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Greencoin: a Proenvironmental Action-Reward System

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Abstract

The massive destruction of the natural environment is rapidly eroding the world's capacity to provide food and water, threatening the security of billions of people. In order to facilitate green lifestyles – understood in terms of both pro-environmental behaviors and green self-image on the one hand, and to build sustainable local and global communities, on the other, we put forward an idea of a novel action-reward system based on an application solution, namely Greencoin. In this paper, the framework of the pilot system, underpinning its earnings and value, is introduced. The novelty of the Greencoin system is in introducing an application adjusted to the local needs, that is, based on gamification and aims at encouraging, facilitating and rewarding citizens who undertake pro-environmental actions. In this context, we have formulated and answered two research questions, namely: what practical pro-environmental activities an individual can practice and evidence, as well as what rewards can be offered to an individual for performing such activities in the Greencoin application. To explore these topics, we adopted the literature review (along with the content analysis) method as the methodology for the research. The results concern a broad and multifaceted review of the literature on individual pro-environmental behavior through multiple disciplinary and subject-matter lenses, outlining the corresponding system of rewarding its participants (citizens) with non-monetary and monetary benefits that are to be used in the Greencoin pilot. The study contributes to the topic of smart cities, in particular digital and mobile eco-innovations, resulting in significant progress toward the goal of sustainable development by promoting and facilitating a more efficient and responsible use of natural resources.

Keywords: Digital Eco-Innovation, Smart City, Sustainable Development, Pro-environmental behavior, Ecological Behavior.

Introduction

Undoubtedly, both individuals and organizations worldwide are looking for ways to go green, and for good reason. It is not just a good-looking fashion, on the contrary, the greatest threat to global security is climate change, and it is not merely an environmental problem (Parry 2021). For years, under-appreciating evidences have been neglected, exposing both animals and humans to an unprecedented level of insecurity (Solheim and Swing 2018). Being in line with Klenert et al. 2020, a more holistic and timely approach, as visible during the SARS-CoV-2 crisis, is essential to mitigate the consequences of climate change, because delay indeed comes at a high price while inequalities, lack of transparency and coordination could limit the effects of policy actions (Klenert et al. 2020). Shaping our future requires both governments and individuals to act immediately. But still, one question arises in the mind of people that are really aware of this ongoing and deepening crisis: what can I do to stop it?

Today, on the other hand, we are facing a digital transformation, driven by emerging technologies such as artificial intelligence (Magistretti et al. 2019; Owoc and Weichbroth 2017), the Internet of Things (Orłowski et al. 2020), 5G (Ejaz et al. 2016) and many others. In general, modern information and communication technologies (ICTs) are able to mitigate, monitor and adapt to the impacts of climate change. The examples in this area cover the full range of systems and tools. For instance, NASA's Earth Observing System (EOS) is a set of satellites designed to monitor and better understand key components of the climate system and their interactions over an extended period (Space 2018). Other examples concern solutions devoted to reducing greenhouse gas emissions (Haines et al. 2009), water and waste management (Avellán et al. 2017), and energy efficiency optimization (Griego et al. 2015). Nevertheless, individual actions are essential for solving the climate crisis.

The road toward the green transition includes daily decisions that any individual can make, including flying and driving less, using public transportation, changing to a plant-based diet, conserving water and energy, and other green-oriented actions (Wynes and Nicholas 2017). But still, Gore and Rotter (1963) argue that "people expect reward in a large variety of situations" which should not be surprising, if one simply considers the impact of social media channels (Spartz et al. 2017), along with the proliferation of mobile devices (Schäfer and Painter 2021). To the best of our knowledge, the problem of promoting, evidencing and rewarding a green life style has not been thoroughly undertaken yet. Therefore, to fill this gap, in this study the following research questions were addressed:

- What pro-environmental activities can an individual practice and evidence using a mobile device?
- What rewards can be offered to an individual for the evidenced pro-environmental activities?

