opinions regarding the segregation of household waste;
- the preferred sorting validation control system;
- the motivation to segregate waste;
- knowledge of the principles of waste segregation;
- the attitude to waste sorting;
- the impact of segregation on the environment.

A mixed Computer-Assisted Web Interview (CAWI) and Computer Aided Personal Interviewing (CAPI) technique was employed in a three-phase study: pilot, wave I, and wave II. The survey underwent design updates after the pilot and between waves I and II. CAWI involved two legal panels, sending 6,827 invitations. Internet Protocol (IP) blocking and other measures minimised repeated participation risks. CAPI used a random route selection with 500 addresses; interviews were conducted until meeting quotas. A total of 1,020 participants took part in the study: 697 through CAWI and 323 through CAPI. Control measures included follow-up confirmation and removal of nine interviews with incorrect answers. The main findings from this quantitative analysis were as follows.

Awareness of the obligation to segregate waste was high, with approximately 78% of respondents indicating that they were aware of this requirement. However, nearly one-fifth of respondents believed that segregation of waste was voluntary. The subsequent finding was that overall satisfaction with the waste collection system was high (82%), yet dissatisfaction was evident regarding the cost (42%) and the limited space for bins (36%). Most respondents indicated that waste was collected with sufficient frequency. However, they expressed concerns regarding bulky items and plastics, suggesting they require more attention.

A further finding revealed that over half of the respondents (58%) had observed improper waste segregation in their localities. The respondents indicated that most of the observed errors were related to unsegregated waste in mixed bins (34%). The financial implications were identified as the primary factor influencing the decision to separate waste by 67% of respondents. The motivation to sort waste was driven primarily by the potential for cost savings.

One noteworthy outcome of the survey pertains to educational matters. Although the respondents indicated sufficient knowledge about waste sorting, the quiz results demonstrated notable inaccuracies, particularly regarding specific items. Knowledge gaps existed about sorting animal-derived waste, with confusion evident in cities such as Gdynia and Sopot.

The respondents indicated a preference for environmental protection, citing segregation's potential health and nature benefits. The respondents underscored the significance of public education. There was considerable variation in opinions regarding the sorting habits of neighbours, whereas respondents themselves were convinced that they were aware of and adhered to segregation rules at home.

Results showed us that Greencoin could incentivise proper waste segregation by offering rewards for residents. Residents expressed a need for improved knowledge, particularly regarding specific waste types. We concluded that educational campaigns to reinforce proper sorting practices should be implemented in our application. The survey results provide valuable insights into public perception and behaviour regarding waste segregation in Gdańsk. As a result, we aimed for Greencoin to position itself as a useful tool for promoting sustainable waste management practices in Gdańsk and potentially other municipalities.

Value proposition design

Personas

Persona is a tool for deepening understanding of consumer behaviour and locating the final user of the product (Caballero et al., 2014). This market research tool is used to create a product with a specific target user in mind, helping to imagine the target recipient's use of the product. The whole representation process of target users is developed based on previous research (usually qualitative).

In the Greencoin context, the results of focus groups and workshops with stakeholders were used to create personas for this project. The methodology of creating personas based on focus group interviews was divided into four steps:

- 1) Data analysis from focus group interviews;
- 2) Defining similar behavioural patterns;
- 3) Creating personas;
- 4) Usage of personas for further strategic planning.

The process has yielded the development of six personas, which reflect the diversity of residents engaged in city life. These include (1) a representative of a non-governmental organisation (NGO), (2) a representative of the city, (3) a representative of a business – a large company (4) a representative of a start-up business, (5) a sceptical city resident, and (6) a city resident who is a believer.

The next phase of the analysis entailed a comprehensive examination of the pivotal elements associated with each persona by the methodology delineated by Osterwalder et al. (2015). The following points have been determined as requiring further attention:

- Gains: identifying and highlighting the positive aspects, desires, and benefits that motivate each persona.
- Pains: uncover and emphasise the challenges, frustrations, and negative aspects experienced by each persona.
- Customer Jobs: to understand the specific tasks or responsibilities that the persona is required to fulfil daily in their professional or personal roles.

Gain creators: Outline the strategies or features that have been implemented to enhance and deliver the gains identified for each persona.

- Pain relievers: to specify the actions or solutions implemented to mitigate the pains and address the challenges each persona faces.
- Products and services: to specify the tangible offerings or features provided to meet the needs and expectations of each persona.
- 5 WHYS: Apply the five WHYS technique (Card, 2017) to delve deeper into understanding the motivations and reasoning behind each persona's attitudes or behaviours.
- Value proposition: Provide a clear and concise articulation of the unique value proposition, explicitly delineating how the product or service addresses the identified gains, pains, and customer needs.

This method ensured a thorough understanding of each persona, providing a structured framework to design and tailor solutions that genuinely resonate with their motivations and challenges. Analysing the results led to the following conclusions, presented in Table 2.

Customer Journey Map

As a next step in the process, the gathered data from personas were allocated to a tool called the Customer Journey Map (CJM). According to the definition, the CJM is a graphic representation of a series of actions that potential customers may take while interacting with a service or product provider over the entire process of a purchase (Rosenbaum, 2017). Every single potential touchpoint that clients can come across during the exchange process with a given service or product is listed by the Customer Journey Map. The management section can collaborate with cross-functional team members to implement proper strategies that boost product or service innovation by understanding customer touchpoints in-depth. By strengthening the end-user experience connected to every touchpoint, these strategies aim to improve interactions between customers and customer service providers.

CJMs were arranged in a timeline on which a given persona's behaviour was marked. Each touchpoint emphasises behaviour that provides the opportunity to interact with this person using the Greencoin tool. This helped to observe the potential user experiences at each touchpoint. Two Customer Journey Maps were finally created based on the personas created. These were the CJMs of the sceptical resident and the believer resident.

TABLE 2. Value Proposition

Stakeholder	Gains	Pains	Greencoin solutions	Pain relievers	Value proposition
Resident sceptic	Enjoying activities like watching sport events, going to the gym, driving, eating meat, drinking beer	Costs of living, lack of trust in institutions	Gym and match ticket discounts, carpooling with co-workers, promoting a healthy and eco-friendly diet.	Building trust through unpopular facts, demonstrating solidarity through neighbourhood cleaning, showcasing savings from habit changes.	Guide residents to care for their neighbourhood, enhance their lives
Resident believer	Gains from yoga, cycling, meeting friends, showcasing eco-friendly behaviours	Feelings of loneliness, perceived pointlessness of individual actions	Tools to share achievements, illustrate the environmental impact of cycling, suggest sustainable events and places.	Aggregating user achievements, inviting others to the app, rewarding green actions.	Connect people to save the planet, city, and neighbourhood
City representative	Change public attitudes, integrate applications, foster bottom-up initiatives	Lack of resident awareness about city initiatives, uncoordinated projects, hierarchical decision-making, public criticism	Connect bottom-up initiatives with city actions, integrate system with resident cards, change attitudes through trend support	Building trust, providing a centralised platform for green events, testing solutions before implementing them.	Test solutions before implementing them, centralised platform for green events

Stakeholder	Gains	Pains	Greencoin solutions	Pain relievers	Value proposition
Business representative	Support eco initiatives, foster positive atmosphere, build community	Parking issues, negative image among residents, decreasing demand for office space due to remote work	Support group challenges, showcase achievements, offer opportunities to support the project	Supporting car-sharing, building relationships in real places like offices.	Make the company a green spot on the map of Gdańsk
Start-up representative	Integration with Greencoin, app attractiveness, promotion of new green app	Low interest from potential users	Earn Good Coins while using the app, include partner info, find partners together	Offering the possibility to earn Good Coins while using the app, including partner information, and finding partners together to promote the app and attract users.	Form and support green communities
NGO representative	Social recognition, accessibility of services for diverse groups, influencing government decisions	Difficulties in influencing government decisions, low resident interest in social issues	Promote NGO initiatives, ensure system inclusivity, search for accessible events/places	Earning Good Coins for social participation.	Act together with Greencoin to improve neighbourhood, city, and planet

The first one, Radosław, a 42-year-old resident of Orunia district, is a lease seller. He displays basic pro-environmental behaviours but is reluctant to change some of his daily habits, like driving a car or eating a meat-based diet. His primary needs and challenges include financial and professional stability, security for his children and a neat and safe neighbourhood. Radosław is looking for stability, primarily financial, he cares about personal comfort and wants to live in a better environment. To meet his expectations, suggestions from CJM include offering tickets as a form of reward for green actions, lowering transport costs, and providing guidance on savings on utility bills. Throughout his day-to-day routine, opportunities arise to promote alternative mobility methods (car sharing and public transport), incentivise eco-friendly choices, and encourage healthier eating habits. In addition, engaging in challenges, e.g. by providing discounts on eco-friendly products and illustrating potential savings, could help him adopt more sustainable behaviours in various aspects of his life.

The latter one, Maja, is a 36-year-old kindergarten principal. She lives in the Wrzeszcz district. She demonstrates conscious behaviours regarding the environment, like commuting using alternative transport methods (biking and public transport), limiting chemical use within a household, and switching towards a more plant-based diet. Her attitude is characterised by a concern for global warming, care for animals and a desire for personal satisfaction obtained by impactful actions. Her primary needs include the feeling that she makes a change through personal choices and that all her efforts remain meaningful. She is motivated by personal satisfaction by positively impacting the planet and educating others about protecting the environment. To meet her needs, the CJM tool suggested rewarding her efforts, visualising the overall impact of all her eco-friendly activities, and providing her with further education on reducing her carbon footprint. Throughout Maja's daily routine, there are opportunities to support her motivation, offer relevant content, facilitate connections with like-minded people, promote sustainable practices at work and when shopping and provide alternative ways to spend her free time with an emphasis on environmentally friendly aspects.

Business Model Canvas

The Business Model Canvas has been applied to merge the already outlined partners (both local and strategic) and users. It is a tool developed to deter-

mine the business model and its components, together with a graphic visualisation (Qastharin, 2016). It is essential for many stakeholders to discuss the assumptions of the business model. It allows for a comprehensive look at various aspects of product development strategy, which helps achieve success in introducing the product to the market. The nine core themes outlined in this visualisation are as follows:

- 1) Customer segments: the process of defining product target groups.
- 2) Value proposition: the identification of product features that meet customer needs more effectively than competitors or substitutes.
- 3) Channels: aspects related to product promotion, sales, and distribution.
- 4) Customer relationships: formulating a strategy for building relationships and supporting customers.
- 5) Revenue streams: the revenue a business generates from each customer segment.
- 6) Key resources: determination of the required resources for the implementation of the application.
- 7) Key activities: actions required for the establishment of a relationship.
- 8) Key Partnerships: identification of the most significant project partners.
- 9) Cost Structure: delineation of all expenses incurred in operating a business model.

Due to the non-commercial nature of the Greencoin project, the model has been slightly modified, but its main assumptions remain. The cost structure element needs to be included, and the revenue streams block focused more on building the benefits, i.e. sources of obtaining benefits for application users. Distinct customer segments have been identified. One segment is formed by local patriots, driven by a sense of loyalty. The next one comprises eco-aware citizens, so-called 'hipsters', seeking green engagement. The last segment is connected to the people interested in life-hack activities and gamification. The value proposition for this whole group revolves especially around fostering a sense of community-building potential. Customer relations focus on encouraging their active participation while using Greencoin. It aims to ensure that end users are an integral part of the evolution of the project.

Regarding the collaboration with partners, as with customer segments, the aim is to engage them in vital co-creation of the project. Key activities in this area include mapping potential partners, setting up a timeline, develop-

ing app content, and conducting preliminary recruitment. The success of the project strongly relied on the relationship with partners. The ones outlined in the Business Model Canvas included Fahrenheit Union of Universities in Gdańsk, the Olivia Centre, the Experiment Science Centre in Gdynia, and various local partners in green gastronomy, services, startups, and NGOs. Regarding this group, a value proposition revolves around enhancing the image of these partners, providing access to potential new clients, and ensuring customer retention.

A key element outlined throughout this tool was the pilot event of Greencoin, which was aimed at introducing the project's core ideas to the community and serving as an enthusiasm boost for potential users.

Defining value proposition

The value proposition was the final product, which stemmed from all the previous tools used in the preparatory process for launching the Greencoin test phase (Figure 9). The offer needed to be a multifaceted and inclusive value proposition, aligning with its stakeholders' diverse needs and aspirations, i.e. partners and customers. Prior analysis helped to understand that each stakeholder group brings unique perspectives.



FIGURE 9. Value propositions depending on the types of stakeholders

Regarding businesses and startups, the value proposition was centred around enhancing their brand image within the city of Gdańsk. Greencoin offers businesses an integral part of the city's green narrative. It can be done by positioning themselves as responsible contributors to environmental awareness. The potential partnership of any company in a sustainable initiative such as this might add a layer to the corporate social responsibility aspects.

This, in turn, can appeal to environmentally conscious customers and create a positive brand image beyond solely focusing on profit.

NGOs find value in Greencoin through the creation process of supportive and strong communities focused on environmental issues. Despite the business aspect mentioned above, startups can also be included in this area of value proposition. For both groups of stakeholders, the project might act as a catalyst by bringing together like-minded people and entities to cooperate, amplify joint impact and share resources. The effect of such a process may be the development of a green ecosystem on a micro scale, the scale of one city, supporting sustainable development combined with innovation.

Step 3.

Identification and selection of pro-ecological actions

The main objective of this step was to identify suitable ecological actions to be used as the basis for the set of pro-environmental behaviours in the Greencoin system. We developed a specific research question that led the study:

SQ: What specific pro-environmental actions are suitable for the Greencoin system to fit the needs of the local community?

The system was designed using a detailed methodology involving literature reviews of environmental issues affecting cities worldwide and a set of pro-environmental actions addressing the challenges and stakeholder consultations. The selection of actions supported within Greencoin is divided into four stages, as illustrated in Figure 10.

The first stage was identifying the city's environmental problems based on a literature search, reports, planning and sectoral documents of Gdańsk and information on the city's website. It was also decided to conduct a series of meetings and interviews with employees of the Municipal Offices in Gdańsk and Warsaw and local activists and representatives of non-governmental organisations in Gdańsk. The purpose of the first stage of work was to identi-

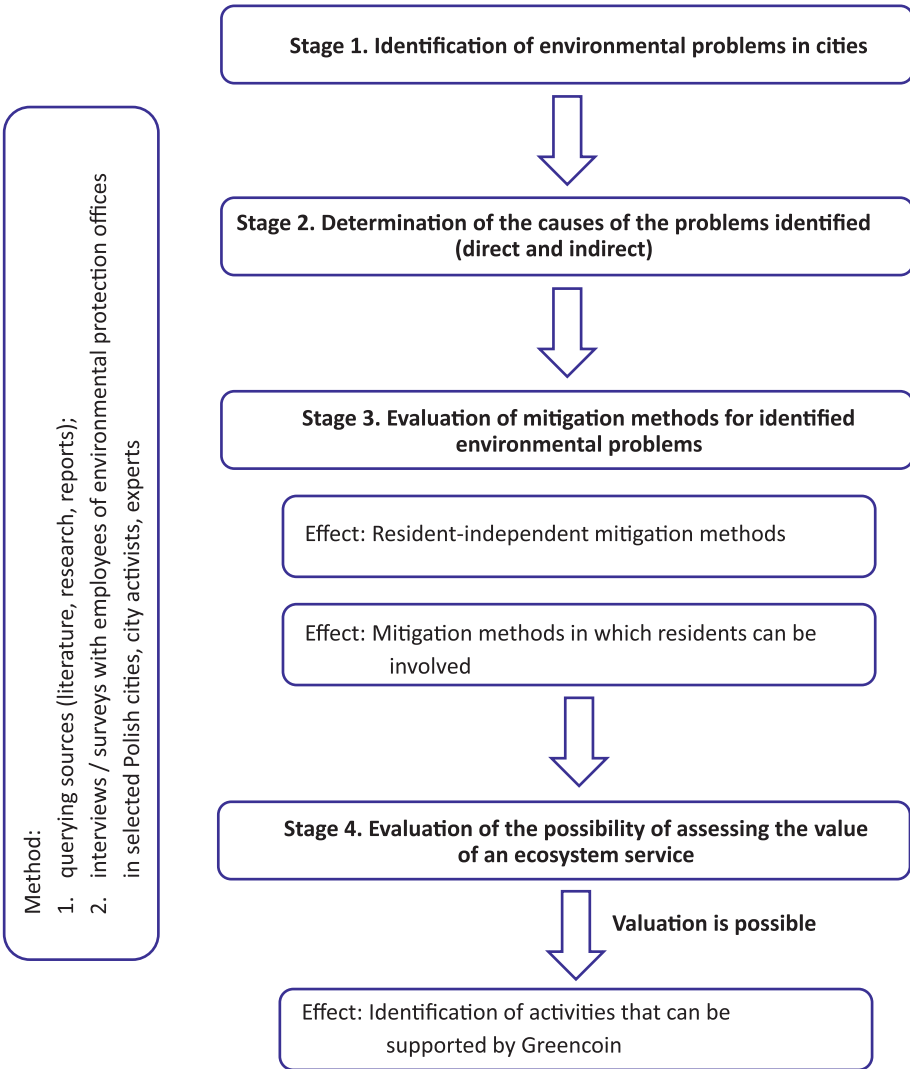


FIGURE 10. Diagram showing the research approach adopted. Authors’ elaboration

fy all actions that residents can take that relate to the city’s environmental problems. This process identified various pro-environmental actions tailored to address specific urban ecological challenges. The project team thoroughly analysed existing literature to compile a comprehensive list of environmentally friendly practices in different areas such as energy consumption, transport, and waste management. The thorough selection process ensured that the

chosen actions were practical, widely accepted, and successfully addressed urban environmental challenges.

The next stage was to identify the causes of the city's environmental problems. As in the previous stage, the primary method of identifying these problems was a query of sources and meetings and interviews with employees of the Gdańsk City Hall and local activists. Identifying and selecting ecological actions in the Greencoin project involved an elaborate procedure combining extensive research with real-world implementation. Beginning with thoroughly examining existing research, the project team conducted a comprehensive analysis of the environmental issues present in urban areas. The team specifically looked at how urban water, heat, and pollution cycles affect the well-being of individuals (Livesley et al., 2016). The research conducted served as a solid basis for establishing criteria to assess potential actions, considering factors such as societal acceptance and feasibility of implementation. These considerations align with emerging trends in smart cities and circular economy approaches (Przywojska et al., 2019).

The third stage was identifying methods for mitigating the identified environmental problems. Here, it was also decided to research sources and interview employees of the City Hall in Gdańsk and representatives of ecological organisations operating in the city. The expected effect of this stage was the division of previously selected urban environment problems into those that residents can influence and those that residents do not influence. When determining whether a given activity could be included in the Greencoin project, only those problems that could be solved with the participation of residents were considered.

Various ecological actions were identified, encompassing energy consumption, transport, and waste management, highlighting the immediate need to improve environmental quality in urbanised settings (Wohldmann et al., 2022). These actions encompassed many everyday behaviours, such as walking, cycling, and using public transport. Additionally, they are involved in community-oriented activities like cleaning beaches or parks and creating green urban spaces. The selection process also strongly emphasised community involvement, ensuring that the actions were meaningful and achievable at the local level. This approach aligned with inclusive urban sustainability indicators (Thomas et al., 2021).

In the fourth stage, the application development team was consulted to assess the possibility of verifying selected actions in the system. This

entailed considering activities that have a real effect on reducing the city's environmental impact and assessing whether it is technically possible to implement these activities in the system. These actions were later incorporated into the Greencoin system, which aims to encourage citizens to participate in these activities. This step aligns with the idea of creating data-driven intelligent sustainable cities. It emphasises the importance of energy efficiency and reducing environmental pollution (Bibri & Krogstie, 2020). The final compilation of ecological actions, thus, functions as both a thorough inventory of environmentally friendly activities and a practical framework for encouraging and acknowledging pro-environmental behaviours within the Greencoin system.

Furthermore, the possibility of verifying these activities in the system was assessed. This stage identified activities that could be included in the project. This detailed process showcases a systematic approach to tackling urban environmental challenges, highlighting the significance of making evidence-based decisions and involving the community in promoting sustainable actions.

Finally, repeated consultations were conducted with selected representatives of the City Hall in Gdańsk, local activists, and representatives of non-governmental organisations, during which the final prioritisation of activities included in the application as part of the Greencoin project was carried out.

Literature review: Pro-environmental actions

Pro-environmental behaviour is the key to modern climate change strategies. It involves people and groups taking conscious steps to reduce environmental damage. Individual and collective environmental sustainability practices have increased as human contributions to global climate change are recognised. Understanding that small, everyday decisions can have significant environmental effects when aggregated across populations emphasises the importance of such behaviour. Pro-environmental behaviour is essential to mitigating climate change and preserving our ecosystems for future generations.

As we examine pro-environmental actions and their quantifiable effects, each measure, however small, contributes to a more significant, collective effort to reduce carbon footprints, conserve resources, and create a more

resilient and sustainable world. The following sections discuss pro-environmental actions, their roles in urban sustainability, and how to measure and incentivise them. We have selected among some of the most adopted pro-environmental actions in the literature with relevance to the local Polish context (Obracht-Prondzyńska et al., 2022) and present the state-of-the-art that confirm their integration within the quantification methodology.

