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Co-De|GT: The Gamification and Tokenisation of More-Than-Human Qualities and Values

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Abstract: The article explores how the quality of life within a deprived urban environment might be improved through the 'gamification' of and interaction with, more-than-human elements within the environment. It argues that such quality may be achieved through the community's multicentered value from the bottom up. This is shown through the case study of the Co-De|GT urban mobile application that was developed in the Synergetic Landscapes unit through real-life research by design experimental studio teaching. Complimentary experimentation took place during the Relating Systems Thinking and Design 10 symposium in the Co-De|BP workshop, where experts were able to be collocated for interactive real-time data gathering. This application addresses the need for collective action towards more-than-human synergy across an urban ecosystem through gamification, community collaboration and DIY culture. It intends to generate a sustainable, scalable token economy where humans and non-humans play equal roles, earning, trading and being paid for goods and services to test such potentials for future economies underpinned by blockchain. This work diverges from dominant economic models that do not recognise the performance of and the limits to, material extraction from the ecosystem. The current economic model has led to the global financial crisis (GFC). Furthermore, it is based on the unsustainable perpetual consumption of services and goods, which may lead to the untangling and critical failure of the market system globally. Therefore, this work investigates how gamification and tokenization may support a complementary and parallel economic market that sustains and grows urban ecosystems. While the research does not speculate on policy implications, it posits how such markets may ameliorate some of the brittleness apparent in the global economic model. It demonstrates a systemic approach to urban ecosystem performance for the future post-Anthropocene communities and economies.

Keywords: gamification; urban ecosystem; DIY; token economy; blockchain; systemic design; systemic approach to architectural performance; urban design; interaction design; prototypical urban interventions

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1. Introduction

This article extends Co-De|GT Beta [1] that demonstrated work in progress on the discussed mobile application presented at the Relating Systems Thinking and Design 10 Symposium [2] where it was also expanded during the Co-De|BP workshop [3]. This article introduces the finalised prototype. Co-De|GT addresses several areas of the European Green Deal, such as Sustainable Industry, Building and Renovation, Farm to Fork, Pollution Elimination, Biodiversity and Sustainable Finance [4]. From a broad perspective, this project refers to the New European Bauhaus that aims at beautiful, sustainable and inclusive forms of living [5]. It also addresses several United Nations Sustainable Development Goals, such as Zero Hunger [6], Good Health and Wellbeing [7], Industry, Innovation and Infrastructure [8], Sustainable Cities and Communities [9], Responsible Consumption and Production [10], Climate Action [11] and Life on Land [12]. Smart city initiatives are often led by engineering, construction, consultancy and technology companies that influence the city's decision making toward solutions that may be disconnected from the specific needs, priorities and context of the city. This has sometimes led to a greater concern for economic growth and technology innovation than for environmental sustainability or social impacts and could create more harm to the environment and society. However, innovation should also be directed to environmental sustainability and inclusion [13]. The United Nations (UN) system is keen on leveraging new technologies to optimise its daily operations and accelerate its work and efforts to achieve the Sustainable Development Goals (SDGs). The benefits of increased computational power and advancements in technologies such as blockchain, the Internet of Things (IoT), Artificial Intelligence (AI), amongst others—whose roots were traditionally deep in the private sector—are now being utilised more frequently in the humanitarian, development and public sectors for the advancement of human welfare. To this end, the UN has provided a framework to leverage new technologies as outlined in the Secretary General's Strategy on New Technologies [14]. Blockchain technology as a foundational form of innovation is among the most trending technologies attracting more interest for future urban development initiatives and smart sustainable city efforts. The public sector and more specifically public service, are where blockchain could have the most impact [13]. There is a current rise in discussions related to the use of information and communications technology (ICT) when dealing with urban ecosystems in sustainable smart cities [15]. This paper aims to address these challenges.

1.1. General Objectives

Spotswood et al. in their review point out that several species benefit more from urban than other environments. Although some do not, this may be attributed to suboptimal adaptions necessary for their survival [16]. This situation needs to be reflected by architects and urban designers that engage with the urban environment and its connectivity, habitats and edible landscapes. However, such parameters are related to larger complex socio-technical and economic systems. The recent independent review on the economics of biodiversity ordered by the British Government written by Dasgupta points to the clear dependency of the economy and ecosystems [17]. For example, we clearly cannot harvest vegetables without plants and pollinators or wood building materials without trees and forests. This needs to be reflected in our economic models that should integrate more-than-human stakeholders, which is a phenomenon that has already begun to emerge in the 21st century. A coffee machine can have a blockchain wallet and be programmed to make autonomous decisions and purchases [18] or an object such as a river can obtain legal personhood and be afforded the rights of a human being [19]. The two years of the annual Synergetic Landscapes unit have related several dependencies within an urban complexity, such as the human and non-human communities, circular economy, token economy, material techniques, natural materials and biocorridors for edible and habitable landscape for all [20] through gamification. At its initial stage, a discussion on how such edible and habitable cross-species landscapes can be tokenised and provide agency within an economic system using blockchain technology was started [21]. In its second year, these relations were integrated into a Co-De|GT mobile application prototype for the Grangetown community of Cardiff, Wales, UK. The work is integrated within a larger Grangetown-focused Community Gateway project [22] managed by Cardiff University. Today, the area is home to generations of Welsh and Welsh Somali, Bangladeshi, African/Caribbean, Pakistani, Indian, European, British and multi-ethnic Welsh-language communities, constituting Wales' most ethnically diverse electoral ward. Containing super-output areas ranked within the 10% most deprived areas overall in the Welsh Index of Multiple Deprivation, Grangetown addresses key challenges in the areas of poverty and health through well-established Church, Mosque, Temple, public sector, third sector and voluntary networks [22–24]. However, Grangetown is also laying on an important biocorridor connecting Bute Park and Cardiff

Bay through the river Taff. However, biodiversity is lower in Grangetown than in other connecting locations due to urbanisation. Therefore, this project aims to work with the Grangetown community to give the mentioned human and non-human stakeholders a voice and to build a system of quality values from the bottom up through a gamified mobile application that introduces a more-than-human economy. The hypothesis is that such systemic intervention might improve the quality of life of both the human and the non-human stakeholders.

1.2. Quality and Value

The search for a universal definition of quality has yielded inconsistent results. Such a global definition does not exist; rather, different definitions of quality are appropriate under different circumstances [25]. System Integrity, justice and quality of life are key dimensions to sustainability [26]. Interestingly, most investigators proceed with their assessment tasks, essentially ignoring the concerns of those who question whether quality-of-life can be assessed. Yet, the degree of frustration in defining quality-of-life is palpable, even among quality-of-life researchers. There seems to be no a priori criteria that can be used to decide whether a particular operational definition is adequate on not. As a result, an operational definition is initially a subjective statement whose creditability rests on being able to replicate the operations and duplicate the initial findings [27]. The challenge is to safeguard and reconcile requirements of environmental sustainability, technical functionality and social quality, such as quality of life and the user-friendliness of buildings, especially against the background of climate change, environmental crises and a growing world population [28].

The built environment is particularly problematic regarding the quantification of quality. In the first instance, many measures of 'quality' have been historically quantified through male perceptions, Including things such as environmental comfort and safety [29]. Although this has been recognised for some time, it continues to be a problem. Research shows that basing a building's environmental requirements only on the male metabolic rate may mean they could be 'intrinsically non-energy-efficient in providing comfort to females' [30]. Thus, even within the human species, the idea of 'quality' is contested and environments privilege certain stakeholders and disadvantage others. This bias is even more pronounced when we consider how our environments disadvantage other-than-human species. Increasingly, a lack of biodiversity is being recognised as potentially catastrophic for humanity [31].

Extending this discussion, there is increasing evidence that access to a variety of environments is good for the human species. For example, research shows that green areas reduce the effects of urban heat islands [32,33]; and that access to both green and blue spaces—spaces that have a view of the water—increase a feeling of wellbeing [34]. However, the value of multi-species and more-than-human environments lacks the compelling well-being 'value' that has been established with green and blue spaces. Even where the value of green space is recognised, the relationship between it and the built environment is often seen as a zero-sum game. In the economics of the modern neo-liberal city, green space is preventing the full market monetisation of the city space.

It is with this problem in mind that our research attempts to speculate how green spaces, what we might term as more-than-human infrastructure, might be included within the value framework of the built environment instead of existing in opposition to it. The application we discuss here is the first step in the gamification of this problem and represents an attempt to find a solution. Specifically, our research explores how the concepts of gamification might be used to create a trading ecology to include and thus increase, the value and quantity of other-than-human spaces and infrastructure.

In Co-De | GT, we explore how the quality of life in urban environments can be appreciated by the community from the bottom up by assigning values to different living agents' performances via eco-socio-technological systems for social and environmental justice. Quality of life can be viewed as a subjective, multidimensional concept that places emphasis on the self-perception of an individual's current state [35]. Therefore, this research applies a multi-centred perspective to it through gamification and tokenisation. Different community actors can assign value through tokens to what they perceive as quality. As the result integrates multiple perspectives, individual parameters are considered within this holistic model of urban gaming.