These questions are in principle difficult to respond to precisely, due to the wide variety of aspects which play a role in determining an individual's pro-environmental behavior. Therefore, we adopted the literature review method, and in this we followed the guidelines elaborated by Synder (2019). To identify relevant sources, we identified each time a combination of keywords was used that correspond to the particular topic. We used both Google and Google Scholar, as well as academic research databases such as: ACM, IEEE Xplore, Scopus and Web of Science, as the primary data sources. There were no restrictions defined, however only documents written in English were the subject of analysis. The reliability and quality assessments of the search results were based on the Author credibility and number of document citations, respectively. Next, a detailed analysis concerning the content validity was performed, considering the defined research questions.

The rest of the paper is structured as follows. Section 2 outlines the background and motivation of the study. Section 3 outlines the framework, describing both actions and rewards. Section 4 discusses the significance and relevance of the results. Section 5 concludes the results and briefly specifies the future work directions.

Background and Motivation

One of the major challenges of our time listed by the United Nations (2021) is climate change. Global in scope and unprecedented in scale, it has caused more frequent wildfires, increased the duration and intensity of tropical storms, accelerated sea level rise, caused longer, more intense heat waves, lengthened periods of drought in some regions and increased their number (NASA 2021), just to name a few. In October 2018, the Intergovernmental Panel on Climate Change (IPCC), which includes more than 1,300 scientists from the United States and other countries, issued a special report on the impacts of global warming of 1.5°C, revealing that limiting global warming to 1.5°C would require far-reaching, rapid, and unprecedented changes in all aspects of society (IPCC 2018). Moreover, the World Health Organization (WHO) argues that climate change affects the social and environmental determinants of health such as clean air, safe drinking water, sufficient food and secure shelter, estimating the direct cost to be between USD 2–4 billion/year by 2030 and points out that "reducing emissions of greenhouse gases through better transport, food and energy-use choices can result in improved health, particularly through reduced air pollution" (World Health Organization 2018).

By definition, a carbon footprint is the total amount of greenhouse gases (including carbon dioxide and methane) that are generated directly and indirectly by an individual, event, organization or product expressed as mainly CO2 emissions (Zhang and Xu 2015), in a fixed period of time (typically per year) (Liu et al. 2019). In 2018, Qatar had the highest emissions at 31.3 tonnes (t) per capita, followed by Kuwait (21.2t),

and the United Arab Emirates (20t) (Statista 2021). However, many of the major carbon producers have a relatively small population meaning their total annual emissions are relatively low. The more populous countries with the highest emissions per person, and therefore the top five countries, representing over 58 percent global carbon emissions are China (10.06 gigatons,Gt) the United States (5.41Gt), India (2.65Gt), the Russian Federation (1.71Gt), and Japan (1.16Gt) (ucsusa.org 2020). However, in 2020, the coronavirus pandemic is claimed to be a major reason for a 'record fall' of 2.4Gt CO2 emissions, in comparison with 2019, and will eventually clock in at 34 bn tonnes of CO2 worldwide (carbonbrief.org 2020).

The results of a special Eurobarometer 2017 opinion poll show that nearly 75 percent of EU citizens now see climate change as a very serious problem, while almost 80 percent believe that fighting climate change and using energy more efficiently will bring economic benefits. These expectations have been taken into account by the European Commission that put forward a specific issue under further consideration of the Green Deal call, being a part of the Horizon 2020 work programme, namely: "*It is essential to directly involve citizens and communities in contributing to climate action and protecting the environment, thereby encouraging them to change their personal behaviour, reducing their carbon and environmental footprint and taking action at the individual and collective level*" (European Commission 2018).

In response to this call, in this paper, we introduce and discuss the results obtained from a pilot study, carried out as part of the **Greencoin** project. Its primary objective is to develop an effective tool to promote pro-environmental behaviors and improve pro-environment awareness among citizens, by introducing a reward system and a marketplace mechanism, in which urban citizens can exchange their earned rewards for environmentally friendly products and services offered by the government, as well as organizations from the public and the private sector.