Walking and cycling

Despite decades of research on environmentally friendly transport by organisations such as the (OECD, 2019), global efforts to implement and regulate sustainable mobility continue to encounter considerable challenges. The demand for transport is increasing, reflected by traffic congestion and rising energy consumption, resulting in higher emissions, mainly CO₂, which is anticipated to be the primary greenhouse gas contributor by 2050 (Intergovernmental Panel on Climate Change, 2015). Transport, which accounts for approximately 25% of GHG emissions, with road transport being the primary source, is a severe environmental challenge triggered by the sector's ongoing emission growth from 1990 to 2019 (Kobize, 2015).

However, transport plays a vital role in modern economies, providing access to crucial services and opportunities, and restrictions on mobility might threaten broader socio-economic goals (Mateescu & Popa, 2017). Active transport, such as walking and cycling, is emerging as a long-term strategy for reducing air pollution and GHG emissions while improving human health. However, physical mobility depends on infrastructure, weather, and safety problems (Booth et al., 2005; Handy et al., 2002). Understanding these issues is critical for developing successful policies to promote active transport while reducing environmental impacts (Mueller et al., 2018). Furthermore, efficiently examining the environmental impact of transport emissions, particularly in terms of local air pollution, requires thorough data and evaluation tools to quantify external costs and minimise associated damages (UIC, 2022).

Public transport use

Public transport (PT) is critical for sustainable urban transport as it offers a viable alternative to car ownership (Holmgren, 2007; Mulalic & Rouwen-

dal, 2020). With greater capacity rates, PT systems generate less emission per passenger kilometre than individual vehicles, promoting resource efficiency and economic sustainability (Hassold & Ceder, 2014). They also enhance urban quality of life, increase property values, and decrease automobile reliance (Mulley et al., 2016; Munoz-Raskin, 2010). The growing usage of electric buses in Poland and trolleybuses in the Tricity (Gdańsk, Gdynia, Sopot) demonstrates the environmental benefits of supporting PT systems (Transport Publiczny, 2022). According to studies, electrification dramatically reduces greenhouse gas emissions, resulting in considerable socioeconomic savings and health benefits (Bhat & Farzaneh, 2022). Furthermore, PT technology and operations developments promise future emission reductions (Huber et al., 2022; Nesheli et al., 2017).

Research on travel behaviour emphasises the importance of reliability, frequency, speed, accessibility, and comfort in attracting PT users (Redman et al., 2013). According to (Beirão & Sarsfield Cabral, 2007), individual motivations for physical activity are influenced by perceived benefits such as reduced stress and pollution and factors for comfort and convenience. Car ownership can hinder PT adoption, influencing attitudes and actions towards sustainable modes (Márquez et al., 2019; Simsekoglu & Klockner, 2019). Factors such as PT network accessibility, distance to stops, and park-and-ride facilities greatly influence PT utilisation patterns (Guerra et al., 2018; Walton & Sunseri, 2010).

Cleaning public spaces

Keeping public areas clean through community involvement is critical for protecting the environment and public health, ultimately improving the quality of life. In this context, “to clean a public area” is about keeping public space free of waste such as sweets’ wrappers, empty packaging, cigarette butts and others. Generally, all human and human waste can easily be cleaned up as part of joint social activities. Although the relationship between green areas and resident perceptions has received less attention, such initiatives’ benefits exceed public engagement concerns. According to research, clean public places lower pollution and disease transmission hazards, making environments safer (Mattocks et al., 2019; Prasetyo et al., 2019; Ramyar et al., 2020). Furthermore, measures such as vacant lot reuse programmes improve public environment appearance while encouraging recreational use and fostering community identity (Heckert & Kondo, 2018; Sanecka et al., 2020).

Unsealing concreted surface

Soil sealing, an ongoing issue in metropolitan environments, remains a worry despite efforts to address it. A study comparing three types of pavements – impermeable, permeable, and porous, discovered that all affected the water cycle when compared to natural soil, with spongy pavements producing the most minor disruption (Cafiso et al., 2022). Absorbent pavements allow more water infiltration and evaporation, which helps to reduce soil warming and, perhaps, urban heat island effects. Furthermore, CO₂ accumulation was observed beneath impermeable and permeable pavements but not under porous ones, showing their potential for carbon management.

Creating green spaces

Green spaces in urban environments are crucial in mitigating the Urban Heat Island effect, especially in the face of climate change-induced temperature rise and heat wave intensity, offering cooling benefits that extend to surrounding areas (Yu & Hien, 2006). These spaces combat rising air and noise pollution levels and contribute to urban sustainability and improved quality of life (Decker et al., 2000; Nielsen & Hansen, 2007). Additionally, urban greenery assists the adaptation to adverse climatic effects by absorbing CO₂, reducing energy consumption, and enhancing human health (Gill et al., 2007; Sanesi et al., 2006).

Creating green walls and/or green roofs

Incorporating green walls and roofs is advocated to augment urban green space, particularly within dense city constructs. These living systems serve multifunctional roles in environmental amelioration, from stormwater mitigation to thermal regulation and air pollution reduction. They are recognised as key components of the EU's nature-based solutions, aligning with the broader aim of addressing urban environmental and social challenges (Norton et al., 2015; Raymond et al., 2017).

Segregating household waste

Adequate segregation and management of household waste are critical to reducing greenhouse gas emissions and relieving pressure on non-renewa-

ble resources. The transformation from conventional disposal to segregation and recycling practices is marked by significant environmental benefits, as evidenced by the reduction in landfill use and the associated cost savings (Gautam & Agrawal, 2021; Vaccari et al., 2013).

Visiting repair shops

The emphasis on repairing and repurposing products rather than disposing of them speaks to a broader sustainable strategy to conserve resources and minimise waste. This approach, particularly relevant in sectors like the textile and ICT industries, underscores the importance of extending product life cycles to reduce environmental impacts (Cooper & Gutowski, 2017).

Choice of actions

A source query was carried out by the research method presented earlier. Based on this, a summary that contained the eleven most important environmental problems of the city of Gdańsk and twenty-two processes/sources influencing the emergence of these problems was prepared.

The next step was to analyse which of these urban environmental protection problems may be influenced by the behaviour of residents. For example, one of the identified problems was poor air quality, the source of which is, among others, emissions from industrial plants and large energy plants. However, it was found that residents had no direct influence on reducing emissions from these sources. For this reason, no direct actions that citizens could take to reduce these emissions have been identified. Therefore, actions to reduce these emissions were not included in further analysis. However, since individual transport is also an important source of poor air quality and citizens can choose alternatives with less negative impact (e.g. going to work on foot or commuting to work by bicycle or public transport), activities aimed at reducing the impact of transport on air quality have been included in the analysis.

The analysis allowed for identification of 76 activities that could potentially be added to the application created as part of the Greencoin project. For environmental protection activities undertaken by residents to be rewarded under Greencoin, it was necessary to ensure that their implementation could

be verified. Therefore, it was examined in cooperation with the team responsible for creating the application whether it was technically possible to verify individual activities. This resulted in a final list of 42 activities.

Local consultations

At the initial stage of the project, it was decided that the selection of activities supported under Greencoin must be made in consultation with representatives of local authorities and residents. Representatives of both groups were asked which of the identified problems they considered important. Nevertheless, the purpose of the consultation varied slightly, depending on the group of respondents. The officials were asked primarily which activities the city authorities would be willing to pay the residents for conducting. Representatives of local ecological organisations were asked which actions they would expect the city to compensate (pay) residents for, with the purpose of reducing the pressure on the environment.

Two rounds of local consultations were carried out. The first round concerned the selection of basic environmental problems in Gdańsk that could be solved with the participation of residents, and the second round focused on the selection of activities that would be supported within Greencoin. In practice, one additional round of local consultations was organised. Its aim was to determine the importance of selected activities from the point of view of the authorities and the community of Gdańsk, as well as preferences regarding the amount of remuneration for people undertaking them. The results of these consultations were used to validate the value of the activities.

The meetings in the first round of consultations were virtual and were based on a similar scenario. At the beginning, the project representative presented what Greencoin would be, its assumptions, and its goals. After the question session, a discussion was held, and participants were asked to choose their preferred activities. Only those actions that were supported by all participants of a given meeting were accepted.

Following the meetings that were held and the conclusions that were drawn from them, the team members were able to identify the five most significant urban issues out of the 42 activities that were previously mentioned. These were:

- 1) air pollution – transport,
- 2) air pollution – energy,
- 3) waste management,
- 4) water and sewage management,
- 5) urban and municipal greenery.

Twenty-one activities were selected to help counteract these problems. Some of them refers to processes/sources that influence environmental problems, e.g. in the case of air pollution, we have sources such as: industrial and energy emissions, domestic heating systems, individual transport, and others. Number 21 concerns activities that can be carried out by everyday people and that will help reduce emissions from the previously mentioned sources.

To determine whether the identified problems are characteristic of large Polish cities and whether it will be possible to transfer the experiences from Gdańsk to other local governments, it was decided to also conduct interviews with officials of the Capital City Office at this stage of consultations. Three individual (physical) meetings were organised. These meetings were attended by the Director of the Environmental Protection Department of the City of Warsaw, the Director of the Infrastructure Department of the City of Warsaw, and a representative of the Public Roads Authority in Warsaw (ZDM). Consultations in the next stage were aimed at the final selection of activities that will be included in the Greencoin system. It was decided that for logistical reasons, the maximum number of activities supported under the system should not exceed 12. Consultations at this stage were individual. They covered the same group of people as in the first stage of consultations: both from City Hall and local non-governmental organisations. Each group received a list of 21 selected activities, from which they had to choose a maximum of 9 activities that, in their opinion, should be included in the application created as part of the Greencoin project. It was also decided that each participant could add a maximum of two ideas for activities that Greencoin should support to the list.

As a result of the consultation, a list of the nine activities that received the most votes from respondents from both groups was created. However, team members responsible for preparing a list of activities decided to remove one measure from the list (investments in renewable energy sources – single-family houses/private housing estates) and replace it with another. It was decided to withdraw investments in renewable energy due to the fact that it is a one-

time action and cannot be repeated regularly (so a person who invested in a renewable energy source would have to receive a very high one-time reward for it, which could lead to a situation in which the user will download the application, and after receiving the reward, he will no longer use it). An additional reason was that investments in renewable energy implemented by private individuals are already supported by public funds. Instead, it was decided to include in the system the activity of residents delivering sorted waste to Municipal Waste Selective Collection Point (PSZOK).

Ultimately, a list of nine prioritised activities was obtained. Following consultations with representatives of the office and local NGOs, the number of 21 was reduced to 9. A review of the list of 21 activities revealed that nine of them were duplicative, indicating a shared interest among the society and the city authorities in implementing these activities. The idea was to find activities that both societies would want to carry out and the city would be willing to support. Ultimately, both sides will benefit from this. In the next stage, methods of valuation were determined for these activities. The final set of pro-environmental actions is revealed in Table 3.

TABLE 3. Final list of selected pro-environmental actions adopted

No	Final list of pro-environmental actions
1	Walking and cycling. Access to work, kindergarten, etc. by bike or on foot
2	Public transport use. Access to work, kindergarten, etc. by public transport
3	Cleaning public spaces. Cleaning the beach or green areas and returning the collected waste to an agreed place
4	Rainwater retention. Reservoirs, retention ponds, rain gardens or construction of an installation ensuring its drainage in green areas
5	Unsealing concreted surfaces. In private gardens or in housing cooperatives and communities
6	Creating green spaces. Creating pocket parks or micro-gardens and their care in devastated or neglected areas (yards, areas neglected by the city authorities, etc.)
7	Create green walls and/ or green roofs
8	Segregating household waste. Delivery of segregated waste to Municipal Waste Selective Collection Point (PSZOK)
9	Visiting repair shops/workshops

The activities presented in Table 3 were incorporated into the application. Several actions taken by the team responsible for creating the list of activities supported by the application prove a meticulous selection process, in which great emphasis was placed on the involvement of all interested parties, from officials to city residents. To increase the involvement of the local community in promoting sustainable activities, the final decisions were made based on the results of these consultations.

Step 4.

Quantification model

In the quantification analysis, the main objective was to propose a systematic framework for the identification of equitably measured actions and products and methods to analyse the relevant values for both actions and products. The sub-objectives were the following:

- SO1: Identify suitable measured ecological actions to be used as the basis for the set of pro-environmental behaviours in the Greencoin system.
- SO2: Identify suitable green products to be used as rewards in the Greencoin system.
- SO3: Develop methods to quantify the value of selected ecological actions and products for the Greencoin system.
- SO4: Ensure consistency between the value of actions and the value of green products through reward value quantification.
- SO5: Support the pilot phase of the Greencoin system implementation to bridge the theoretical assessment of the values and the market responses.

Specific research questions

As the quantification methodology is an integral part of the project, it is essential to address some specific research questions that will contribute to its

completion. In the quantification model work package, we developed specific research questions that extend and complement the main research questions addressed in the introduction.

SQ1: What specific pro-environmental measured actions are suitable for the Greencoin system to fit the needs of the local community?

SQ2: What types of sustainable products can be used as rewards in the Greencoin system?

SQ3: How can the reward value of ecological actions and the green value of products be quantified?

SQ4: How can the Greencoin system be improved to enhance its effectiveness during the pilot project?

Research methods

This section uses the following analysis methods, addressing the specific research questions for developing the quantification model.

- Literature review of environmental issues affecting cities worldwide and the set of pro-environmental actions addressing the challenges.
- Identifying a set of sustainable products aimed at satisfying a low environmental impact.
- Development of an assessment framework to quantify the value of pro-environmental actions.
- Development of a method for quantifying the value of selected sustainable products.

Methodological approach for the quantification model

The quantification model is comprised of three steps:

1. Identification of relevant pro-environmental behavioural actions: the system of stakeholders carefully identifies a spectrum of actions contributing to environmental well-being (presented in previous chapter).
2. Quantification of pro-environmental behavioural actions: each identified action is assigned a quantifiable value based on its environmental impact, ensuring a fair and objective evaluation.

3. Conversion system for fair product access: earned rewards can be redeemed for sustainable products that promote the circular economy within the local community.

This meticulously designed framework ensures all ecological actions and sustainable products are equitably measured, fostering user engagement, and facilitating the achievement of project objectives through a user-friendly and accessible interface.

The quantification model represents a comprehensive and innovative approach to promoting pro-environmental actions and sustainable consumption. Key elements of the system's design include the process of identification and selection of ecological actions, their integration with a reward mechanism, and the quantification of actions and rewards. Subsequently, validation using technological tools is necessary, along with stakeholder engagement. Each of these will be detailed in the following paragraphs.

Quantification of pro-environmental behavioural actions

The Greencoin project's comprehensive framework for quantifying pro-environmental actions represents an innovative approach in the fields of smart cities and circular economies. The methodology utilised involved developing models to assess the impacts of different actions, considering factors such as potential for reduction and acceptance among the public. This led to the development of a scoring system that evaluates actions based on their environmental, social, and economic impact. This system allows for the ranking and prioritisation of actions to maximise their environmental benefits (Figure 11).

This approach is in line with the growing necessity to tackle complex urban environmental, economic, and social issues. Referring to the research conducted by Lakatos and colleagues (2021), the framework highlights the importance of evaluating the ability of actions to address environmental concerns, their acceptance by society, ease of implementation, and effectiveness measurement. This aligns with the pressing need to improve environmental quality in urban areas, as emphasised by Moktadir et al. (2018). The framework's incorporation of a scoring system that assesses and ranks actions based on sustainability factors encompassing the environment, society, and economy is a direct response to the demand for comprehensive urban sustainability indicators. According to Gravagnuolo et al. (2019), this aspect

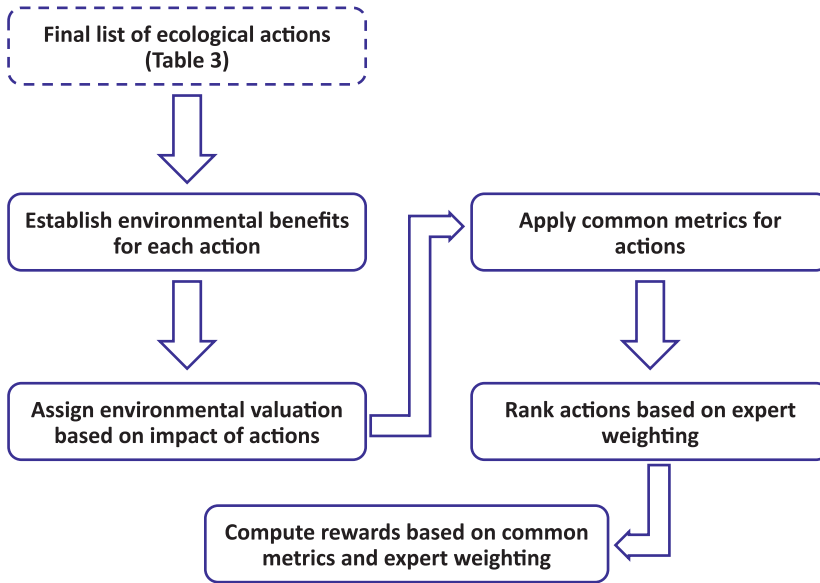


FIGURE 11. Quantification framework for pro-environmental actions

emphasises the importance of considering equity in the Greencoin project, setting a standard for sustainable urban development.

The analytical framework to assess pro-environmental behaviours among urban citizens emphasises three fundamental elements of analysis: 1) Engagement, 2) Community, and 3) Environment. The current investigation employs an evaluation approach incorporating a) energy expenditure metrics, b) public administration engagement, and c) quantifiable environmental benefits. These assessments are used as the foundation to measure the possible rewards that citizens can earn for pro-environmental behaviours. The framework for assessment is sketched in Figure 12 (Toşa et al., 2024).

The resulting standardised system for evaluating ecological actions promotes a fair and unbiased assessment, aligning with the idea of data-driven, smart sustainable cities. These cities prioritise enhancing energy efficiency, reducing environmental pollution, and offering immediate feedback, all of which are crucial in modern urban environmental management (Yigitcanlar et al., 2021). The system's capacity to establish a rewarding system that incentivizes actions with a significant environmental impact is in line with the pressing need to promote sustainable behaviours in urban settings. This idea is supported by (Shen & Liu, 2022).



FIGURE 12. Methodological framework for rewards assessment (Toşa et al., 2024, p. 4)

In addition, the scalability and adaptability of the methodology enable customisation in different regional contexts, establishing a well-rounded and efficient incentive system within the Greencoin project. According to (Marin & De Meulder, 2018), this approach allows for the successful implementation of the system in various urban environments, effectively addressing specific environmental concerns.

Ultimately, the Greencoin System's strategy of incentivizing eco-friendly actions with tangible rewards sets a precedent that can be adopted in various contexts to promote environmental sustainability. This cutting-edge approach, as explored by (Yeo et al., 2020), showcases a remarkable progress in fostering environmental responsibility within urban areas. It is built upon the principles of smart cities and sustainable urban development.

Conversion system for fair products access

The Greencoin project's conversion system is a landmark approach that encourages sustainable behaviour through a rewards mechanism that is fair and equitable. This system aims to contribute to the way environmentally friendly

actions are rewarded, providing a diverse selection of sustainable products and services. It embodies the principles of valuing nature for both fairness and long-term sustainability, as highlighted by (Zafra-Calvo et al., 2020). The methodology behind this system is based on an estimated incentive approach, where points are assigned to different pro-environmental actions according to their specific environmental impact, community engagement, and effort of everyone. This approach not only acknowledges and incentivizes actions, but also promotes a mindset of continuous learning in dynamic and uncertain circumstances, as discussed by (Sauer et al., 2022).

Partners from diverse sectors contribute to the rewards system by providing a variety of products. Gdańsk University and the Gdańsk University of Technology offer complimentary access to their facilities and educational opportunities, along with discounts on promotional merchandise. The Experiment Science Centre and Olivia Centre provide reduced-price and complimentary access to educational and leisure facilities. Good Deal, Zeroban, and Avocado (see chapter 6) offer a range of discounted environmentally friendly products and vegan dining choices, catering to a sustainable lifestyle. These rewards collectively promote sustainable living and enhance educational opportunities for participants of Greencoin.

We developed a thorough evaluation framework for sustainable products, considering a range of sustainability factors. The Greencoin Product Score was created to ensure that rewards are in line with the environmental value of the products, promoting the advancement of circular economy objectives through the rewards system (Figure 13).

The process of determining the financial worth of Good Coins earned from ecological activities involves converting the amount of time dedicated to each activity into GC, which is then matched with the hourly labour cost (see Table 4). This calculation allows us to infer the monetary worth of a single Good Coin. Once the value of each Good Coin is determined, we can calculate the minimum number of points that users must collect to obtain the products provided by project partners. In essence, the Good Coins earned from one hour of sustainable actions, such as walking, cycling, or using public transport, are compared to an hourly wage. This allows for the conversion of Good Coins into a tangible currency equivalent. The approach guarantees an equitable conversion rate between the amount of time and effort dedicated to eco-friendly actions and the availability of sustainable products within the Greencoin system.