In a similar way to quality, value is a subjectivist notion related to perceived needs and preferences [36]. However, some findings have indicated that some people view their values as explicit, stable and universally applicable guidelines in their life, while others see them as contradictory, changing and highly subjective [37]. Both perspectives need to be taken into consideration. Therefore, this model addresses 'time-based design' [38] that constantly coevolves across multiple stakeholders (users) in real-time and real-life environments, within the 'real-life codesign laboratory' [39,40]. This laboratory cocreates a prototype of a new economic model of Post-Anthropocene where different kinds of living beings have a wallet and can operate with it.

1.3. Gamification and Tokenisation

Climate change and biodiversity loss are closely related as one is causing the other [41,42]. There is an urgent need for effective ways to engage diverse audiences on global climate change. The complexity of climate change overwhelms diverse and geographically disconnected individuals preventing them from creating a meaningful impact on the overall health of the planet. Climate change is a complex challenge where a significant positive change in the environment requires a collective and synergistic action towards improving biodiversity at local levels.

In '*Reality is Broken*' McGonigal demonstrates how gaming concepts can be successfully applied to complex global problems [43]. She unpacks the gaming concepts that result in communities collaborating on complex multi-dimensional problems in multiple time zones. Players devote more time per week to this type of collaborative gaming than to their paid employment. The global reach of these platforms means communities can engage in the game and challenges 24 h a day. McGonigal later uses these concepts to design a game around the problem of globally depleting oil supplies. In the case study, a community not only codesigns a series of challenges that the world will face, but they also collaborate on solving these problems to achieve the goal of a better world without oil. Climate change games may offer the tools necessary to address these challenges [44]. The use of smartphones for leisure activities has widened the game-playing population spectrum while introducing new genres labelled as 'social gaming' (games with an emphasis on social interactions, usually with friends) and 'casual gaming' (games designed to be played without needing special skills or strong player commitment, in contrast to 'hardcore games') [45].

Gamification is the use of game design elements in nongame contexts. Its goal is to afford the motivating, enjoyable experiences characteristic of gameplay in nongaming contexts. Challenge, motivation and enjoyment are critical to that. These are systemic, emergent properties [46]. The research presented here broadens this discourse, applying the concepts of gamification to the challenge of creating a more inclusive 'more-than-human' multi-species urban environment. It also advances McGonigal's work by developing a prototype technology application that will be necessary to scale adoption. Emulating online digital gaming platforms, it speculates on a technology infrastructure that will be necessary to enable a global community to address the challenges of the Anthropocene.

Co-De|GT is a hybrid model, combining 'puppet master/player' and personas and direct user interaction. Puppet masters are described by McGonigal as modes when game designers send exact tasks to the player without decisive options [47]. To join Co-De|GT, the new player must perform the DIY recipe and by doing that they gain tokens. However, there are always options for player interpretation [47]. Just at the moment, the player gains enough tokens, they can become a puppet master, giving tasks to the others. This sort of hybrid mode has no winners and losers. It is not necessarily that a persona represents one user; some practitioners create a persona based on a mash-up of users. They extract characteristics from different people and aggregate them into one persona [48]. In Co-De|GT, users can play for themselves or take the persona of other living beings. In the application prototype, we classified five types of living creatures as mash-up personas. When assigning the task, the user also assigns a value to the personas.

Turning to tokenisation, blockchain has emerged over the last decade as a technology underpinning a speculative new type of digital currency, bitcoin. It is also a financial system that exploits some of the automation afforded by computer systems [49]. There have been well documented and publicised problems with this system, which have included fraud and illicit dark web marketplaces for anonymous trading in drugs [50]. Perhaps most concerning is its energy consumption. Despite this, blockchain and the experimental currency bitcoin continue to be used; fortunately, more energy-efficient variants are emerging. Accordingly, in this research, we focus on the underlying technology and opportunities blockchain represents for a more socially just economic model. In terms of Gartner's 'hype cycle,' we appear, however, to have surpassed both the inflated expectation and disillusionment phase of the perception of blockchain. We may be approaching enlightenment in—if not yet being productive with—blockchain technology. This is not a baseless supposition. Recently, conservative organizations have been exploring and using it. For example, the World Food Programme has adopted it to underpin a system that expedites financial assistance to refugees citing a saving of up to 98% of fees compared with traditional banking and associated fees [51].

The World Economic Forum has speculated that this ability to reduce fees and red tape combined with the possibility of new types of community currency and tokenization will improve access to communities deprived of access to financial systems which is estimated by the world bank to be approximately 30% of the global adult population [52]. A study of blockchain and other distributed ledger technologies in the humanitarian sector has concluded that although transparency and trust are the most cited significant benefits of the technology, other benefits such as 'improved efficiency, bureaucracy and project cost savings' are important for humanitarian actors [14]. In summary, this research not only explores initiatives for an 'other-than-human' environment, but it also speculates on the development of a technology that explores the uses of gamification and emerging technology such as blockchain to scale those initiatives globally to the scale required in the Anthropocene.

2. Methodology

2.1. Systemic Approach to Architectural Performance

The work is grounded in the Systemic Approach to Architectural Performance methodology (SAAP). SAAP is a fusion of several process-based fields and their media and agency, namely: (a) systems oriented design; (b) performance-oriented architecture; (c) prototypical urban interventions; (d) Time-based design; (e) Service design; and (f) Co-design, cocreation and DIY [40]. SAAP combines codesign through gigamapping (see Figures 1 and 2 and prototyping (see Figure 3) and such relations can be found within larger complex systems [53] (see Figure 2). It is part of the systems oriented design (SOD) [54]. SOD integrates tools of 'gigamapping' and 'rich design research space' (RDRS). Gigamapping is a typically collaborative visual diagramming of complexity, bringing on board multiple perspectives for 'codesigning'. 'Codesign' in this article is discussed as cocreation where the stakeholders play a creative and active role within the design process as coauthors [55]. A similar notion to this is often known as 'participatory design' within the digital development community [55]. This appears in the RDRS that offers information, media and stakeholder richness [56]. In this case, the RDRS is represented through a 'real-life codesign laboratory' which is a non-reductionist laboratory where the design is tested, developed and redesigned through real-life interaction in feedback loops in real-life environments [39,40]. Into this laboratory, 'prototypical urban interventions' are placed that were invented by CHORA [57]. These perform as 'leverage points' [58]. Leverage point interventions have been evaluated as a key strategy in the transformation towards sustainability as reductionist strategies mainly fail due to the complexity of the real world [59,60]. The methodology deals with and synergises the 'prototypical urban interventions' through physical object prototypes and their DIY recipes (see Figure 4), the virtual prototypes such as mobile applications.and public events that promote the prototypes for their DIY reproduction [61]. The DIY reproduction for supporting urban biodiversity has been also discussed by the London-based group 'Rewild my Street' through architectural drawings [62]. However, this project is bringing a systemic perspective to this concept. The important part of SAAP is that the analogue-built full-scale prototypical interventions that are placed in the real-life environment are marked with QR codes which lead to the application with their DIY recipes. Therefore, the interventions are generative objects to increase the impact of the project and themselves. The gamified token mobile application relates and supports social and environmental systems through technology, engaging low-tech DIY recipes to be built from resources that are available in nature. This way, there is no need for initial investments when joining the system by replicating the DIY recipes, thus gaining the tokens. This is critical for handling social and environmental justice from the bottom up, specifically when we discuss deprived communities with low incomes.

