ATARCA

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ATARCA

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Abbreviations

AE	Allocative Efficiency
API	Application Programming Interface
B2B	Business-to-Business
B2C	Business-to-Consumer
CO2e	Carbon Dioxide Equivalents
DLT	Distributed Ledger Technology
DRM	Digital Rights Management
EIP	Ethereum Improvement Proposal
MC	Marginal Cost
MOOC	Massive Open Online Course
MVP	Minimum Viable Product
NGO	Non-Governmental Organisation
NFT	Non-Fungible Token
PSP	Payment Service Provider
REC	Real Economy Currency
sNFT	Shared Non-Fungible Token
UI	User Interface
UX	User Experience

1. INTRODUCTION

1.1. Background and scope of this deliverable

The objective of the ATARCA project was to design incentive mechanisms that could allocate anti-rival resources efficiently and capture the benefits of sharing such resources. An anti-rival resource—for example an academic article, an open-source contribution or cultural work—increases in value when it is shared or used by more people. This contrasts with rival resources, which decrease in value as they are shared. The concept of anti-rivalry has gained attention in recent years as a potential alternative to traditional market-based approaches to resource allocation, which rely on scarcity and exchange.

To reach its aims, ATARCA developed pilots to explore anti-rival value accounting and appropriation in anti-rival systems. The project conducted three independent studies: Barcelona Green Shops, Streamr Community, and Food Futures. The goal of these studies was to assess the impact of new kinds of incentive mechanisms quantitatively and qualitatively.

The ATARCA project used distributed ledger technologies (DLTs) and cryptographic tokens to create the pilots' incentive systems. The rationale for such an approach was that as anti-rival value can be highly context dependent, community-organized accounting methods are needed. Also, in the communities, one needs to avoid excessive power centralization. DLT-based token systems provide the necessary technological foundations for required levels of decentralization and immutability.

As a primary contribution to anti-rival research and practice, ATARCA introduced a new cryptographic token type called the Shareable Non-Fungible Token (sNFT), which is a variation of the more widely known Non-Fungible Token (NFT). The programmability of NFTs allowed for novel incentivization mechanisms that anti-rivalry needs. ATARCA took advantage of this characteristic by creating "smart tokens" that followed anti-rival logic and promoted anti-rival behavior. In practice, the sNFT can be shared like anti-rival goods: such tokens function thereby as a medium of sharing instead of exchange, serving as both a store of value and a unit of account. To disseminate the token innovation, an Ethereum Improvement Proposal ERC-5023 was published.

The purpose of this deliverable is to provide a comprehensive analysis of the pilot experiments conducted under the ATARCA project, especially from the perspective of allocative efficiency. Moreover, the report provides an in-depth analysis of the service and user experience designs, to enhance our understanding of the user-side of new anti-rival institutions.

2. CONCEPTS

2.1. Anti-rival value

Definition. Rival, non-rival, and anti-rival goods are different from accounting and allocation perspective. Rival goods are (usually physical) goods that can be owned and exchanged. Examples of rival goods include food, clothing, cars, books, furniture, and other physical items that can be possessed and used by only one person or group at a time. When one person consumes or uses a rival good, it becomes unavailable to others. For instance, if one person eats an apple, no one else can eat the same apple. If one person drives a car, it's not available for someone else to use at the same time.

The theory also recognizes non-rival goods. Their use does not affect their availability to others. Non-rival goods are those which can be used by multiple people at the same time without diminishing their availability. Examples of non-rival goods include public parks, street lighting, and radio broadcasts. Some non-rival goods can however become congested, which means that too many people try to use them at the same time; consider, e.g., a freeway with too many cars during rush hours.

Anti-rival goods, in turn, are unique in that they become more valuable when they are shared. More theoretically, we can say that anti-rival goods have “negative subtractability”. Further, we can divide anti-rival goods into two categories based on their exclusivity. Exclusive anti-rival goods are those that whose use can be limited. An example of this is a private chat group where only a select few members are allowed to participate. Non-exclusive anti-rival goods, on the other hand, are those that can be used by anyone, regardless of their relationship to the creator or initial user of the good. For instance, open-source software is a non-exclusive anti-rival good because anyone can access, use, and modify it. The non-exclusivity of this type of good does not diminish its value, and it may increase its value as more people use and improve it. However, sometimes these anti-rival systems can become polluted. This means that when a lot of people use a system to share resources, it can become difficult and time-consuming for users to find the resource they need among all the ones available.

Measuring and appropriating anti-rival value. Measuring the value of anti-rival goods is challenging. One possible approach is to use money and markets to assign a value to these goods based on their exchange value in relation to other commodities. However, as already hinted before, this approach has limitations as it may transform sharing into an exchange transaction and—in the worst case—promote a system where anti-rival benefits are diminished through artificial scarcity.

The approach we took in ATARCA is to design new accounting systems that are more aligned with anti-rivalry. Such accounting can be designed to recognize anti-rival resources' unique attributes, especially their potential for increasing value through sharing and collaboration. This involves programming algorithms to track contributions within a community, rewarding individuals for their contributions based on the value they bring to the network as a whole. Such algorithms can account for the non-transactional value of sharing, such as the positive social and emotional experiences that come with contributing to a community. Additionally, these new kinds of accounting systems could encourage the development of trust and identification among community members. Ultimately, the goal of new accounting systems for anti-rival resources would be to create a system that supports and amplifies the value of sharing and collaboration, while preserving the integrity and autonomy of the community.

The role of cryptographic tokens in anti-rival value appropriation. Based on our understanding, community-level accounting is essential for anti-rival systems because the valuation of anti-rival resources often contextually depends on their respective communities. Unlike traditional monetary accounting where accounting items are standardized, and valuations are universal, anti-rival resources require tailored accounting. At the same time, they must maintain the same level of integrity as the global monetary economy. An immutable system that works at the local level is needed.

DLTs, particularly blockchains, provide one solution to the need. DLTs offer the necessary foundations for decentralized and immutable community accounting. They enable the creation of a secure and reliable distributed computing system managed through a peer-to-peer network, allowing all members of the community to trust the platform and participate in governance.

More precisely, blockchains offer the benefits of so-called integrity and transparency effects. The integrity effect ensures the immutability of data and strict time ordering of transactions, making them reliable for accounting purposes and allowing for efficient and trustworthy records of economic activities. Once data is recorded in a blockchain, it cannot be modified, deleted, or overwritten. The transparency effect, in turn, refers to the public availability of all transaction records on a blockchain network. This chain of records can be viewed by anyone with access to the network. The transparency effect is one of the defining features of blockchain technology as it eliminates the need for third-party intermediaries to verify transactions.

Together, the integrity and transparency effect enable the creation of decentralized institutions with immutable rules necessary for sustaining long-lived communities. Digital community platforms built on open blockchains offer a way to create decentralized communities that are resistant to unwanted modification and coercion. These platforms allow for context-dependent, efficient, and trustworthy accounting for anti-rival resources.

2.2. Allocative efficiency

(Re)defining allocative efficiency. The concept of allocative efficiency (AE) refers to the ability of an economy to allocate its resources in a way that produces the optimal combination of goods and services. In a perfectly competitive market, firms are considered efficient in allocation when their price is equal to their marginal cost. This market equilibrium occurs when demand equals supply, and it represents the most efficient allocation of resources, maximizing net benefits.

However, the definition of AE needs to be redefined for anti-rival systems, as anti-rival resources cannot be allocated efficiently in markets. Anti-rival resources, such as knowledge, information, and software, are not rivalrous, meaning that their use by one person does not prevent others from using them. Also, the cost of producing one more copy of an anti-rival good is usually negligible. The challenge is that the market would set marginal cost of production and price to zero. This would mean there would be no good to share in the first place. Artificial scarcity (e.g., digital rights management, DRM) can solve this problem, but then the allocative efficiency would suffer as with anti-rival resources more sharing improves the good and system's well-being.

The essential role of externalities. In contrast to looking at price mechanisms, in designing systems that efficiently allocate anti-rival resources, we must consider primarily the externalities created by resource usage. Externalities refer to indirect benefits or costs that arise as a result of the actions of others in the economic system.

In the context of anti-rival systems, we are especially interested in positive externalities (in contrast to market regulation systems which usually try to mitigate negative externalities. Positive externalities occur when the use of a resource by one person increases the well-being of others without compensation. For instance, someone's contribution to an open-source community creates positive externalities by making the software better to a wider range of users, even beyond the particular community. Another example of positive externalities is the sharing of knowledge and information. When individuals or organizations share their expertise and knowledge with others, it can lead to the development of new ideas and innovations that benefit society as a whole. This is especially true in fields such as scientific research and development, where the sharing of information can accelerate progress and lead to breakthrough discoveries. An additional example is the use of renewable energy sources such as solar or wind power. When individuals or organizations invest in these technologies, they create positive externalities by reducing carbon emissions and contributing to a healthier environment for everyone. This is because the benefits of renewable energy are not limited to the individual or organization using it but are shared by society as a whole in the form of reduced pollution and a more sustainable future.

The concept of externalities is of course not unique to anti-rival systems, but the focus on embracing positive externalities is. Let's go back to the example of DRM, as it is a great example of a measure used to mitigate negative externalities in a market economy, that is, to prevent piracy and unacknowledged use of creative work. However, DRM also prevents positive externalities from forming. DRM restricts the use of digital media by limiting the number of times it can be accessed or shared, which reduces the positive externality created by sharing and promoting the content. For example, a person may purchase a digital movie or album and be prevented from sharing it with friends or family, thereby limiting the exposure of the content to potential new fans. The result may be a net loss of economic value–especially for creators who are not yet very popular–as the potential positive externalities of increased exposure and promotion are not realized. However, at the same time, it is to be acknowledged that the initial contributors must be compensated, and therefore DRM's have a legitimate role in current market systems.

How allocative efficiency was defined in ATARCA pilot cases. As mentioned, the value of anti-rivalry is context-dependent, which raises the question of what constitutes an efficient allocation in each economic system. In our three cases, the focus was specifically on organizing community work to create positive externalities for the community and connected communities. Furthermore, since pilot community resources were predominantly anti-rival, the community work was primarily about sharing the community's resources. Thus, broadly speaking, all pilots aimed to direct community members' sharing efforts towards achieving the community's goals as efficiently as possible. In practice, this manifested in various forms: the Barcelona Green Shops promoted sustainable consumption in local stores; the Streamr Community organized open-source contributions; and Food Futures aimed to have a positive impact on the climate.

2.3. Service design and user experience

Definition. In the general sense, service design encompasses all aspects of developing and delivering a service to a customer, including the business model, service architecture, operational management and user experience. When differentiating service design from general business management, however, the emphasis lies in the customer-perspective, i.e., not what value is being delivered to the customer by the service provider, but what value the customer actually receives, which is based on the collective subjective experiences of the customers. A key aspect of service design is the need to match the frontend operations, which constitutes the customer experience, with the backend operations, which describes the operations management invisible to the customer but necessary to deliver the service.

In digital products and services, the customer is typically referred to as the "user" and since backend operations, once fully developed, are typically less costly to maintain than in retail or physical experiences, a big design emphasis is placed on the user experience (UX) through the user interface (UI). The UI constitutes the visible and tangible part of the service, such as the visible expression of a platform, the functionality of buttons and other features necessary to experience the provided service. UX on the other hand refers to the way in which the UI influences the customer experience.

UX design is an important aspect of web service development because it directly impacts how users interact with and perceive the service. A positive user experience can lead to increased user engagement, satisfaction, and loyalty, while a poor user experience can result in frustration, abandonment, and negative word-of-mouth. Subsequently, in a pilot study utilizing web-based services, an otherwise rigorous research design can be ruined by sub-par pilot implementation leading to a poor UI, and consequentially an ineffective UX. In such case, the pilot does not sufficiently resemble a real setting, creating a risk of biased results. In contrast, by focusing on user needs, preferences, and behaviors, a user experience can be designed to be intuitive, efficient, and an enjoyable, so that it helps users achieve goals and objectives accessible through the service. This becomes particularly important when piloting novel services with mechanisms unfamiliar to the user, which is the case in the pilots developed in ATARCA.

The UX of a platform can be measured by a vast number of different attributes, such as functionality, usability, accessibility and visual aesthetics[1]. The ATARCA pilots all aim to develop community platforms, where users can interact and form a sense of belonging through either collaboration (Green Shops), collective impact (Food Futures), or both (Streamr Community/Talko). The most essential feature of a community platform is the ability to share information, exchange ideas, and communicate. Therefore, the most important component of such a platform is a type of open messaging interface, such as a virtual forum. Other features vary depending on the specific purpose of the platform, but often include components such as private messaging, member profiles, and shared activity calendars.

The success of a community platform targeted at a specific user group naturally depends on the platform's attractiveness as a shared medium for that group. Therefore, when creating a platform that fits the intended context, future users are typically involved in the development of the platform in question. While UX is typically concerned with improving the experience of the individual user, the focus here is on the community. Hence, the platform should be evaluated both by its UX, and the extent to which it strengthens the community and provides the service of increasing allocative efficiency.

[1] Mkpojiogu, E., Okeke-Uzodike, O., Eze, C. & Emmanuel, E. (2022). A Conceptual UX Model for the Design and Evaluation of Interactive Digital Artifacts over Time. 1-6. [Conference paper]. 2022 IEEE Conference on Information Communications Technology and Society (ICTAS). DOI: 10.1109/ICTAS53252.2022.9744658.

3. PILOT CASE: BARCELONA GREEN SHOPS

3.1. The context and purpose of the pilot

In Barcelona, there are economically disadvantaged neighborhoods where sustainable purchases, especially outside the national- and global chain stores, constitute a challenge for residents. Despite this, there are local shops selling sustainable products, but such shops face intense competition from large enterprises.

The Green Shops pilot aimed to support the local businesses by incentivizing non-wasteful consumption through the introduction of a platform (later referred to as the B2C platform) with tokenized rewards. To reduce the adoption barrier, the reward mechanisms were built on top of Barcelona's existing local currency, named Real Economy Currency (REC)[2]. By doing all this, the pilot sought to improve the allocation of resources in the defined communities for sustainability goals.

The pilot also featured a B2B platform that facilitated the horizontal flow of information among shop owners regarding the benefits of an improved zero-waste business models. The B2C and B2B platforms were connected to allow cross-platform communication and rewards alignment between stakeholders. Overall, the success of the pilot was defined by its ability to incentivize sustainable consumption while supporting local businesses in the face of global competition.