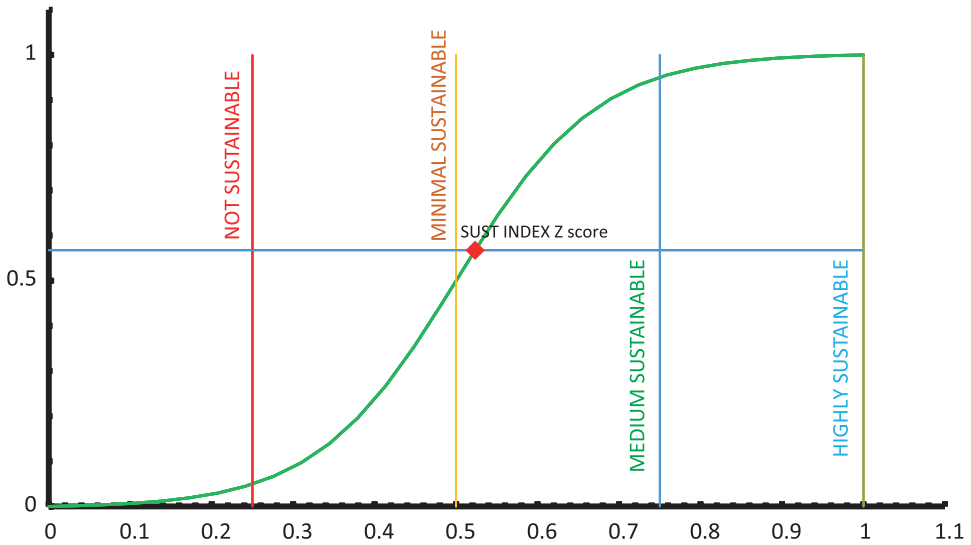


FIGURE 13. Assessment of product sustainability

The findings from the Greencoin project demonstrate strong user involvement (Obracht-Prondzyńska et al., 2023). Participants were enthusiastically engaged in redeeming their earned points for a wide range of eco-friendly products. This engagement was in line with the objectives found in Australian local government policies that aim to establish a food system that is healthy, sustainable, and equitable, as outlined by Carrad and colleagues (2022). The impact of the Greencoin system in encouraging environmentally conscious actions was significant. It successfully links environmental actions with tangible, desirable rewards, reflecting the goals of a sustainable economy as discussed by Novaglio and colleagues (2022).

When it comes to challenges and opportunities, we have thoroughly assessed the system's design and implementation with a focus on constant improvements. It is important to prioritise user feedback and sustainability goals, as highlighted by Temper and colleagues (2018) who stress the need for significant changes towards sustainability. The Greencoin project demonstrates a strong dedication to environmental responsibility and sustainability, aligning with global views on creating healthy environments and the importance of thoughtful analysis for new ideas and progress, as emphasised by (Dooris, 2016).

TABLE 4. Assessment of monetary value for Good Coins

Pro-environmental actions	GC for one hour of activity	Hourly labour costs EUR	Weight	Weighted value of GC (EUR / GC)	Value of one hour of activity in EUR weighted
Walking	6.45	9	0.071	0.099	0.64
Cycling	6.45	9	0.071	0.099	0.64
Public transport use	7.92	9	0.058	0.06	0.52
Cleaning public spaces	3.84	9	0.12	0.28	1.08
Rainwater retention	14.20	9	0.03	0.02	0.29
Unsealing concreted surfaces	20.70	9	0.02	0.009	0.20
Creating green spaces	9.69	9	0.04	0.044	0.42
Create green walls and/ or green roofs	9.92	9	0.04	0.04	0.41
Segregating household waste	1.32	9	0.34	2.37	3.14
Visiting repair shops	2.58	9	0.17	0.62	1.61

In general, the Greencoin project's conversion system is seen as a groundbreaking model that encourages environmental responsibility and sustainability. It accomplishes this by effectively connecting ecological actions with equitable access to sustainable products, promoting a culture of environmental consciousness and active involvement among its users.

Conclusions

Greencoin has the potential to be a powerful tool for promoting eco-friendly behaviour and reducing environmental impact. Below are some practical conclusions that were implemented in the mobile application PULA.

The application, an essential component of the Greencoin system, includes a comprehensive approach to environmental responsibility with its wide range of features. It contains a wide range of ecological actions, organised in a systematic manner for easy access by users. This extensive repository allows users to easily navigate and choose actions that align with their individual environmental objectives.

In addition, the application includes a comprehensive collection of environmentally friendly products and services, which can be accessed by earning rewards. This feature encourages users to engage in sustainable practices, creating a connection between environmental activism and tangible rewards. Selecting relevant actions and products is key to ensuring the impacts of the Greencoin gamification in tackling urban environmental issues. However, we are aware that each city's context, resources, and stakeholders may affect these activities' efficacy and practicality. Environmental issues, priorities, and resources vary per city, and region. Thus, these environmental actions must be tailored to the local situation to function appropriately. These measures require stakeholder participation to succeed, and thus, city governments, environmental agencies, community organisations, corporations, and residents must collaborate. Future research and partnership with local people and authorities are needed to execute and sustain these pro-environmental activities.

At the heart of the application's design is a well-defined incentive mechanism. This mechanism carefully evaluates and assigns points to every ecological action performed by users, encouraging actions that have a significant positive effect on the environment. This system not only promotes active involvement but also measures the environmental impact of each user. En-

hancing user engagement becomes more effective with the implementation of personalised profiles and dashboards. These features offer users a complete overview of their environmental impact, keeping track of their actions, points earned, and rewards redeemed. This personalised tracking is designed to inspire and encourage users, promoting ongoing engagement.

In addition, the application shares educational content and tips, helping to increase public awareness and understanding of environmental issues. The thoughtful incorporation of informative materials enhances the application's functionality, helping users make environmentally conscious choices that align with their personal preferences. The application, supported by the Greencoin research, showcases a unique combination of gamification and environmental activism. Through the implementation of a points-based reward system, it successfully encourages users to actively participate in climate-friendly actions, thereby making a valuable contribution to the promotion of eco-conscious behaviour.

Step 5.

The application

Application functionalities

The app includes several functionalities that have been designed to make it easy for users to navigate, while also shaping their e-conceptions and enhancing their knowledge. Mobile apps are primarily characterised by ease of use, so the PULA app has been designed to ensure that the interface is intuitive to use, so the user can access all the functionalities quickly and easily. The key functionalities of the application are:

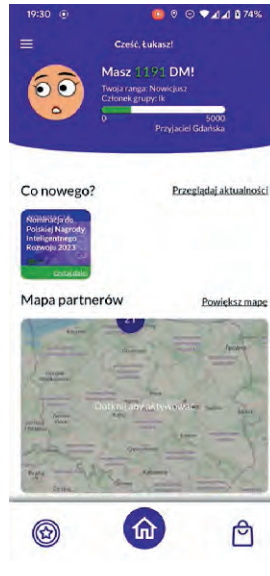
- User actions
- Tracking progress and achievements
- User account management
- Community functions
- Content management
- City partnerships.

The interface for mobile users had three basic screens: Earn, Homepage and Spend. These views are directly accessible from a menu bar visible at the bottom of the smartphone screen, allowing the user to easily switch between

Section: Earn



Section: Homepage



Section: Spend



FIGURE 14. Screen shot of the PULA app’s user interface

the app’s functions. In addition, the app includes a side menu and a user profile (see Figure 14).

User actions

In the application, user activities are divided into several categories. These are:

- Transport
- Quizzes
- Actions
- Local community events and other (confirmed by Quick-response code)
- Verification.

Through these activities, app users accumulated Good Coins, which they could redeem for vouchers from the “Spend” screen.

Transport activities based on choosing the form of travel within the city limits result in the lowest carbon footprint. The user could choose to walk,

take public transport or ride a bicycle. For each kilometre of travel, the user was rewarded with points.

Quizzes have an educational form. In the application, using Quizzes, the user learns environmental information on a given topic and then proceeds to a knowledge test. The user is awarded points – so-called Good Coins for correct answers to the questions. The quizzes contained -single-choice questions (Figure 15).

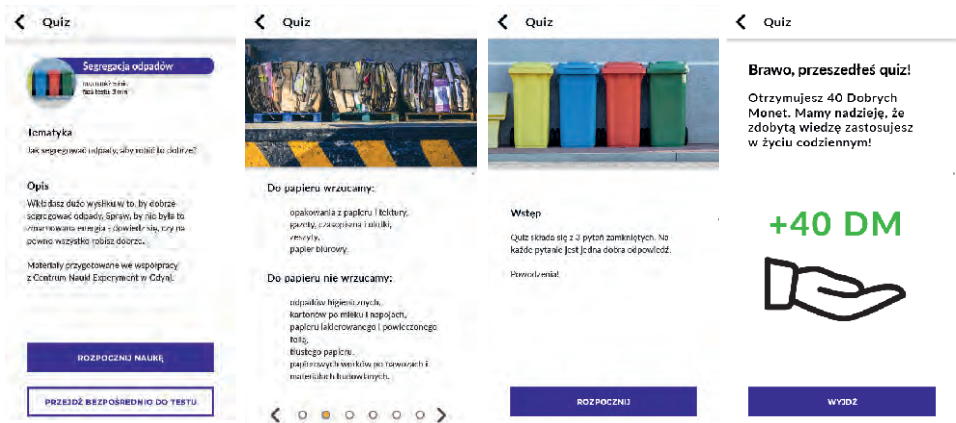


FIGURE 15. The screen shot of the PULA app's Quizzes section

Actions – using the app, the user was motivated to take various actions that had a pro-environmental effect (see Figure 16). Each action had to be documented in the app with a before and after photo, which adequately represented the start of the work and then the effect. While developing the app, the following actions were selected and entered into the research tool:

- waste segregation,
- reusable containers,
- waste bag collection,
- waste collection,
- rainwater collection above 1 m³,
- rainwater collection under 1 m³,
- collecting rainwater in a bucket,
- creating micro-gardens,
- green wall at home,

- building a green wall/roof,
- using reusable shopping bags,
- buying local food.

The last two were further verified by location to see if changes were being undertaken in the defined research area – Gdańsk, Poland.

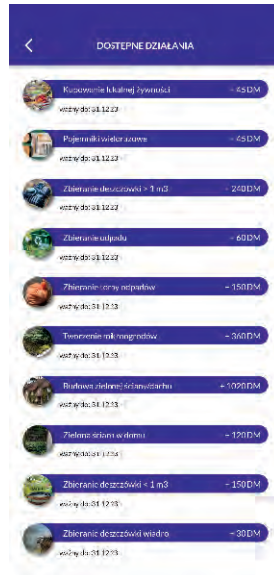


FIGURE 16. The screen shot of the PULA app's Actions section

Local community events and others – the action aimed to integrate the community of the app's users, to undertake eco-actions, as well as to take part in them. When a user or partner wanted to organise an eco-action, a message appeared in the app addressed to each user about the possibility of joining the event. An app user who met the conditions for participation or action could collect additional points (Good Coins) during this event by scanning the Quick-response (QR) code. The application's use of local community events supports community integration, user interactivity, involvement, initiative, and the activities of project partners and the application.

Verifications were actions taken by and for users of the application. When a user acts, such as segregating garbage, through the app (s)he was obliged to document the action. S/he then takes two photos before and after performing the action. These photos were then sent for verification, which was

performed by another app user. The person undertaking the verification, regardless of the result (positive or negative) got Good Coins. The person whose action was negatively verified does not receive points (Good Coins).

Tracking progress and achievements

The application also gave participants the opportunity to track their progress and achievements. Monitoring the progress of individual users and adding up the scores of all active members of the app was intended not only to track achievements in the successive categories of pro-environmental activities introduced in the app, but also to have a positive effect on the motivation of the experiment's participants, stimulating their activity to continuously take on challenges (Figure 17).



FIGURE 17. The print screen of the PULA app's Tracking progress section

Account management

This is the basic functionality of the application, which allows the user to manage his account and personalise the settings according to individual needs (Figure 18). In the application, due to the pilot nature of the pro-

ject, the functionality was limited to the necessary functions, which can be further developed. A user of the application from his profile was able to change his name and photo. In the user's profile it was also possible to check the points (Good Coins) one possessed as well as the achieved rank of the user.

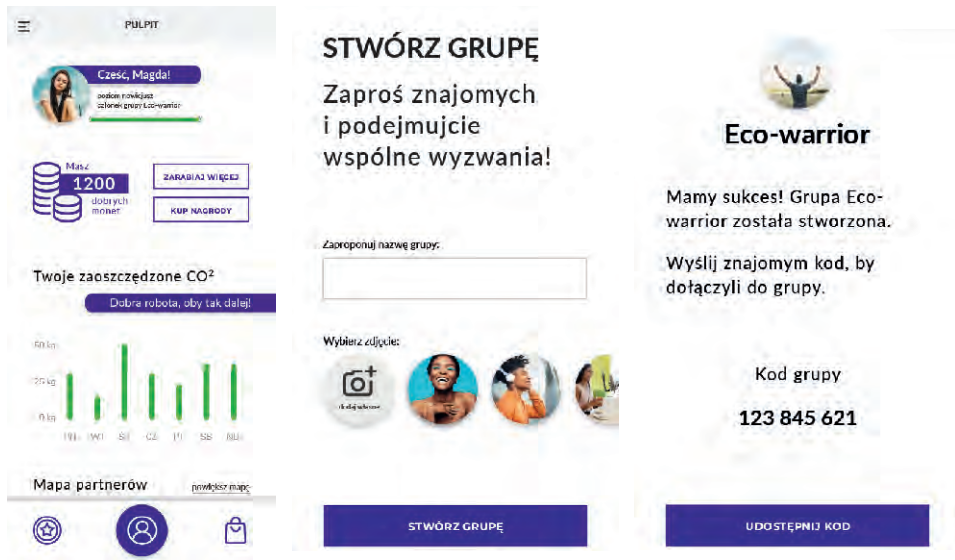


FIGURE 18. Screen shot of the PULA app's Account management section

Social functions

The application also allowed users to engage in social functions that allowed them to interact with each other. An example of such activity is the functionality of creating groups of users whose scores were aggregated (Figure 19). Users of the app were able to create their teams and compete among them.

Content management

On the application's main screen, in a place clearly visible to the user, there was a section 'What's New?' whose task was to inform the user about new events and engage them in new available activities (Figure 20). This section



FIGURE 19. The screen shot of the PULA app’s social functions section

allowed those authorised to do so to manage content (add, edit, delete), for reading which participants were additionally and one-time rewarded with Good Coins.

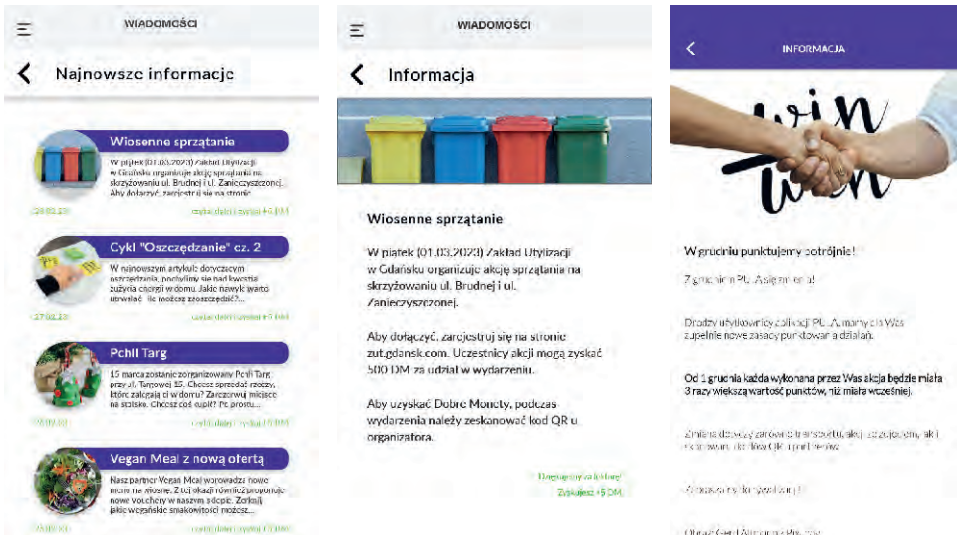


FIGURE 20. The screen shot of the PULA app’s Content management section

City partnership

On the application's main page, the 'Partners' map' was also available, where users could freely search for the locations of project/application partners on the map of Gdańsk (Figure 21). In addition to promoting the partners, this section also played an informative role for the user about the places on the map of Gdańsk that demonstrate pro-environmental activities. The dots also indicated the locations of the prize collection.

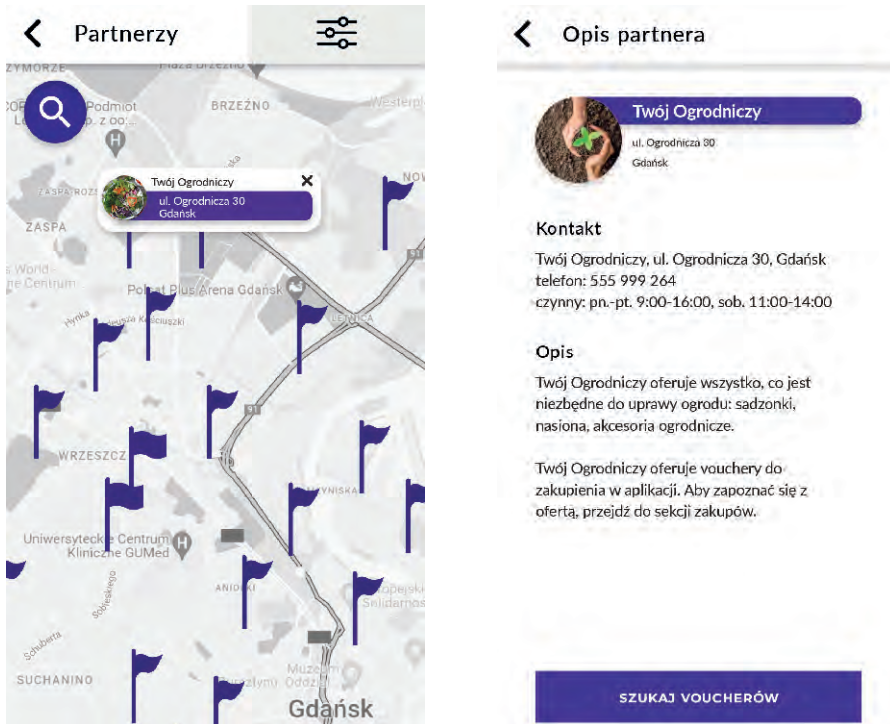


FIGURE 21. The screen shot of the PULA app's Partners' map section

During the development of the app, there were many discussion points on several topics related to the functionalities that should be included. Also, after the application entered the testing phase, participants in the pilot part provided feedback related to functionalities. In the following section of the monograph, we will present user feedback, as well as barriers to the introduction of functionalities that are worth considering when developing this type of application.

Users' feedback on functionalities

During the app's testing and pilot programme, participants provided feedback through surveys, qualitative interviews, and email submissions. During the app's trial release, user feedback was collected through various channels and methods. The qualitative interviews and email communication were the most effective methods for gathering users' opinions on the app's functionality.

E-mail communication

The participants' willingness to provide feedback during the pilot study varied. Initially, there was a high level of interest and involvement, with participants actively testing and reporting bugs. They were eager to share their experiences. However, over time, their involvement gradually decreased. Most participants were passive during the process of building and testing the application, although a few remained involved until the end and participated in additional events, sharing ideas. Despite encountering various difficulties during app testing, participants expressed pride in their participation in the project and believed in its potential, with some eagerly anticipating its public release. Regarding application feedback received, the following is noteworthy:

1. *No 'Report a problem' or 'Contact' functions.* Many users have noted the absence of these two functions, which is crucial for quickly resolving any difficulties.

It is recommended that a contact form be made available directly in the application as early as the testing stage. This should be considered as one of the essential functionalities of the application. Given that the app is still under development, it is particularly important to address this issue.

2. *Information about partners and opening hours.* Messages indicated the need to update information on partner opening hours to reflect reality. Questions of this type indicate a high level of user engagement regarding the specific points they can use and the app's partners who support local activities and share environmental concerns.

This type of question indicates a high level of user engagement regarding the specific points they can use and the app's partners who support local activities and share environmental concerns. Therefore, it is important to provide precise and regularly updated information about app partners. To maintain accuracy and foster collaboration with partners, providing them with additional functionality can benefit both parties and the app.

3. *User interface.* Many users commented that the application's interface could be made more user-friendly and attractive, for example, by using more colourful graphic elements. These comments mainly concerned the ability to personalise one's personal profile.

Specifically, they have recommended incorporating more colourful graphic elements to personalise their profiles. As a result, it is recommended that the user profile section be updated to include more personalisation options. This will encourage participants to use the application more frequently. It is also recommended to introduce gamification elements, such as individual achievements or user ranks.

4. *Method of accruing points.* Many comments focused on the way points were accrued for various activities, such as public transport, hiking, or participation in events. Users reported problems with the way and accuracy of points accrual, or their proportionality to effort or involvement.