The Greencoin Framework: an Individual Action-Reward System

Nowadays, the common practice is to design and develop large, complex software systems in cooperation with their end-users (Weichbroth 2018). However, at this early stage of the Greencoin project, we collected the initial set of functional requirements during in-person and online brainstorming sessions which were subsequently organized and synthesized by the team. Eventually, the requirements were divided among two groups, the first of which includes individual pro-environmental actions, while the second corresponds to the system of their rewarding.

An Individual Pro-environmental Behavior

The determinants of individual behaviors that provide shared environmental benefits are a longstanding topic in not only the social science studies. Aside from the reasons, which may encompass economic, moral and rational factors, we provide a set of actions which one can take to downsize their carbon footprint, and which an individual can freely practice. According to Glinski 2017, ecological political movements in Poland are rather weak in terms of influence on legislation, overall coordination and widespread support, still, their professionalism and popularity have increased over time. While often steering clear of political battles, non-governmental pro-ecological organizations and movements in Poland are based on bottom-up initiatives and arise from the 'energy' and needs on the ground (Glinski 2017), which shows the huge potential of participating in such initiatives, for example by becoming involved in ecological collective actions, such as singing petitions, participating in pro-environmental demonstrations, emailing politicians, etc.

Reduce water usage. A person can reduce water usage by using Smart Home automation systems. According to Li (2013), installation of home automation elements and systems for energy and water management is both economical and ecological. These solutions save energy and reduce bills by using off-peak hours and switching-on equipment only when needed, e.g. when in use or when the temperature in the room drops or rises above the designated level. Another way of reducing water usage is identifying water leaks and fixing leaking taps. Magiera and Froelich (2014) maintain that among the multiple water saving methods are those related to "no sacrifice in behavioral change" (for example, the habit of turning off the tap while washing the dishes and hands, shaving and brushing teeth), or related to "limited personal sacrifice" (for example, using a toilet half-flush, reducing the flushing amount and turning off the tap when soaping).

Consider near-sourcing. Van Buren *et al.* (2016) claim that 'near-sourcing' – a strategy to relocate and adapt processes and suppliers, reuse, repair, recover materials and equipment while bringing all of that closer to the end-users – is progressively moving forward. According to the authors, the circular economy generates higher employment in the "eco-industry" – innovative and technological industry based on circular chains of production and consumption in environmentally protected areas. On the other hand, Perry *et al.* (2014) points out that because of rising outsourcing and shipping costs as well as the negative environmental and social impact, the European fashion industry is paying more attention to ecological sustainability and corporate social responsibility and is considering near-sourcing materials and products closer to end-users in the European Union.

Install renewables. Despite the fact that a household renewables installation could generate higher capital costs, it could save energy, money and the environment in the long run. According to Caird et al. (2008), UK users of the main household renewables, such as solar thermal water heating, micro-wind turbines, and solar photovoltaics, stated that they archived their goals to save the environment, energy and money, despite some adverse effects related to the higher installation costs. An additional source of renewable energy could come from geothermal energy installations. However, in spite of various grants and more than a hundred of such renewables being installed in Germany alone, the high costs and regulatory shortcomings have contributed to a decrease in the number of new installations in the last decade (Weber et al. 2015). Another source of renewable energy is a heat pump, which is more affordable, thereby a more popular renewable among individual households. According to Lillemo et al. 2013, Norwegian households that are concerned about energy costs are likely to install air-to-air heat pumps. Another piece of research on heat pumps in 185 Danish summerhouses and dwellings shows that a 20 percent expected reduction in energy consumption transforms into a change in heating behaviors with longer heating periods and a higher on average temperature level which increased the overall comfort of the examined households (Gram-Hanssen et al. 2012).