3.2. Allocative efficiency in the pilot

In the Green Shops experiment, allocative efficiency was operationalized as the degree to which the use of the B2B and B2C platforms encouraged sustainable consumption in local shops, specifically those shops using the REC. Thus, the operationalization sought better allocation of local community work and resources in terms of sustainability targets.

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[2] "The REC (Real Economy Currency) is Barcelona's social currency, a type of social or local currency. It is a citizen exchange system complementary to the euro, allowing transactions in a community between individuals, institutions and businesses that accept it. Social currencies favor local businesses and the profits revert to the community. The REC (ℝ) is an exclusively digital currency and can be used with a mobile app." Source: https://rec.barcelona/en/what-is-it/

Following such rationale, the key metrics used to measure allocative efficiency included:

1. Activity related to community actions such as sharing and proposing sustainable practices within the communities
2. Community adoption of pilot incentivization mechanisms such as token-based awards
3. The realized user scores and awards shown in tokens
4. Completion of challenges proposed by the platform coordinators to encourage sustainable practices among members

In addition, we analyzed quantitative metrics through a qualitative analysis of public conversations and topics generated among shop owners in the platforms, with a particular interest in community building and sharing of strategies for promoting sustainable practices and products.

Thus, the increased use of the platform and completion of sustainability challenges were considered proof of increased allocative efficiency as community work was then more properly focused on sustainable consumption in local shops.

3.3. Methods to co-design and assess the pilot

General design approach (for both platforms)

Participatory design. To address the challenges of the local shops, we conducted research using a participatory process to understand the perceptions of economic agents in the local shop sector in Barcelona. The process included a focus group with shop owners and a survey for consumers, which took place from May to December 2021. The focus group involved green shops, which had obtained the "green" label granted by Rezero, an NGO promoting zero-waste consumption.

Based on the focus groups, the shop-owners in the focus group felt "alone and weak" in the face of ongoing competitive dynamics. They also believed that having coordination mechanisms to communicate with other shop-owners would be a positive development. Additionally, they expressed that Green Shops did not form a strong enough community to face ongoing competitive challenges.

The consumer survey, in turn, targeted a randomized group of 400 middle-income consumers residing in Barcelona. The survey showed that 91% of participants often buy in large supermarkets, but 71.5% of them would buy more in local shops if they had more information about the positive impact of small local shops. The participants also noted that it is difficult to perceive the aggregate social benefit resulting from their own individual actions and the seemingly negligible positive externalities of their individual purchases in relation to the environment, health, neighborhood resilience, labor, and human rights.

We concluded that externalities related to small green shops could be internalized through the allocation of informational goods using communication and marketing platforms that include proper incentive mechanisms. Therefore, we decided to develop and introduce two platforms; the first for shop-owners with the objective of improving communication among them (B2B platform), and the second for consumers to incentivize responsible consumption at green local shops (B2C platform). Both platforms would include coordination and compensation mechanisms using non-monetary DLT-based crypto-tokens representing positive contributions to the community. The expected outcome was that such mechanisms would contribute to the decrease in costs for local shops and the increase in demand from consumers. It was also envisioned that such token-based systems could make the system potentially scalable and exportable to other similar communities.

Piloting. During the design phase of the experiment, we had to choose between a controlled lab environment, which would produce cleaner results for analysis, but would sacrifice depth and complexity, or a real market scenario with established economic agents. We chose the latter as we wanted to test our socio-technical proposals in a real economic activity setting, which would provide valuable information about building communities through anti-rival value sharing in the digital sphere.

We decided to conduct a longitudinal experiment with only one group of participants over eight months, connecting all shops and customers through the two developed platforms. To control for the impact of the incorporation of the anti-rival socio-technical solution, the experiment was designed in two phases. In the first half, the platforms introduced without the anti-rival tokens. In the second phase, the promotion of sharing through tokens was added.

The pilot was launched in July 2022. Over a period of 8 months, data was collected to understand how people were using the new technology. The focus of the study was on how people adopted the technology and what specific features of the technology they were using. The study ended in February 2023. During the first four months (July to October 2022), the technology was fully functional, but a rewards system for users was not yet visible. During the second four months (November 2022 to February 2023), a rewards system was introduced for users. Altogether, the study included 24 shop owners who participated in a B2B platform and approximately 1,000 users who participated in B2C platform.

Design process (B2B platform)

UX development. The co-design of the pilot's B2B platform involved a series of actions. The process began with a meeting with Green Shop owners (Figure 1), during which they expressed the need to have a common communication tool for shops using the same Green Shop label. The owners indicated that if they had a common digital platform, they could share knowledge and help each other market products. Therefore, a simple and user-friendly messaging platform was needed.

Figure 1. The first session with shop owners from the Green Shops.

Having identified the specific user need, the developer team proceeded to evaluate different implementation possibilities. The first option was to develop a new software from scratch. This option would have granted the administrators complete control over the system but would have required a significant development effort.

The second option was the possibility of developing the platform upon existing closed or open-source projects. To this end, Mesensei (mesensei.com) and Discourse (discourse.org) were two projects considered and assessed as a base for the Green Shops platform. After evaluation, Discourse was chosen. The project is open-source with a large developer community and free developer licensing.

Another important design decision was that the system administrators offered to act as custodians to the users' token wallets, as shop owners felt that they were not prepared to manage their own blockchain wallets.

With these basic guidelines, Qbit's development team started building a new custom platform on top of the Discourse messaging platform. At the end of 2021, the insights from the initial workshop had been used to develop the first wireframes for the new platform. An internal testing session was organized with the NOVACT team to validate the UX at that time (Figure 2). The feedback received from the session was used to modify the first version of the design.

Figure 2. UX Testing with the NOVACT team.

With the platform in an advanced stage of development, a second workshop was organized with shop owners on 6 April 2022, where the wireframes and designs of the platform were presented. This generated positive feedback on the usability and design of the platform, and only few changes were needed to adapt the platform to the user's preferences. One important suggestion from the users was that they wanted to differentiate the discussion topics into three specific categories: relevant information to be shared, questions, and proposals for actions. The platform design was updated to incorporate this suggestion.

The third workshop included the presentation and official launch of the platform on 14 July 2022 (Figure 3). During the session, shop owners were asked about their areas of interest so administrators could post periodic content on the platform. The users asked for tips on online marketing, how to highlight the values of Green Shops, information about the REC, and specific challenges facing green shops. In the feedback the users found the platform to be useful and acknowledged that the development team incorporated feedback provided during earlier workshops.

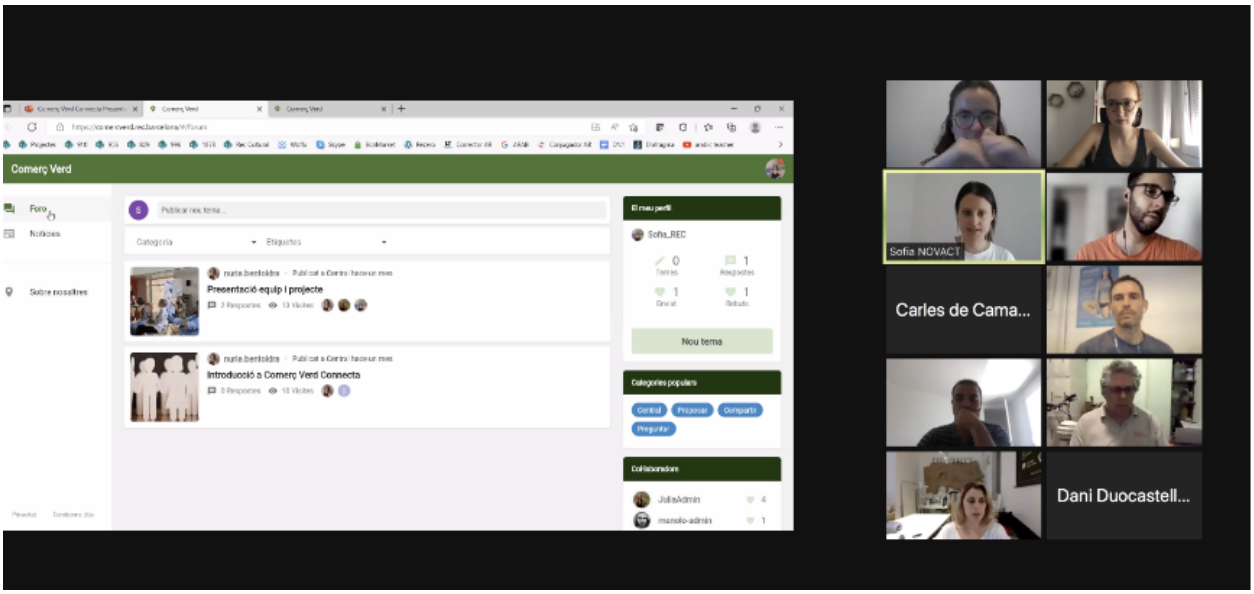


Figure 3. Third session with shop owners: official presentation.

After the platform was launched, Telegram and WhatsApp groups were created to keep open communication channels with shop owners participating in the pilot. Through these channels users could continue to provide feedback on their experiences. Occasionally, some personal direct messages were sent in these groups. The topics ranged from personal experiences regarding the pilot to setting up ad-hoc community events, such as arranging visits to concerts.

The micro-messaging groups also allowed for direct support of the users whenever they had problems with the platform. The most common issues encountered were minor and often related to users' inexperience in using discussion groups, such as password recoveries and login difficulties.

The messaging groups were also useful for completing the necessary legal paperwork when incorporating new shops into the REC system (to allow shops to access the Payment Service Provider (PSP) used for REC-EUR exchange). This is an important technical detail, as shops registering into the B2B platform automatically register into the REC system but lack access to the PSP until all the required legal documents have been provided.

Further, in the later stages of the project, one-on-one interviews were conducted with shop owners to evaluate the service created in more detail. Three main aspects were evaluated:

- *Functionalities.* Shop owners expressed a positive opinion about the platform's functionalities. They believed that the platform covers the main needs expressed during the initial participatory process: having an exclusive space for Green Shops to share important information regarding their businesses. The owners also thought that an additional functionality to implement in a later phase would be a private chat between shop owners within the same platform.
- *UX.* Regarding the user experience, the shop owners found the platform to be simple, intuitive and straightforward to use. They did not encounter any major problems with using the platform, and any doubts that arose were quickly resolved by communicating with the platform administrators.
- *Opportunities.* The main positive aspect of the platform, as seen by the shop owners, is the ability to serve as a common forum to promote joint initiatives that go beyond mere information exchange. It appeared that the shops, often run by one or two people, had a history of considering similar initiatives (such as ecological delivery or a marketplace) but being unable to proceed with the plans due to a lack of time and resources. The shop owners believed that more coordination among shops with similar visions could enable the economies of scale and network effects needed for implementing these initiatives in the near future.

Design process (B2C service/REC platform)

UX development. The co-design of the B2C service began with a pre-pilot survey with consumers. The respondents mentioned that they would be willing to buy in local shops more if they could obtain better information about the impact of their consumption. Hence, the results supported the assumption that the platform needs to highlight the sustainability impact and positive social externalities of buying from local and green shops.

One way to assess the impact of consumption would have been to create a catalog of all products sold in the shops and assess each product's sustainability individually. This would require identifying each product according to its sustainability with a barcode or QR code. Such an approach would have produced a reliable picture of the sustainability of each purchase. However, the investment and development effort required to create such a system would have been significant. Additionally, there would have been concerns regarding data protection. All these aspects prompted the design team to consider a more general and less intrusive approach.

The chosen alternative for development was to create a consumer-driven recognition system. This allowed platform users to easily indicate if shops meet specific sustainability criteria by clicking a survey presented after each transaction. The qualitative measures included a variety of attributes, such as providing *home delivery service, take-away options, attention to customers, handmade products, vegan options, bulk items, local offerings, ecological products, or zero waste items*. The recognition system was given the public name of "badge system", shown in Figure 4.

Another important priority for the pilot was the enjoyment of the user experience. To this end, different options were studied. The first concept evaluated was a game with anti-rival incentives involving a garden representing the impact of each user. The garden would be an identity token, similar to a Tamagotchi, that would become more beautiful as one purchased from environmentally friendly green shops. After carefully considering this possibility and getting feedback from a small group of users, the idea was discarded due to complexity and resource availability.

As a derivative of the original idea, a concept of “challenges” emerged as a way to stimulate sustainable purchases. The idea was based on the “ALS ice-bucket challenge” on social media, where celebrities and ordinary people are challenged to shower in a bucket full of ice[3]. In these videos, the users proceed to complete the challenge before sending the challenge to someone they know, creating a chain akin to old chain emails. This idea received positive feedback in the consortium meeting held in Barcelona in June 2022. It was considered a viable concept that could create positive network effects. Thus, a decision was made to create a weekly challenge that the administrators would manage during the pilot. Users who completed these challenges would receive an award in the form of a token shared by the admin, who was the original token holder. The award would often come with tips about how to consume more sustainably. For example, one of the awards included a tip about reducing plastic bottle consumption by drinking filtered water instead.

The B2C platform was built on top of an existing platform[4] (hereafter referred to as the REC platform), initially launched in 2018 to enable transactions using the REC. To test the added challenges feature within the platform, the NOVACT team organized an internal UX testing session in December 2022. This generated positive feedback from colleagues, indicating that the platform was easy to use and understand. Seeing the purchases, completed challenges, and the REC spent in local shops was inspiring for the users. Seeing the changes in consumption habits was found to be particularly rewarding. The users requested some minor modifications to the platform, including visual simplification and some label name changes.