The point accrual system requires improvement, particularly regarding accurately reflecting the user's effort and commitment towards the task. Additionally, the scoring methodology should be clearly explained in either the app's terms and conditions or an information section to guide users through the complex system. In cases where QR codes were used for scoring, users frequently encountered difficulty in obtaining the necessary code. Organising the event and scoring additional activities was difficult due to the need for a specific person to dispose of it. Consider rethinking the process of verifying user participation in additional events.

5. *Communication while travelling.* Some users have reported difficulties interacting with the app while on the move, such as the inability to

return to the home screen or the app's problematic behaviour when changing means of transport.

The 'Transport' section was found to contain numerous inaccuracies and system errors. In the future, it is recommended to thoroughly test all functionalities before the pilot to avoid confusing or discouraging users. The text does not require any additional changes. The 'Transport' section in the PULA application faced strategic decisions regarding its fit with the pilot city of Gdańsk, as well as errors resulting from insufficient system analysis.

6. *Quizzes.* During the testing phase, users provided suggestions for improving the quizzes. These included increasing the number of points awarded for completing them and making the questions more engaging. The length and number of questions varied during testing.

Ultimately, it was found that the quizzes needed to be shorter in comparison to their scoring in the app and were subsequently shortened by half. Despite this, the quizzes remained functional, with each quiz consisting of a text followed by questions. The provision of educational information can be made more appealing by incorporating additional images to aid memorisation or by introducing infographics.

Interviews with users

Interviews were conducted with pilot participants willing to participate in the study. The general conclusions from the interviews can be divided into several categories, which include technical aspects, application content, increased motivation, and opportunities for application development. Each category, which represents the opinions of surveyed users and relates directly to the application, is described below.

Technical aspects

In considering the technical aspects of the app, users identified a greater number of deficiencies than advantages. One advantage of the app was the ability of users to track their daily activity, including walking, using public transport, and cycling. This feature was perceived as motivating users to engage in further physical activity. Another advantage was the app's quizzes

and news items, which provided users with opportunities to expand their knowledge of ecology in their free time.

Among the limitations of the application, its low speed was most frequently mentioned. Another issue that was frequently raised was the occurrence of bugs in the app, particularly in transport activities. These bugs can easily be exploited by generating additional, undue points, which may result in inaccurate data being recorded. Furthermore, numerous users have highlighted the high battery consumption when utilising the app. Another limitation of the app was the difficulty users encountered when attempting to join groups of other users. This difficulty made it challenging, if not impossible, for users to contact other users. Furthermore, users expressed a lack of functionality in the provision of verification information for tasks performed by the user. Additionally, the application exhibited spatial limitations, as it could only be utilised within the confines of Gdańsk. Furthermore, users observed that the transport function (when travelling by public transport) and quizzes could not be used simultaneously.

Application content

The app's users identified the availability of engaging quiz topics as a significant advantage. Furthermore, the app offered the potential for further content expansion, encompassing both quiz topics and additional activities that could motivate users to undertake novel actions. Additionally, the app presented the possibility of learning about environmentally conscious institutions or locales in the user's city. Moreover, the option was perceived to have educational value. Users expressed appreciation for the app's provision of information about current ecological events in Gdańsk. Further details can be found in the analyses provided by Duda et al. (2024).

In contrast, users identified inconsistency in the quiz texts and questions as a significant drawback of the app. The app was perceived to lack sufficient notifications prompting users to act or participate in events. Additionally, users indicated that the number of challenges in the app should be increased. Another issue that users identified was the unfavourably rated descriptions of vouchers that could be exchanged for accumulated points. According to the users, the descriptions required improvement as they were not sufficiently clear.

Motivation increasing

According to user opinions, the app's most effective functionalities were those offering economic incentives in the form of discounts on products or vouchers for lunches at participating establishments. Furthermore, the app offered incentives related to the social sphere, including notifications to encourage users to engage in daily pro-environmental activities. Another factor that influenced user behaviour was the presentation of positive examples of pro-environmental behaviour, which offered support to encourage the formation of more positive habits. Furthermore, users identified collective action or actions based on a competition mechanism, in the form of displayed rankings, as a motivating factor for pro-environmental action.

In contrast, users perceived a suboptimal scoring system, which led to the use of mainly cost-effective, higher-priced app features where more Good Coins can be earned with less effort. This was perceived as undermining motivation. Furthermore, it was evident that a significant proportion of users were likely to abandon the app due to a lack of incentives to prompt them to return, such as notifications. This was attributed to users forgetting to use the app amidst the demands of their daily routines. Additionally, the limited number of partners available to the app was identified as a potential limitation, which could facilitate reaching a wider audience.

The app users' feedback suggests that the app's operation could be improved in several areas. The feedback demonstrates the survey participants' dedication to pro-environmental activities and the advancement of this type of application. Based on the information gathered, the PULA application has advantages, areas for improvement, and opportunities for development. These findings provide a positive outlook for future projects.

It is important to note that the above-mentioned areas and points reflect the spontaneous responses and opinions of the application's users and should, therefore, be considered suggestions for improvement, summarised in Table 5.

Validation of application parameters using the transport action as an example

Developing an application is a complex process that requires coordinating many areas and considering various actions. The first and most important chal-

TABLE 5. Development opportunities

Technical aspects	<p>Introducing the ability to add an event to your calendar.</p> <p>Introducing a running feature to the Transport section.</p> <p>Adding an option to contact people using the app, which could increase user engagement and help traffic to the app.</p> <p>Expanding the possibility of notifications on a user's profile, where they could find information about verifications of their actions (positive/negative).</p> <p>Introduction of shortcuts, to the most frequently selected actions.</p> <p>Proposal to add the function of 'offline ecology' with information on how much time the user is offline.</p> <p>The ability to create your own events and invite others to them, with the possibility of earning additional points for this (p. local world cleanup).</p> <p>Addition of differentiated levels of advancement to develop the application's gamification and user ranks.</p>
Application content	<p>The ability to enter found eco-events into the app's calendar, or those organised by themselves.</p> <p>Creating a place where the content of quizzes would be collected with sources.</p> <p>Introducing regular voluntary notifications with a reminder to perform actions for example: before leaving for work.</p>
Motivation increasing	<p>Point dynamics – promoting point-wise actions that users use at a lower rate.</p> <p>Introducing limits on function usage, which would increase the importance of developing new habits over those already performed.</p>

lenge we encounter during application development is technical. Some features may be difficult to implement due to performance, battery consumption, or application stability. Solving such problems can cost a lot of time and money, so each application's functionality should be considered as carefully as possible at the initial analysis level, and then validation should be carried out for the application, the most difficult functionality to implement and monitor was 'Transport'. The first barriers of analysis arise when identifying the possible means of transport that users can use in the selected city and differentiating them technically. Then there were questions of assigning a level of greenness to the means of transport, and then from and to when. An important question in planning the introduction of this functionality will also be the level of detail we want to capture or cover with the created functionality.

At the level of creating the application, it was determined that the possible modes of transport would be travelling on foot, cycling, and using public transport. The accrual of points for each successive mode of transport is done according to the size of the reduced carbon footprint, so user actions were scored differently depending on the choice of mode of transport. Discrepancies in scoring should be verified, but this generates some technical problems, with the problem growing with each successive mode of transport added.

Due to the possibility of selecting three different forms of transport, which the application was initially unable to distinguish, the application had many errors. The errors were related to the interface itself, calculating points, verifying speed, and the app's ability to distinguish which mode of transport the user was using.

From an analytical point of view, the following validations were proposed:

1. Validation of the maximum possible distance travelled per day
Use case: An athlete can run as much as 100 km per day, but this is not included as an environmental measure.
2. Validation of maximum speed
Use case: An app user can travel by public transport with the walking travel option enabled, thereby earning more points.
3. Location validation
Use case: Walking 500 metres is more environmentally friendly than using public transport.
4. Distance validation
Use case: An app user can walk around the office while working, but this is not an environmentally friendly action. A recommended setting of walking a minimum distance, for example, 1 kilometre.

By design, the validations are meant to reflect the ecological actions taken by a regular user, not an athlete. Moreover, they are tailored to a specific city – Gdańsk. As can be seen below for each transport activity, i.e. travel on foot, travel by bicycle, travel by public transport, several system validations are proposed to be applied:

- The maximum distance a user can travel by this mode of transport: 20 km per week;

- The maximum speed the user can travel with this mode of transport: X km/h;
- The minimum distance the user must travel for points to be credited to him is 1 km.

It is also recommended to add the following validation:

- The maximum number of points a user can earn per week under the 'Transport' option.

For example, a user who took a walk would have to walk at least one kilometre for points to be credited to their account. In addition, the system would verify that the user moves at walking speed. The maximum distance a user could be rewarded for walking per day is 20 kilometres.

To avoid errors in the application, especially with other forms of travel, or to control the value of the vouchers in the application, it is also recommended to check for each user in the context of transport actions, what is the maximum number of points an ordinary user (not an athlete) could earn in the application every week, for example. Such a measure would ensure the value and number of vouchers available in the application. At the time of any abuse in the application, the number of points that could be earned would be limited, giving the application developers more time to react and fix the error while at the same time securing the number of vouchers available in the application. Such a measure would also pre-emptively protect the city's partner networks and not violate the trust that has been built up in the event of voucher abuse caused by bugs in the app.

The following technical problem is to decide and select the modes of transport that could be included in the application. The most straightforward choice is to include those options that can be easily distinguished, i.e. walking up to 8 km/h, cycling up to 20 km/h, and public transport up to 50 km/h. However, the problem arises with a deeper verification analysis. The first case of abuse that appears is using the public transport option in the app while driving a car up to 50 km/h. Then, the user-driver could cheat the app and get points for driving by car.

Even more problems are introduced by adding all possible urban transport modes used by the user. In the case of Gdańsk, this would be trams. Buses (whose speed varies from one part of the city to another), and the Rapid Urban Rail (SKM). For each of the above-mentioned means of transport,

appropriate validations would have to be established, which will be difficult to establish and then communicate to the user. There seem to be two technical solutions that can be applied to the problems that have arisen, but they require a lot of resources and time.

The first solution is to impose appropriate validations on the successively selected means of transport in terms of: distance, speed, and location, as well as the maximum number of points to be earned by the user, which will ultimately not disrupt the application. With this option, it will be extremely important to communicate these rules to the user, so that the user is aware of the rules of the application and the reason for subsequent decisions or stops of point accrual. An example of the messages that can be applied to users is in Table 6.

TABLE 6. Examples of the users’ messages

Transport mode	Comment	Validation of the maximum distance per day	Validation of maximum speeds	Location validation
Walking	Necessary	The maximum distance a user can travel per day using this method is: 20 km (per week)	The maximum speed at which the user can travel using this method of transport is: XX km/h	The minimum distance a user must cross for points to be credited to him/her is: 1 km
	Notification	‘The maximum daily distance for this type of transport has been reached. Use another one’. ‘The points for the trip you made have been credited to your account’.	‘The maximum speed for this type of transport has been exceeded’. ‘Start the trip over again’. ‘Points for the trip you made have been credited to your account’.	‘The minimum distance you must cross for your points to be credited is: 1 km’. ‘Points have not been credited to your account’. ‘Try again’.

The second solution that can be applied is to plot the routes of selected means of transport of a given city on a map, e.g. bus and train routes, which have repeatable routes, and can be used to verify that the user is actually moving on the chosen means of public transport. This solution, however, requires huge expenditures, which is why it was decided not to use this option.

When solving technical problems related to user travel, speed analysis is also an important factor, with the methodology itself being particularly important. Speed can record speed fluctuations, so it can recognise, for example, city bus stops or calculate the average speed from a defined section. The decision on which calculation method to choose for a particular means of transport can be extremely important, especially for exceptional use cases, such as (1) walking: speeding up to 8km/h and then running up to a bus stop; (2) bicycle travel: Downhill; (3) city bus travel: the maximum speed is 50 km/h, and the driver slightly exceeds it.

In summary, rewarding user actions within the 'Transport' section requires the introduction of a set of parameters to validate user actions.

Step 6.

Testing phase

Background

Based on the research conducted during the project (described in detail in previous chapters) it was decided that the pilot project should be realised under a new local brand. The main reason for this was the recognition that potential users of the application can be discouraged by the “green” etiquette implied by the name Greencoin. Thus, instead of directly promoting local currency as an environmental tool the team decided to brand the currency as a tool that promotes and rewards behaviours and habits that contribute to a healthier environment, cleaner neighbourhoods, and improved living conditions. This broader focus avoids alienating users who might be hesitant to identify themselves as overtly “environmentally conscious” – which was proved in the research to be the real fear of potential users. From that point a new brand originated. The goal of the new brand “PULA”, which means in Polish, a group of one or more things/people, or jackpot, stake of-money colloquially, is to involve new potential users not only with pro-ecological values but border values oriented towards sustainability, locality, being responsible for own environment as well as the local economy and community.

The pilot project for the PULA application took place from March to December 2023 in the city of Gdańsk. The pilot consisted of three phases:

- (1) internal testing within the Greencoin team,
- (2) a closed phase aimed at testing the application on a smaller group of recruited users (called early adopters),
- (3) an open phase, during which the application was made available for a broader public through online application stores such as Google Play and Apple Store.

The rationale for the pilot project was to verify the theoretical assessments underpinning the development of the application in the earlier phases of the Greencoin project and to improve the architecture of the application. Within this monograph we will focus only two phases conducted (2) in a closed group and (3) under conditions of public accessibility for residents of Gdańsk. The phase (2) of the pilot was limited to a smaller group of users as a means of risk management.

The specific objectives of the pilot project phase were to:

- SO1: verify the proposed partner structure;
- SO2: verify the proposed application functionalities;
- SO3: verify the proposed rewards;
- SO4: verify the proposed promotion and networking strategy; and
- SO5: explore future scenarios and opportunities for the PULA application.

The pilot project was led by two teams. First team was led mainly by partner City Initiative Association and was associated with real-life contact with partners, event organisation, communication and general social aspect of the pilot project. Second team was led mainly by the Gdańsk University of Technology – responsible for technical management and administration of user data, working with the app developers to collect data on user activity, manage the application, respond to arising bugs, collect ongoing feedback on the product and make decisions on system development and updates. The progress of the pilot, feedback from users, data trends and potential directions for changes in content and applications were consulted with other representatives of the Greencoin consortium.

Other key collaborators on the pilot projects were strategic partners and local partners who agreed to participate in the process pro-bono, as well as

a pool of early adopters who participated actively in the closed phase of the pilot project.

Timeline

The project implementation timeline, as depicted in Figure 22, encompassed three distinct phases. The initial closed test phase spanned the period from May to July 2023. In this time the application was made available to a small group of early adopters. The team conducted empirical research including questionnaires and interviews on the group of early adopters.

The second phase, called Development, application improvement, spanned the period from July to October 2023. During this time, the team evaluated research findings and developed guidelines for application improvement. Necessary changes were implemented, and internal testing of the application was carried out. During this phase, the team prepared to launch the app for the general public.

The third phase, called as Testing, open phase, spanned the period from October to December 2023. The application was made available for download from the Google Play and Apple Stores. The team undertook monitoring and evaluation of the PULA application in real-life conditions.

The fourth phase, as Summarising and gathering the results, was the next step of the project. Figure 22 provides an overview of the PULA pilot project timeline (in Polish), which was employed by the team to present project progress to stakeholders and indicate the phase in which the project was situated at that time.

Strategic partners

The pilot project involved five strategic partners representing academia, business, and science. Initially, we assumed that a strategic partner was a passive member whose role was to promote the project, help recruit new users, and possibly create content in the app in the form of educational materials. The first assumption was verified when negotiating the terms of cooperation. The role of these partners went beyond our expectations. They offered their rewards to the app and sought other forms of interaction. The



FIGURE 22. Screenshot of the content presented at the stakeholder meeting; the PULA pilot project timeline

role and contributions of each partner were defined by agreements signed individually by each partner prior to the pilot start and reflected the internal capacity, will and *character* of each institution (for detailed description of the process of forming partnerships, see also Step 3). The strategic partners presented in Figure 23 included (1) Universities, (2) Business sector, and (3) Scientific centre.

Universities were represented by institutions forming a part of the Fahrenheit Union: University of Gdańsk, Gdańsk University of Technology and Medical University of Gdańsk. Key contributions of these partners were project promotion, recruitment of users and rewards for the application. The business sector was represented by the Olivia Centre, which also made a valuable contribution to the project, including promotion and the provision of rewards for participation. The scientific centre was represented by the Experiment Science Centre, which also contributed to the project, including developing quizzes for the application.



FIGURE 23. Screenshot of the content presented at the stakeholder meeting; overview of strategic and local partners in pilot project

Local partners

A local partner is a member who offers services or products through the app or allows users to earn virtual coins as part of his or her business (e.g. at a shoemaker for repairing shoes or at an organic food store for shopping). A local partner’s participation in the partnership is contingent on its meeting general sustainability criteria. The pilot project involved a total of thirteen local partners. The partners included green/local gastronomy, green/ local services, and green/local NGO. Within this group three types of partners can be discerned based on their engagement in the pilot and type of relationship formal/ informal:

Local partner (active/ formal) – partners actively participating in the pilot project who signed an agreement with the team before the pilot start. Key contributions: project promotion and contribution of rewards for the application. This group included the following partners:

-
- Avocado Bistro, Avocado Spot – vegan bistro, restaurant and shop;
 - Zeroban/ Dobry Deal – organisation working with the framework of social economy concerned with upcycling of old banners;
 - Hevelianum – a public institution working with science, history and culture located in the centre of Gdańsk;
 - Centre for Ecological Information and Education (CIEE) – a branch of the *Pomorski Zespół Parków Krajobrazowych* (Pomeranian Landscapes and Park Department) concerned with education and promotion of ecology;
 - Gdańsk Water Supply and Sewage Infrastructure (GIWK).

Local partner (active / informal) – partners actively participating in the pilot project, not bonded by a formal agreement; contributing to selected pilot project activities:

- PLONY – local NGO concerned with the exchange of ecological knowledge located in the former shipyard areas in Gdańsk;
- *Inkubator Sąsiedzkiej Energii Dolne Miasto* (ISE) is a local NGO concerned with community empowerment and activation based in the city district of Dolne Miasto.

Local partner (passive) – partners, green/ local business – spots and sites on the map where app users could earn coins by using their services or buying their product. Partners not contributing actively to the pilot.

- ZiemiaSfera – ecological shop;
- Tu Pralnia & Tu Krawiec – local laundry and tailor;
- Book book – local bookstore.

Early adopters

Early adopters participating in the closed phase represented a group of deeply engaged people ready to discover and share information about the project and contribute to the development of the application. The group was recruited through our partner network, and their role in the open phase was to further promote the app among other residents of Gdańsk.

The closed phase of the pilot project involved 55 early adopters. This group of people represented users of various backgrounds and ages including students, university employees and business centre employees as well as

selected members of the Greecoin project team. The group of early adopters was recruited prior to the pilot with the assistance of the strategic partners. There were two information meetings (14.04.2023 in person meeting, 23.04.2023 online meeting) held before the pilot kick-off to inform the early adopters about the conditions of the participation in the testing phase as well as the benefits of being a part of the process. The early adopters were asked to actively use the application, participate in short questionnaires concerned with the functionalities of the application (seven in total) and participate in an interview concluding the closed phase. In return, the early adopters received Good Coins for actively testing the app and participating in research, official certificates of commitment for testing the application, and early access to rewards offered by pilot partners. From the 55 early adopters that set out to take part in the closed phase – 29 actively participated in the process, 17 users took part in the cyclical questionnaires, and 17 participated in the interview that concluded the process.

PULA application – acting and earning

The application was created to allow users to earn so-called ‘Good Coins’ in return for their sustainable and pro-environmental behaviour. The application had an intuitive interface allowing for quick and easy access to all its functionalities. In the context of the pilot project, it was key to understand whether the users found the application design attractive and intuitive as intended. The application consisted of three main screens allowing the users to earn coins and spend them and a homepage enabling them to read news, engage with other users and identify local partners (for a detailed description of the application, see chapter 5).

Key users’ activities allowing earning coins that were tested during the pilot project were:

- Transport – rewarding travel activities within the city limits with the smallest carbon footprint.
- Quizzes – single-choice educational quizzes on selected topics related to the environment.
- Actions – a variety of actions with a pro-environmental effect, ranging from day-to-day activities such as waste segregation to building a green wall (for a list of actions, see chapter 3).

- Local community events and other (confirmed by QR code) actions aim to strengthen local communities through collective pro-environmental activities.
- Verification – verification of self-reported user activities by other users rewording the user undertaking the verification.

The activities were quantified using the quantification model developed in earlier phases of the project (for a detailed description of the quantification model, see chapter 4).

Rewards

The vouchers available through the application were provided by project partners and varied in their character and number depending on the partner. While all strategic partners and selected local partners were asked to contribute rewards for the application, this was ultimately voluntary.