Reduce, reuse, recycle. There are many different ways to reduce, reuse and recycle: for example, an individual can give a preference to a product with less or no packaging, or made of recyclable materials. Ferrara and Missios (2016) advocate more such actions, for example, it is more environmentally friendly to repair things instead of throwing them away, use packages, such as bottles or containers, several times and borrow or donate things. Moreover, responsible consumer choices are important, e.g, giving preference to items with "recyclable product" or "environmentally friendly" labels. In addition, long warranty products, reusable items and a "buy only what you need" consumer policy are preferable in order to reduce the carbon footprint. The results of a qualitative study by Hoek *et al.* (2017) show that consumers are in favour of buying less packaged food containing fewer chemicals, followed by support for a reduction of over-consumption and food waste behaviors.

Give preference to eco-friendly and public transportation. Another example of perceptible ecological and economical behavior is to choose eco-friendly means of transportation and public transport instead of private cars. According to Saleem et al. (2018), "highly CO2-emitting oil-based fuels" constitute about 95 percent of transport energy, whereas passenger cars alone produce 44.5 percent of the whole transport emissions. Based on research by Shaheen and Lipman (2007) on mobility management policies, road pricing policies and car-sharing have the biggest carbon dioxide reduction potential. Additionally, integrated regional smart cards, parking cash out, carpooling, park-and-ride facilities and smart growth policies contribute to the reduction of CO2, according to the authors.

Use energy more efficiently. Since the 1970s when the increase in the oil price occurred, the level of energy consumption per capita has significantly decreased, stabilizing over the years. From the 2000s, households' energy consumption embarked on a downward trend in the region of Europe and North America due to technological developments in energy efficiency (Looney 2020). This trend is tenable by upgrading the electricity energy production infrastructures via intelligent automation, following the principles of the Internet of Energy concept (Shahzad et al. 2020). An individual can implement a similar concept of efficient energy use through the application of Internet of Things (IoT) solutions (Atzori et al. 2017) – a network of devices embedded with sensors and software. By applying various types of sensors, a user can gain insight into their household energy consumption patterns and significantly reduce the usage by extending the IoT network by the implementation of intelligent devices which automatically adjust the light intensity (Jeyasheeli

and Selva 2017) and heat supply (Zakharov et al. 2019).

Reduce food waste and support food banks. Per capita food wasted by costumers in Europe and North America reaches a 115kg/year, while globally nearly one third of food produced is wasted (Gustavsson et al. 2011). For this reason, food waste has become a growing topic among NGOs, national policy-makers, international organizations and academics in recent years. Food waste occurs during different stages of a food supply chain, but private households are responsible for major waste generation (Schanes et al. 2018). While consumers are generally aware of the food waste they produce, personal economic arguments elicit stronger motivation to change a behavior than environmental concerns (Graham-Rowe et al. 2015). In order to change consumers' behavior, the use of technology is unidentified as a possible tool for consumer waste reduction. This can be achieved by redistribution of the surplus food via online platforms or groceries management apps and software.

Get involved in the local budget and community pro-ecological projects. Van der Jagt *et al.* (2017) focus on European communal urban gardening, which is gaining in popularity across the EU and is promoted in the Global North. While the local needs, support of municipal authorities, social capital and financing opportunities differ significantly across different EU member states, communal urban gardening has real potential in community-based ecological solutions adjusted to local urban needs and challenges. The researcher also points out differences in the availability of local leaders engaging in community-building and the accessibility of 'local food champions', however, for a success story across the EU, both adequate support of the municipal authorities and community involvement in the municipal initiatives and political activities are essential (Jagt et al. 2017).

Plant local plants to reduce water and fertilizer use. Cultivation of local plants native to the area could reduce the amount of water and pesticides or fertilizers used, preserve the area from soil and groundwater contamination and support local wildlife and pollinators. According to Tallamy (2009), gardening could bring a series of benefits, e.g. outdoor exercise is good for the health, gardening brings aesthetic benefits to the house, garden and community, it supports the nation's wildlife and "makes a difference" in terms of the preservation of native plants and future biodiversity. The research results of Pardee and Philpott (2014) demonstrate a positive correlation between the richness of the bee population and local attributes of backyard gardens. Among other things, the authors stay that planting native plants in the garden plays an important role in preserving the diversity of the bee population in urban ecosystems. Moreover, the model results of Daniels and Kirkpatrick (2006) demonstrate that variation of garden characteristics substantially affect the characteristics of garden bird assemblages in suburbia, giving gardeners an important role in the preservation of 'urban native avifauna'.