[3] ALS Association. (2019, June 4). Ice Bucket Challenge dramatically accelerated the fight against ALS.https://www.als.org/stories-news/ice-bucket-challenge-dramatically-accelerated-fight-against-als

[4] https://rec.barcelona/en/what-is-it/

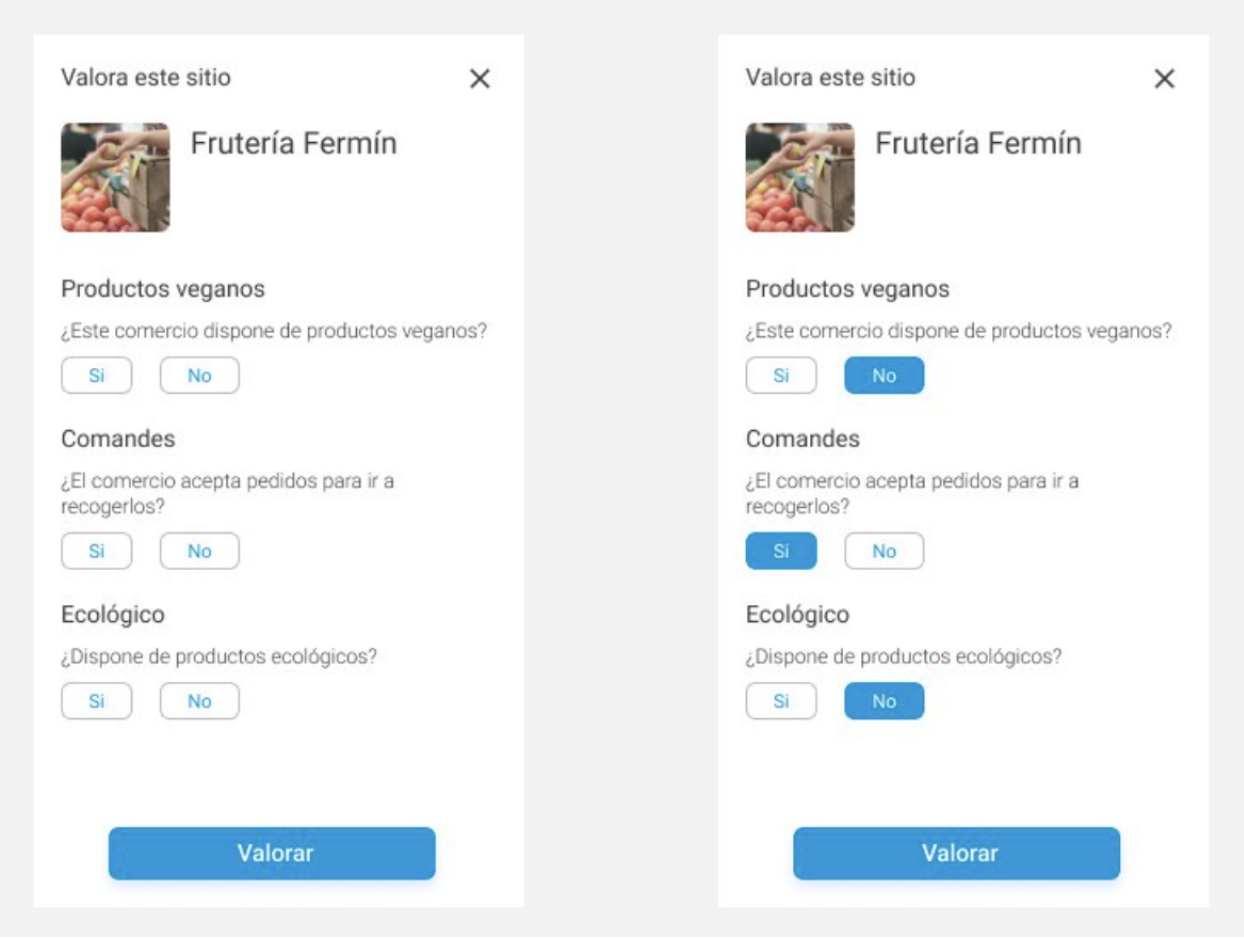


Figure 4. The first design of the badges feature, asking users to assign attributes to a shop they visited.

3.4. Description of implementation and UX design

B2B platform

Current service and UX implementation. To gain access to the Connecta platform, shop owners need to register on the platform, so administrators can validate that the user indeed owns a green shop. Like on any forum, users interact on the platform by posting content that is automatically visible to all other users (Figure 5).

However, unlike conventional forums, interactions on the platform are rewarded with digital tokens, which use the new sNFT token standard developed in the ATARCA project. There are three types of tokens in the Connecta platform:

1. *Contribution tokens*. A contribution token is minted when a discussion topic is started. The token is issued for the originator of the new topic as a reward for contributing to the community.
2. *Share tokens*. A share token is minted when the originator of a topic (one who possesses the contribution token) recognizes a valuable comment under their topic. Share token is issued to the commenter.
3. *Like tokens*. A like token is minted when a user gives a like to a topic posted on the platform. Like token is issued to the author of the liked post.

The share and like tokens maintain the link to the contribution token through the sNFT standard. Technically, share and like tokens are copies of the original contribution token, but assigned to different users (to be more specific, at least to different wallets). Per design, all three tokens receive different levels of recognition within the community. The contribution token is the most important, the share token ranked second place, and the like token is in third place. Furthermore, the number of share and like tokens will determine the value of the original contribution token, as a topic will be more visible on the platform if it receives more shares and likes.

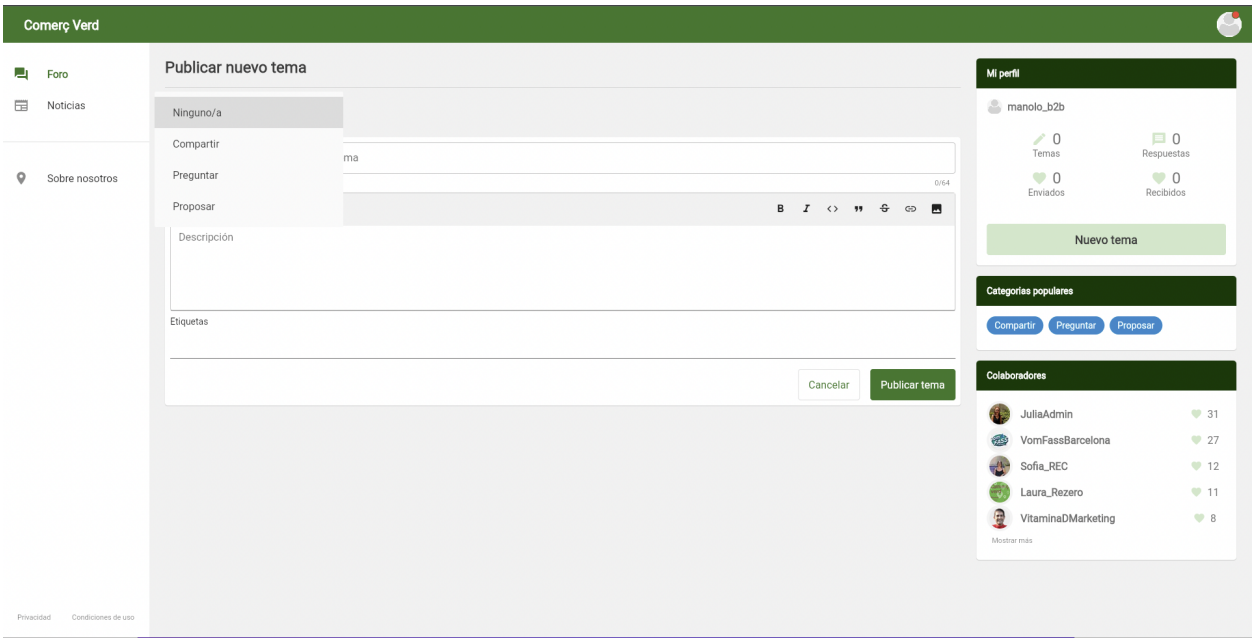


Figure 5. Publishing a new topic on the platform.

A second feature added on top of the Discourse software was a system of rewards represented by an identity token that is not published on the blockchain. Through this identity token, users can see their contributions to the community through simple and intuitive scores. The scoring system was defined by a set of categories that classify the different types of interactions on the platform. There are four categories, of which three are available for users to choose from when creating a new topic (Figure 6):

1. *News.* This category refers to topics published by the administrators about news on sustainability in shops. These publications have been posted by both Rezero, a partner NGO promoting zero-waste consumption, and NOVACT, promoting activity on the platform. The news section has its own section on the platform and is separated from topics belonging to the other categories (Figure 7).

2. *Share.* This refers to a category in which shop owners share valuable information with the rest of the community. An example would be a shop owner wanting to share with the community that they have discovered a new type of low-waste packaging that may be useful to others.

3. *Propose.* The propose category refers to topics proposing a debate or action. For example, a shop owner may propose to organize joint purchases with other shops, or to offer home delivery services.

4. *Ask.* This category refers to posting general questions to other members.

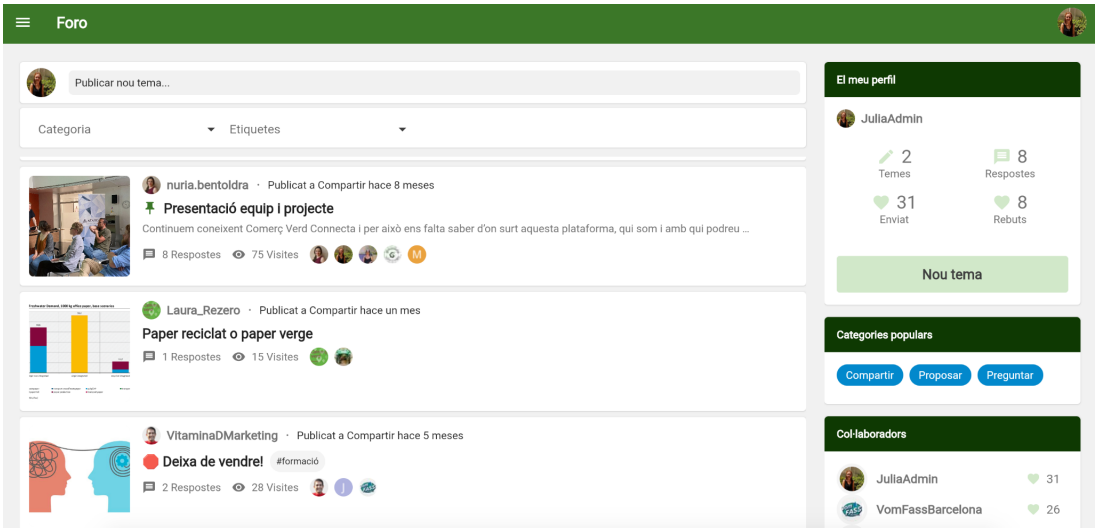


Figure 6. Topics posted on the forum of the platform.

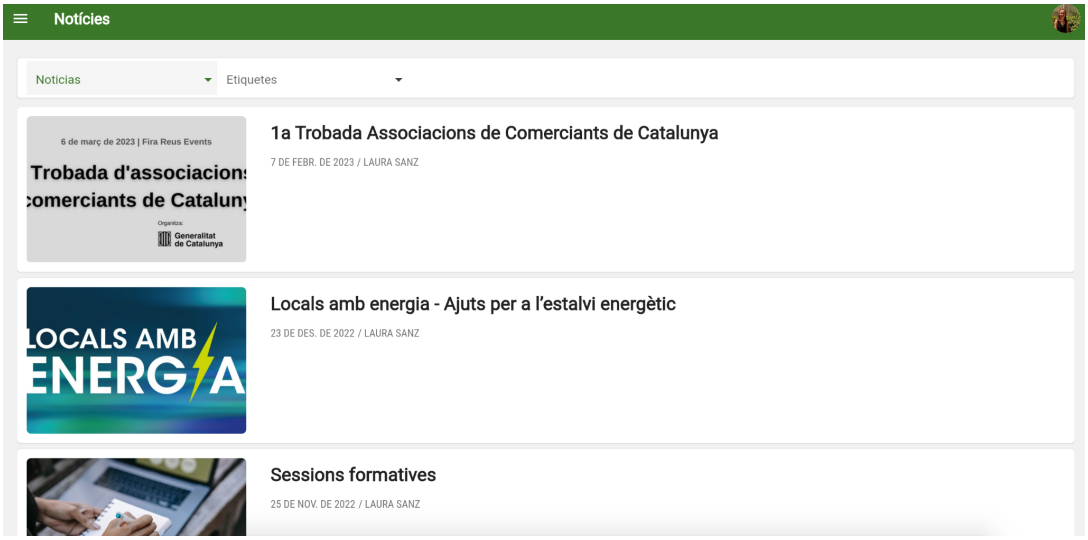


Figure 7. News section with news posts written by administrators.

The REC API assesses the value of interactions according to a set of pre-defined criteria, incorporating the results into the identity token presented on the front end of Connecta platform. Each action generates cumulative scores in three categories: wisdom, word, and momentum. Each category has different levels, corresponding to ranges of scores: Level 1: 0-20 points; Level 2: 20-50; Level 3: 50-100, and beyond. The scores were generated as presented in Table 1 and presented in the UI as shown in Figure 8.

Table 1. The scoring table for the Connecta platform.

Category	Action	Score (points)
Word	Start topic in the forum in “Ask" category	5
	Answer a topic in the forum in “Ask” category	2
	Answering a news article	2
Wisdom	Start topic in the forum in “Share” category	5
	Answer a topic in “Share” category	2
Momentum	Start a topic with “Share” category	10
	Answer a topic with the “Share” category	2
	Like a post in the forum	1
	Like a topic in the forum	1
	Liking a News post	2
	Receive a like in a topic	3
	Receive a like in a post	2
	Sign-in to the platform	1

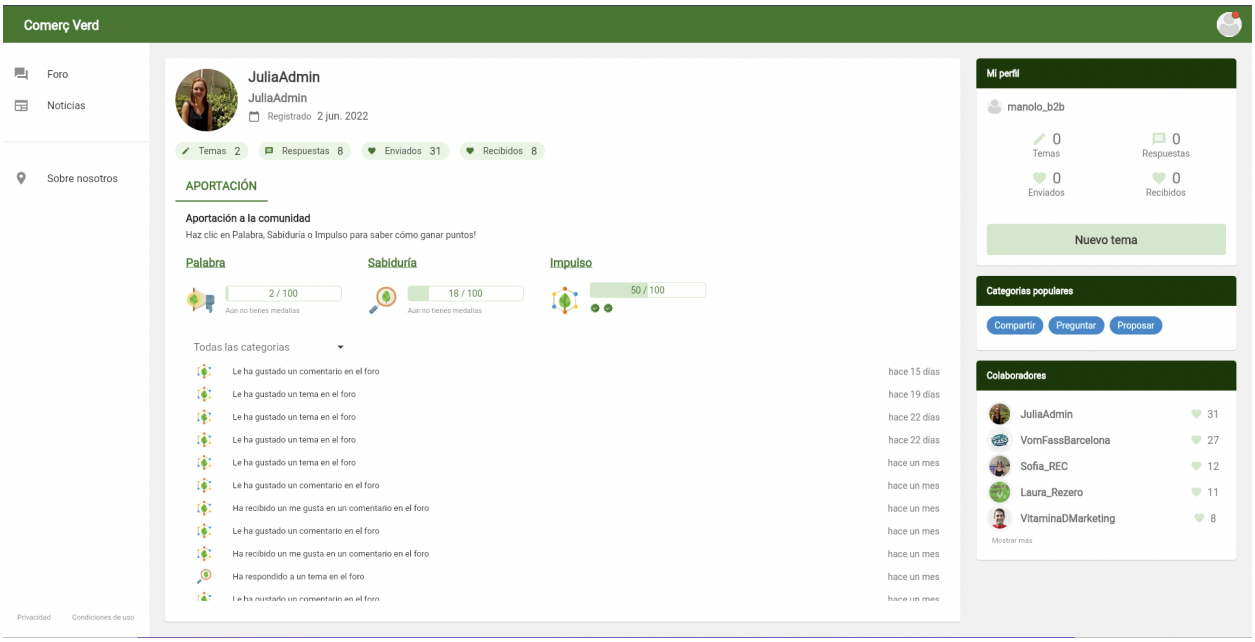


Figure 8. A screen showing the identity token with corresponding scores and awards.