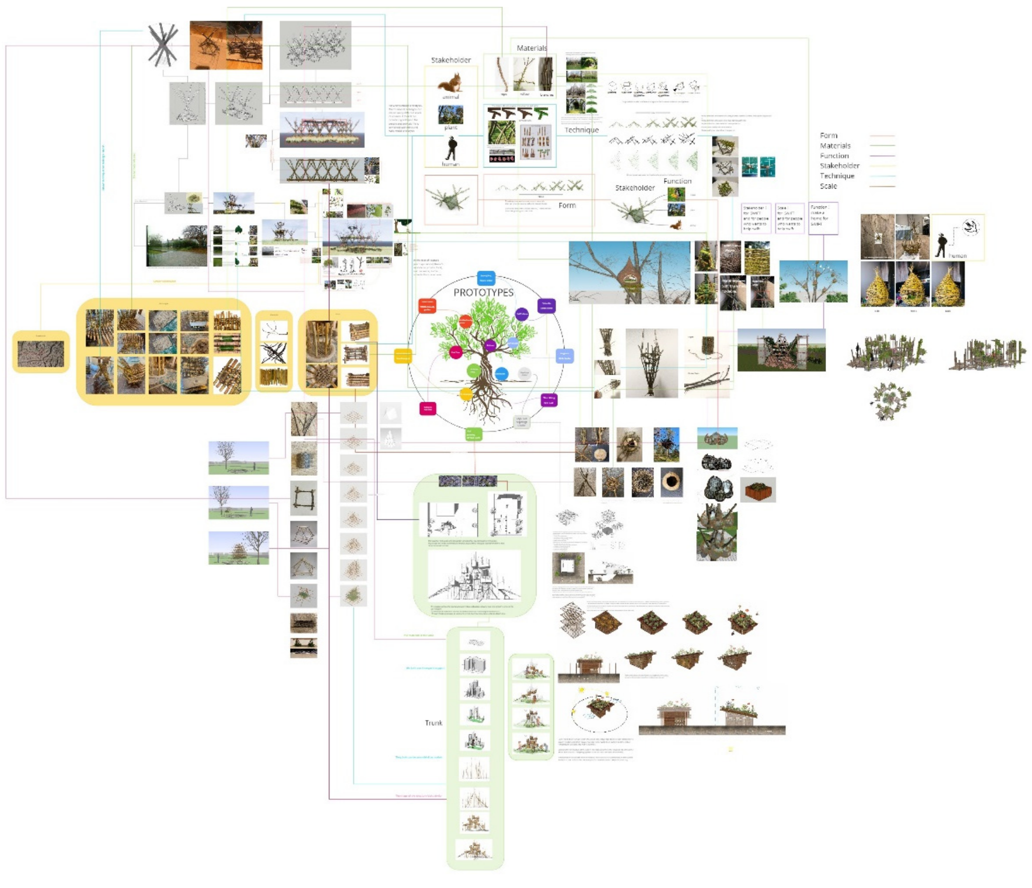

Figure 1. The WIP prototyping gigamap (authorship: Synergetic Landscapes Unit led by Davidová, 2021).

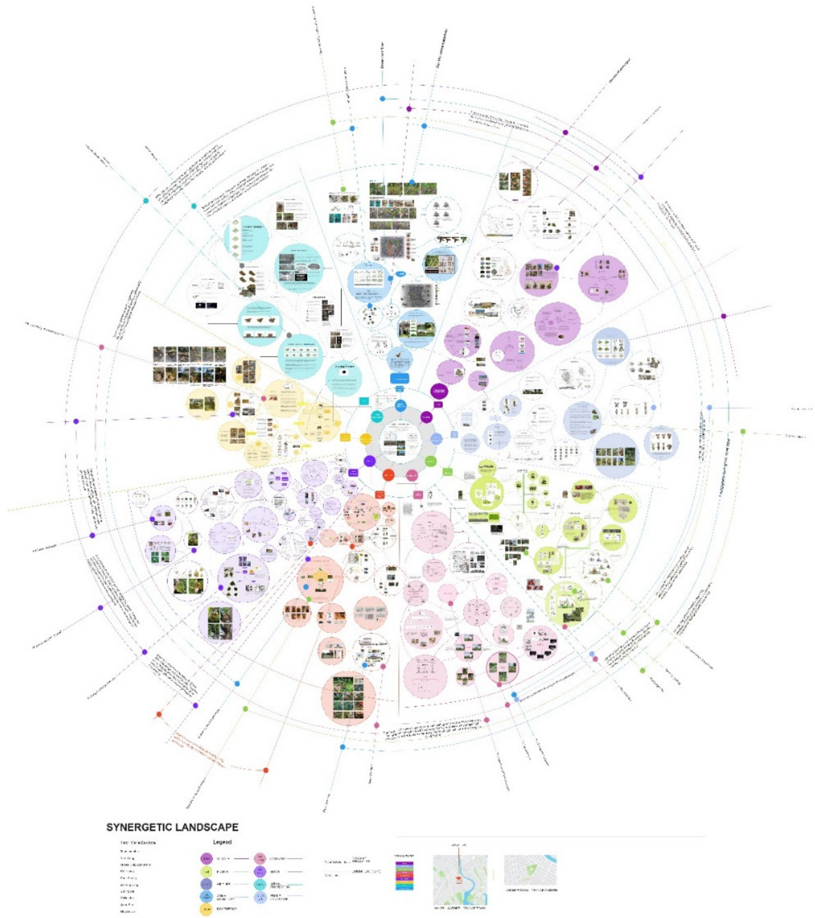

Figure 2. The larger systems related to the prototyping gigamap (authorship: Synergetic Landscapes Unit led by Davidová, 2021).

Figure 3. Vermicomposting—A lens to Biocentrism prototype with the visualised future scenario (authorship: Alghunaim led by Davidová, 2021).

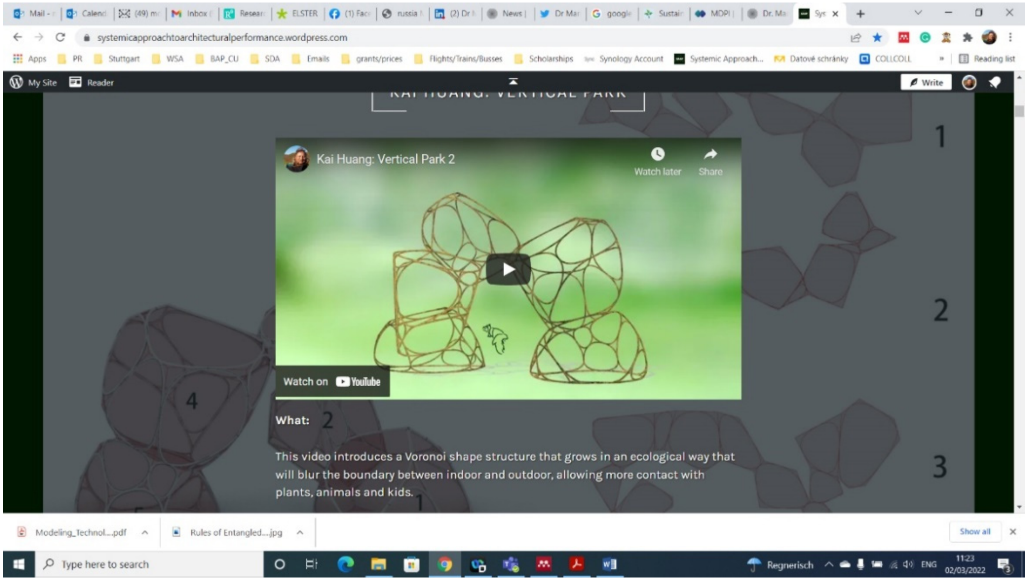

Figure 4. DIY recipe (authorship: Huang led by Davidová, 2020) on SAAP blog [63].

2.2. Gamification Design

Serious games have emerged as powerful tools in research for understanding, analysing and designing complex systems [64,65] such as natural resource governance, collective actions coordination, climate change, etc. In 1974, Richard D Duke [66] proposed 'Gaming as the Future's language' that can sensitise and stimulate a hypothetical world to the people giving them an immersive experience with the power to change the dynamics of the complex system. The decision made by the players in the game self-organises the system's dynamics making the consequences of connected choices visible to the player. This provides the best learning-by-doing experience to constantly observe and reflect upon an individual's role in the self-organizing complex systems. This experience can encourage people to actively participate in collective prosperity.

In our research, the city gaming mobile application Co-De|GT was the design intervention. It is also a self-evolving tool of progressive research to address and understand the dynamic needs of the human and non-human actors of the marginalised community of Grangetown, Wales. Co-De|GT is the gaming application designed to experience beneficial impacts and to encourage active participation within a marginalised community in the replication of DIY recipes of prototyping using a token-based blockchain model to support biodiversity. To develop this gaming application, we developed a structured framework for translating the complex resource interdependency of the human and non-human actors of the community into a token-based economy game mechanism. We designed a simple framework 'Game design Canvas' for a systemic inquiry into the micro-entanglements between networks of stakeholders (humans and non-humans) in the existing community to create interdependency mapping. This framework was used online on a collaborative platform 'Miro' where real-world observations gathered from the contextual inquiry into the community were systematically projected at different steps of the canvas. The canvas is comprised of 4 steps of translation, i.e., contextual inquiry, stakeholder selection, complex interdependence mapping of both the selected stakeholder and lastly the translation of the dynamics of positive interdependency in the game mechanics to the reward incentives. This process created the systemic study, resource interdependency and leverage points visible to the participants to make an informed decision about collective actions and gaming incentives design. Each layer of this framework encouraged the participants to focus on brainstorming techniques to map the network's interdependency between humans and non-humans, artefacts (stakeholders designed objects), resources and the environment on each other. Detailed instructions of the brainstorming techniques were explicitly mentioned in each layer to translate real-world interdependency into a gamified mechanism of a token-based economy. The intent and outcome of all the steps are discussed in the following section.

2.2.1. Step 1: Contextual Inquiry

This step focuses on gathering naturalistic observations of community stakeholders, (human and non-human) shared resources, environment, biodiversity and existing practices of the community. Participants were divided into 6 teams with 2 members in each group. The geographic location of Grangetown was also divided into 6 smaller sections. Each team conducted an ethnographic field study of the marginalised community of Grangetown using photo documentation, direct observation, in-depth interviews and focused group discussions. All the groups collected data and presented the insights in this step. Participants mapped the problems and opportunities of their site. The contextual inquiry into all the sites was then presented on the Miro board to understand the emerging issues in the whole community as shown in Figure 5. This step helped to zoom in and out to look at the multiple layers and multi-dimensionality of the concerns of this community. Some interesting insights demonstrated the prevalence of a dog as a pet culture in the community which emerged as one of the concerns against the loss of biodiversity, as favouring one restricts the synergy between many other species unintentionally.