In return for their earned coins, the users of the application were able to, for instance, get a free coffee, buy merchandise, or receive discounts for products and meals. Alternatively, if they managed to collect a greater number of coins, they could spend it on a guided tour or a weekend by the lake. In total the partners contributed with 784 of vouchers, which roughly fall into the following categories:

- Discount or free meals/drinks
- Discount on products
- Experience

Value of the rewards was assigned based on the quantification model developed in earlier phases of the project. The value of rewards offered through the application was estimated based on the market value of a single virtual coin (based on the effort and time required to get the coins). To determine this value, we adopted a kilometre biked as the basic unit of calculation. Informed by previous literature reviews, we established that the reward needs to be lower than the market value to preserve users' intrinsic motivation. Based on our research, the labour value of one kilometre biked was €0.45 (equivalent to PLN 2.09). We chose 10% of labour value (PLN 0.21 per kilometre) to incentivize participation without diminishing internal motivation. As we rewarded 60 virtual coins per kilometre biked, then 285.71 virtual

coins = PLN 1. Given this conversion rate, the market value of each proposed product and service was converted into virtual coins.

Additional activities

One way of engaging users of the application and allowing them to earn Good Coins was through events aimed at strengthening local communities through collective pro-environmental activities. The themes of the events referred to the list of actions that a local currency in Gdańsk should support, described in chapter 3. As a part of the pilot project three activities were organised in collaboration with local partners to test various ways of engaging users.

More Water! A hands-on workshop on how to collect rainwater – 25 June 2023

An event led by the NGO Plony, the aim of which was to gain hands-on experience in construction of rainwater retrieval systems. The workshop took place in the community garden run by Plony located in the former



FIGURE 24. Promotion material from the activity More Water! (photo: Marcin Zdziuch/ The Montaż)

Shipyard in Gdańsk. The event was met with great interest; a total of 20 people from across Gdańsk took part in the workshop. Plony led the communication and promotion of this event. The example of promotion material is presented in Figure 24.

Building green walls – 28th October 2023

An event led by the NGO ISE Dolne Miasto (in Polish: *Inkubator Sąsiedzkiej Energii*, in English Neighbourhood Energy Incubator) concerned with constructing green walls in Dolne Miasto. The event was met with limited interest. While successfully realising its aim of building green walls, the workshop involved only residents of the local neighbourhood. The event was not promoted widely on social media but relied primarily on word-of-mouth promotion led by ISE Dolne Miasto.

Houses for hedgehogs – 18 November 2023

An event led by the ISE Dolne Miasto concerned with the construction of houses for hedgehogs in Dolne Miasto. The event was met with minimal interest. While successful in realising its aim of building houses for hedgehogs, the workshop involved only residents of the local neighbourhood. The event was not promoted widely in social media (Figure 25) but relied primarily on word-of-mouth promotion led by ISE Dolne Miasto.

Partners – networking meetings and communication

As part of the collaboration with pilot partners, we facilitated a networking process driven by the needs expressed during meetings aimed at defining the scope of collaboration. Consequently, we coordinated specific initiatives and hosted networking sessions. In total, two such meetings took place during the pilot phase (17.04.2023 and 30.11.2023), focusing on exploring shared collaboration opportunities among participants, ongoing project evaluation, and the development of future scenarios. Instead of holding a third meeting, we took advantage of an excellent opportunity to exchange experiences and opinions at a popular science conference we organised on 22 February 2024.



FIGURE 25. Promotion material from the activity building houses for hedgehogs (photo by Marcin Zdziuch / The Montaż)

The communication with project partners was an ongoing activity and was concerned with project promotion, project updates and partner meetings. To increase the efficiency of communication and reduce the amount of time spent on reading and replying to emails by pilot partners, the communication followed a strict schedule related to key information.

Promotion and communication

The pilot project was promoted and communicated on two levels. One was concerned with its overall promotion, and the other was related to the PULA application.

Channels of communication

To promote the application the pilot project relied above all on social media such as Facebook and Instagram, which were used to promote project partners, rewards and ongoing activities. A designated Facebook page was created for that purpose. Posts were also shared by project partners through their own social media. For key pilot events we prepared information packages with promotion material that we shared with partners asking for their dissemination through their channels. This approach proved to be successful. Sharing information via partner channels turned out to be more effective than using PULA communication channels. Higher engagement was especially visible in the case of Facebook posts shared by the following entities: Gdańsk University of Technology Faculty of Architecture, Experiment Science Centre, University of Gdańsk Centre for Sustainable Development, ISE Dolne Miasto, Gdańsk Water and Sewage Infrastructure.

Through the pilot project the team created a total of 40 posts on Facebook and 62 on Instagram, the Facebook pages dedicated to PULA had 56 followers while Instagram had 49. The overall outreach of the posts was limited between 500 to 600 people. Information concerned with PULA shared by project partners with a considerably greater number of followers received much more attention.

In addition to social media, a website for the PULA application was also created, the website consisted of information on the application, overview of partners and contact information for potential new partners. Each of the strategic partners was also asked to share information on their websites on the pilot project and circulate through their channel's key updates and information on events.

PULA promotion

The team also promoted the pilot project through articles in local and national media and through participation in conferences. Two press notes were shared with local media at the beginning of the closed and open phases (June and October 2023), neither of the press notes resulted in an article. In October, to strengthen the outreach of the open phase, one sponsored article was published in a local media platform (trojmiasto.pl). The kick-off of the open phase was also marked by a press conference organised at the Gdańsk

University of Technology in relation to the annual Celebration of the Architectural Department (Figure 26). In addition, the pilot project was showcased during a national conference taking place in Gdańsk – Smart Metropolia on the 5th of October.



FIGURE 26. Promotion of PULA during Celebrations of the Architectural Department at Gdańsk University of Technology (photo: Inicjatywa Miasto)

We used also other materials, like:

- Quick-response (QR) code stickers distributed to partners and potential users at events, linking to the PULA website.
- A4 posters placed at partner locations with QR codes that users could scan to add coins to their wallets.
- Additional posters provided instructions for scanning QR codes and redeeming vouchers.
- Roll-up banners used to promote PULA at events.

In line with our commitment to environmental sustainability, we made a conscious effort to minimise printed materials during the project’s promotional phase. We prioritised the development of a comprehensive web-

site as the primary source of information about the project. This allowed us to provide detailed information, updates, and resources in a digital format, eliminating the need for printed brochures or flyers. We utilised QR codes on digital and physical materials, such as posters and stickers, to direct users to the project website and other relevant online resources. This eliminated the need for additional printed information.

We printed a limited quantity of universal QR code stickers that could be used in various contexts. This reduced the need for multiple print runs for different events or campaigns. We strategically printed small quantities of high-quality posters for targeted distribution at key locations, such as partner businesses and events. This ensured that our materials reached a relevant audience while minimising waste.

PULA in numbers

The pilot phase succeeded in achieving its objectives. However, it should be stressed that the limited time that was allocated to the pilot did not allow to fully explore the potential of the application and the network of partners and users that was formed in the process. Building interest and engagement in new initiatives requires above all time. Efforts that were directed towards promotion of the initiative at strategic moments in the process such as the start of the open phase allowed it to gain a substantial number of users. In particular, the number of users increased from 55 in the closed phase (Figure 27) to 140 in the open phase (Figure 28). However, the increased number of users did not translate into increased user activity nor an increased number of followers on PULA social media. Likewise, building trust, engagement and understanding among the network of partners is a long process. In the proposed model, strategic and local partners enter the network because they believe in the positive effect of the initiative. They commit their time and resources to support the cause a receive promotion and become a part of an engaged and expanding network. The benefits of participating in the initiative may be clear to thriving and well-established institutions and businesses, however, gaining trust of small local businesses and initiatives requires more time.

The pilot project allowed the team to test and verify the proposed application functionalities and activities through which Good Coins could be

02

podsumowanie
pilotażu

Faza zamknięta



199 598 Dobrych Monet



55 Użytkowników

dziesiątki wniosków...

i setki poprawek...

FIGURE 27. Closed phase in numbers

earned. Here it is worth mentioning that sustainable transport and quizzes were the preferred ways of earning coins which suggests that low threshold activities are the best ways to build initial interest among users. During the pilot, the team co-organised three community events. While in principle this is a great way of community building, strengthening local identity and forming new alliances while collaborating on pro-environmental activities the events were met with a varied attendance. Location and weather are key factors while organising events. The first event took place in June, with great weather encouraging outdoor activities. Its location is also generally perceived as more central and accessible than the location of the remaining two events which took place in Dolne Miasto during autumn. Another factor which is likely to have impacted the attendance of the events is the outreach of the collaborating organisations. While both are acknowledged and well established, the NGO Plony works on a city level and targets primarily young adults; thus, it has a wider outreach than the NGO ISE, which, through its activities, primarily targets the residents of Dolne Miasto.

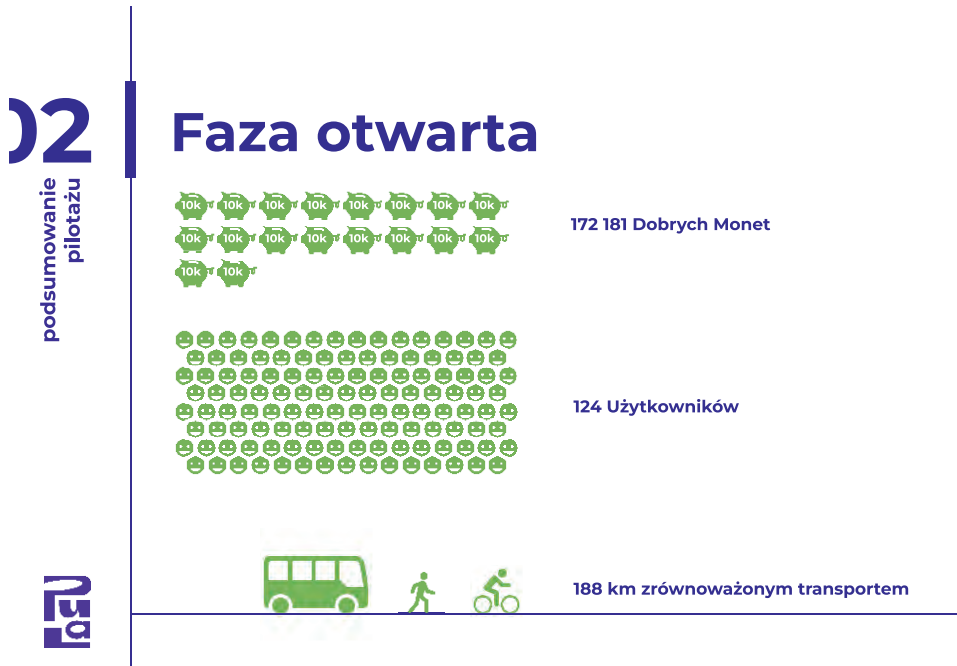


FIGURE 28. Open phase in numbers

During the pilot project the most popular rewards proved to be meals and drink, in particular the rewards offered by the local partner Avocado, a chain of vegan food spots (stores and restaurants), which included: lunch, dessert, breakfast, coffee or tea, gift boxes, a less-waste accessory kit and discounts. Products from other partners such as – Gdańsk Infrastruktura Wodociągowo-Kanalizacyjna Sp. z o.o., Gdańsk University of Technology and Gdańsk Medical University – also attracted interest. These included reusable bags, backpacks and bidons, honey vouchers and shopping vouchers. In general, the experience of the pilot shows that it is worth offering users a variety of rewards in different price ranges. But – less ‘expensive’ – hence easier to gain rewards in particular food and drinks which is something we all would like to treat ourselves to everyday should be paramount.

Maintaining good communication with early adopters and partners throughout the pilot was key. The communication strategy sought to keep up the engagement, without overflowing the partners with unnecessary information. At the same time, it was important to make sure that the partners felt comfortable reaching out to the team at any time. Feedback

from partners proved that the strategy taken in the process was successful. It was particularly useful to agree prior to the pilot on a tentative communication schedule and expected feedback from the partners. In terms of maintaining partner engagement, networking meetings were more important than direct communication via email. While we failed in organising three meetings as planned, the ones that we did organise show that in-person meetings in relaxed settings are the best ways to receive feedback, critical reflection and strengthen feelings of ownership. The networking meetings also showed a great potential for forming new collaborations among strategic and local partners and building a community of driven and likeminded organisations, which in turn strengthened the PULA network and outreach. Time constraints did not allow exploring this potential further, but we suspect that if continued the networking meeting would eventually result in a wider recognition of the initiative and an increased number of local partners.

Promotion of the application proved to be the most resource intensive part of the pilot project. This applies not only to finances, but also to the required human resources. Building and promoting a brand takes time and is work intensive. In the process, the team used various tools of communication to promote the initiative. While Facebook and Instagram were important for reaching new audiences, building up a follower base is slow.

Regarding this, what proved particularly useful was asking partners to share posts via their social media which ensured access to a much larger group of followers. The promotion event organised in relation to the press conference at the Gdańsk University of Technology proved to be an efficient way of recruiting new users. The team prepared QR codes that allowed for an easy registration to a mailing list through which information on the application was later circulated. For the overall promotion of the pilot project several local and national media were contacted. The response was limited, and the subject proved to be more relevant for trade journals concerned with subjects of technology, ecology, and sustainable development than local news outlets. With regards to the promotion activities undertaken as a part of the pilot it should be stressed that the team did not have a designated communication officer and hence did not prioritise social media activity in the process. This can be seen as one of the major shortcomings of the pilot. It is likely that if more time and resources were spent on promotion activities the overall outreach and user number would be larger.

One of the key objectives of the pilot was to explore future scenarios and opportunities for the PULA application especially through the partner network, but also by showcasing and promoting the initiative at relevant conferences. Through the activities undertaken as a part of the pilot, the team managed to build up a strong network of relevant partners who took an interest in the initiative and expressed a will to continue the discussion on its future beyond the lifespan of the project. The team is currently exploring future opportunities with several public institutions in Gdańsk. At the same time, we are in contact with stakeholders who are interested in implementing similar solutions in other cities. Attached to this document is a guide for stakeholders who would like to develop similar projects using our experience. The guidebook (Anacka et al., 2024) includes various scenarios for using local currency: as a tool for building relationships between local government and residents, as a tool for schools and/or universities, as a time bank application, or to support the circular economy. We also show possible forms of currency management and financing.

Step 7.

Key findings and insights gained from the implementation of the project

Based on the project process carried out and described in earlier chapters, we would like to narrow down our focus to the educational mobile application, which aims to motivate urban dwellers to engage in pro-environmental activities by combining the benefits of community currency and digital means. Like similar pro-environmental applications, the application encourages sustainable practices among city residents. The application serves as a platform for promoting eco-friendly behaviours and addressing environmental challenges specific to Gdańsk metropolitan area. By analysing the research outcomes of the Greencoin project, insights can be gained into how mobile applications can effectively promote ecological awareness and sustainable activities among its users.

Based on the first step of the process, we identified key challenges facing urban environments through the participatory co-design workshops, such as: inefficient urban transport systems, waste management issues, and the need to promote a metabolic approach to resource consumption (Duda, 2022; Duda et al., 2022). We also incorporated existing good practices and proposed solutions, including integration of educational modules into the GC-system, providing real-time feedback and incentives, and promoting

eco-friendly choices using Good Coins or PULA points. Additionally, we have found that engaging users in the verification process and involving various stakeholders in the design and implementation of the Greencoin system is crucial for its success.

An important takeaway message is that because many community currency projects aim to attract a large user base, a precise definition of the target social group is often broad and inclusive, which can lead to challenges in stakeholder engagement, particularly during the design phase, which is crucial for a project's success. Our study emphasised the importance of active stakeholders' involvement, particularly during the design phase, to ensure project success and impact (Obracht-Prondzyńska et al., 2023). For instance, the inclusion of potential users, local municipalities, and business partners during the design stage is crucial for the overall success of a community currency project.

In the Greencoin project we adopted a multidisciplinary and cross-sectoral approach to design and implement chosen activities. We utilised design thinking methodology enriched with case studies evaluation, workshops, User Experience design, low fidelity prototyping, system usability scale survey, and testbeds to develop the concept of Greencoin, as a community currency application. This approach allowed active involvement of stakeholders in the co-creation process, ensuring that our digital tool is tailored to meet the needs and preferences of the intended users. Among the revealed strengths of the Greencoin approach was its emphasis on human-centred design, which enabled the development of agile solutions to promote climate awareness and pro-environmental behaviours. However, we also faced challenges, such as the need to ensure the scalability and sustainability of the PULA application beyond the initial research phase. Additionally, the iterative nature of the design process required careful consideration of feedback from stakeholders and continuous refinement of the concept to ensure its effectiveness and usability.

Another lesson learned from the Greencoin project is the importance of collaboration and co-creation in developing effective solutions to complex challenges like climate change mitigation. By bringing together diverse actors from different sectors, projects like Greencoin can leverage collective expertise and resources to maximise their impact. Furthermore, an iterative nature of the co-design process allows for continuous improvement and adaptation based on user feedback, research progress and constantly evolving external

needs. The Greecoin project underscores the potential of co-designed digital tools to empower communities and individuals to take meaningful actions in mitigating climate change. By adopting a human-centred methodology, flexibility, leveraging innovative technologies, and fostering collaboration among stakeholders, similar projects can contribute to building more resilient and sustainable cities.

Based on our research results the role of local authorities and stakeholders in supporting the initiative and promoting sustainable actions should be emphasised. The importance of group work and social networks in strengthening eco-friendly behaviours should also be mentioned (Toşa et al., 2024). Additionally, we have noted the effectiveness of digital tools, gamification techniques and constant feedback in achieving positive results, especially during an application pilot phase. Moreover, simple communication complemented by user-friendly, graphic messages to impact multiple dimensions of behaviour (Kuntz et al., 2012; Aguiar-Castillo et al., 2019) proved its relevance within the PULA pilot study.

Our study underscores the importance of digital-based solutions in shaping climate awareness and promoting pro-environmental behaviours in cities. Yet, there is a need for further research in this area. Recommendations include conducting more case studies, scaling-up the sample, and continuing empirical test-based research to validate theoretical models and exploring interdisciplinary approaches to address complex urban challenges. Additionally, the importance of collaboration between researchers, practitioners, policymakers, and stakeholders to implement digital-based solutions effectively in smart city contexts cannot be underestimated. The possible future steps should include developing, testing, and evaluating the Greecoin prototype on a larger scale as well as in different urban areas.

Furthermore, the Greecoin project has been observed to offer benefits to the city of Gdańsk, functioning as a testing ground for the implementation of novel solutions within the urban environment. The success of this project has the potential to distinguish Gdańsk from other Polish cities in terms of innovative and environmentally friendly solutions.

The final stakeholder segment, users and therefore residents of Gdańsk, whether they are sceptical or believers in sustainable practices, can gain value from the unified platform created by Greecoin (Figure 29). The first subgroup, sceptical residents, might find value in actively caring for the neighbourhoods they live in through engagement in activities directly improving

their immediate surroundings. On the other hand, residents belonging to the group of believers might see the whole project to initiate actions needed to help the environment. Greencoin empowers this group of stakeholders to be a part of something bigger, a larger movement. The sense of belonging to a group will be further strengthened by the visible effects of individual efforts for the environment and building a community around it. In all the above aspects, Greencoin can become a bridge between diverse perspectives on ecological issues, offering Gdańsk residents tangible ways to engage and contribute to the improvement of their city and local environment.

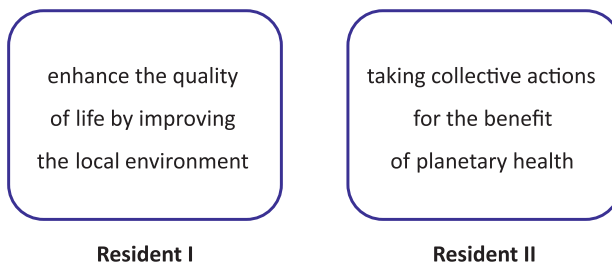


FIGURE 29. Value propositions depending on types of residents

Regardless of a fact that it is a company or startup looking for ways to improve its ecological reputation, an NGO focused on the process of building communities focused on environmental issues, a city looking to test and integrate novel and innovative solutions, or ordinary citizens, Greencoin's value proposition can be adapted and tailored to meet the aspirations of each of these stakeholders. This project fosters a common sense of belonging together with a shared purpose among its stakeholders.

A few aspects can be indicated in a form of overall conclusion from the methods applied in the research as well as results stemming from that. Based on research, three key players have been defined in the concept of Greencoin ecosystem: strategic partners, local partners and users. Strategic partners are large organisations which play a pivotal role in elevating Greencoin's profile and impact. They provide resources and recognition to the Greencoin network, simultaneously boosting the visibility of local partners. Additionally, they can improve their own brand image and contribute to sustainability efforts in the city. In turn, local partners serve as the project's backbone, offering sustainable products, services and rewards redeemable with Good Coins

earned by users. Their participation not only increases their visibility, but also strengthens social bonds and fosters a sense of collective responsibility for sustainable development. Thanks to this partnership, a greater recognition might help them expand their customer base.