Backend. The back-end of the Connecta platform was built on top of the open-source forum Discourse. Additional functions were added to the source code to adapt to the needs of the pilot. Furthermore, a new front-end was created that allowed the administrative team to link Discourse and the REC API.

When the shop owners used the platform, their actions were notified by the core of the system, the REC API, which connects all services. The REC API is responsible for deciding the relevance of the interactions and responding to them accordingly (for example, by sending a recovery password email or minting a token). Regarding interactions like topics and contributing comments, the REC API is connected to the Web3 Manager software, which executes the different functions on smart contracts. The system schematic is illustrated in Figure 9.

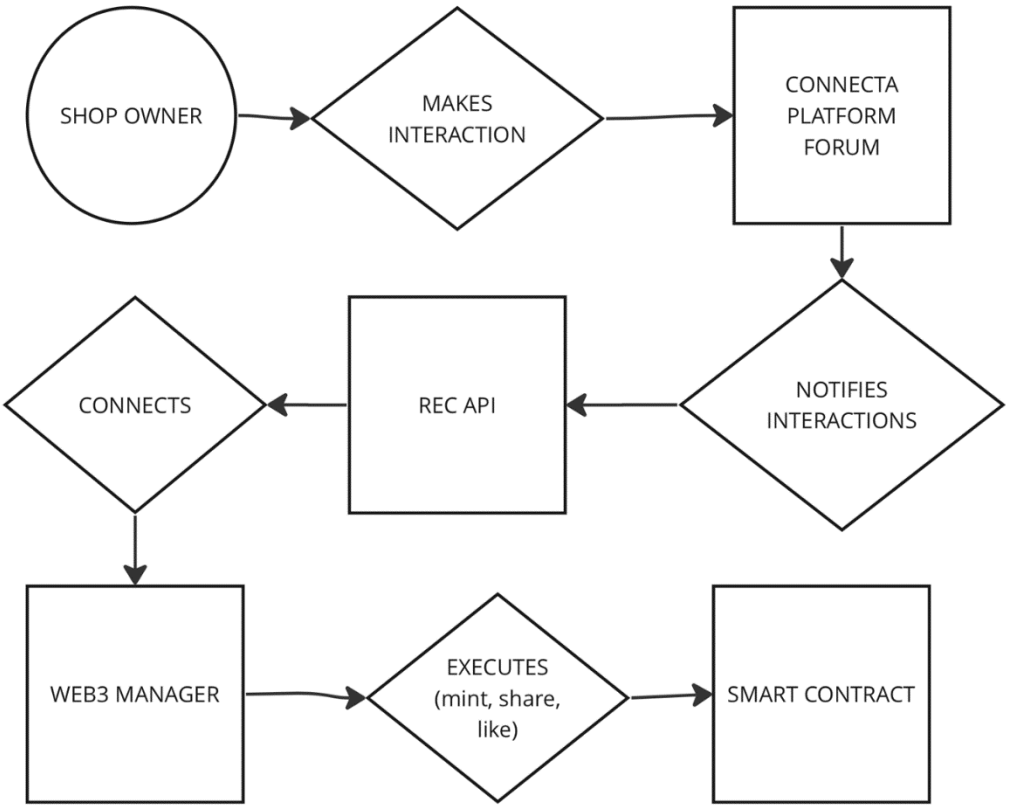


Figure 9. Implementation scheme of the B2B platform.

B2C service/REC platform

Current service and UX implementation. As mentioned, the B2C service has been created as an added feature to the existing REC platform and includes both a badge system to recognize shop characteristics and an incentive system to promote sustainable shops.

Each time a consumer buys in a shop, a survey on the platform asks them to attribute characteristics to the shop as described earlier (Figure 10). In this way, the incentives created with the challenge campaigns can be accurately targeted to shops with different characteristics and according to specific consumers' preferences. When a pre-defined amount and share of consumers identify a shop as part of a particular category in the post-transaction survey, the shop is given the respective badge. As a result, consumers can filter their searches in the REC platform's map using the identified categories.

Figure 10. The survey to consumers after a transaction (left). The shop information view on the platform (right).

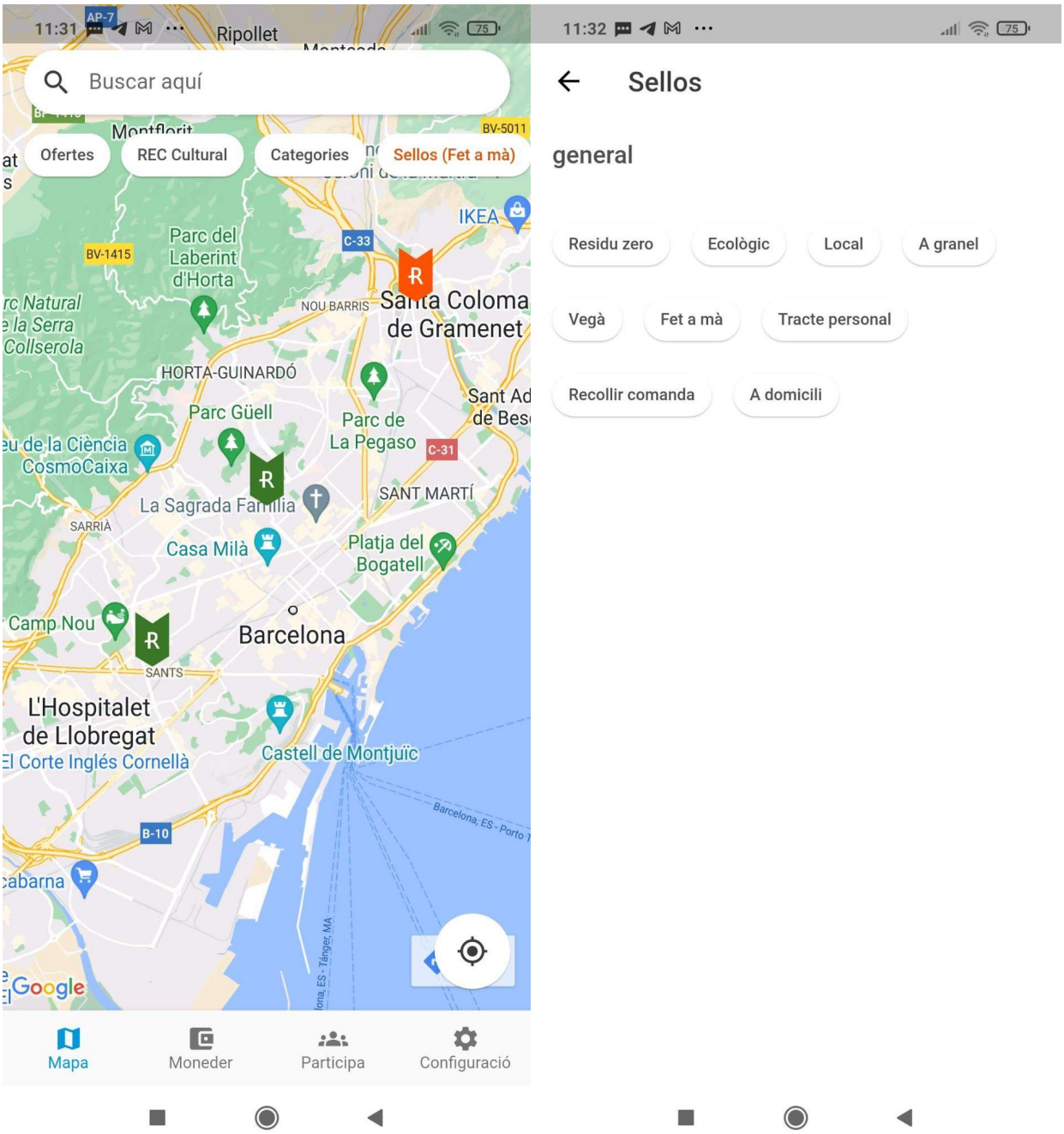


Figure 11. A map showing three shops (left). Badge filters of the map search (right).

The challenges were created periodically by system administrators since January 2023. The administrators defined which action was required to complete each challenge. The challenges created were:

1. Spend 5 RECS at REC establishments
2. Spend 10 RECS at the shops on the map
3. Make two purchases at the shops on the REC map
4. Spend 15 RECS at any shop on the map
5. Spend 5 RECS at any shop on the map
6. Shop at two shops on the map
7. Spend 10 RECS at any shop on the map

For the users, the challenges were found in the bottom menu of REC platform (Figure 12). Through the "Participate" button ("Participa" in Catalan), the users could access two tabs of "Challenges" and "Awards" ("Reptes" and "Premis"). The "Challenges" tab contained the content of the challenge, the time remaining for completing it, and the proportion so far completed by the user. The "Awards" tab ("Premis"), in turn, contained the challenges completed by all users, the number of transactions, and the amount of REC spent on the platform. By clicking on the "Completed Challenges" ("Reptes Completats"), the user could also view the pictures, videos, and other metadata of the token that the users got when they completed a challenge.

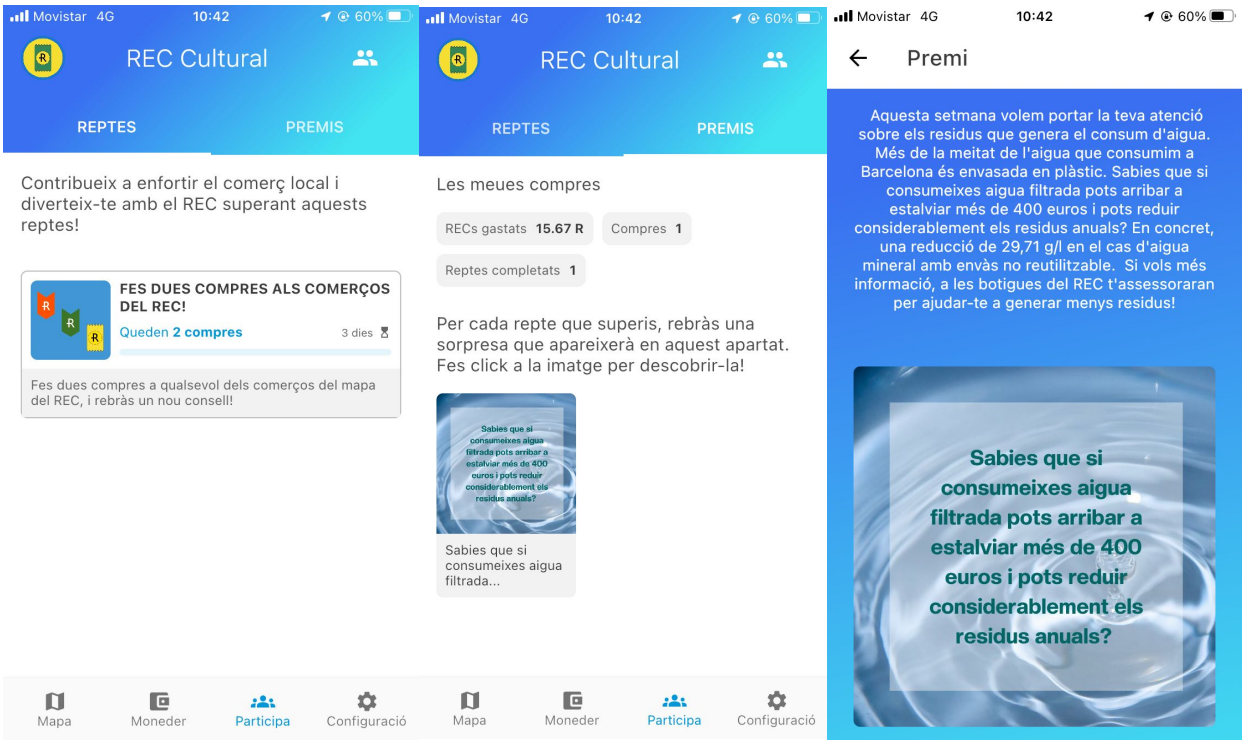


Figure 12. REC platform with challenges and awards (left and center). Stylized award token metadata (right).

Backend. When an administrator creates a challenge, they add all the information related to the challenge to the metadata, and a new token is minted. This metadata contains information on the actions to complete the challenge, the image of the challenge, and information about the receiver and issuer of the token. There is also a "category" attribute in the metadata that only allows the "buy" action corresponding to spending in REC for the time being. However, the system is prepared to add new categories like "vote" and "shop validation", which could be used to organize polls and surveys, respectively. This would also allow users to recognize shops by giving badges or tokens. These options should be tested in future development.

The original token created with the challenge belongs to the system administrators. However, when users complete a challenge, which involves spending REC in green shops, the REC API identifies the completion of the challenge. The platform automatically issues a share token to the user, a clone of the original challenge token belonging to the administrators, through the Web3 Manager service, publishing the new token on the blockchain. This system is illustrated in Figure 13.