Figure 5. Photographic documentation of the emerging issues in all the 6 sites of the Grangetown Welsh community (authorship: Synergetic Landscapes Unit lead by Davidová, 2021).

2.2.2. Step 2: Stakeholder Selection

This step focused upon the inquiry into the interdependencies of human and non-human stakeholders, for example, elderly people with pets as human stakeholders and hedge dogs as non-human stakeholders. Each group identified and focused only on the two most important human and non-human stakeholders that were of primary importance to address certain connected concerns of biodiversity. Participants in all the teams explicitly selected and studied this interdependence, such as natural habitats, food, role in biodiversity and concerns of non-human stakeholders. Similarly, socio-economic concerns, behavioural aspects, daily routines, role in the community, etc., of the human stakeholder within the marginalised community were also studied. Primary and secondary data supported the creation of the profiles of both the stakeholders. This helped to further zoom in on the behavioural inquiry at the individual level of needs, aspirations, living environment, everyday behaviour, food security and so on. Details of both the stakeholders established the role and relevance of each persona/species in enhancing biodiversity.

2.2.3. Step 3: Complex Interdependence

This step provided a structure for brainstorming and mapping the dynamic interdependence and interactions of human and non-stakeholders as shown in Figure 6. In this task, group members explained the different nature (positive and negative) of interdependency between human and non-human stakeholders such as shared resources, shared artefacts, shared environment, types of interaction and so on. The stakeholders' actions affect each other and the environment for the good or otherwise. The canvas provided six questions to map the nature of the interdependencies of the stakeholders with the shared urban environment and resources. The questions were as follows:

I. How do human actions positively affect the environment of the non-human actor?
II. How do human actions negatively affect the environment of the non-human actor?
III. How do the 'artefacts/products' used/created/consumed by humans positively affect the non-human actor?
IV. How do the 'artefacts/products' used/created/consumed by humans negatively affect the non-human actor?
V. How do the 'artefacts/products' used/created/consumed by human actions positively affect the environment of the urban ecosystem?
VI. How do the 'artefacts/products' used/created/consumed by human actions negatively affect the environment of the urban ecosystem?

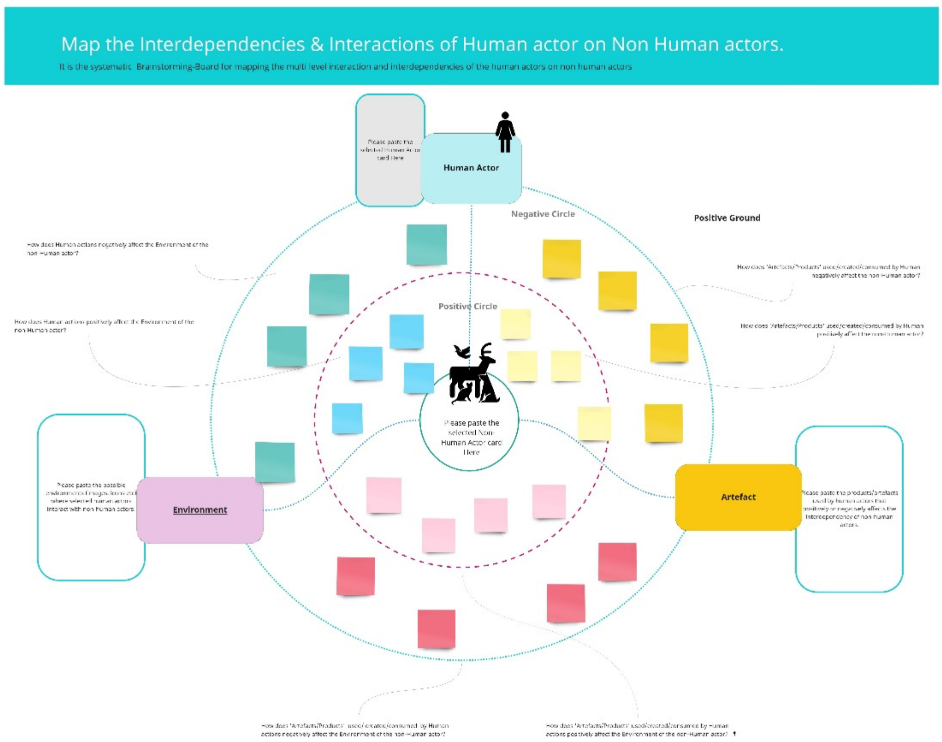

Figure 6. Canvas for mapping the interdependencies and interactions of human actors on non-human actors (authorship: Sharma, 2021).

Participants mapped the direct and indirect multi-level interactions and interdependencies of both the human and non-human stakeholders on each other in a shared environment of common resources within the urban ecosystem. This helped to analyze broader systemic level interdependencies of multispecies in an ecosystem and the associated consequences of different kinds of interaction. The positive interaction between the human and non-human stakeholders gave directions to create DIY recipes and incentive models to encourage active participation to protect biodiversity. Once exhaustive observations and mapping were achieved, participants were asked to move to the last step of the canvas.

2.2.4. Step 4: Gaming Mechanics

The gaming mechanics step provided a sequential brainstorming canvas to think collectively about the micro- to macro-level details of the stakeholder interdependency on the larger aim of the gamification. The mapping of interdependencies and the interactions of human actors on non-humans are translated into gamified rules, incentives, interactions, actions, etc., in this step. The canvas is divided into five fundamental layers of game development, as shown in Figure 7.

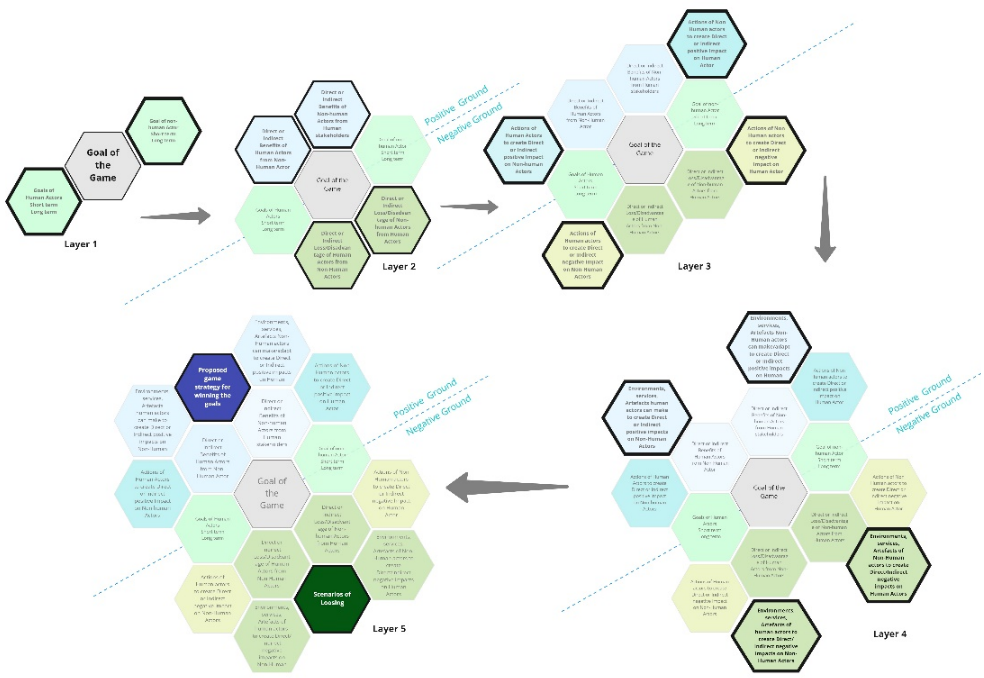

Figure 7. Layer-wise representation of the Game Design Canvas (authorship: Sharma, 2020).

Defining the goal of the game: Explaining the purpose of synergised actions of humans and non-humans. Participants were asked to explain explicitly the overall goal of the game and also, the short term and long-term goals of human and non-human stakeholders. This provided a shared vision of the goal of each group about the collective goal as well as the individual goals of the human and non-human community gaming application.

Map the duality: This step reflected upon the direct or indirect benefits and disadvantages of non-human Actors from human stakeholders and vice versa. The mapped interdependencies were translated into different kinds of gamified interaction and associated negotiations between the stakeholders.

Actions proposition: To ideate upon simple actions of humans that may create a positive impact on non-human stakeholders and vice versa. Likewise, this step of the canvas collectively ideates on the actions of humans that may create a negative impact on non-human stakeholders and vice versa to encourage the positive action towards synergised coliving.