A Reward System

Undeniably, rewards shape human actions (Vassiliadis and Derosiere 2020). In order to engage users in Greencoin and maintain their regular involvement, a set of methods based on rewards systems will be applied. Encouraging pro-environmental behavior has been argued as a critical factor to create sustainable and inclusive cities. Climate morality – the moral obligation to reduce one's negative impact on the environment – can significantly affect people's motivations and choices (Söderberg 2020). Having said that, below, we have formulated and described a set of non-monetary and monetary example rewards.

Social connection reward. Interacting with a peers in a harmonious relationship and being with other people are a fundamental social behavior. Praise and attention during a social connection activates the forebrain's ventral striatum, a part of the reward system resulting in positive feelings (Izuma et al. 2008). In contrast, a lack of social connection can lead to lowering the self-esteem and put the person at health risk, which can be compared to smoking (House et al. 1988). It is important to mention social media rewards, which are based on public feedback, where users engage in social comparison (Meshi et al. 2015).

Social-recognition reward. One of the key components in reward systems is social-recognition, which makes a customer or a user realize what activities and actions are widely approved within a given set of norms (Reno et al. 1993) and motivates the users (Bandura et al. 1999). According to goal-framing theory, strategies focusing on normative aspects of social behavior are more effective than strategies focused on the materialistic aspects (Lindenberg and Steg 2007). Interestingly enough, when people were asked to rate the

factors which might influence their energy consumption, they estimated that social rewards would be the least effective factor in shaping their behavior, while the study shows otherwise (Nolan et al. 2008).

Another study shows that social rewards can be more attractive for users to change their environmental behaviors than financial rewards. During the study, 83 employees from 5 different departments of a Dutch environmental consultancy company were monitored based on their energy consumption for 13 weeks. During that time, each week the participants received "Personal Energy Savings" detailing their energy consumption. Participants were divided into four groups: financial reward (both private and public) and social-recognition reward (both private and public). The results show that public social rewards were the most effective, resulting in the highest energy conservation among the participants (Handgraaf et al. 2011).

Competition through gamification. Multiple studies demonstrate that gamification can be an effective tool to offer citizens direct and positive experiences with a product and to change their behaviors to utilize such a product in the future. Gamification makes a reward program more attractive for users, bringing a successful impact to the marketing of the product and is likely to cause people to enjoy altruistic benefits because they are motivated to use such benefits for the satisfaction of the activity itself, not only for direct benefits (Hwang and Choi 2019). On the other hand, another type of rewards concerns monetary rewards. There is a plethora of evidence showing that such incentives are powerful motivator (Aguinis et al. 2013), sparking and maintaining healthy competition between participants with respect to their performance and productivity.

Cash rewards. In order to keep the customers or users repeatedly engaged in a service, loyalty-based programs are developed. Companies are developing loyalty programs, often based on cash rewards, because it is less expensive to keep customers than to attract a new ones (Reichheld and Schefter 2000). The Greencoin system will have similarities to cash-back rewards programs, as it combines products and services of multiple companies. In such a program, a user can earn points by purchasing products at any company, and spend them on services or purchases from a different one, leading to post-opportunistic behavior and low firm-specific customer loyalty.

Bonuses. Apart from a reward system, it is planned to apply Greencoin bonuses, a compensation above the normal payment expectation. Bonuses might be awarded to both entry-level users and to senior-level users in order to stimulate a high level of activity. There is evidence suggesting that bonuses for spontaneous user actions show a particularly high positive effect (Venkatesan and Farris 2012). Additionally, it has been proven that coupon and bonus campaigns which were customized to consumer preferences based on their profile and activities history demonstrate higher performance.