It is of paramount importance to recognise that the users of Greencoin represent the primary motivating factor behind its success. They are encouraged to engage in sustainable behaviours and earn Good Coins, thereby reinforcing their commitment to this virtuous economic system. Those ultimately can be exchanged for rewards from local partners. Thanks to their participation, users become active agents of change, shaping the ecological awareness of communities, promoting a culture of sustainable development, and caring for their neighbourhood. All in all, Greencoin fosters a win-win situation by encouraging eco-friendly behaviour among citizens, supporting small businesses in the region and improving an image of large, strategic partners. It extends far beyond the traditional transactional type of benefits. The Greencoin project has the potential to become not just a currency, but rather a catalyst for community engagement, promoting sustainable development and economic revitalisation. By facilitating the partnership and cooperation among aforementioned entities, Greencoin exceeds traditional notion of currency and becomes a vehicle for positive change.

The early adopters participating in the pilot followed a different communication approach which was related to their role as testers and the request to provide ongoing feedback. Early adopters were a group of motivated users willing to commit their time to the process. However, the pilot project experience shows that even when dealing with a selected group of people it is hard to maintain continuous engagement among participants. Rewards in the form of 'Good Coins' and a certificate confirming participation in the project were attractive incentives but did not suffice to motivate more than 34 people in total to actively participate in the questionnaires and interview. The two information meetings held at the start of the pilot project were met with a substantial interest. If resources allowed for more, a good way of maintaining early adopters' engagements could be organising regular networking meetings like the ones organised for partners.

Furthermore, our study revealed gender differences in application usage patterns, with females showing greater engagement in educational activities while males focusing more on transport functions. Understanding these differences can inform the design of gender-sensitive interventions and ensure

that applications effectively cater to all users' diverse needs and preferences. The Greencoin project underscores the potential of technology-enhanced interventions to promote sustainability and encourage environmentally friendly behaviours. By incorporating user-centred design principles, leveraging innovative technologies, and conducting rigorous applied research, similar projects can contribute to a more sustainable, greener future and benefit society.

Importantly, potential partners do not have to remain a constant number. Additional support can be easily gained in the future. Forms of further expansion to gain new partners include actively recruiting other businesses to participate and hosting special events or promoting the local currency model within their businesses. From local governments to schools and businesses, everyone can contribute to Greencoin's success. Whether it is offering discounts, promoting the programme, or simply using Greencoin, there are many ways to support a more sustainable future.

Important issue to outline is the fact that Greencoin aimed at covering wide and various partnerships. Such a form of inclusivity raises a chance to reach an ample audience, connects unused resources with unmet local needs and makes the currency a tool for building local interactions between different stakeholders. However, because of the desired diversity, there are problems that need to be addressed. Important remark resulting from conducted analysis emphasises that Greencoin currency cannot be directly promoted as a pro-environmental tool. Due to its aforementioned inclusivity, such association may alienate undecided people or the ones who appear to be rather sceptical towards such a narrative. Requiring people to declare care for the environment from the beginning may have opposite effects than those intended by the authors of the project, potentially discouraging this particular audience group. Therefore, the currency should promote desirable habits and behaviours as an action for health, neighbourhood, city, or improvement of living conditions.

Additionally, user research showed that the application should prioritise inclusivity by rewarding a variety of pro-environmental behaviours. This ensures that everyone can participate, regardless of their capabilities or resources. This broad range of actions makes the programme more accessible and appealing to a wider audience. Moreover, Greencoin should seek to connect users' real-life actions with the virtual reward system, encouraging individual efforts while also fostering group dynamics within workplaces and neigh-

bourhoods. This approach strengthens the sense of community and collective impact, motivating users to participate more actively. By incorporating educational functionalities, Greencoin aims to bridge the knowledge gap. This empowers users to make informed choices and develop long-term sustainable habits.

In essence, project Greencoin embodies a vision for a more sustainable and inclusive future. By merging the interests of strategic partners, local partners, and citizens, it creates a virtuous cycle of sustainability. It unites these entities in a common commitment to environmental stewardship and community well-being. By aligning the interests of these diverse stakeholders, Greencoin initiates a space wherein sustainable practices are not only incentivized but also become a part of everyday life, fostering a harmonious coexistence between humans and their environment. Importantly, this solution, thanks to its universality, can evolve and expand to other cities, using tailor-made specifications adapted to a given local context.

Recommendations

The assessment of the Greencoin system, using the quantification methodology, highlights its success in promoting sustainable behaviours. This is evident from the strong user participation and the positive environmental results that have been observed. Nevertheless, the system encountered difficulties ensuring ongoing participation and aligning the reward system with achievable sustainability goals.

The further work on the Greencoin system requires careful attention to developing the parameters to measure the values of the actions and the products that are part of the gamification. We also found that the identification of actions and products is critical. In our analysis, a combination of systematic literature review and interviews with stakeholders is essential to identify relevant actions and products. Our study demonstrates a systematic approach to identify the actions and the products as well as proposes a set of methodologies to estimate the values of actions and products of the Greencoin system.

To ensure long-term success, increasing community engagement and awareness for future improvements is advisable. Future iterations of the system have the potential to expand the range of actions and rewards, incorporating a wider variety of local and culturally specific options to enhance

relevance and attractiveness. This approach seeks to improve the influence and scope of the Greencoin system in advancing sustainable practices.

The assessment of the Greencoin system, conducted from the perspective of the community-building phase, revealed the significance of the preparatory phase and its pivotal role in the success of subsequent actions. It is imperative to establish a network of strategic and local partners well before the project's commencement. The preparation phase should be employed to construct a robust community from a network of partners that will be sufficiently attractive to encourage the involvement of other partners. Preparatory phase should also be used to gain the first group of users (early adopters) to be a base for the future community of users involved in the project. Cooperation with strategic partners proved to be a good starting point in building that community.

Pilot study proved that the future project must be managed by an active operator. It is impossible for the application to run by "itself" and be managed only from a technical point of view (helpdesk). The operator of the application must be active in communication with partners and users, be engaged in communication with the social, cultural, and economic environment to create application content.

It is paramount that the operator maintains active communication with partners and coordinates their activities. In the case of strategic partners, this entails coordinating events, building a brand image, providing support for strategic partners in executing their own activities through the application's functionalities, and creating new benefits for users.

It is also essential for the operator to actively engage in continuous communication with partners and to facilitate collaboration. Regarding local partners, ongoing cooperation involves promoting them through applications, coordinating their activities, and creating new benefits for users.

The need for professional marketing support and promotion of the project has emerged as the primary unrecognised deficiency, the fulfilment of which is crucial for implementing a "true" project in the future. The recognition of the application and its promotional potential constitutes, in the project team's assessment, the main decisive factor in the interest of local cooperation partners.

Only small enterprises whose managers are actively interested in implementing and promoting sustainable development principles have decided to cooperate on the pilot project. Entrepreneurs whose profile was not directly

related to this issue did not express interest in cooperation. Another significant factor contributing to the lack of interest in cooperation on the pilot project was the low level of trust in the project and fear that the pilot project was some form of fraud or greenwashing agency. Consequently, only niche enterprises with a strictly defined profile were able to be engaged in cooperation. Both of the aforementioned issues point to a significant need for building the social capital of projects such as Greencoin in the future.

It is vital for the operator to monitor ongoing social situation as well as search for new potential partners, rewards, and activities. It is an ongoing process. New application content can be found through many activities, such as:

- contact with partners,
- media and social-media research,
- communication with local institutions, municipalities, NGOs, and
- communication with users.

Partners, especially those involved in sustainability initiatives, can recommend individuals or groups with a keen interest in Greencoin's mission. Sustainability enthusiasts can be also found by identifying online forums, social media groups, or local organisations focused on environmental sustainability and engaging with their members.

Conclusions

Pro-environmental behaviours are key aspects in mitigating the adverse consequences of the ongoing climate change. Researchers and practitioners are seeking ways to motivate people to undertake them and to engage more for achieving a greener lifestyle. It can be especially crucial among people living in towns and cities, where the air pollution and limited green spaces result in greater risks for the environment and for the well-being of people. With these considerations in mind, the focus of both the Greencoin project and the presented monograph is to educate city dwellers and support their efforts to care for the environment.

In this monograph, we embarked on a comprehensive exploration of promoting pro-environmental behaviours among urban dwellers, focusing on insights derived from the educational mobile application developed by our project team. Our journey traversed the realms of research methodology, data analysis, stakeholder engagement, and application design, culminating in valuable insights and recommendations for fostering sustainable urban living.

Through our rigorous research endeavours, we sought answers to fundamental questions driving our inquiry. We explored how currency-based systems might promote pro-environmental behaviour in urban contexts, the role of digital tools, especially mobile applications, in shaping climate awareness and

encouraging sustainable practices among urban dwellers, and the potential of participatory co-design methodologies in developing innovative solutions for promoting pro-ecological attitudes and behaviours within urban settings.

Our findings offer compelling insights into the transformative potential of digital tools, the efficacy of currency-based systems, and the importance of participatory approaches in fostering sustainable behaviours. We suggest that the new technologies can help convince city dwellers to undertake environmentally friendly behaviours, making them reward, challenging, and fun. Moreover, we highlight the importance of co-designing the application with the potential users, which is encouraging civic engagement from the very start of the application's lifecycle. It also enabled us to adjust the application's functionalities to the community needs, and as a result, maximise the chances of interesting the wider audience with our project and the application itself. By employing diverse research methodologies and conducting thorough data analysis, we uncovered nuanced dynamics and identified recommendations for policymakers, practitioners, and technology developers which can be implemented in the future.

All in all, the Greencoin project demonstrates the potential of participatory co-design methodologies in developing innovative solutions for promoting pro-ecological attitudes and behaviours in urban settings. By addressing challenges, leveraging good practices, and incorporating feedback from stakeholders, the Greencoin project has contributed to the development of pro-environmental awareness and eco-friendly behaviours among Gdańsk city dwellers. Our research project adds to the understanding of how digital means can be leveraged to support climate awareness and behaviours in smart cities. However, further research is needed to fully realise the potential of digital tools in shaping climate awareness and promoting pro-environmental behaviours in other urban areas.

Thus, the Greencoin project represents a novel technological solution using virtual points (PULA application points), which are awarded to active application users after successful completion of certain activities in the application, as well as gamification techniques, related to informal learning and a focus on pro-environmental locally-based and user-tailored activities. More specifically, applied gamification techniques supported focused attention span and allowed peers' competition, e.g. by doubling points after certain activities performed in a group, after timely challenge completion or first-time task completion, which encouraged regular learning, greater collaboration, and general openness to new application challenges. These activities bring

Pula points that could be exchanged for the eco-friendly products offered by the local green businesses to promote pro-environmental behaviours in the Gdańsk metropolitan area. The project aimed to shape pro-ecological behaviours, educate citizens, and change their habits, and promote eco-inclusion, with the potential for scalability and customisation to address local ecological goals in other European cities.

Yet, the project also faced challenges, such as the limited sample size of early adopters during the pilot phase and potential biases in users' behaviour due to their awareness of participating in research. These challenges highlight the importance of conducting extensive higher-scale studies involving larger and more diverse user groups to ensure the reliability and generalisability of research findings. In the future, projects like Greencoin should aim to address these challenges by incorporating rigorous research methodologies and involving a broader range of participants. Additionally, efforts should be made to mitigate biases and ensure the validity of research outcomes, thereby enhancing the effectiveness and impact of technology-based interventions in promoting sustainability.

The Greencoin project yielded valuable insights into the potential of mobile applications to promote environmentally friendly behaviours among urban dwellers. The results suggest that mobile applications like PULA have the potential to raise ecological awareness and encourage sustainable activities, such as using public transport and engaging in educational quizzes. Overall, the Greencoin project represents a novel approach to activating and empowering the local Gdańsk urban area community in climate change mitigation efforts, with the potential to mobilise resources and foster collective action at a regional level. A key lesson learned from the Greencoin project is the importance of tailoring application features to local user preferences and habits. For example, our pilot study revealed that transport activities and quizzes were the most engaging functionalities among users, which might suggest an interest in eco-friendly transport options and knowledge acquisition. By designing applications that align with user interests and preferences, developers can maximise user engagement and promote sustained behavioural change.

Despite the comprehensive nature of our inquiry, we acknowledge certain limitations inherent in our study. These may include sample size constraints mentioned earlier, geographical specificity, and temporal factors influencing the generalisability of our findings. Despite designing and testing our application among the dwellers of Gdańsk in Poland, we argue that similar solutions

could be implemented in other cities in Poland and beyond. However, given the differences in the pro-environmental attitudes and policies across countries, it would be interesting to observe how the PULA application or similar solutions are implemented and accepted in other cities, also outside Poland. Thus, moving forward, future research endeavours could focus on wide-scale longitudinal studies, comparative analyses across different urban contexts, and interdisciplinary and international collaborations to further enrich our understanding of promoting pro-environmental behaviours.

Our empirical research has implications for the discourse on sustainable urban development, environmental psychology, and technology-mediated behaviour change. It shows how a digital innovation can be introduced and diffused within a local community, and a pathway to go when designing similar projects. In the previous chapters we discussed the strengths and weaknesses of our project implementation process, as well as stressed out the potential areas of improvement. We focused on feedback from users, underlining the importance of a participatory approach in innovation design and introduction. Our practical recommendations hold relevance for policymakers, practitioners, and technology developers seeking to implement effective strategies for fostering sustainable behaviours and mitigating the adverse impacts of urbanisation.

Our research beneficiaries encompass a broad spectrum of stakeholders, including urban planners, policymakers, pro-environmental organisations (public, nonprofit and grassroots), technology developers, and urban residents. By translating our insights into actionable interventions and policy recommendations, we aspire to catalyse positive change within urban communities and contribute to the broader goal of building resilient and sustainable cities. The participatory approach serves as a strategy to enhance civic engagement and a sense of responsibility for the local and global, natural, and social environment. Moving forward, future research endeavours could delve deeper into specific aspects of our findings, explore novel interventions, and assess the long-term impacts of pro-environmental initiatives on urban sustainability.

In conclusion, our monograph contributes to the discourse on promoting pro-environmental behaviours among urban dwellers. By unravelling the complexities of human behaviour, technology-mediated interventions, and participatory approaches, we aim to empower stakeholders to enact meaningful change and pave the way for a more sustainable future.

References

- Aguiar-Castillo, L., Clavijo-Rodriguez, A., Saa-Perez, D., & Perez-Jimenez, R. (2019). Gamification as an approach to promote tourist recycling behavior. *Sustainability*, 11(8), 2201. <https://doi.org/10.3390/su11082201>
- Akin, D., Jakobsen, K. C., Floch, J., & Hoff, E. (2021). Sharing with neighbours: Insights from local practices of the sharing economy. *Technology in Society*, 64, 101481. <https://doi.org/10.1016/j.techsoc.2020.101481>
- Al Mamun, A., Naznen, F., Jingzu, G., & Yang, Q. (2023). Predicting the intention and adoption of hydroponic farming among Chinese urbanites. *Heliyon*, 9(3), e14420. <https://doi.org/10.1016/j.heliyon.2023.e14420>.
- Anacka, H., Bojanowski, J., Czyż, P., Duda, E., ... & Zawieska, J. (2024). *The Greencoin project A guideline for the implementation strategy*. Maria Grzegorzewska University Press. ISBN 978-83-67721-46-2
- Balińska, A., Jaska, E., & Werenowska, A. (2021). The role of eco-apps in encouraging pro-environmental behavior of young people studying in Poland. *Energies*, 14(16), 4946. <https://doi.org/10.3390/en14164946>
- Bamberg, S., & Möser, G. (2007). Twenty years after Hines, Hungerford, and Tomera: A new meta-analysis of psycho-social determinants of pro-environmental behaviour. *Journal of Environmental Psychology*, 27(1), 14-25. <https://doi.org/10.1016/j.jenvp.2006.12.002>

- Beirão, G., & Sarsfield Cabral, J. A. (2007). Understanding attitudes towards public transport and private car: A qualitative study. *Transport Policy*, 14(6), 478–489. <https://doi.org/10.1016/j.tranpol.2007.04.009>
- Bhat, T. H., & Farzaneh, H. (2022). Quantifying the multiple environmental, health, and economic benefits from the electrification of the Delhi public transport bus fleet, estimating a district-wise near roadway avoided PM2.5 exposure. *Journal of Environmental Management*, 321, 116027. <https://doi.org/10.1016/j.jenvman.2022.116027>
- Bibri, S. E., & Krogstie, J. (2020). Environmentally data-driven smart sustainable cities: Applied innovative solutions for energy efficiency, pollution reduction, and urban metabolism. *Energy Informatics*, 3(1), 29. <https://doi.org/10.1186/s42162-020-00130-8>
- Bolderdijk, J. W., Lehman, P. K., & Geller, E. S. (2018). Encouraging pro environmental behaviour with rewards and penalties. *Environmental psychology: An introduction*, 273-282. <https://doi.org/10.1002/9781119241072.ch27>
- Booth, K. M., Pinkston, M. M., & Poston, W. S. C. (2005). Obesity and the built environment. *Journal of the American Dietetic Association*, 105(5 Suppl 1), S110-117. <https://doi.org/10.1016/j.jada.2005.02.045>
- Boncu, Ş., Candell, O. S., & Popa, N. L. (2022). Gameful green: a systematic review on the use of serious computer games and gamified mobile apps to foster pro-environmental information, attitudes and behaviors. *Sustainability*, 14(16), 10400. <https://doi.org/10.3390/su141610400>
- Bulkeley, H., & Betsill, M. (2005). Rethinking sustainable cities: Multilevel governance and the ‘urban’ politics of climate change. *Environmental Politics*, 14(1), 42-63. <https://doi.org/10.1080/0964401042000310178>
- Caballero, L., Moreno, A. M., & Seffah, A. (2014). Persona as a tool to involving human in agile methods: contributions from HCI and marketing. In *Human-Centered Software Engineering: 5th IFIP WG 13.2 International Conference, HCSE 2014*, Paderborn, Germany, September 16-18, 2014. Proceedings 5 (pp. 283-290). Springer Berlin Heidelberg.
- Cafiso, S., Di Graziano, A., Marchetta, V., & Pappalardo, G. (2022). Urban road pavements monitoring and assessment using bike and e-scooter as probe vehicles. *Case Studies in Construction Materials*, 16, e00889. <https://doi.org/10.1016/j.cscm.2022.e00889>
- Carmen, E., Fazey, I., Bergseng, A. M., & Om, E. S. (2023). Building policy synergies: A case of community resilience, climate change and community empowerment policies in Scotland. *Environmental Science & Policy*, 150, 103579. <https://doi.org/10.1016/j.envsci.2023.103579>

- Card, A. J. (2017). The problem with '5 whys'. *BMJ Quality & Safety*, 26(8), 671-677. <https://doi.org/10.1136/bmjqs-2016-005849>
- Carrad, A., Aguirre-Bielschowsky, I., Reeve, B., Rose, N., & Charlton, K. (2022). Australian local government policies on creating a healthy, sustainable, and equitable food system: Analysis in New South Wales and Victoria. *Australian and New Zealand Journal of Public Health*, 46(3), 332-339. <https://doi.org/10.1111/1753-6405.13239>
- Chen, Y., Burton, T., Vorvoreanu, M., Whittinghill, D. (2015). Cogent: A Case Study of Meaningful Gamification in Education with Virtual Currency. *International Journal of Emerging Technologies in Learning (IJET)*, 10(1), 39-45. <https://doi.org/10.3991/ijet.v10i1.4247>
- Cohen, B., & Kietzmann, J. (2014). Ride on! Mobility business models for the sharing economy. *Organization & Environment*, 27(3), 279-296. <https://doi.org/10.1177/1086026614546199>
- Cooper, D. R., & Gutowski, T. G. (2017). The Environmental Impacts of Reuse: A Review. *Journal of Industrial Ecology*, 21(1), 38-56. <https://doi.org/10.1111/jiec.12388>
- de Jesus, A., Antunes, P., Santos, R., & Mendonça, S. (2019). Eco-innovation pathways to a circular economy: Envisioning priorities through a Delphi approach. *Journal of Cleaner Production*, 228, 1494-1513. <https://doi.org/10.1016/j.jclepro.2019.04.049>
- Dearden, A. & Kleine, D. (2021). Interdisciplinarity, self-governance and dialogue: the participatory process underpinning the minimum ethical standards for ICTD/ICT4D research. *Information Technology for Development*, 27(2), 361-380. <https://doi.org/10.1080/02681102.2020.1840321>
- Decker, E. H., Elliott, S., Smith, F. A., Blake, D. R., & Rowland, F. S. (2000). Energy and Material Flow Through the Urban Ecosystem. *Annual Review of Energy and the Environment*, 25(1), 685-740. <https://doi.org/10.1146/annurev.energy.25.1.685>
- Dini, P., & Kioupkiolis, A. (2014). *Community currencies as laboratories of institutional learning: emergence of governance through the mediation of social value*. Inaugural WINIR Conference, London, UK.
- Dooris, M. (2016). International perspectives on healthy settings: Critical reflections, innovations and new directions. *Global Health Promotion*, 23(1_suppl), 5-7. <https://doi.org/10.1177/1757975916637811>
- Duda, E. (2022). Building the Learning Environment for Sustainable Development: a Co-creation Approach. In J. Koskinen, K. K. Kimppa, O. Heimo, J. Naskali, S. Ponkala and M. M. Rantanen (Eds.). *Effectiveness of ICT ethics – How do we help*