Resource interdependency: To ideate upon the shared resources such as shared artefacts, built space, shared environment, shared natural resources, etc., that can be optimised to create a positive impact on humans and non-humans. Similarly, ideate upon the shared resources that can create a negative impact on human and non-human wellbeing.

Based on all the previous information on the canvas, this layer enquires about the conditions of collective winning. This is a crucial decision for designers that can provide a collective vision towards the tangible outcome of the collective actions of humans and non-humans. This was further expanded to propose various levels of the game with winning incentives where the initial level may sensitise the people on the issues of collective wellbeing within the Grangetown community. The canvas of each group was then connected with the rest of the group to create a holistic and gamified proposition of multi-species coliving and a token-based economy within the Grangetown community. The tasks of the initial level may encourage people to know about the context well. Advanced levels of the game encourage people to interact and perform simple actions of reproducing DIY Recipes in the real world to create a positive impact. In the further advanced levels, the gamification must promote the active participation of the players to perform higher-level tasks at an individual level as well as the community level. The WIP application has been tested on community stakeholders that were wandering in the neighbourhood and the larger variety, the better. The total number was about thirty. Based on their responses, the application has been constantly updated.

The Game Design Canvas was created to overcome the challenges of the online workshop due to COVID-19 restrictions. However, this research tool was a success in designing the gamified application. Therefore, in the Relating Systems Thinking and Design 10 symposium [2], we conducted a 3 h workshop to demonstrate and test the gaming canvas tool. The online tool was contextualised for a different geographical location of a marginalised community of Bhopal, India to test the effectiveness and generalizability of the tool. In a very short time, participants of the workshop were able to design interesting games to promote biodiversity.

2.3. New Token Economies

National currencies are not the only monetary systems that circulate in societies. This section looks at some of these to contextualise our research and the proposition of the mobile application, which can be summarised as the intention to underpin an economy with environmentally conscious behaviour. A token economy can be—loosely—defined as a method of encouraging desirable behaviour. Tokens are exchanged for specific behaviour and can be exchanged for desirable things. Typically, a token has no intrinsic monetary value except within its limited economic and usually geographic area. They have been criticised when deployed in institutional settings where they have historically been implemented to modify and ‘correct’ aberrant behaviours.

Complementary currencies are another alternative monetary system; an unofficial currency that circulates in parallel with a national currency. They are typically set up by private citizens or advocacy groups and used only within a limited geographic area. The Bangla-Peso from Kenya and the Fureai Kippu from Japan are well-established examples [67,68]. The Bangla-Peso is a voucher system that can be traded for limited goods and services when the national currency is not available. The Fureai Kippu is traded for helping senior citizens. Unlike token economies, they are not imposed; they operate in parallel with national currencies and are deployed for more socially conscious reasons. Consequently, they have significantly more positive associations than token economies.

In addition, there are digital currencies such as M-Pesa that circulate on the African continent. This currency can be traded via mobile phones and provides access to micro-financial transactions without the need for a bank account. It is often cited as improving quality of life by providing access to financial services for the population that cannot access an official bank account, which in Africa is estimated to be 57% of the adult population.

However, the M-Pesa has come under criticism for being monopolistic and controlled by large organizations.

Blockchain offers the potential to take these concepts into the 21st century and address some of the shortcomings and criticism of the aforementioned alternative currencies. It is designed and operates without monopolistic control; digital currencies such as bitcoin also offer the potential to circulate globally. Furthermore, socially conscious initiatives are beginning to combine the concepts of a token economy and complementary currency. For example, the Plastic Bank uses these technologies to stimulate a specific economy around removing waste plastics and redirecting them into a recycling system [69]. The novelty in the original research reported here is that the Co-De|GT application aims not only to underpin an economy with environmental conscious behaviour but it also extends existing research to include and support other-than-human species within that economy.

3. The Co-De|GT Mobile Application

3.1. Performance

The Co-De|GT application's [70] aim is to lower the disbalance across the different disadvantaged human and non-human stakeholders. It enables the submission of—and volunteering in—different tasks that are assigned tokens as a payment. To gain tokens, one first completes certain tasks. Once someone 'earns' tokens and they are deposited in their wallet, they can assign or create tasks for others. When others compete for those tasks, they are paid from the assignee's wallet. At the application's starting point, only the Synergetic Landscape unit's members have tokens. They assign tasks for people to reproduce their designed prototypes (i.e., bat or bug hotels, etc.) for expanding cross-species habitable and edible landscapes. These prototypes are to be built from natural materials that can be found in the location. Therefore, joining the system does not require any initial investment [71]. Whilst giving the tasks, the related members of the more-than-human community are rewarded. Therefore, for planting a tree, one must pay the pollinators. This way, the pollinators gain their tokens and they might be buying their habitats. Since the pollinators cannot use the application, they are acted on their behalf by the community members. Thus, the application questions the traditional winning and losing concept of traditional games through layering multiple systems and cross-relating their systemic relations. Non-human species could be acted on behalf by AI as will be explored in the systemic future visions section.

This unit was mainly developed during the COVID-19 pandemic when direct analogue social interaction was very limited. Therefore, more attention was paid to online interaction through social media, a video channel, blogging, etc. The application has been tested through two online events, the Cardiff University Sustainability Week [72] and the UN World Creativity and Innovation Day [73]. Later, the application was tested in real life in the Grangetown community. We organised public picnics using QR codes to introduce the public to the mobile phone application, as most of Wales has been vaccinated. A poster with the application's QR code was presented in the Grangetown Pavilion that was opened to the public as part of the Community Gateway project in spring, 2021.

The application is an MVP (minimum viable product) prototype. It should differentiate several local species (see Figure 8). For the initial stage, we selected only the categories of land, water, sky and underground creatures and the types of tasks in the categories of community, health, environment, animal and 'other'. The users can upload their tasks to the map location with these categories, assigning tokens for completing the task and assigning tokens to other species that relate to the task. Settings cover a timeframe for completing the task. The application starts with the DIY edible and habitable prototypes recipes that are located on the first author's blog [63]. However, anyone can upload their recipes for their tasks. The application can place DIY videos from YouTube and other video channels and blogs. Different community members can act on behalf of other creatures and extend their habitats and edible landscapes for their tokens by assigning tasks to community members. This way, the community members value, appreciate and cogenerate the quality of their environment and life within the community from the bottom up.

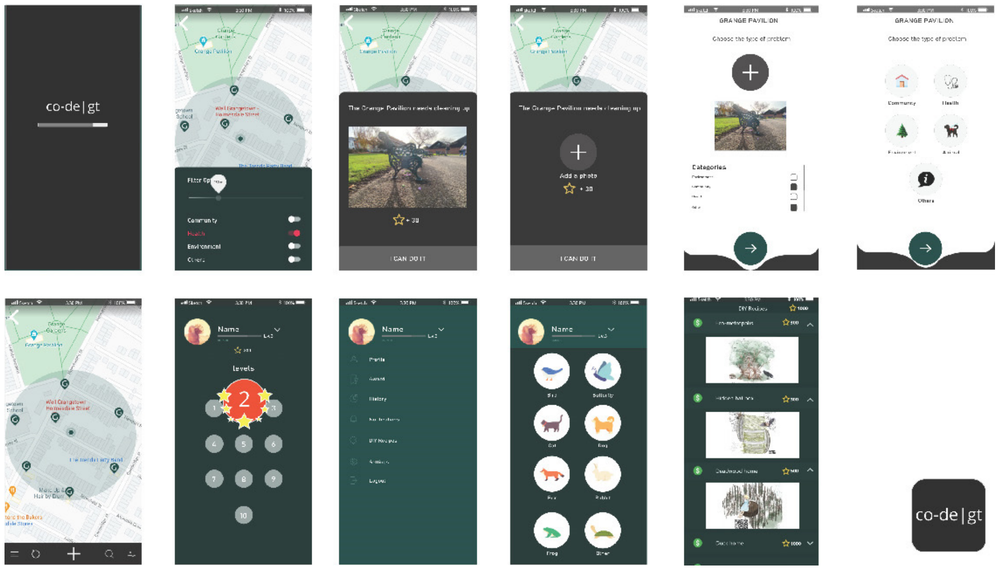

Figure 8. Co-De∣GT mobile application WIP interface design (authorship: Synergetic Landscapes Unit led by Davidová, 2021).

3.2. *Technology*

In order to be able to adapt to our user base, we deployed a flexible approach when designing the software solution. Although the target audience was set and the personas were clear, we were largely unaware of what the reception and adoption [74] of technology would be. It was therefore impossible to predict and model the created prototype target devices which would most likely span the spectrum of phones and operating systems. We did, however, have the confidence to predict that the end-users of the application would be in this scenario developed world users; therefore, we were allowed to make an educated guess on the technology we would use. One example is that we assumed that our users would be using Android Version 8.0 (codenamed Oreo) or above, based on over 90% of UK users employing Android 8.0 [75]. Similarly, we assumed that the equivalent iOS user base would be using iOS 12.5 and above, with an over 87% market share on Apple Mobile devices [76] This decision created both opportunities for us to create the best and safest build, but there are also limitations to our work; namely, although the ecological validity of our work will be high, the external validity of our work may be limited if we were to replicate the experimentation to less-developed societal surroundings. Most importantly, we were also able to establish the likely web browser capabilities of these operating systems which gave us more development options with regards to compatibility. For these reasons, we decided the application would be developed using an HTML-based progressive web application (PWA) approach in order to allow for operating system agnostic capabilities and an adaptive design approach [77]. This allowed the solution to be accessed via a web browser and made the device and operating system agnostic.