Discussion

Motivation and public engagement are important factors to promote pro-environmental behaviors. Motivation is often triggered by monetary-related incentives such as money, points or discounts, therefore, people tend to repeat the same actions over the long term, motivated by such a reason. Moreover, the motivation to contribute to making an environmentally positive impact can be first influenced by monetary incentives, but after a long series of activities accompanied by positive and pleasant feelings, people could develop repetitive behaviors (Fujii and Kitamura 2003). This argument is also reported in marketing research, revealing that consumers can transform into loyal users when they obtain positive experiences with the product purchase (Beck et al. 2015).

The prepared study concerns a proposal of a system rewarding residents for pro-ecological behavior. The article does not describe the existing systems using elements of gamification in order to protect the environment, involving groups of residents. The analysis of existing or completed pro-environmental initiatives will help in the development of appropriate models and the use of some functionalities in the designed system (Morganti et al. 2017). In addition, an important element that requires in-depth analysis is social currencies, which are developed for the needs of the local community, often with the aim of improving the social situation and reducing the negative effects of the local economy on the natural environment (Seyfang and Longhurst 2013). With regard to the theory of games and user reward systems, an analysis of the methods and elements of gamification should be carried out, which, in relation to the activities and rewards men-

tioned, will enable the achievement of the project's goal in the best possible way. It should also be noted that the above set of pro-ecological activities and methods of rewarding users is the first set of functionalities that will be adequately expanded and analyzed during further research on the system. Moreover, a model of actions, values and rewards will be developed in the form of a mobile application. Such mobile or web app-based systems are used worldwide, encouraging the users to change their behavior in a pro-environmental direction in the field of transportation (Jylhä et al. 2013; Meloni and Sanjust 2015), household energy saving (Geelen et al. 2012; Wemyss et al. 2016) and water saving (Koroleva and Novak 2020).

The further research will cover three areas: action-reward model, social feasibility and technological feasibility of the system. Firstly, a set of actions should be selected, influencing the users not only to maintain their pro-environmental behaviors, but to form new ones. The set of environmental actions will be valued based on its carbon footprint (Druckman and Jackson 2016) and focus group research by application of 'Willingness to pay' methods (Breidert et al. 2015). Additionally, the actions and rewards should maintain the users' engagement. Apart from actions with direct environmental impact, the rewards value model should take into consideration methods for creating long-term user loyalty. Secondly, a study on the social structure of the pilot city of Gdańsk will be performed in order to design the model in accordance with the target user groups. Lastly, the system architecture will be developed, which will involve analysis of the selected set of pro-environmental actions in regard to the technological possibility of their verification and recording.

Conclusions

The above literature review presents a collection of individual pro-ecological activities, on the one hand, and corresponding rewards, on the other. There is a visible trend of using methods related to game theory in order to activate societies in relation to sustainable development, healthy society or building new interpersonal relationships (Valetto et al. 2015). Modern technological development in such areas as mobile applications, social media, the Internet of Things, and machine learning, allow the development of new type of digital tools, facilitating and promoting pro-ecological behavior. An important element of the work on the Greencoin project will be the selection of instruments and prizes adapted to a diverse group of individuals, both in terms of age, occupation and attitude to pro-ecological activities. An important factor for the success of the project will be cooperation with the city council and municipal companies related to waste segregation, transport and infrastructure. Additionally, active cooperation with business organizations is planned in order to engage in ongoing, critical dialogue around the Greencoin initiative. However, for us the most important aspect is to attract the attention of the residents to our initiative, regarding their collaboration and engagement in further application development and promotion. Here, an effective communication channel is not the only one that we must considered. The development of the application, in addition to a set of methods for assessing pro-ecological activities and the reward system, will also require an appropriate understanding of the citizens' motivation and developing a model of the value of individual activities in terms of their impact on sustainable development.

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