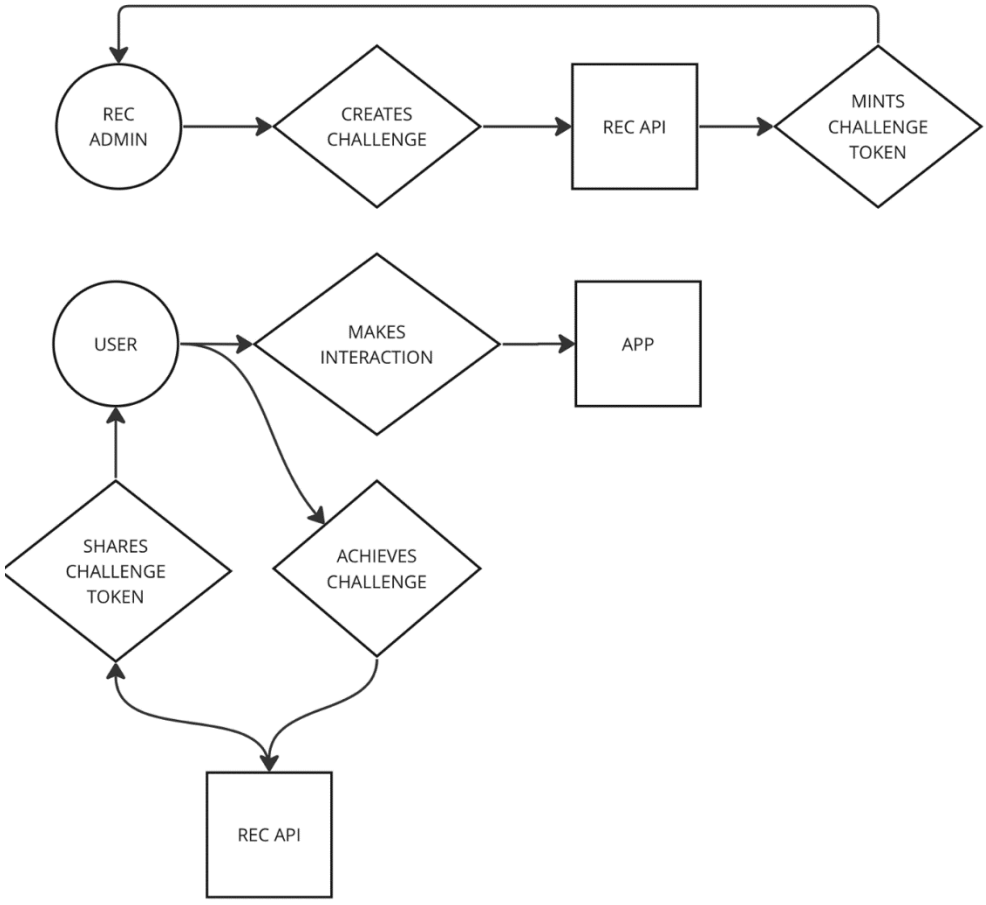


Figure 13. Implementation scheme of the B2C platform for admin and users.

Further development. There are multiple ways in which the platform could be further developed. For instance, future developments could allow users to create their own challenges, making them more shareable and interactive. This way, REC platform users would be more incentivized to challenge each other to complete them. This feature would bring the platform closer to the ice-bucket challenge that initially inspired the green shop challenges. Additionally, observing other users completing challenges could encourage more frequent use of these features. Another potential way to enhance the platform would be to connect both platforms, enabling REC customers to see which shop owners are more active on the Connecta platform. Such a connection would increase the competition between shop owners, thereby incentivizing them to be more active in the community. However, to avoid any adverse effects that could potentially emerge from the competition, such features should be carefully discussed with shop owners.

3.5. Results of the pilot

Quantitative analysis. Based on our quantitative analysis, we have observed a clear increase in user activity on the platform since the introduction of the token-based incentives. Tying to our allocative efficiency targets directly, the B2C users have coordinated their efforts and investments toward community goals, and in the B2B platform, the frequency of new posts, and topics has increased.

In more detail, our analysis of the B2C service data reveals significant community activity related to the challenges that the members completed. As mentioned, these challenges were proposed by the platform administrators as a way to encourage sustainable practices among the members. A large number of participants completed each of the challenges, indicating a commitment to sustainability and a willingness to take concrete actions towards it.

Table 2 summarizes the challenges, the total amount of RECs used in challenges (1 REC = 1 EUR), the number of participants, and the number of challenges completed.

Table 2. Community challenges.

Challenge no	Challenge content	Total RECs used	Number of participants	Challenges completed
1	Spend 5 RECS at REC establishments	23,086	112	97
2	Spend 10 RECS at the shops on the map	24,730	130	123
3	Make two purchases at the shops on the REC map	23,169	153	17
4	Spend 15 RECS at any shop on the map	15,047	107	104
5	Spend 5 RECS at any shop on the map	28,851	121	125
6	Shop at two shops on the map	32,937	191	23

7	Spend 10 RECS at any shop on the map	37,520	164	157

In the B2B platform, the community actions attributed as the sharing of information about sustainable practices (Figure 14), exhibits a marked increase in activity from September onwards, culminating in a peak towards the end of 2022 and early 2023. The actions attributed as proposing new collective sustainable practices displayed significantly lower activity, however with more activity emerging towards the end of the year 2022. Both changes at the end of 2022 could potentially be attributed to the introduction of the token and its associated incentives.

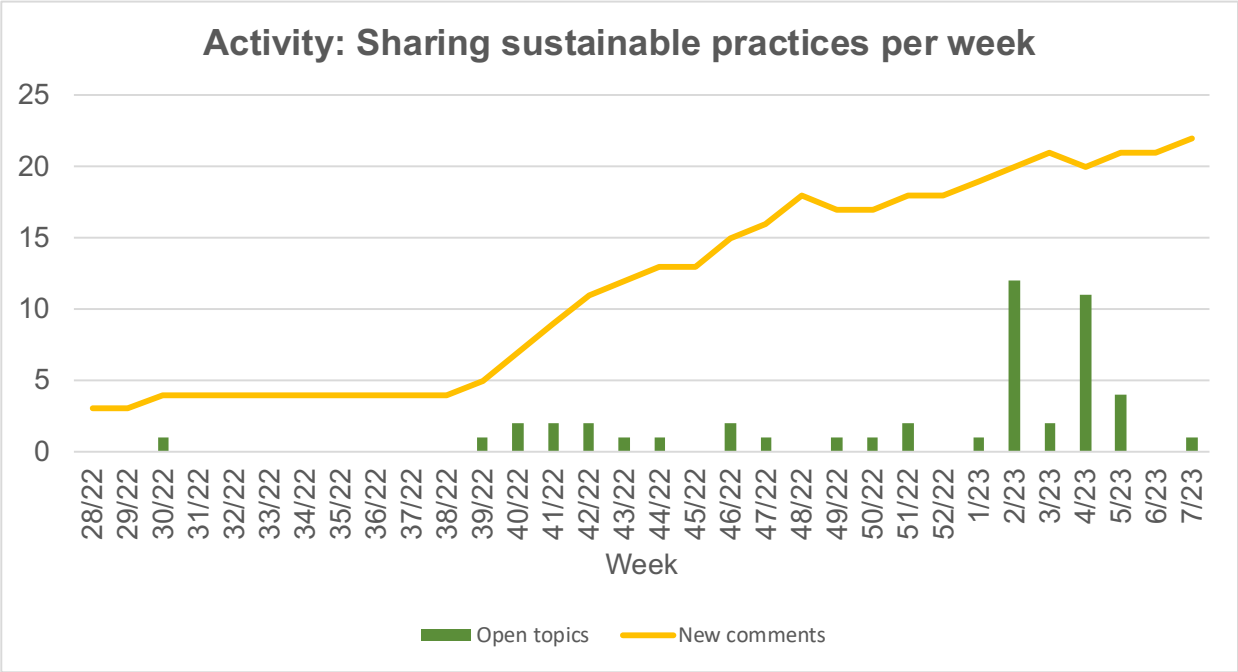


Figure 14. New topics attributed as belongin in the "Sharing" category, which is when users share information (e.g., advice or experiences) about sustainable practices.

Qualitative analysis. The qualitative analysis was a crucial component of this experiment as it provided a deeper understanding of the motivations and content of the interactions between shop owners. Our study focused on analyzing public conversations and the topics that generated more interest among shop owners.

The topic that generated the most conversation among participants was self-presentation (Figure 15). Many members posted a text presenting themselves and their shops, expressing satisfaction for becoming members of the newly created platform and their desire to create a real community. This indicates that the B2B platform achieved its main objective of fostering a strong community of green shops.

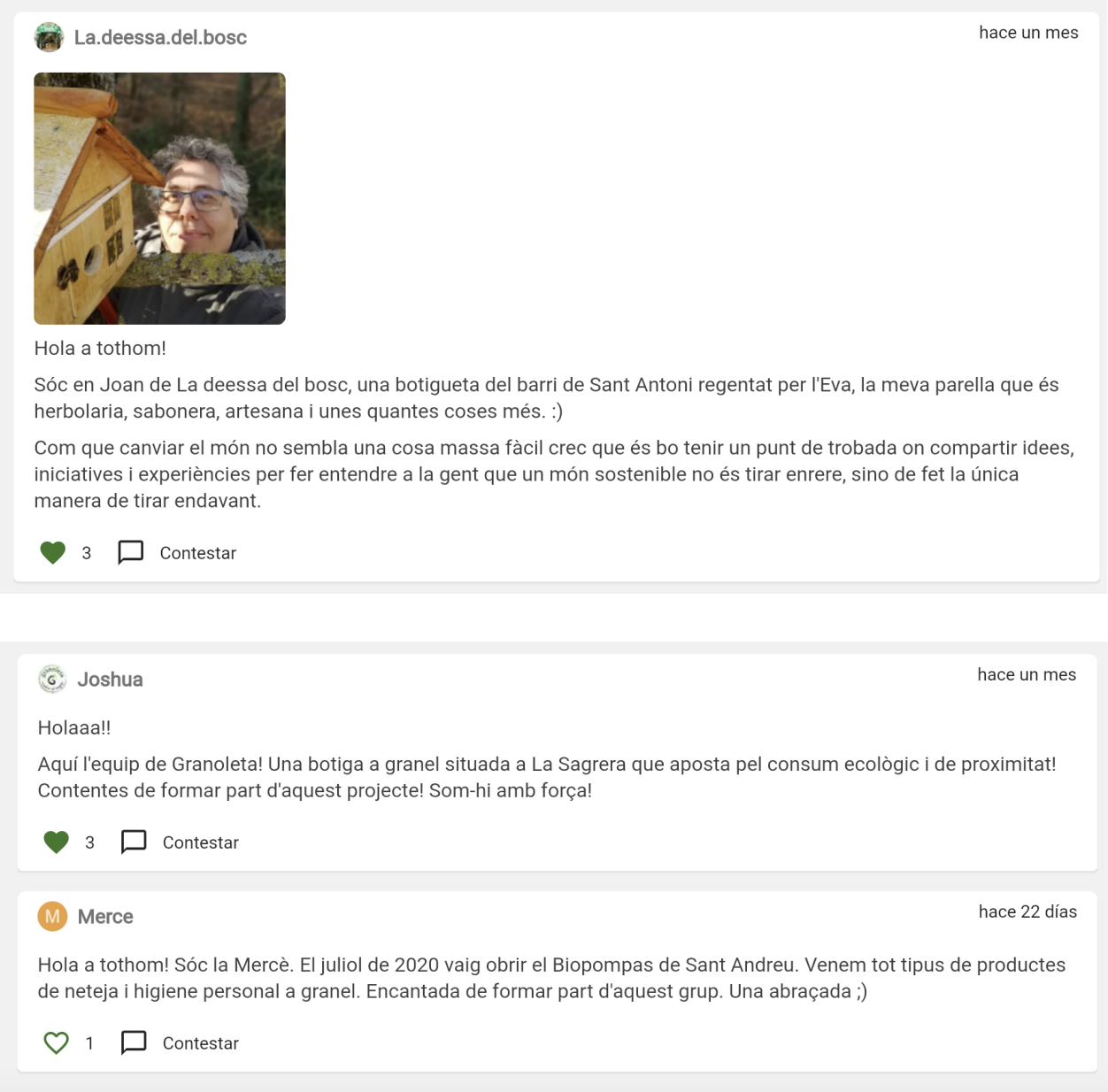


Figure 15. Excerpts from community discussions (self-presentations).

Moreover, we observed that topics related to green products generated more interest than those related to marketing tools. For instance, a post discussing the issue of compostable bags and bio-plastics had 33 views and different comments. This topic was followed up with more information to answer questions that emerged from the initial post. This indicates that shop owners are interested in discussing and sharing information on sustainable products in particular. The conversations are illustrated in Figure 16.

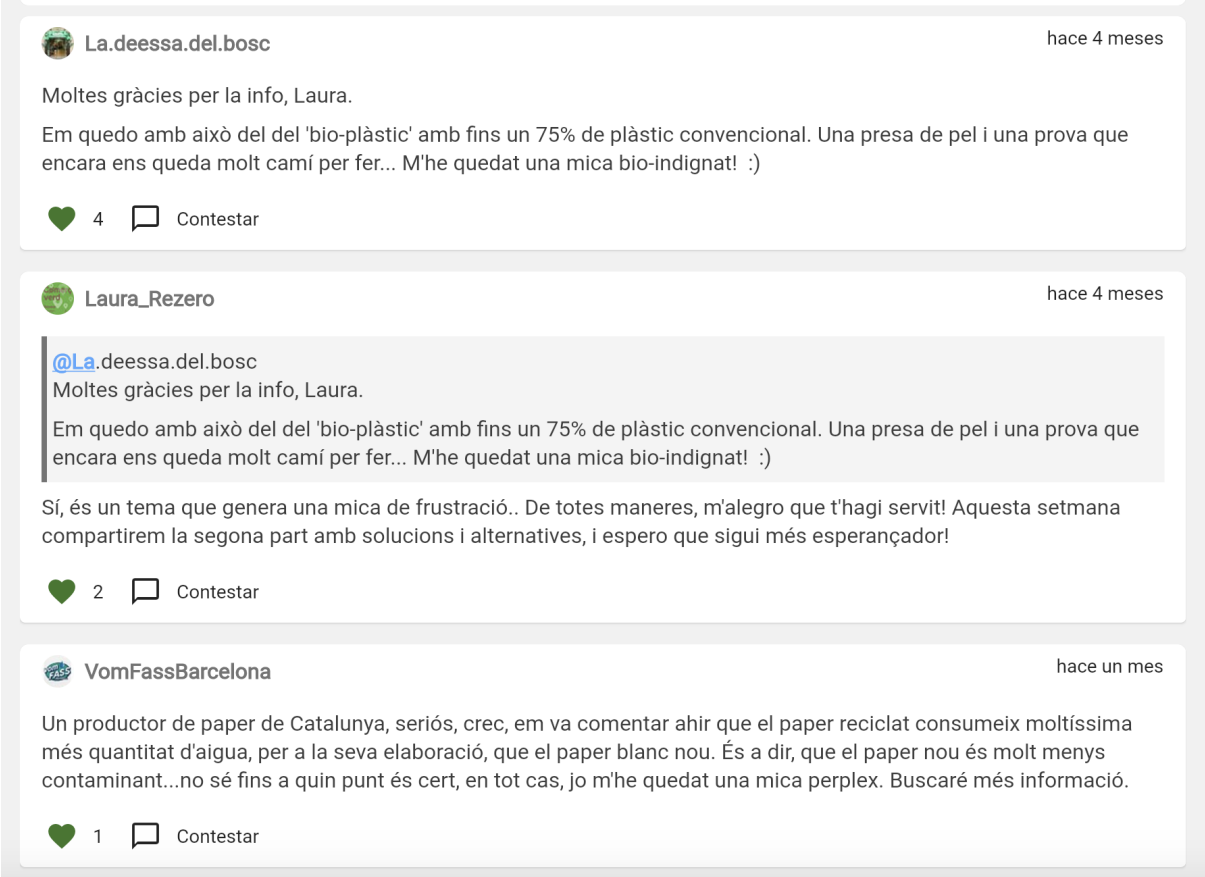


Figure 16. Excerpts from community discussions (sustainable practices).