Due to the nature of the application and the natural environment that the application would be likely to be used in, one of the challenges that were made evident was that the use of the prototype would be limited access to WIFI or even cellular data services such as 4G. We were, therefore, inclined to create a web-based application but due to the PWA nature, once saved to the home screen of a mobile device (Phone or Tablet/iOS or Android) it could be accessed via that link, where all browser-based UI elements are hidden and the application behaves as if it is a native mobile application. One can simply access the website once and save it to the home screen. This increased the external validity of our work, as we can cater for developing country environments, but we note that the limitation of the operating system mentioned above must also be taken into consideration if the replication of the findings is attempted.

'Under the hood' we employed HTML, HTML5 technologies with Javascript for the UI and C# for the functionality. We deployed Google Maps (which is a reliable source of GPS tracking and a location finder carrying several offline capabilities through caching) to perform the location services and location finders. This was wrapped in a .NET container for compatibility with the rest of our technology. Finally, the application utilised a database subsystem on a Microsoft SQL Server with custom firewalls and two-factor authentication for security. We created differential backups daily and had an uptime of 99.9% as an aim which is currently successful.

4. Discussion and Conclusions

The potential for blockchain to impact the built environment has been explored elsewhere [78], including the specific potential for a radical reconfiguration of the relationship between people and other agents with which we share the environment, such as animals, buildings and plants [21]. The World Economic Forum has recognised that blockchain, crypto-currency and the 'token economy' provide a means for 21st century communities and distributed organisations to reclaim power and enact their values in a way not possible through 20th century centralised banking, industrial and commerce models [79]. This is critically important in deprived urban communities, especially in relation to the quality of human and more-than-human lives and living environment. This project expands further on this work in two areas: (1) in relation to extending community or 'complementary' currencies to circulate beyond traditional geographical limits [80], and (2) the potential for a crypto-currency economy to support environment regeneration. Unlike existing complementary currencies, this research has shown the potential for a new type of community currency that has no geographical limits. The economy it facilitates is not traditional and it is not based on practices such as material extraction or behaviours such as continued consumption. This economy supports and rewards behaviour that establishes and regenerates a multi-species environment, whereas traditional economies result in their destruction.

We argue this can also apply across species, things and whatever intelligent systems (including AI) within such communities. The work here explores how more-than-human agents can be integrated into our economic models, strengthening clear dependences and co-performing better through interactions. To expand on such a co-performance, we need to adapt our cities for coliving with others [61]. This project tried to achieve this through a gamified token application with free DIY recipes, approaching communities of makers that have recently questioned the building market [81] and hopefully soon the building industry. León-Jordán and Kuruvilla projected in 2011 that the mainstream supply chain of the building industry would change from the traditional model of Supplier—Manufacturer—Distributor—Retailer and Consumer, to a compact supply chain of Design and Raw Materials reaching the customer who is also the manufacturer [82]. Many such initiatives have appeared since the 1960s to fight homelessness and poverty [83]. Boeva and Troxler point out that the making needs to abandon the market/state duopoly of the first and second industrial revolution, the market economy based on the assumption of unlimited growth and the fair functioning of the free market [84]. This project tested how making could be integrated into the community-based post-Anthropocene economy and industry for the 21st century that may hopefully become fully Non-Anthropocentric in the future.

This research has explored how the features of contemporary digital currency can be combined with concepts of complementary currencies to stimulate an economy of value and quality of life; an economy of products and services that re-populate the urban environment with wild-life habitats that will result in a more balanced ecosystem. This was approached through gamification to engage with the community in a real-life environment and real-life situations. The central idea of gamification is to take the 'building blocks' of games and to implement these in real-world situations, often with the goal of motivating specific behaviours within the gamified situation [85]. The majority of the studies have yielded positive effects/results from gamification, though gamification is context-dependent [86]. Therefore, it is crucial to test whether this concept can improve the quality of life in specific communities, such as Grangetown which is listed as one of the most deprived communities in Wales.

5. Systemic Visions of the Future

The future vision direction of integration of this investigation is a transition towards post-Anthropocene where different beings (humans, other species, AI, robots) may co-live in synergy. We are interested in the real-life application, development and testing of the posthumanist discourse discussed by Haraway and Latour from a more-than-human perspective [87,88] that has taken place around the world in the last few decades. Municipal and national governments, along with supra-national states, such as the European Union, positively endorse the smart city concept as the path to socio-economic progress and more liveable, secure, functional, competitive and sustainable cities [89]. With the adoption of emerging technologies such as the Internet of things (IoT) for facilitating smart city transitions, there has been a surge in the number of sensors and devices within the smart city ecosystem. With the traction gained by IoT within smart cities, there has been an increase in the generation of data, which can be leveraged by AI for active training and the operation of real-time smart machines to automate the provision of certain services. However, the trade-off between data transparency (and privacy) and the utility of AI in supporting big data analytics, is the foremost concern for smart city stakeholders. In this context, blockchain technology is increasingly seen as a tool that can boost data transparency and traceability in smart cities. As a decentralised IT infrastructure, blockchain technology can serve as a suitable means to manage the growing networks emanating from smart cities in terms of monitoring supply chains, executing and validating data trails along with ensuring authenticity and integrity of data. Blockchain technology through secure and transparent infrastructure presents opportunities for an immutable and traceable exchange of sensitive data and property values, not only between people but also between machines [13]. We are interested in the development of a new model of BioDigital architectural, urban and landscape interventions for the 21st century through 'Do-It-Yourself' (DIY) for biodiversity loss mitigation with a special focus on the urban environment. In the work presented here, people traded and supported a multi-species environment. However, we envisage the possibility of more-than-human species and machines trading autonomously within the economic ecology. We would like to integrate digital currency with existing ecosystems, assigning, for example, value to a work of a pollinator or a DIY maker by AI thanks to robotic and citizen science monitoring evaluations. We want to target the cocreation of adjustable (parametric) reproducible digital models for DIY that would integrate multi-being coliving. These models would develop advanced species habitats (i.e., swifts', bats' and insects' hotels) and edible landscaping (i.e., supporting insects' habitats that generate food for swifts and bats) in an urban, peri-urban and rural environment and their connectivity with wilderness. For the autonomy of the system, we would like to develop small collaborative robots equipped with sensors that would monitor, maintain and redesign the prototypes based on the ecosystem's performance in real-time. The DIY recipes for the robots would be developed as well. The DIY recipes have the potential to emerge as a new form of NFT (non-fungible token) in the future to encourage active participation of people in creating original yet effective DIY prototypes to promote biodiversity for a healthy coliving environment. This would be evaluated via the blockchain gamified mobile application. We wish to address our dependency on the overall ecosystem: we do not have a harvest without pollinators. However, recently, we are facing Anthropocene extinction and the fact that the urban and other cultural landscapes may play a critical role in this has been documented by several ecologists.

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References

1. Davidová, M.; Sharma, S.; McMeel, D.; Loizides, F. Co-De|GT BETA: The 21st Century Economy App for Crossspecies Coliving. In Proceedings of the Relating Systems Thinking and Design, Delft, The Netherlands, 2–6 November 2021; van der Bijl-Brouwer, M., Ed.; Systemic Design Association: Toronto, ON, Canada, 2021; pp. 1–10.
2. Systemic Design Association. RSD Symposium—Relating Systems Thinking and Design. 2021. Available online: https://rsdsymposium.org/ (accessed on 25 February 2022).
3. Sharma, S.; Davidová, M.; Jayadevaiah, Y. Gaming Complexity: Rules, networks, and green economy. In Proceedings of the Relating Systems Thinking and Design, Delft, The Netherlands, 2–6 November 2021; Available online: https://rsdsymposium.org/gaming-complexity-rules-networks-and-green-economy/ (accessed on 25 February 2022).
4. European Commission. *The European Green Deal*; European Commission: Brussels, Belgium, 2019; Volume 53. [CrossRef]
5. European Commission. New European Bauhaus: Beautiful, Sustainable, Together. 2021. Available online: https://europa.eu/new-european-bauhaus/index_en (accessed on 3 January 2022).
6. United Nations. *2: Zero Hunger*; United Nations: New York, NY, USA, 2019.
7. United Nations. *3: Good Health and Well-Being*; United Nations: New York, NY, USA, 2021. [CrossRef]
8. United Nations. *9: Industry, Innovation and Infrastructure*; United Nations: New York, NY, USA, 2021. [CrossRef]
9. United Nations. *11: Sustainable Cities and Communities—Sustainable Cities: Why They Matter*; United Nations: New York, NY, USA, 2016.
10. United Nations. *12: Responsible Consumption and Production*; United Nations: New York, NY, USA, 2020.
11. United Nations. *13: Climate Action*; United Nations: New York, NY, USA, 2019; Volume 46.
12. United Nations. *15: Life on Land—Life on Land: Why It Matters*; United Nations: New York, NY, USA, 2016.
13. Ben Dhaou, S.; Pires, K.; Backhouse, J. *Blockchain for Smart Sustainable Cities*; United Nations: Geneva, Switzerland, 2020.
14. Sagar, A.; Bananayo, P. *Blockchain for Urban Development—Guidance for Urban Managers*; UN-Habitat: Nairobi, Kenya, 2021.
15. Catalano, C.; Meslec, M.; Boileau, J.; Guarino, R.; Aurich, I.; Baumann, N.; Chartier, F.; Dalix, P.; Deramond, S.; Laube, P.; et al. Smart Sustainable Cities of the New Millennium: Towards Design for Nature. *Circ. Econ. Sustain.* **2021**, *1*, 1053–1086. [CrossRef]