- solve ethical problems in the field of ICT? Proceedings of the ETHICOMP 2022*, pp. 63-77.
- Duda, E. (2023). Exploring perceptions of pro-environmental educational mobile applications based on semantic field analysis. *AMCIS 2023 Proceedings*. 1. https://aisel.aisnet.org/amcis2023/sig_ccris/sig_ccris/1/
- Duda, E., Anacka, H., Kowal, J., & Obracht-Prondzyńska, H. (2022). Participatory co-design approach for Greencoin educational tool shaping urban green behaviors. *2022 International Conference on Advanced Learning Technologies (ICALT)*, 98–100. <https://doi.org/10.1109/ICALT55010.2022.00037>
- Duda, E., Anacka, H., Kowal, J., Nowakowska, I., & Obracht-Prondzyńska, H. (2023a). Technology-enhanced environmental learning: co-design of educational mobile. Application case. In *31st International Conference on Computers in Education. Asia-Pacific Society for Computers in Education*, Vol. 2 (pp. 967-969).
- Duda, E., Anacka, H., Kowal, J., Nowakowska, I., Obracht-Prondzyńska, H., Geirbo, H. C., Radziszewski, K., Romanowska, M., Wyciszewicz, A., & Zawieska, J. (2023b). Encouraging pro-environmental behaviour through an educational mobile application: Preliminary insights from early adopters. *International Journal of Pedagogy Innovation and New Technologies*, 10(1), 64-78. <https://doi.org/10.5604/01.3001.0053.9400>
- Duda, E., Anacka, H., Obracht-Prondzyńska, H., Geirbo, H. C., and Kowal, J. (2024). Enhancing environmental literacy through urban technology-based learning. The PULA app case. *AMCIS 2024 Proceedings*. 7. <https://aisel.aisnet.org/amcis2024/elevlife/elevlife/7>
- Evans, J., & Karvonen, A. (2010). Living laboratories for sustainability: exploring the politics and epistemology of urban transition. In H. Bulkeley, V. Castán Broto, M. Hodson, & S. Marvin (Eds.), *Cities and Low Carbon Transitions* (pp. 142-157). Routledge. <https://doi.org/10.4324/9780203839249>
- França, A. S. L., Neto, J. A., Gonçalves, R. F., & Almeida, C. M. V. B. (2020). Proposing the use of blockchain to improve the solid waste management in small municipalities. *Journal of Cleaner Production*, 244, 118529. <https://doi.org/10.1016/j.jclepro.2019.118529>
- Fuller, C. H., & Brugge, D. (2020). Chapter 20 – Environmental justice: Disproportionate impacts of transportation on vulnerable communities. In H. Khreis, M. Nieuwenhuijsen, J. Zietsman, & T. Ramani (Eds.), *Traffic-Related Air Pollution* (pp. 495–510). Elsevier. <https://doi.org/10.1016/B978-0-12-818122-5.00020-X>
- Gautam, M., & Agrawal, M. (2021). Greenhouse Gas Emissions from Municipal Solid Waste Management: A Review of Global Scenario. In *Environmental Footprints and Eco-Design of Products and Processes* (pp. 123–160). https://doi.org/10.1007/978-981-15-9577-6_5

- Gill, S. E., Handley, J. F., Ennos, A. R., & Pauleit, S. (2007). Adapting Cities for Climate Change: The Role of the Green Infrastructure. *Built Environment (1978-)*, 33(1), 115–133.
- Gravagnuolo, A., Angrisano, M., & Fusco Girard, L. (2019). Circular Economy Strategies in Eight Historic Port Cities: Criteria and Indicators Towards a Circular City Assessment Framework. *Sustainability*, 11(13), Article 13. <https://doi.org/10.3390/su11133512>
- Guang-Wen, Z., Murshed, M., Siddik, A. B., Alam, M. S., Balsalobre-Lorente, D., & Mahmood, H. (2023). Achieving the objectives of the 2030 sustainable development goals agenda: Causalities between economic growth, environmental sustainability, financial development, and renewable energy consumption. *Sustainable Development*, 31(2), 680–697. <https://doi.org/10.1002/sd.2411>
- Guerra, E., Caudillo, C., Monkkonen, P., & Montejano, J. (2018). Urban form, transit supply, and travel behavior in Latin America: Evidence from Mexico's 100 largest urban areas. *Transport Policy*, 69, 98–105. <https://doi.org/10.1016/j.tranpol.2018.06.001>
- Gurel, E., & Tat, M. (2017). SWOT Analysis: A Theoretical Review. *The Journal of International Social Research*, 10, 994-1006. <http://dx.doi.org/10.17719/jjsr.2017.1832>
- Hadavi, S. (2017). Direct and Indirect Effects of the Physical Aspects of the Environment on Mental Well-Being. *Environment and Behavior*, 49(10), 1071-1104. <https://doi.org/10.1177/0013916516679876>
- Handy, S. L., Boarnet, M. G., Ewing, R., & Killingsworth, R. E. (2002). How the built environment affects physical activity: Views from urban planning. *American Journal of Preventive Medicine*, 23(2, Supplement 1), 64–73. [https://doi.org/10.1016/S0749-3797\(02\)00475-0](https://doi.org/10.1016/S0749-3797(02)00475-0)
- Hargreaves, T. (2011). Practice-ing behaviour change: Applying social practice theory to pro-environmental behaviour change. *Journal of Consumer Culture*, 11(1), 79-99. <https://doi.org/10.1177/1469540510390500>
- Hartman, C. L., Hofman, P. S., & Stafford, E. R. (1999). Partnerships: a path to sustainability. *Business Strategy and the Environment*, 8(5), 255-266. [https://doi.org/10.1002/\(SICI\)1099-0836\(199909/10\)8:5%3C255::AID-BSE214%3E3.0.CO;2-O](https://doi.org/10.1002/(SICI)1099-0836(199909/10)8:5%3C255::AID-BSE214%3E3.0.CO;2-O)
- Hassold, S., & Ceder, A. (Avi). (2014). Public transport vehicle scheduling featuring multiple vehicle types. *Transportation Research Part B: Methodological*, 67, 129–143. <https://doi.org/10.1016/j.trb.2014.04.009>
- Heckert, M., & Kondo, M. (2018). Can “Cleaned and Greened” Lots Take on the Role of Public Greenspace? *Journal of Planning Education and Research*, 38(2), 211–221. <https://doi.org/10.1177/0739456X16688766>

- Holmgren, J. (2007). Meta-analysis of public transport demand. *Transportation Research Part A: Policy and Practice*, 41(10), 1021–1035. <https://doi.org/10.1016/j.tra.2007.06.003>
- Huber, D., Viere, T., Horschutz Nemoto, E., Jaroudi, I., Korbee, D., & Fournier, G. (2022). Climate and environmental impacts of automated minibuses in future public transportation. *Transportation Research Part D: Transport and Environment*, 102, 103160. <https://doi.org/10.1016/j.trd.2021.103160>
- Intergovernmental Panel on Climate Change. (2015). *Climate Change 2014: Mitigation of Climate Change: Working Group III Contribution to the IPCC Fifth Assessment Report*. Cambridge University Press. <https://doi.org/10.1017/CBO9781107415416>
- Joachain, H., & Klopfert, F. (2012). Emerging Trend of Complementary Currencies Systems as Policy Instrument for Environmental Purposes: Changes Ahead? *International Journal of Community Currency Research*, 16, 156–168.
- Jones, C., Hine, D. W., & Marks, A. D. (2017). The future is now: Reducing psychological distance to increase public engagement with climate change. *Risk Analysis*, 37(2), 331–341. <https://doi.org/10.1111/risa.12601>
- Kamrowska-Zafuska, D. (2021). Impact of AI-Based Tools and Urban Big Data Analytics on the Design and Planning of Cities. *Land*, 10, 1209. <https://doi.org/10.3390/land10111209>
- Khatibi, F. S., Dedekorkut-Howes, A., Howes, M., & Torabi, E. (2021). Can public awareness, knowledge and engagement improve climate change adaptation policies? *Discover Sustainability*, 2, 1–24. <https://doi.org/10.1007/s43621-021-00024-z>
- Kitchenham, B., & Brereton, P. (2013). A systematic review of systematic review process research in software engineering. *Information and Software Technology*, 55(12), 2049–2075. <https://doi.org/10.1016/j.infsof.2013.07.010>
- Klug, K., & Niemand, T. (2021). The lifestyle of sustainability: Testing a behavioral measure of precycling. *Journal of Cleaner Production*, 297, 126699. <https://doi.org/10.1016/j.jclepro.2021.126699>
- Kobize. (2015). *POLAND'S NATIONAL INVENTORY REPORT 2015*. https://www.kobize.pl/uploads/materialy/Inwentaryzacje_krajowe/2015/NIR_2015_POL.pdf
- Kollmuss, A., & Agyeman, J. (2002). Mind the gap: Why do people act environmentally and what are the barriers to pro-environmental behavior? *Environmental Education Research*, 8(3), 239–260. <https://doi.org/10.1080/13504620220145401>
- Kuntz, K., Shukla, R., & Bensch, I. (2012). How Many Points for That? A Game-Based Approach to Environmental Sustainability. In: *2012 ACEEE Summer Study on Energy Efficiency in Buildings*, 7, 126–137. ACEEE, Pacific Grove.
- Lakatos, E. S., Yong, G., Szilagyi, A., Clinci, D. S., Georgescu, L., Iticescu, C., & Cioca, L.-I. (2021). Conceptualizing Core Aspects on Circular Economy in Cities. *Sustainability*, 13(14), 7549. <https://doi.org/10.3390/su13147549>

- Lawhon, M. (2013). Situated, Networked Environmentalisms: A Case for Environmental Theory from the South: Situated, Networked Environmentalisms. *Geography Compass*, 7(2), 128–138. <https://doi.org/10.1111/gec3.12027>
- Livesley, S. J., McPherson, E. G., & Calfapietra, C. (2016). The Urban Forest and Ecosystem Services: Impacts on Urban Water, Heat, and Pollution Cycles at the Tree, Street, and City Scale. *Journal of Environmental Quality*, 45(1), 119–124. <https://doi.org/10.2134/jeq2015.11.0567>
- Marin, J., & De Meulder, B. (2018). Interpreting Circularity. Circular City Representations Concealing Transition Drivers. *Sustainability*, 10(5), 1310. <https://doi.org/10.3390/su10051310>
- Marshall, A. P., & O'Neill, D. W. (2018). The Bristol Pound: A tool for localisation?. *Ecological Economics*, 146, 273–281. <https://doi.org/10.1016/j.ecolecon.2017.11.002>
- Márquez, L., Macea, L. F., & Soto, J. J. (2019). Willingness to change car use to commute to the UPTC main campus, Colombia: A hybrid discrete choice modeling approach. *Journal of Transport and Land Use*, 12(1), 335–353. <https://doi.org/10.5198/jtlu.2019.1460>
- Mateescu, C., & Popa, I. (2017). European best practices and policies in promoting green mobility. *EEA – Electrotehnica, Electronica, Automatica*, 65(4), 12–16. http://eea-journal.ro/ro/2017/art-2017_4-02-p012.pdf.
- Mattocks, N., Meyer, M., Hopkins, K. M., & Cohen-Callow, A. (2019). Clean and green organizing in urban neighborhoods: Measuring perceived and objective outcomes. *Journal of Community Practice*, 27(3–4), 351–368. <https://doi.org/10.1080/10705422.2019.1657538>
- Mendoza, J. M. F., Gallego-Schmid, A., & Azapagic, A. (2019). A methodological framework for the implementation of circular economy thinking in higher education institutions: Towards sustainable campus management. *Journal of Cleaner Production*, 226. <https://doi.org/10.1016/j.jclepro.2019.04.060>
- Merz, J. J., Barnard, P., Rees, W. E., Smith, D., Maroni, M., Rhodes, C. J., Dederer, J. H., Bajaj, N., Joy, M. K., Wiedmann, T., & Sutherland, R. (2023). World scientists' warning: The behavioural crisis driving ecological overshoot. *Science Progress*, 106(3), 00368504231201372. <https://doi.org/10.1177/00368504231201372>
- Miller, L. B., Rice, R. E., Gustafson, A., & Goldberg, M. H. (2022). Relationships Among Environmental Attitudes, Environmental Efficacy, and Pro-Environmental Behaviors Across and Within 11 Countries. *Environment and Behavior*, 54(7–8), 1063–1096. <https://doi.org/10.1177/00139165221131002>
- Moktadir, M. A., Rahman, T., Rahman, M. H., Ali, S. M., & Paul, S. K. (2018). Drivers to sustainable manufacturing practices and circular economy: A perspective of leather industries in Bangladesh. *Journal of Cleaner Production*, 174, 1366–1380. <https://doi.org/10.1016/j.jclepro.2017.11.063>

- Mueller, N., Rojas-Rueda, D., Salmon, M., Martinez, D., Ambros, A., Brand, C., de Nazelle, A., Dons, E., Gaupp-Berghausen, M., Gerike, R., Götschi, T., Iacorossi, F., Int Panis, L., Kahlmeier, S., Raser, E., & Nieuwenhuijsen, M. (2018). Health impact assessment of cycling network expansions in European cities. *Preventive Medicine, 109*, 62–70. <https://doi.org/10.1016/j.ypmed.2017.12.011>
- Mulalic, I., & Rouwendal, J. (2020). Does improving public transport decrease car ownership? Evidence from a residential sorting model for the Copenhagen metropolitan area. *Regional Science and Urban Economics, 83*, 103543. <https://doi.org/10.1016/j.regsciurbeco.2020.103543>
- Mulley, C., Ma, L., Clifton, G., Yen, B., & Burke, M. (2016). Residential property value impacts of proximity to transport infrastructure: An investigation of bus rapid transit and heavy rail networks in Brisbane, Australia. *Journal of Transport Geography, 54*, 41–52. <https://doi.org/10.1016/j.jtrangeo.2016.05.010>
- Munoz-Raskin, R. (2010). Walking accessibility to bus rapid transit: Does it affect property values? The case of Bogotá, Colombia. *Transport Policy, 17*(2), 72–84. <https://doi.org/10.1016/j.tranpol.2009.11.002>
- Nesheli, M. M., & Ceder, A. (Avi), Ghavamirad, F., & Thacker, S. (2017). Environmental impacts of public transport systems using real-time control method. *Transportation Research Part D: Transport and Environment, 51*, 216–226. <https://doi.org/10.1016/j.trd.2016.12.006>
- Nielsen, T. S., & Hansen, K. B. (2007). Do green areas affect health? Results from a Danish survey on the use of green areas and health indicators. *Health & Place, 13*(4), 839–850. <https://doi.org/10.1016/j.healthplace.2007.02.001>
- Niemegeers, J. (2009). *'Zet Milieu Op de Kaart' een gemeentelijk boloningssysteem. Infobrochure*. Bond Beter Leefmilieu: Overpelt, Belgium.
- Norman, D. A. (2013). *The design of everyday things: Revised and expanded edition*. Basic Books.
- Norton, B. A., Coutts, A. M., Livesley, S. J., Harris, R. J., Hunter, A. M., & Williams, N. S. G. (2015). Planning for cooler cities: A framework to prioritise green infrastructure to mitigate high temperatures in urban landscapes. *Landscape and Urban Planning, 134*, 127–138. <https://doi.org/10.1016/j.landurbplan.2014.10.018>
- Novaglio, C., Bax, N., Boschetti, F., Emad, G. R., Frusher, S., Fullbrook, L., Hemer, M., Jennings, S., van Putten, I., Robinson, L. M., Spain, E., Vince, J., Voyer, M., Wood, G., & Fulton, E. A. (2022). Deep aspirations: Towards a sustainable offshore Blue Economy. *Reviews in Fish Biology and Fisheries, 32*(1), 209–230. <https://doi.org/10.1007/s11160-020-09628-6>
- Obracht-Prondzyńska, H., Anacka, H., Duda, E., Radziszewski, K., Wereszko, K., & Kowal, J. (2021). Greencoin – educational information system for eco-inclusion

- and empowering urban adaptability. *GlobDev 2021*, 1. <https://aisel.aisnet.org/globdev2021/1>
- Obracht-Prondzyńska, H., Duda, E., Anacka, H., & Kowal, J. (2022). Greencoin as an AI-Based Solution Shaping Climate Awareness. *International Journal of Environmental Research and Public Health*, 19(18), 11183. <https://doi.org/10.3390/ijerph191811183>
- Obracht-Prondzyńska, H., Radziszewski, K., Anacka, H., Duda, E., Walnik, M., Wereszko, K., & Geirbo, H. C. (2023). Codesigned digital tools for social engagement in climate change mitigation. *Sustainability*, 15(24), 16760. <https://doi.org/10.3390/su152416760>
- OECD. (2019). *Going Digital: Shaping Policies, Improving Lives*. OECD. <https://doi.org/10.1787/9789264312012-en>
- Ölander, F., & Thøgersen, J. (2014). Informing versus nudging in environmental policy. *Journal of Consumer Policy*, 37, 341-356. <https://doi.org/10.1007/s10603-014-9256-2>
- Osterwalder, A., Pigneur, Y., Bernarda, G., & Smith, A. (2015). *Value proposition design: How to create products and services customers want*. John Wiley & Sons. ISBN: 978-1-118-96805-5
- Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., ... & Moher, D. (2021). The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. *BMJ*, 372. <https://doi.org/10.1136/bmj.n71>
- Palanivel, T. (2017). *Rapid urbanisation: opportunities and challenges to improve the well-being of societies*. Human Development Report Office, United Nations Development Programme.
- Paneru, C. P., & Tarigan, A. K. (2023). Reviewing the impacts of smart energy applications on energy behaviours in Norwegian households. *Renewable and Sustainable Energy Reviews*, 183, 113511. <https://doi.org/10.1016/j.rser.2023.113511>
- Patton, M. Q. (2023). *Qualitative research & evaluation methods: Integrating theory and practice*. Sage publications.
- Piwowar-Sulej, K., & Kołodziej, I. (2022). Organizational practices promoting employees' pro-environmental behaviors in a Visegrad Group country: How much does company ownership matter? *Plos One*, 17(2), e0261547. <https://doi.org/10.1371/journal.pone.0261547>
- Prasetyo, W. H., Kamarudin, K. R., & Dewantara, J. A. (2019). Surabaya green and clean: Protecting urban environment through civic engagement community. *Journal of Human Behavior in the Social Environment*, 29(8), 997-1014. <https://doi.org/10.1080/10911359.2019.1642821>
- Prati, G., Albanesi, C., & Pietrantoni, L. (2017). The interplay among environmental attitudes, pro-environmental behavior, social identity, and pro-environmental

- institutional climate. A longitudinal study. *Environmental Education Research*, 23(2), 176–191. <https://doi.org/10.1080/13504622.2015.1118752>
- Przywojska, J., Podgórnica-Krzykacz, A., & Wiktorowicz, J. (2019). Perceptions of Priority Policy Areas and Interventions for Urban Sustainability in Polish Municipalities: Can Polish Cities Become Smart, Inclusive and Green? *Sustainability*, 11(14), 3962. <https://doi.org/10.3390/su11143962>
- Puska, P., Vartiainen, E., Nissinen, A., Laatikainen, T., & Jousilahti, P. (2016). Background, Principles, Implementation, and General Experiences of the North Karelia Project. *Global Heart*, 11(2), 173-178. <https://doi.org/10.1016/j.ghheart.2016.04.010>
- Qastharin, A. R. (2016). Business model canvas for social enterprise. *Journal of Business and Economics*, 7(4), 627-637.
- Rabiee, F. (2004). Focus-group interview and data analysis. *Proceedings of the nutrition society*, 63(4), 655-660. <https://doi.org/10.1079/PNS2004399>
- Ramyar, R., Saeedi, S., Bryant, M., Davatgar, A., & Mortaz Hedjri, G. (2020). Ecosystem services mapping for green infrastructure planning—The case of Tehran. *Science of The Total Environment*, 703, 135466. <https://doi.org/10.1016/j.scitotenv.2019.135466>
- Raymond, C. M., Frantzeskaki, N., Kabisch, N., Berry, P., Breil, M., Nita, M. R., Geneletti, D., & Calfapietra, C. (2017). A framework for assessing and implementing the co-benefits of nature-based solutions in urban areas. *Environmental Science & Policy*, 77, 15–24. <https://doi.org/10.1016/j.envsci.2017.07.008>
- Redman, L., Friman, M., Gärling, T., & Hartig, T. (2013). Quality attributes of public transport that attract car users: A research review. *Transport Policy*, 25, 119–127. <https://doi.org/10.1016/j.tranpol.2012.11.005>
- Reed, M. S. (2008). Stakeholder participation for environmental management: a literature review. *Biological Conservation*, 141(10), 2417-2431. <https://doi.org/10.1016/j.biocon.2008.07.014>
- Robbins, S., Judge, T. A., Millett, B., & Boyle, M. (2013). *Organisational behaviour*. Pearson Higher Education AU.
- Rogers, E. M., Singhal, A., & Quinlan, M. M. (2014). Diffusion of innovations. In D. W. Stacks, M. B. Salwen, & K. C. Eichhorn (Eds.), *An integrated approach to communication theory and research* (pp. 432-448). Routledge.
- Rogers, E. M. (2003). *Diffusion of innovations* (5th ed.). New York: Free Press.
- Rosenbaum, M. S., Otalora, M. L., & Ramírez, G. C. (2017). How to create a realistic customer journey map. *Business horizons*, 60(1), 143-150. <https://doi.org/10.1016/j.bushor.2016.09.010>
- Salvador Costa, M. J., Leitão, A., Silva, R., Monteiro, V., & Melo, P. (2022). Climate change prevention through community actions and empowerment: a scoping