Other topics that gained considerable traction were those related to promoting products with sustainability criteria and using community communication to understand customer needs. Such findings suggest that shop owners are interested in sharing and learning about strategies for promoting their sustainable products and understanding their customers better.

Synthesis of the results. All in all, the quantitative results suggest that the introduction of the token-based incentives have been effective in generating positive incentives for users to contribute to the platform. This outcome is in line with the platform's goal of fostering community engagement and collaboration. The qualitative results, in turn, provide further evidence that the B2B platform is generating positive incentives for shop owners to engage in conversations and share information related to sustainability.

Thus, we conclude that after the introduction of our B2B and B2C platforms, the community members were more engaged and motivated to participate in sustainable consumption practices in local shops, which can be seen as a form of increased allocative efficiency. With the help of the token-based incentives, community members were able to better allocate their resources in a way that supports their values and contributes to the local economy. This can ultimately lead to more sustainable and efficient resource allocation in the community.

Limitations. Primarily due to ethical reasons, we did not implement control groups because it would have constrained the potential positive network effects in the community. Also, the groups would have been too small in size to extract any quantitative meaning from the data on the interactions. Instead, we complemented the analysis with qualitative in-depth case studies to overcome the limitations of a purely quantitative approach.

Other limitations include a small sample size, limited duration of the experiment, low potential bias in participant selection, and the fact that the experiment was conducted in a single location and may not be representative of other areas.

4. PILOT CASE: STREAMR COMMUNITY

4.1. The context and purpose of the pilot

Community contributions are vital for any open-source project, and they can take many forms, such as code contributions, bug reporting, documentation, community management, and marketing. However, it remains challenging to motivate community members to contribute, and in particular, to focus the contributions efficiently. This applies especially to non-coded (not programming related) contributions.

The Streamr pilot was designed as an experimental initiative to incentivize and focus community work in the Streamr ecosystem. Streamr is a decentralized platform for real-time data and offers tools for data streaming, data analytics, and data monetization. The platform has a community of developers, data scientists, and data enthusiasts who are actively engaged in building and improving the Streamr ecosystem. The pilot was aimed at further engaging the Streamr community and rewarding their contributions in an anti-rival way.

The pilot was launched in October 2022 and consisted of a pilot platform, including the necessary technical infrastructure and tools for operating it, pilot operators, and pilot users. The pilot operators were members of the Streamr marketing and communications team, who were responsible for identifying, evaluating, and rewarding significant contributions made by community members. The pilot was designed to be open-ended and flexible, allowing for the pilot operators to use their discretion in rewarding the community members as they saw fit.

4.2. Allocative efficiency in the pilot

Allocative efficiency was operationalized in the Streamr pilot experiment on tokenized incentives as the ability of the Streamr community to effectively allocate its resources, including time and skills, towards the development and improvement of the Streamr Network. The pilot experiment measured allocative efficiency by examining the level of community engagement and contribution to the Streamr Network.

The study operationalized several variables to assess the impact of tokenized incentives on the Streamr community's allocative efficiency. The number of community members and their activity levels were operationalized using token data, which allowed for tracking participation before and after the implementation of tokenized incentives. The engagement and activity levels of community members were operationalized by collecting Discord data, including the number of active users and messages sent during the pilot experiment compared to the pre-pilot period. Finally, the impact of tokenized incentives on community members' perceptions of their ability to contribute was operationalized using survey data. The survey assessed how community members perceived Streamr Awards in terms of its ability to motivate them to contribute to the community, assist them in discovering where and how they could contribute, and help them to use their time more effectively while contributing.

4.3. Methods to co-design and assess the pilot

General design approach

Participatory design phase. Streamr pilot's co-design process involved various data sources, including surveys and interviews with Streamr ecosystem stakeholders. The surveys were designed to collect quantitative data on stakeholders' opinions, before and after the pilot, about the proposed cryptographic incentives and their potential impact on the Streamr ecosystem. Meanwhile, the interviews aimed to gather qualitative data on stakeholders' perceptions of the proposed incentives, their concerns, and their suggestions for improvement.

Additionally, service design tools were used to visualize and co-create solutions to address the challenges faced by the Streamr ecosystem. These tools helped identify key pain points and opportunities for improvement within the ecosystem. Furthermore, ecosystem design tools were utilized to map out the relationships between stakeholders in the Streamr ecosystem and how they interact with each other. This provided a better understanding of the ecosystem's dynamics and helped in the design of appropriate incentives that would encourage participation and collaboration.

Piloting phase. The Streamr community case pilot became operational in mid-October 2022 and as of February 2023, it is still ongoing and being updated. The pilot was developed and released in phases. The first phase, which took place from 15 October 2022 to 14 November 2022, involved launching and communicating the pilot to a small number of core members of the Streamr community. In the second phase, which started on 15 November 2022, the pilot was openly communicated and advertised to the rest of the Streamr community. Throughout the rest of the pilot timeline, new features and updates were added to the pilot platform.

The experiment consisted of the pilot platform including the technical infrastructure required to operate it, pilot operators, and pilot users. Two members of the Streamr marketing and communications team that managed the Streamr community were designated as pilot operators and given the necessary access rights and tools to create new Streamr Award tokens for the Streamr community members.

Pilot operators were instructed before and during the pilot to identify, evaluate, and reward significant contributions completed by community members with Streamr Award tokens. Prior to the pilot launch, an objective criterion for the definition and evaluation of community contributions was explored with the Streamr marketing and communication team. However, it was found that establishing an exact criterion for evaluating and rewarding contributions was not feasible as the historical community contributions varied greatly by their context, quality, and quantity.

Hence, the pilot operators were given the freedom to reward the community members as they best saw fit. However, operators were reminded that if Streamr Award tokens were given ‘too easily,’ their perceived benefit or value may depreciate, and the tokens may not be seen anymore as rewards and incentives by the Streamr community.

Throughout the pilot, weekly meetings were held between the pilot operators and the Streamr Community case developers. During these meetings, events that had happened in the community since the last meeting and any prospective community contributions that had occurred since the last meeting were discussed. In addition, the pilot operators were frequently asked about the community’s impression towards Streamr Awards, and, if needed, any assistance for operating the Streamr pilot experiment was offered and given.

Design process

Pre-pilot surveys and interviews. The user experience was scoped using surveys and interviews. Prior to the official launch of the pilot, between July and September 2022, a survey was sent to the community members to determine if the design choices, including the use of tokenized non-monetary incentives, aligned with the members' expectations. 31 community members responded, The survey also asked if respondents' would be willing to participate in a short interview to further investigate survey results and test the pilot platform.

The survey consisted of four sections: 1) Personal background information, 2) Activities in the Streamr community, 3) Motivation and incentives to be active in the community, and 4) How the respondent thinks about community awards. Table 3 provides a summary of the survey themes, community responses, and implications for pilot concept and scope.

Table 3. The survey questions, responses, and implications for pilot design.

Question	Response summarized	Implication
Members' activity types in the community	The most typical roles in the community were investors (DATA token holders) and Streamr node runners. Developers who create platforms to the Streamr ecosystem seemed to be a minority.	This result affected how the award categories were defined. The role of node runners needed to be emphasized.
Do members act alone or in teams	74% of the respondents indicated that they work alone.	The result was seen to affect award sharing. In the case of solitary work, there are no team members. However, one might want to share the award with some prominent community members that have provided inspiration or a model on how to contribute.

Motivations to be part of the community	The responses were divided roughly 50-50 between monetary benefits (getting DATA tokens or having DATA tokens rise in value) and non-monetary benefits (learning new skills, getting recognition and references).	Non-monetary rewards seemed to play an important role to a large share of the community members, but not to all.
The motivating role of additional benefits (e.g., tokens)	About 97% indicated that they could do more.	A promising result for the pilot experiment.
Which additional benefits would be most motivating	Most respondents (68%-77%) selected different monetary or project status-related incentives. 39% indicated "Streamr offering better tools, documentation, and resources for community participation", and only 32% indicated "Getting more recognition for my efforts from the community".	This was a concerning result for the pilot as it seems that monetary rewards are overwhelmingly important.
Reasons preventing from contributing	Lack of time and not knowing how to contribute were the most typical reasons (40% each).	An important result since Streamr could offer community members more advice about the different ways to contribute.
Perception toward Award tokens	More than 90% think positively about award tokens.	A promising result for the pilot experiment.

After the survey, 30-minute pre-pilot interviews were conducted to obtain more profound qualitative insights into the survey themes. The interviews were also utilized to collect feedback about the community award platform before its public launch. Additionally, a user test was conducted during the interviews, focusing on the platform's usability and general feedback about the platform's UX and the service concept.

The initial four interviews were conducted internally with members of the Streamr/TX team, followed by four interviews with actual members of the Streamr community. The interviews were recorded, and the data were analyzed based on these recordings. The results of the user tests were categorized according to the participant's success level, and conclusions were drawn based on this categorization.

User tests. After the platform was fully functional, the team conducted user testing sessions, which consisted of both a short thematic interview and usability tasks. Four members of the Streamr community participated in these sessions, in addition to the four Streamr and TX employees who were previously interviewed.

Prior to the user tests, testers were asked to provide their wallet address, and a test reward token was minted for each tester. The testers were then instructed to navigate to the test server, where a version of the pilot platform had been deployed. During the testing sessions, the testers' behavior and activities were observed, and the testers were guided through any issues they encountered. The testers were asked to accept privacy and cookie policies (with an option to quit testing at this stage if they so wished), connect their wallet to the pilot platform, and provide informed consent (again, with an option to quit). The testers were also asked to browse the awarded tokens, share an awarded token to another user, and "like" a token.

Several interviewees said that they initially became interested in the Streamr network's DATA coins from an investment point of view, and only later joined the Streamr community and began activities such as node running. They viewed Streamr as a "friendly" community of people with a genuine interest in Web3 innovation and utility, rather than a group of "pump and dump" enthusiasts as in some other crypto communities. While there were some periods when the connection to the team was lacking, the interviewees generally expressed satisfaction with the engagement of the Streamr team and their responsiveness to community members. As one informant put it: *"even the CEO reads your emails and answers to you"*. However, some interviewees expressed a desire to contribute more to the Streamr community but were unsure of how to do so. This finding was seen already in pre-pilot survey findings, where 10 out of 31 respondents expressed a similar sentiment.

In general, the interviewees indicated a positive interest in sharing their awards, although their willingness to do so depended on the nature of the award, which remained unclear at this stage. When asked with whom they would share their award, they mentioned some important and well-known Streamr community members. This suggestion resonated with the survey findings where most respondents (74%) indicated that they work alone when contributing to the community. Based on these results, award sharing may be less common with actual co-contributors and more typical among prominent community members who have provided inspiration or practical advice.

Notably, several interviewees were wondering what would happen if they clicked the “Share” or “Like” button next to a community award (see Figure 17) and requested better information or a help-text explanation. It seemed that some confusion arose because the concept of “sharing” was understood based on its typical use in social media. On the other hand, “Liking” was understood as intended by the platform.

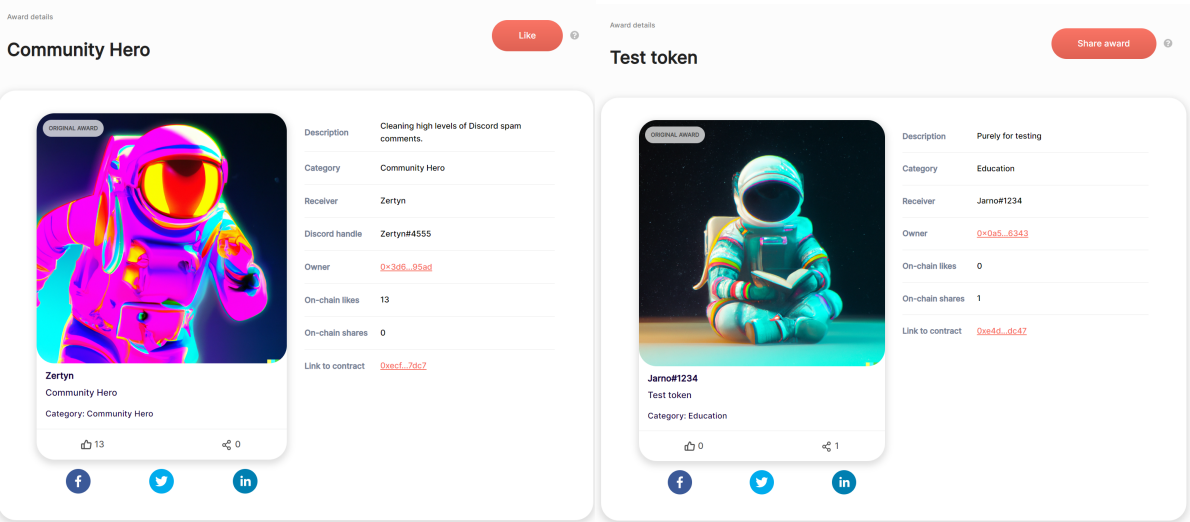


Figure 17. Sharing versus liking. Only a Streamr Award token receiver could share it whereas anyone could like others Streamr Award tokens.