16. Spotswood, E.N.; Beller, E.E.; Grossinger, R.; Grenier, J.L.; Heller, N.E.; Aronson, M.F.J. The Biological Deserts Fallacy: Cities in Their Landscapes Contribute More than We Think to Regional Biodiversity. *Bioscience* **2021**, *71*, 148–160. [CrossRef] [PubMed]
17. Dasgupta, P. *The Economics of Biodiversity: The Dasgupta Review—Headline Messages*; Hm Treasury: London, UK, 2021. [CrossRef]
18. Cathlow, R.; Garrett, M.; Jones, N.; Skinner, S. (Eds.) *Artists Re: Thinking the Blockchain*; Torque Editions & Furtherfield: Lancaster, UK, 2017.
19. Hutchison, A. The Whanganui River as a Legal Person. *Altern. Law J.* **2014**, *39*, 179–182. [CrossRef]
20. Davidová, M. Synergetic Landscapes Unit: The MultiSpecies BioDigital Community CoDesign. In Proceedings of the 2020 Relating Systems Thinking and Design, Ahmedabad, India, 9–17 October 2020; Jones, P., Ed.; Systemic Design Association: Toronto, ON, Canada, 2020; pp. 1–14.
21. Davidová, M.; McMeel, D. CoDesigning with Blockchain for Synergetic Landscapes: The cocreation of blockchain circular economy through systemic design. In *CAADRIA 2020 ReAnthropocene—Des. Age Humans*; Holzer, D., Nakapan, W., Globa, A., Koh, I., Eds.; Association for Computer Aided Architectural Design in Asia: Bangkok, Thailand, 2020; Volume 2, pp. 333–342.
22. McVicar, M. Gathering-In-Action: The Activation of a Civic Space. *Archit Cult.* **2020**, *8*, 468–483. [CrossRef]
23. Cardiff Research Centre. *2011 Census—Key & Quick Statistics Profile Grangetown & Cardiff Who We Are—How We Live—What We Do Who We Are*; Cardiff Research Centre: Cardiff, UK, 2011.
24. Welsh Government. Welsh Index of Multiple Deprivation | GOV.WALES. *Stat. Res. Ser.* **2014**. Available online: https://gov.wales/welsh-index-multiple-deprivation (accessed on 14 August 2021).
25. Reeves, C.A.; Bednar, D.A. Defining Quality: Alternatives and Implications. *Acad. Manag. Rev.* **1994**, *19*, 419–445. [CrossRef]
26. Renn, O.; Jäger, A.; Deuschle, J.; Weimer-Jehle, W. A normative-functional concept of sustainability and its indicators. *Int. J. Glob. Environ. Issues* **2009**, *9*, 291–317. [CrossRef]
27. Barofsky, I. Can quality or quality-of-life be defined? *Qual. Life Res.* **2012**, *21*, 625–631. [CrossRef]
28. Zhang, L.; Balangé, L.; Braun, K.; Di Bari, R.; Horn, R.; Hos, D.; Kropp, C.; Leistner, P.; Schwieger, V. Quality as Driver for Sustainable Construction—Holistic Quality Model and Assessment. *Sustainability* **2020**, *12*, 7847. [CrossRef]
29. Perez, C.C. The Deadly Truth about a World Built for Men—From Stab Vests to Car Crashes. *The Guardian*. 2019. Available online: https://www.theguardian.com/lifeandstyle/2019/feb/23/truth-world-built-for-men-car-crashes (accessed on 15 February 2022).
30. Kingma, B.; Van Marken Lichtenbelt, W. Energy consumption in buildings and female thermal demand. *Nat. Clim. Chang.* **2015**, *5*, 1054–1056. [CrossRef]
31. Cardinale, B.J.; Duffy, J.E.; Gonzalez, A.; Hooper, D.U.; Perrings, C.; Venail, P.; Narwani, A.; Mace, G.M.; Tilman, D.; Wardle, D.A.; et al. Biodiversity loss and its impact on humanity. *Nature* **2012**, *486*, 59–67. [CrossRef]
32. Shishegar, N. The impact of green areas on mitigating urban heat island effect: A review. *Int. J. Environ. Sustain.* **2014**, *9*, 119–130. [CrossRef]
33. O'Malley, C.; Piroozfarb, P.A.E.; Farr, E.R.P.; Gates, J. An investigation into minimizing urban heat island (UHI) effects: A UK perspective. *Energy Procedia* **2014**, *62*, 72–80. [CrossRef]
34. White, M.; Smith, A.; Humphryes, K.; Pahl, S.; Snelling, D.; Depledge, M. Blue space: The importance of water for preference, affect, and restorativeness ratings of natural and built scenes. *J. Environ. Psychol.* **2010**, *30*, 482–493. [CrossRef]
35. Bonomi, A.E.; Patrick, D.L.; Bushnell, D.M.; Martin, M. Validation of the United States' version of the World Health Organization Quality of Life (WHOQOL) instrument. *J. Clin. Epidemiol.* **2000**, *53*, 1–12. [CrossRef]
36. Hallberg, N.L. What Is Value and How Is It Managed? *J. Creat. Value* **2017**, *3*, 173–183. [CrossRef]
37. Seewann, L.; Verwiebe, R. How do people interpret the value concept? Development and evaluation of the value conceptualisation scale using a mixed method approach. *J. Beliefs Values* **2020**, *41*, 419–432. [CrossRef]
38. Sevaldson, B. *Designing Time: A Laboratory for Time Based Design*; Future Ground; Monash University: Melbourne, Australia, 2004; pp. 1–13.
39. Davidová, M.; Zímová, K. COLreg: The Tokenised Cross—Species Multicentred Regenerative Region Co—Creation. *Sustainability* **2021**, *13*, 6638. [CrossRef]
40. Davidová, M. Synergy in the systemic approach to architectural performance: The integral multi- and cross-layered agencies in eco-systemic generative design processes of the post-anthropocene. *FORMakademisk—Res. J. Des. Educ.* **2020**, *13*, 1–30. [CrossRef]
41. Willis, K.J.; Bhagwat, S.A. Biodiversity and climate change. *Science* **2009**, *326*, 806–807. [CrossRef]
42. Alkemade, R.; Bakkenes, M.; Eickhout, B. Towards a general relationship between climate change and biodiversity: An example for plant species in Europe. *Reg. Environ. Chang.* **2011**, *11*, 143–150. [CrossRef]
43. McGonigal, J. *Reality is Broken*; Penguin Press: New York, NY, USA, 2011.
44. Wu, J.S.; Lee, J.J. Climate change games as tools for education and engagement. *Nat. Clim. Chang.* **2015**, *55*, 413–418. [CrossRef]
45. Valls, F.; Redondo, E.; Fonseca, D.; Garcia-Almirall, P.; Subirós, J. Videogame Technology in Architecture Education. *Lect. Notes Comput. Sci.* **2016**, *9733*, 436–447. [CrossRef]
46. Deterding, S. The lens of intrinsic skill atoms: A method for gameful design. *Hum.-Comput. Interact.* **2015**, *30*, 294–335. [CrossRef]
47. McGonigal, J. The puppet master problem: Design for real-world, mission-based gaming. In *Second Person: Role-Playing and Story in Games and Playable Media*; Harrigan, P., Wardrip-Fruin, N., Eds.; MIT Press: Cambridge, MA, USA, 2007; pp. 154–170.