- review. *International Journal of Environmental Research and Public Health*, 19(22), 14645. <https://doi.org/10.3390/ijerph192214645>
- Sanecka, J., Barthel, S., & Colding, J. (2020). Countryside within the City: A Motivating Vision behind Civic Green Area Stewardship in Warsaw, Poland. *Sustainability*, 12(6), 2313. <https://doi.org/10.3390/su12062313>
- Sanesi, G., Laforzezza, R., Bonnes, M., & Carrus, G. (2006). Comparison of two different approaches for assessing the psychological and social dimensions of green spaces. *Urban Forestry & Urban Greening*, 5(3), 121–129. <https://doi.org/10.1016/j.ufug.2006.06.001>
- Šauer, M., Vystoupil, J., Novotná, M., & Widawski, K. (2021). Central European Tourist Flows: Intraregional Patterns and Their Implications. *Moravian Geographical Reports*, 29(4), 278–291. <https://doi.org/10.2478/mgr-2021-0020>
- Sauer, P. C., Silva, M. E., & Schleper, M. C. (2022). Supply chains' sustainability trajectories and resilience: A learning perspective in turbulent environments. *International Journal of Operations & Production Management*, 42(8), 1109–1145. <https://doi.org/10.1108/IJOPM-12-2021-0759>
- Schildermans, H., Vandenabeele, J., & Vlieghe, J. (2019). Prácticas de estudio y la creación de un mundo en común. Desvelando las dinámicas educativas de una iniciativa de agricultura urbana. *Teoría De La Educación. Revista Interuniversitaria*, 31, 87-108.
- Shen, H., & Liu, Y. (2022). Can Circular Economy Legislation Promote Pollution Reduction? Evidence from Urban Mining Pilot Cities in China. *Sustainability*, 14(22), 14700. <https://doi.org/10.3390/su142214700>
- Simsekoglu, O., & Klockner, C. (2019). Factors related to the intention to buy an e-bike: A survey study from Norway. *Transportation Research Part F-Traffic Psychology and Behaviour*, 60, 573–581. <https://doi.org/10.1016/j.trf.2018.11.008>
- Steg, L., Bolderdijk, J. W., Keizer, K., & Perlaviciute, G. (2014). An Integrated Framework for Encouraging Pro-environmental Behaviour: The role of values, situational factors and goals. *Journal of Environmental Psychology*, 38, 104–115. <https://doi.org/10.1016/j.jenvp.2014.01.002>
- Temper, L., Walter, M., Rodriguez, I., Kothari, A., & Turhan, E. (2018). A perspective on radical transformations to sustainability: Resistances, movements and alternatives. *Sustainability Science*, 13(3), 747–764. <https://doi.org/10.1007/s11625-018-0543-8>
- Thomas, R., Hsu, A., & Weinfurter, A. (2021). Sustainable and inclusive – Evaluating urban sustainability indicators' suitability for measuring progress towards SDG-11. *Environment and Planning B: Urban Analytics and City Science*, 48(8), 2346–2362. <https://doi.org/10.1177/2399808320975404>

- Toşa, C., Karaczun, Z. M., Zawieska, J., Paneru, C. P., Bojanowski, J., Joudavi, A., & Tarigan, A. K. M. (2024). Unlocking rewards for sustainability: a framework for valuing pro-environmental behaviors in Polish cities. *Sustainability: Science, Practice and Policy*, 20(1). <https://doi.org/10.1080/15487733.2024.2382381>
- Toşa, C., Paneru, C. P., Joudavi, A., & Tarigan, A. K. (2024). Digital transformation, incentives, and pro-environmental behaviour: Assessing the uptake of sustainability in companies' transition towards circular economy. *Sustainable Production and Consumption*, 47, 632-643. <https://doi.org/10.1016/j.spc.2024.04.032>
- Transport Publiczny. (2022). *Ponad 700 elektrycznych autobusów w Polsce*. <https://www.transport-publiczny.pl/wiadomosci/ponad-700-elektrycznych-autobusow-w-polsce-73582.html>
- Uryga, D., Duda, E., Geirbo, H. C., & Romanowska, M. (2024). Two crises. Constructing the meaning of the “climate crisis” by the residents of Gdańsk. *Political Geography*.
- UIC. (2022). *External costs*. <https://uic.org/support-activities/economics/article/external-costs>
- Vaccari, M., Bella, V. D., Vitali, F., & Collivignarelli, C. (2013). From mixed to separate collection of solid waste: Benefits for the town of Zavidovići (Bosnia and Herzegovina). *Waste Management*, 33(2), 277–286. <https://doi.org/10.1016/j.wasman.2012.09.012>
- Walton, D., & Sunseri, S. (2010). Factors Influencing the Decision to Drive or Walk Short Distances to Public Transport Facilities. *International Journal of Sustainable Transportation*, 4(4), 212–226. <https://doi.org/10.1080/15568310902927040>
- Weiskopf, S. R., Rubenstein, M. A., Crozier, L. G., Gaichas, S., Griffis, R., Halofsky, J. E., ... & Whyte, K. P. (2020). Climate change effects on biodiversity, ecosystems, ecosystem services, and natural resource management in the United States. *Science of the Total Environment*, 733, 137782. <https://doi.org/10.1016/j.scitotenv.2020.137782>
- Wohldmann, E. L., Chen, Y., Schwarz, K., Day, S. D., Pouyat, R. V., Barton, M., & Gonez, M. (2022). Building soil by building community: How can an interdisciplinary approach better support community needs and urban resilience? *Frontiers in Sustainable Cities*, 4, 941635. <https://doi.org/10.3389/frsc.2022.941635>
- Yeo, J. Y. J., How, B. S., Teng, S. Y., Leong, W. D., Ng, W. P. Q., Lim, C. H., Ngan, S. L., Sunarso, J., & Lam, H. L. (2020). Synthesis of Sustainable Circular Economy in Palm Oil Industry Using Graph-Theoretic Method. *Sustainability*, 12(19), Article 19. <https://doi.org/10.3389/frsc.2022.941635>
- Yigitcanlar, T., Kankanamge, N., & Vella, K. (2021). How Are Smart City Concepts and Technologies Perceived and Utilized? A Systematic Geo-Twitter Analysis of

- Smart Cities in Australia. *Journal of Urban Technology*, 28(1–2), 135–154. <https://doi.org/10.1080/10630732.2020.1753483>
- Yu, C., & Hien, W. N. (2006). Thermal benefits of city parks. *Energy and Buildings*, 38(2), 105–120. <https://doi.org/10.1016/j.enbuild.2005.04.003>
- Zafra-Calvo, N., Balvanera, P., Pascual, U., Merçon, J., Martín-López, B., van Noordwijk, M., Mwampamba, T. H., Lele, S., Ifejika Speranza, C., Arias-Arévalo, P., Cabrol, D., Cáceres, D. M., O'Farrell, P., Subramanian, S. M., Devy, S., Krishnan, S., Carmenta, R., Guibrinet, L., Kraus-Elsin, Y., ... Díaz, S. (2020). Plural valuation of nature for equity and sustainability: Insights from the Global South. *Global Environmental Change*, 63, 102115. <https://doi.org/10.1016/j.gloenvcha.2020.102115>
- Zawieska, J., Obracht-Prondzyńska, H., Duda, E., Uryga, D., & Romanowska, M. (2022). In search of the innovative digital solutions enhancing social pro-environmental engagement. *Energies*, 15(14), 5191. <https://doi.org/10.3390/en15145191>
- Zhang, Y., Liu, H., Kang, S. C., & Al-Hussein, M. (2020). Virtual reality applications for the built environment: Research trends and opportunities. *Automation in Construction*, 118, 103311. <https://doi.org/10.1016/j.autcon.2020.103311>
- Zhang, Z., Xiong, K., Chang, H., Zhang, W., & Huang, D. (2022). A Review of Eco-Product Value Realization and Ecological Civilization and Its Enlightenment to Karst Protected Areas. *International Journal of Environmental Research and Public Health*, 19(10), 5892. <https://doi.org/10.3390/ijerph19105892>
- Zulkepeli, L., Fauzi, M. A., Mohd Suki, N., Ahmad, M. H., Wider, W., & Rahamadulla, S. R. (2024). Pro-environmental behavior and the theory of planned behavior: a state of the art science mapping. *Management of Environmental Quality*, 35(6), 1415-1433. <https://doi.org/10.1108/MEQ-10-2023-0361>

Figures

Figure 1. Initial Greencoin Team, formed during the IdeaLab workshops in March 2020 12

Figure 2. Tasks and community that make up the Greencoin project environment 15

Figure 3. Algorithm of information system (IS) as a basis for research format. Source: Obracht-Prondzyńska et al. (2021, p. 4) 20

Figure 4. PULA screenshot. Source: Duda et al. (2023b, p. 68) 21

Figure 5. Research design: steps, contributors, methods, aims, and deliverables. Authors' own elaboration, firstly presented in (Obracht-Prondzyńska et al., 2023, p. 5) 31

Figure 6. Workshop conducted in Gdańsk. Photo by Monika Krzemińska . . . 38

Figure 7. Determining environmental challenges and possible solutions during a workshop in Gdańsk. Photo by Monika Krzemińska . . . 39

Figure 8. Structure of conducted workshops 41

Figure 9. Value propositions depending on the types of stakeholders 54

Figure 10. Diagram showing the research approach adopted. Authors' elaboration 57

Figure 11. Quantification framework for pro-environmental actions	71
Figure 12. Methodological framework for rewards assessment	72
Figure 13. Assessment of product sustainability	74
Figure 14. Screen shot of the PULA app’s user interface	79
Figure 15. The screen shot of the PULA app’s Quizzes section	80
Figure 16. The screen shot of the PULA app’s Actions section	81
Figure 17. The print screen of the PULA app’s Tracking progress section . . .	82
Figure 18. Screen shot of the PULA app’s Account management section . . .	83
Figure 19. The screen shot of the PULA app’s social functions section	84
Figure 20. The screen shot of the PULA app’s Content management section	84
Figure 21. The screen shot of the PULA app’s Partners’ map section	85
Figure 22. Screenshot of the content presented at the stakeholder meeting; the PULA pilot project timeline	99
Figure 23. Screenshot of the content presented at the stakeholder meeting; overview of strategic and local partners in pilot project	100
Figure 24. Promotion material from the activity More Water! (photo: Marcin Zdziuch/ The Montaż)	104
Figure 25. Promotion material from the activity building houses for hedgehogs (photo by Marcin Zdziuch / The Montaż)	106
Figure 26. Promotion of PULA during Celebrations of the Architectural Department at Gdańsk University of Technology (photo: Inicjatywa Miasto)	108
Figure 27. Closed phase in numbers	110
Figure 28. Open phase in numbers	111
Figure 29. Value propositions depending on types of residents	117

Tables

Table 1.	List of projects analysed in the research process	34
Table 2.	Value Proposition	50
Table 3.	Final list of selected pro-environmental actions adopted	66
Table 4.	Assessment of monetary value for Good Coins	75
Table 5.	Development opportunities	91
Table 6.	Examples of the users' messages	94

Biographical notes

Ewa Duda is an Assistant Professor at the Institute of Education, Maria Grzegorzewska University. Her academic background is in Social Sciences, while her professional background is in Mathematics and Environmental Engineering. Her research interests are focused on pro-environmental education, specifically on how ICT technology can support educational interventions to promote environmentally friendly behaviour. In the project, she was responsible for leading the research work package 6, which addressed the evaluation, improvement, up-scaling and dissemination of project results.

Helena Anacka is a PhD candidate in Economics since 2015, associated with the Faculty of Management and Economics at Gdańsk University of Technology (Poland). She co-authors several academic publications and conference proceedings, e.g. 'Digitalization Process and Its Impact on Economic Growth: A Panel Data Study for Developing Countries' (Routledge, 2022); 'Network effects—do they matter for digital technologies diffusion?' (Emerald, 2023); 'Digitalization and digital skills development patterns. Evidence for European countries' (Routledge, 2023). Her research interests concentrate on the ICT, economic development, digitalisation, and digital skills. In the project,

she was responsible for works on both quantitative and qualitative research, conceptual analysis support, research results formulation support, pilot study support and analysis, final conclusions formulation support.

Jakub Bojanowski graduated in environmental protection at the Warsaw University of Technology and is currently writing a PhD on the adaptation of small and medium-sized cities to climate change at the Warsaw University of Life Sciences. Additionally, he completed postgraduate studies in the functioning of European structures and studied ecology at the Universidade de Coimbra as part of the Erasmus+ programme. In the project, he was involved in the comparison, assessment and selection of behaviours, activities and rewards within the Greecoin project in relation to their impact on the natural environment and the development of values and a point flow model of the system within the project. His tasks also included the analysis and development of data regarding the functioning of the GC system in the context of pro-environmental activities, as well as the evaluation of the designed model and its summary and update based on the pilot project.

Hanne Cecilie Geirbo is an Associate Professor at the Department of Computer Science, Oslo Metropolitan University. She has an interdisciplinary background in information systems and social anthropology and a professional background in the telecom industry. She is interested in the role of digital systems in everyday life and how the design of such systems could contribute to increasing environmental and social sustainability. In the project, she was responsible for user insight (work package 2).

Ayda Joudavi is a PhD candidate at the University of Stavanger, focusing on sustainable urban development. In the project, she contributed to the literature review on pro-environmental behaviour, specifically cycling for commuting, and reported on the results.

Zbigniew M. Karaczun is a Professor at the Department of Environmental Protection and Dendrology, Warsaw University of Life Sciences. He conducts research in climate and environmental policy, the integration of their goals into agricultural policy and economic development strategies, and the Europeanisation of Polish environmental policy and environmental protection management. In the project, he was responsible for identifying, assessing,

and valuing ecosystem services generated by activities supported by Green-coin system.

Jolanta Kowal, PhD and DSc. in social sciences, economics, and finance (2020), is a Professor at the University of Wrocław and Gdańsk University of Technology, Poland. A certified Jungian analyst (IAAP) and coach (ICF), she serves as VP for Research at SIG GLOBDEV in AIS. Prof. Kowal has authored over 140 papers on economic psychology, socio-economic methodology, and multicultural influences of psychoanalysis, receiving funding from prestigious institutions. She is also a reviewer and editor for renowned journals such as *Information Technology for Development* and *Management Information Systems* and has co-organised international conferences like AMCIS and ICTM. In the project, she was responsible for reporting results, and publication writing.

Igor Niemczyk is a first-year PhD student in economics at the Faculty of Management and Economics at Gdańsk University of Technology. He previously completed his bachelor's and master's degrees in management at the same faculty. In the project, he was responsible for the section connected to the description of the cooperation process with stakeholders, including both partners and users.

Iwona Nowakowska is a psychologist (2019), PhD in Social Sciences (2022) and graduate of Data Science in Business Applications (2023). Currently she works as an Assistant Professor at the Maria Grzegorzewska University Institute of Psychology. Holder of grants from the National Science Centre, Poland, Polish National Agency for Academic Exchange, and Polish Social Psychological Society. She realised her postdoctoral internship at the Catholic University of the Sacred Heart in Brescia (Italy; 2023-2024). She is a researcher of prosocial behaviours, volunteering, and philanthropy, as well as pro-environmental engagement in the context of individual differences and motivations. She is a member of organisations such as e.g. International Society for Third-Sector Research, International Society for the Study of Individual Differences, and the Polish Social Psychological Society. In the project, she was responsible for co-planning and co-conducting the research on the usage and educational value of the Greencoin application and the motivations to engage in pro-environmental behaviours among the dwellers of the Tricity.

Hanna Obracht-Prondzyńska, PhD MArch Eng., urban designer and urban data scientist with an international experience both academic and practice oriented, Assistant Professor and principal investigator at the University of Gdańsk, Department of Spatial Studies, visiting scholar including Delft University of Technology, TEDx speaker. She specialises in data driven design, urban big data for urban perception and climate positive planning. She has received 13 awards for her work, including two by the Polish Ministry in urban planning and geoinformation, and from the Polish Academy of Sciences. She is recognised as an outstanding young scientist by the Ministry of Science – active member and coordinator at the International Society for City and Regional Planners. In the project, she was responsible for delivering data driven research outputs for PULA design.

Chandra Prakash Paneru is a PhD student at the University of Stavanger. He has a background in civil engineering and sustainable city development. His project is to review the literature on pro-environmental behaviour, particularly energy use behaviour, and results reporting.

Iga Perzyna is an architectural historian working in heritage conservation, architecture, and urban development. She is the vice-chairman of Stowarzyszenie Inicjatywa Miasto and the director of African Architecture Matters. Together with Inicjatywa Miasto she has been working on multiple projects related to participatory urban planning and revitalisation of urban spaces. These include community consultations realised within the programme Gdańsk Design Workshops [Gdańskie Warsztaty Projektowe] where she was responsible for research, workshop development and facilitation. She also collaborates with the Gdańsk City Architect Office on the project *ARCH-ETHICS. Dissonant European heritage as labs of democracy*, funded through EU URBACT programme. In the project she was responsible for research, community outreach and stakeholder involvement. In the project, she worked as part of the team responsible for developing and implementing the application pilot project.

Jana Pieriegud, PhD, is a transport economist with a background in railway engineering, economics and management. She has twenty-five years of experience in R&D&I, market intelligence analysis, and strategic consultancy for entrepreneurs and public administration. She is a Professor at the Institute of

Infrastructure, Transport and Mobility, SGH Warsaw School of Economics. As an independent expert in the areas of transport, infrastructure, logistics, mobility and digitalisation, she works for several institutions and executive agencies for innovation and research in Poland and abroad, including the European Research Executive Agency (REA) and the Climate, Infrastructure and Environment Executive Agency (CINEA) at the European Commission. She is an author and co-editor of a few papers, monographs, and reports on network industries, digitalisation, intermodal transport, new transport systems, and mobility concepts. In the project, she was responsible for managing the work of the SGH team (October 2023 – April 2024) and summarising the project results on transport functionality.

Małgorzata Romanowska is an urban activist and independent researcher. Graduate of Interdepartmental Studies in Mathematics and Natural Sciences at the University of Warsaw, UX Design student at SWPS University in Sopot. Scientifically interested in the relationship between sound and landscape in the city. Professionally, she has experience in both private research and development institutions as well as the third sector. She cooperates with NGOs such as the City Initiative Association, Pro Humanum Association, FILM FORUM Association, and Foundation for Intangible Cultural Heritage. She worked at the Multicultural Centre in Warsaw for the benefit of intercultural integration and cultural education. In the project, she worked as part of the team responsible for developing and implementing the application pilot project.

Ari Tarigan is an Associate Professor at the University of Stavanger, Norway, specialising in urban infrastructure and transportation planning. He led the model quantification work package, PhD supervision, postdoc mentoring, reporting results, and publication writing in the project.

Cristian Toşa is a postdoc at the University of Stavanger, where he focuses on the relationship between human activities and the built environment. In the project, he conducted a literature review and PhD co-supervision and contributed to developing the methodological framework for measuring pro-environmental behaviour.

Danuta Uryga is an Associate Professor at the Institute of Education at the Maria Grzegorzewska University (until 2019 in the Department of Educational Policy, currently in the Department of Social Foundations of Educational Development). She received her doctoral degree in philosophy from the Faculty of Philosophy, Jagiellonian University (2002); her postdoctoral degree in social sciences in the field of pedagogy from the Faculty of Pedagogical Sciences, Maria Grzegorzewska University (2014). Her areas of research activity are: public education, socialisation in education, educational policy of local government, grassroots change of the public school model, grassroots (parental) socio-educational initiatives, parental activism for LGBTQ people. In the project, she was involved in user insight research.

Aleksandra Wyciszkievicz is a PhD student and researcher at the Warsaw School of Economics. She is an IT business analyst and UX/UI specialist who works on business processes and digital products. Her research focuses on innovation implementation, innovation management, innovation capacity development, and the study of digital technologies in the context of learning and crisis management. In the project, she was responsible for developing and testing the application and building communication with project stakeholders.

Iceland
Liechtenstein
Norway grants



Republic
of Poland



NCBR

National Centre for Research
and Development

The presented monograph outlines the course of the Greecoin project activities and their outcomes. Due to the distinct nature of each task and the fact that they were coordinated by the various partners, who bring their own unique perspectives to the table, they are presented in the monograph in a way that reflects this diversity. This approach aims to demonstrate the project's inherent complexity, which is multi-stage and non-linear, with project tasks occurring concurrently over time. It also considers the diverse theoretical assumptions and perspectives, as well as the project team members' respective modes of action and tools. Conducting interdisciplinary research in large, often international teams involving people from outside the scientific community is essential if we want to solve environmental problems together, as the climate crisis is not a one-dimensional phenomenon.

ISBN: 978-83-67721-53-0



9 788367 721530