In summary, users seemed to like the idea of award sharing and the entire concept of the Talko community award platform. However, they considered the current site (right before its public launch) “fairly basic” and in a need of more features in the future. The users also made suggestions for new features and improvements to the Talko platform, including: 1) adding more filtering options for searching, 2) leaderboards (e.g., most awarded community members and most liked awards), 3) gamification of awards, and 4) issuing community awards as rewards for completing a course on a learning platform or for building apps on the Streamr stack. Some even suggested connecting the awards to DATA token income from Streamr.

Some additional generic suggestions from the Streamr community were to introduce more community admins, educate members better about how they can contribute to the community, and improve communication about how the Streamr tech stack can be applied to different use cases. From the user testing and interviews, a 101-item list of UX and UI improvements was created. These improvements were categorized into priority levels (low, medium or high), depending on their criticality. Byt the time of pilot release, all high-level issues were resolved, and the majority of medium and low-priority items were addressed during the pilot. Additionally, a new feature for the pilot infrastructure was implemented based on user testing: notification integrations which generate immediate visibility of new Streamr Awards on both Twitter and Discord (Figure 18).

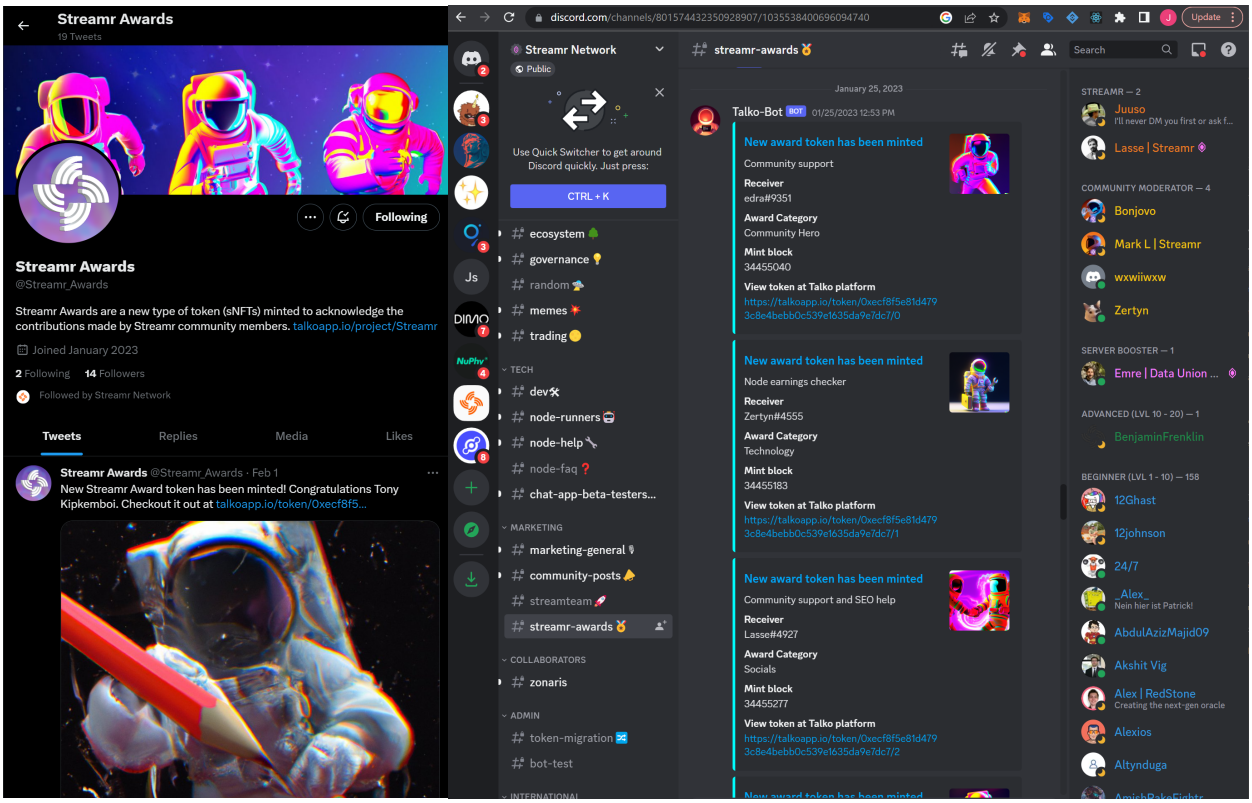


Figure 18. Notifications of new Streamr Award tokens are sent to the main Streamr community channels, Twitter, and Discord once the receiver has given their informed consent for metadata publishing.

4.4. Description of implementation and UX design

Current service and UX implementation. As a result of the process above, the Streamr token system was designed to serve multiple purposes. First, it recognizes and rewards community contributions through shareable non-transferable Streamr Community Award tokens, which are evaluated, verified, and awarded by Streamr project staff. Streamr Award Tokens serve as a record of significant community contributions and provide examples of the type of effort or contributions that have been awarded in the past.

Secondly, the token system includes non-transferable Like tokens and Endorse, tokens allowing community members to voice their opinion on which contributions they have appreciated most. Anyone, inside or outside the Streamr community, can mint a Like token associated with a specific Streamr Award token. In contrast, only community members who have received a Streamr Award token can mint an Endorse token, which is also associated with a specific Streamr Award token. Additionally, an Endorse token minter can leave a short message on the platform to show appreciation or encouragement to the recipient of the Streamr Award token.

Community members can compare, sort, and filter the community contributions based on their perceived significance using the likes and endorsements associated with the awarded contributions. Overall, the Streamr token system serves as a non-monetary incentive for community members, recognizing their contributions and signaling their accomplishments to the rest of the community.

For the users, the token system is manifested through Talko, which is linked to the Streamr token system. Talko was designed to assist community managers and members in creating, browsing, and utilizing different cryptographic tokens and their functionalities that are specific to the Streamr Community Case. Talko aggregates information on token transactions and their metadata from the blockchain and displays it as a collection of cards on the user's web browser (Figure 19). The platform allows users to connect their blockchain wallets and provides them with a web-based user interface to manage their informed consent (Figure 20). By connecting their blockchain wallet to the platform, users can interact with their award tokens by sharing them and with other community members' award tokens by liking or endorsing them.

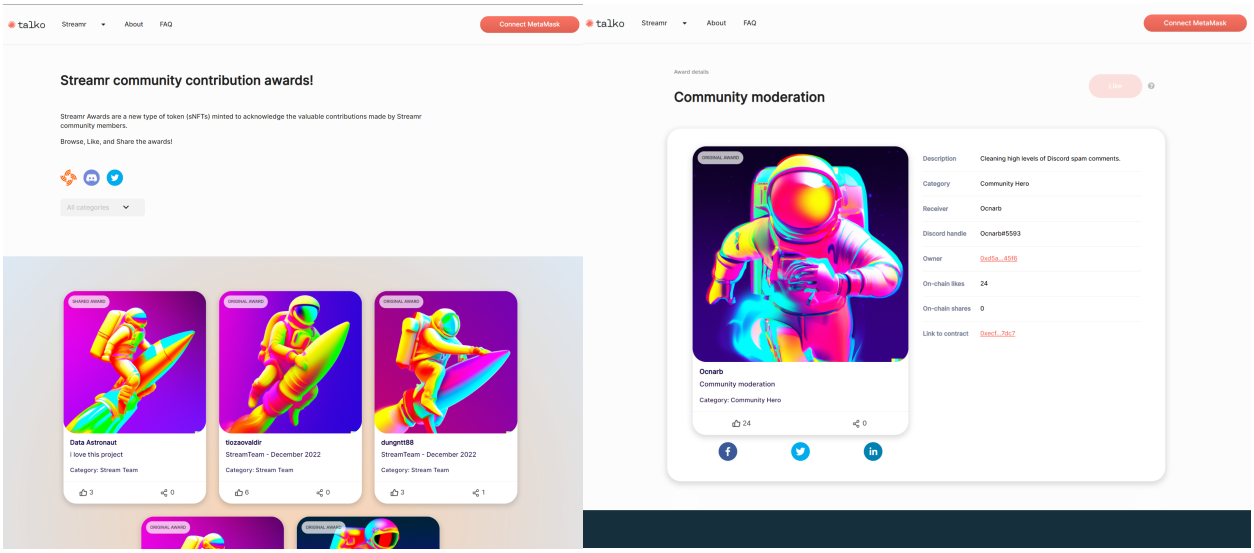


Figure 19. Landing page of the Streamr community awards and browsable tokens (left). Individual tokens open up as cards with detailed information of the award (right).

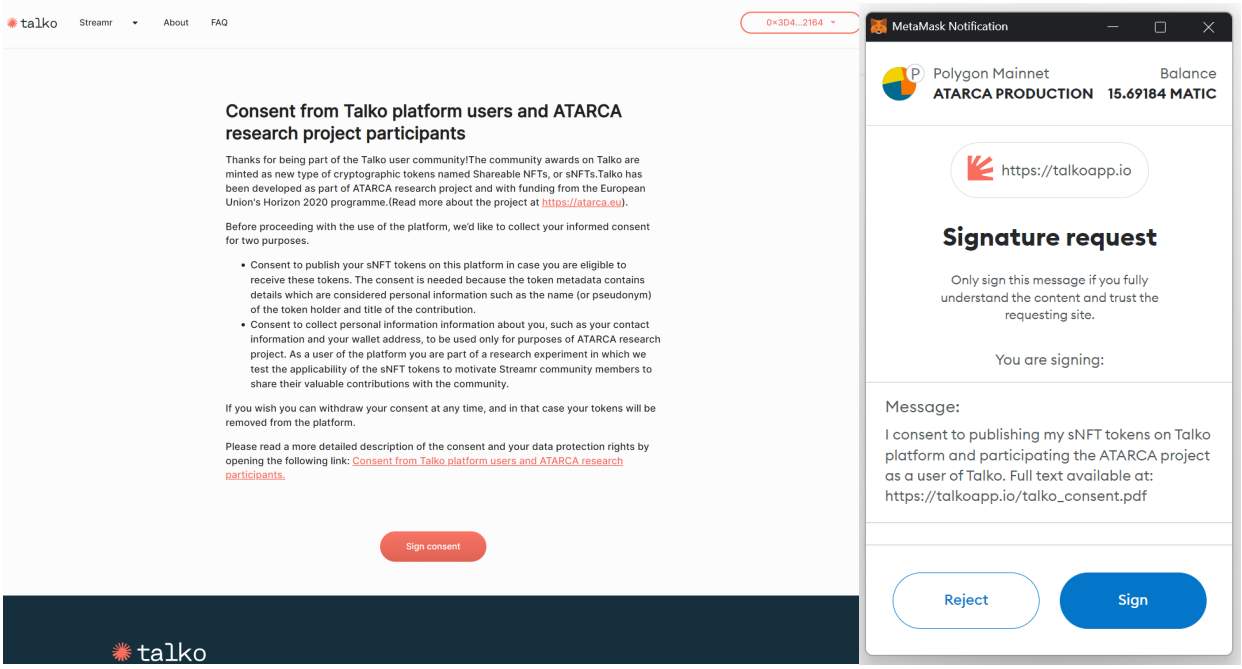


Figure 20. Informed consent that the testers and users need to sign with their connected wallets to have their metadata released and to do token transactions with the pilot contracts via the pilot platform (left). Popup introduced by Metamask wallet when signing the informed consent via the pilot platform (right).

Backend. The pilot was launched in October 2022 and consisted of a pilot platform that included the necessary technical infrastructure and tools for operating it, pilot operators, and pilot users. The pilot operators were members of the Streamr marketing and communications team, who were responsible for identifying, evaluating, and rewarding significant contributions made by community members. The pilot was designed to be open-ended and flexible, allowing the pilot operators to use their discretion in rewarding the community members as they saw fit.

The Streamr pilot environment consists of many services, as shown in Figure 21. Multiple cloud-based services have been utilized in operating Streamr pilot architecture and infrastructure. The backend and frontend are served from Europe-based Amazon Web Services (AWS) cloud instances. Pilot metadata has been stored on a third-party document database provider, and the storage zone has been set to Europe. The blockchain indexing service has rapidly indexed and delivered quick updates to the Streamr pilot-related smart contract activities back to the frontend, such as when minting new community tokens. Pilot smart contracts have been deployed to the Polygon blockchain. Separate Europe-based AWS cloud instances have stored provisionally approved metadata and hosted social media integrations to Streamr's main community channels Discord and Twitter.

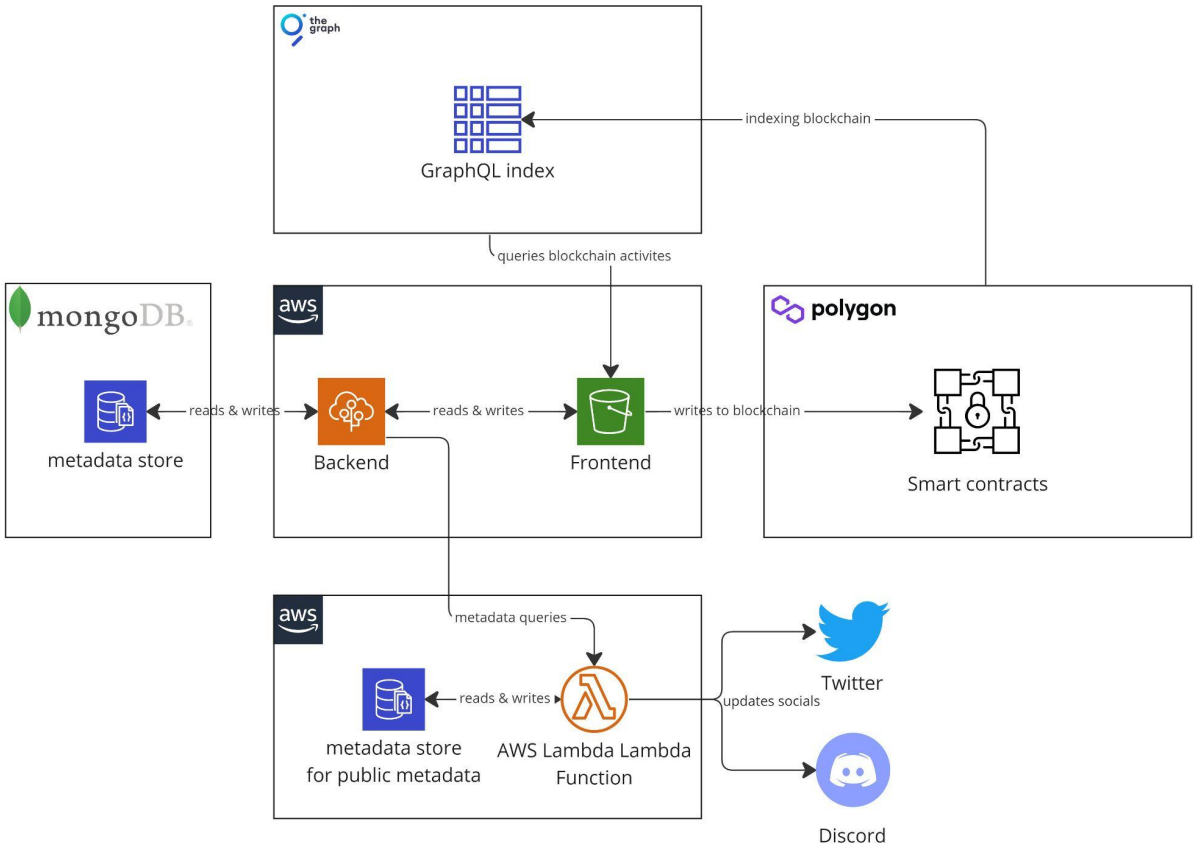


Figure 21. High-level Streamr pilot infrastructure.