48. Chang, Y.-N.; Lim, Y.-K.; Stolterman, E. Personas: From theory to practices. In Proceedings of the 5th Nordic Conference on Human-Computer Interaction, Build. Bridg.—Nord. '08, Lund, Sweden, 20–22 October 2008; ACM Press: New York, NY, USA, 2008; pp. 439–442. [CrossRef]
49. Nakamoto, S. Bitcoin: A peer-to-peer electronic cash system. *Decentralized Bus. Rev.* **2008**, 21260.
50. Bearman, J. The Untold Story of Silk Road, Part 1. WIRED n.d. *Wired Magazine*, 1 May 2015.
51. Zambrano, R.; Young, A.; Verhulst, S. *Connecting Refugees to Aid Through Blockchain-Enabled ID Management: World Food Programme's Building Blocks*; GovLab: New York, NY, USA, 2018.
52. Demirguc-Kunt, A.; Klapper, L.; Singer, D.; Ansar, S.; Hess, J. *The Global Findex Database 2017: Measuring Financial Inclusion and the Fintech Revolution*; World Bank Publications: Washington, DC, USA, 2018. [CrossRef]
53. Davidová, M. Cocreative roles, agencies and relations in post-Anthropocene: The real life gigamaps and full-scale prototypes of SAAP. *Strateg. Des. Res. J.* **2020**, *13*, 185–212. [CrossRef]
54. Sevaldson, B. Visualizing complex design: The evolution of gigamaps. In *Systemic Design*; Jones, P., Kijima, K., Eds.; Springer: Tokyo, Japan, 2018; pp. 243–269. [CrossRef]
55. Sanders, E.; Stappers, P.J. Co-creation and the new landscapes of design. *CoDesign* **2008**, *4*, 5–18. [CrossRef]
56. Sevaldson, B. Rich Design Research Space. *Form. Akad* **2008**, *1*, 28–44. [CrossRef]
57. Doherty, G. *Prototypes in Pinkenba. Nord. 2005—Mak*; Royal Danish Academy of Fine Arts, School of Architecture: Copenhagen, Denmark, 2005; Volume 1, pp. 1–5.
58. Meadows, D. *Leverage Points: Places to Intervene in a System*; Donella Meadows Archives: Hartland, UK, 1999.
59. Abson, D.J.; Fischer, J.; Leventon, J.; Newig, J.; Schomerus, T.; Vilsmaier, U.; von Wehrden, H.; Abernethy, P.; Ives, C.D.; Jager, N.W.; et al. Leverage points for sustainability transformation. *Ambio* **2017**, *46*, 30–39. [CrossRef]
60. Davelaar, D. Transformation for sustainability: A deep leverage points approach. *Sustain. Sci.* **2021**, *16*, 727–747. [CrossRef]
61. Davidová, M.; Zímová, K. COLridor: Co-Design and Co-Living Urban Adaptation. *FORMakademisk—Res. J. Des. Des. Educ.* **2018**, *11*, 1–30. [CrossRef]
62. Moxon, S. Drawing on nature: A vision of an urban residential street adapted for biodiversity in architectural drawings. *City Territ. Archit.* **2019**, *6*, 6. [CrossRef]
63. Davidová, M. Systemic Approach to Architectural Performance. Wordpress. 2020. Available online: https://systemicapproachtoarchitecturalperformance.wordpress.com/ (accessed on 14 July 2020).
64. Wilkinson, P. A Brief History of Serious Games. *Entertain. Comput. Serious Games* **2016**, *LNCS 9970*, 17–41. [CrossRef]
65. Van Noordwijk, M.; Speelman, E.; Hofstede, G.J.; Farida, A.; Abdurrahim, A.Y.; Miccolis, A.; Hakim, A.; Wamucii, C.; Lagneaux, E.; Andreotti, F.; et al. Sustainable agroforestry landscape management: Changing the game. *Land* **2020**, *9*, 243. [CrossRef]
66. Duke, R.I.D. Toward a General Theory of gaming. *Simul. Games* **1974**, *5*, 131. [CrossRef]
67. Kimenyi, M.S.; Muthaka, D. Bangla-Pesa: Slum Currency and Implications for the Poor in Developing Countries. Brookings Inst 2013. Available online: https://www.brookings.edu/blog/up-front/2013/07/17/bangla-pesa-slum-currency-and-implications-for-the-poor-in-developing-countries/ (accessed on 13 May 2021).
68. Hayashi, M. Japan's Fureai Kippu time-banking in elderly care: Origins, development, challenges and impact. *Int. J. Community Curr. Res.* **2012**, *16*, 30–44. [CrossRef]
69. Katz, D. Plastic Bank: Launching Social Plastic®revolution. *Field Actions Sci. Reports J. Field Actions* **2019**, *19*, 96–99.
70. Synergetic Landscapes. Co-De|GT. 2021. Available online: http://grangetown.emotion-robotics.com/ (accessed on 23 April 2021).
71. Davidová, M. Multicentred Systemic Design Pedagogy Through Real-Life Empathy Integral and Inclusive Practice-Based Education in the Research-by-Design Context. *FORMakademisk—Res. J. Des. Des. Educ* **2020**, *13*, 1–26. [CrossRef]
72. Raye, L.; Davidová, M. Synergetic Landscapes. 2021. Available online: https://www.youtube.com/watch?v=OuW5GeWKITA&t=957s (accessed on 15 February 2022).
73. Davidová, M. Synergetic Landscapes DIY and More; Davidová, UK. 2021. Available online: https://www.youtube.com/watch?v=1DAstEewVY8&t=2051s (accessed on 15 February 2022).
74. Besley, T.; Case, A. Modeling Technology Adoption in Developing Countries. *Am. Econ. Rev. Pap. Proc.* **1993**, *83*, 396–402.
75. StatCounter. Mobile & Tablet Android Version Market Share United Kingdom | Statcounter Global Stats 2021. Available online: https://gs.statcounter.com/android-version-market-share/mobile-tablet/united-kingdom/ (accessed on 1 October 2021).
76. StatCounter. Mobile & Tablet iOS Version Market Share United Kingdom | Statcounter Global Stats 2021. Available online: https://gs.statcounter.com/os-version-market-share/ios/mobile-tablet/united-kingdom (accessed on 1 October 2021).
77. Gómez-Sierra, C.J. Design and development of a PWA-Progressive Web Application, to consult the diary and programming of a technological event. *IOP Conf. Ser. Mater. Sci. Eng.* **2021**, *1154*, 012047. [CrossRef]
78. McMeel, D.; Sims, A. Blockchain: A new building block for the built environment? In *Imaginable Futures: Design Thinking, and the Scientific Method, Proceedings of the 54th International Conference of the Architectural Science Association, Auckland, New Zealand, 26–27 November 2020*; GhaffarianHoseini, A., Ghaffarianhoseini, A., Naismith, N., Eds.; The Architectural Science Association (ANZAScA): Auckland, New Zealand, 2020; pp. 211–219.
79. Celine, H.; Waughray, D.; Warren, S. *Building Block(Chain)s for a Better Planet*; World Economic Forum: Geneva, Switzerland, 2018.
80. Amato, M.; Fantacci, L. Complementary currencies. In *Handbook of the History of Money and Currency*; Battilossi, S., Cassis, Y., Yago, K., Eds.; Springer: Singapore, 2020; pp. 501–522. [CrossRef]
81. Aravena, A. (Ed.) *Reporting from the Front: Biennale Architettura*, 1st ed.; Marsilio: Venice, Italy, 2016.

82. León-Jordán, J.; Kuruvilla, A. Home-Made vs. Factory-Made: Emerging Implications on the Supply Chain of the DIY Industry. In Proceedings of the POMS 22nd Annual Conference, Reno, NV, USA, 29 April–2 May 2011; Sriskandarajah, C., Çakanyıldırım, M., Eds.; Production and Operations Management Society: Reno, NV, USA; 2011; pp. 1–18.
83. Lu, Z.; Davidová, M.; Pope, T. Architecture for the Wellbeing of Homeless Youth: Research by Design Project, Pioneering Buskers. In *The City and Complexity—Life, Design and Commerce in the Built Environment*; Lastman, R., Ed.; City University of London: London, UK, 2020; pp. 19–35.
84. Boeva, Y.; Troxler, P. Makers. In *The Handbook of Peer Production*; Wiley: Hoboken, NJ, USA, 2020; pp. 225–237. [CrossRef]
85. Sailer, M.; Hense, J.U.; Mayr, S.K.; Mandl, H. How gamification motivates: An experimental study of the effects of specific game design elements on psychological need satisfaction. *Comput. Human Behav.* **2017**, *69*, 371–380. [CrossRef]
86. Hamari, J.; Koivisto, J.; Sarsa, H. Does gamification work?—A literature review of empirical studies on gamification. In Proceedings of the 2014 47th Hawaii International Conference on System Sciences, Waikoloa, HI, USA, 6–9 January 2014; IEEE Computer Society: New York, NY, USA, 2014; pp. 3025–3034. [CrossRef]
87. Latour, B. *We Have Never been Modern*; Harvard University Press: Cambridge, UK, 1993.
88. Haraway, D. A cyborg manifesto: Science, technology and social-feminism. In *Simians, Cyborgs and Women: The Reinvention of Nature*; Routledge: New York, NY, USA, 1991; pp. 149–181.
89. Kitchin, R. Making sense of smart cities: Addressing present shortcomings. *Camb. J. Reg. Econ. Soc.* **2015**, *8*, 131–136. [CrossRef]