4.5. Results of the pilot

The pilot result data consists of multiple data sources. Streamr Discord community channel messaging and community survey data were collected during and after the pilot. Talko usage data and smart contract transaction data for Streamr Award tokens, Like tokens, and Endorse tokens were also collected. In addition, Streamr's Twitter follower activity was monitored.

Overall, the pilot was advertised in Streamr communications channels, such as the Streamr Blog, Twitter, and Discord, and has been openly accessible to the entire community. Table 4 summarizes the key metrics of the pilot.

Table 4. Key metrics of the Streamr Community pilot.

Category	Quantity
Followers on Streamr Twitter on 18.2.2023	95200 followers
Members on Streamr Discord on 6.2.2023	10186 members
Unique members on Streamr Discord that wrote at least 1 message during 15.10.2022 – 18.2.2023	1700 members
Unique members on Streamr discord that wrote at least 5 messages during 15.10.2022 – 18.2.2023	194 members
Individual users on Talko pilot platform during 15.10.2022 – 18.2.2023	274 users
Pageviews on Talko pilot platform during 15.10.2022 – 18.2.2023	3600 pageviews
Streamr Award tokens minted during 15.10.2022 – 18.2.2023	38
Shared Award tokens during 15.10.2022 – 18.2.2023	4
Unique wallet addresses that received a Streamr Award token	31
Like tokens minted	158
Unique wallet addresses that minted a Like token	43
Unique wallet addresses that either have a Streamr Award token or a Like token	70
Survey responders on pre-pilot survey	31
Survey responders on end of pilot survey	85

Data from Streamr Discord Community. Streamr Discord Community is the primary channel for Streamr community members to engage and collaborate with each other and with the Streamr project team members. Observing the messaging activity in the Streamr Discord Community before and during the pilot gives us a longitudinal view of how we may have impacted the community.

The size of the Streamr Discord Community has been relatively stable in the months leading up to the pilot, averaging 6940 members from 24 August 2022, to 15 October 2022. During the pilot in November and December 2022, Streamr Discord saw a significant increase in community members, growing from 6933 members on November 1st to 10950 members by 13 December

A large number of these new members that joined during November and December can be attributed to another experiment that ran parallel to the Streamr pilot. Nevertheless, the Streamr community has grown significantly in terms of Discord members since the beginning of the pilot.

Observing the messaging activity of Discord Community members provides us also with a view of how many community members have been actively participating in the community and how active individual community members are in terms of messages produced. From 15 October 2022, to 18 February 2023, 1700 community members produced messages on the Streamr Discord server. In comparison, from 1 June 2022, to 14 October 2022, 325 community members produced messages on Streamr Discord.

The number of messages produced by different community members varies greatly, as can be seen in the Figure 22. The most active members in the Streamr Discord produce hundreds of messages monthly, whereas the median number of messages is in the low tens of messages per month, with an exception of November 2022, where an influx of new members joined the Discord and produced only one or two messages, essentially creating noise in the experimental data and in the Discord community channels.

In sum, the increase in the size of the Streamr Discord community and the increased messaging activity can be viewed as indicators of a more engaged and active community. However, it is not necessarily a direct indicator of allocative efficiency. Allocative efficiency involves optimizing the allocation of resources in the community to achieve the greatest benefit for the community as a whole. While increased engagement and activity are positive outcomes, they do not necessarily demonstrate that the resources were allocated in an optimal way.

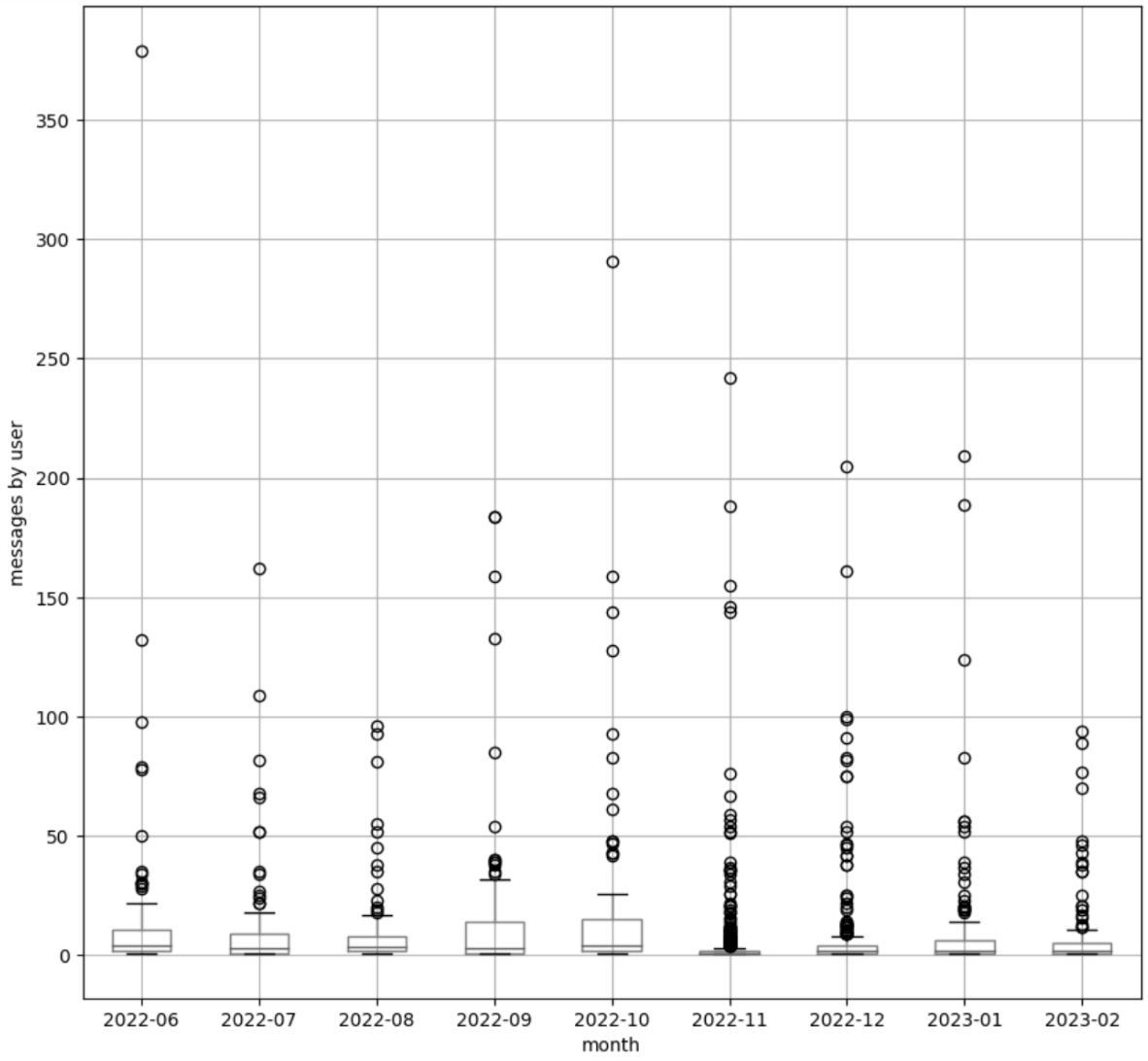


Figure 22. Monthly box-plots of messages produced by the individual community.

Streamr Pilot Token Data. Streamr pilot uses three different kinds of tokens. Community operator minted Streamr Award tokens capture the community contributions, Like tokens convey community users preference of community contributions, and Endorse tokens emphasize the awarded community members preference of community contributions.

The Figures 23 and 24 portray how minting award tokens and like tokens have accumulated during the experiment. Unfortunately no endorse tokens were minted during the pilot. This may have been affected by the fact that endorse functionality was delivered fairly late into the pilot.

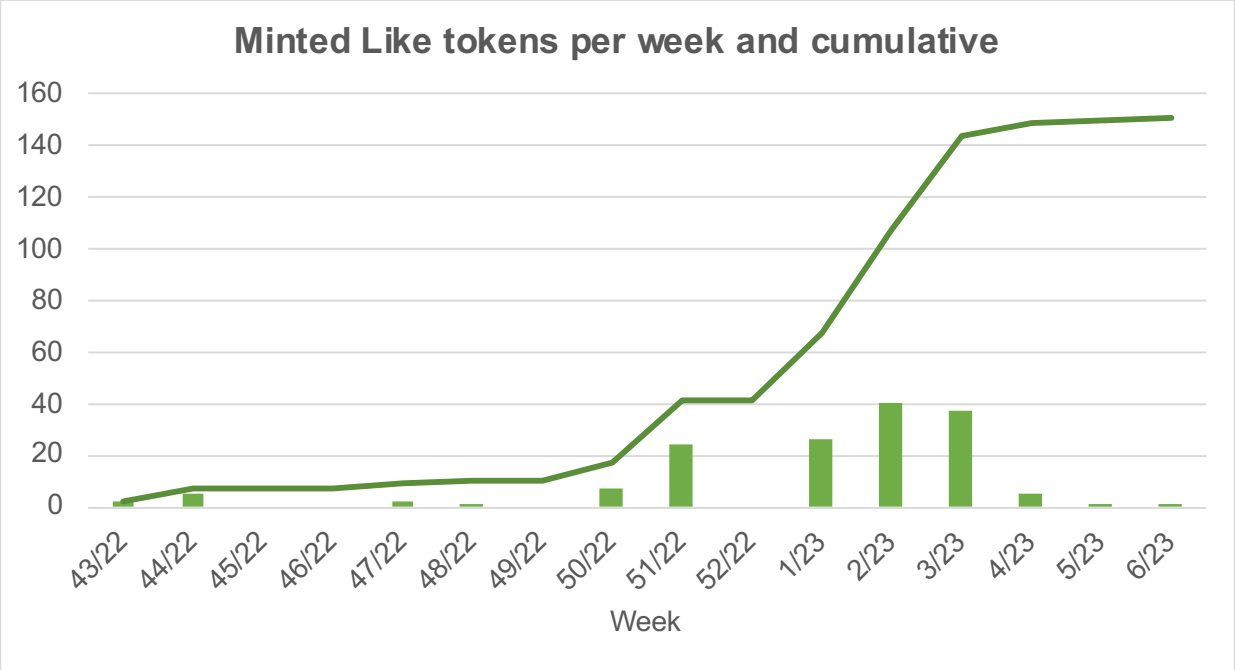


Figure 23. Minted like tokens.

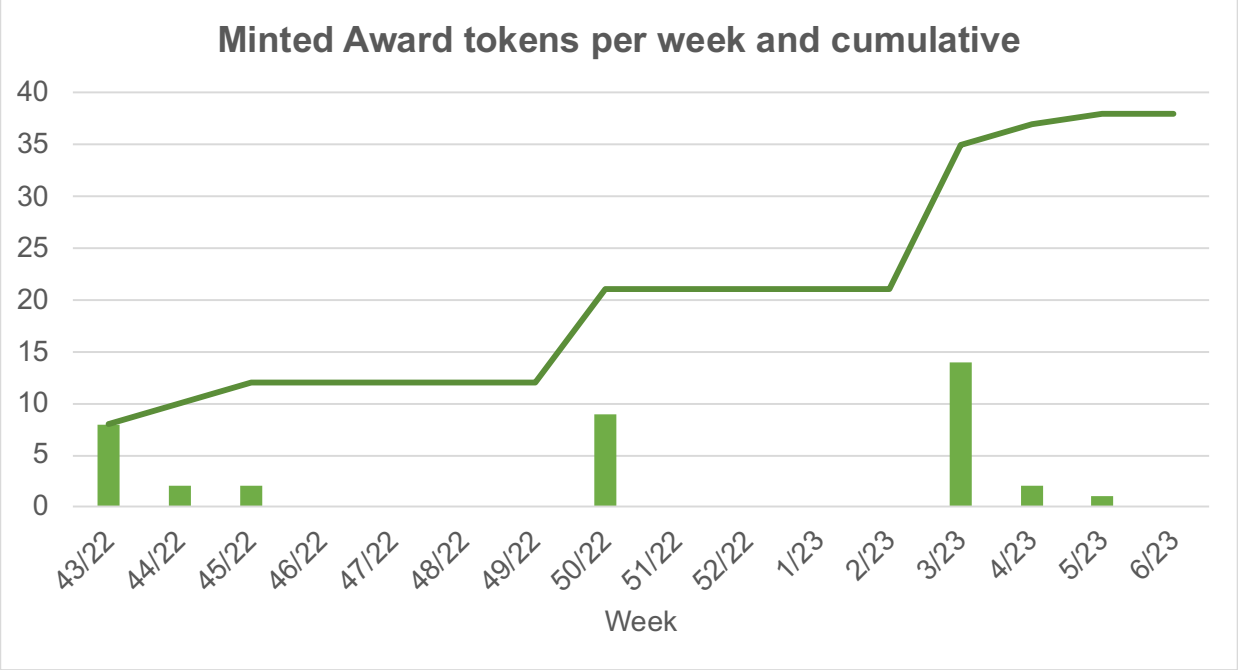


Figure 24. Minted award tokens, including shared tokens.

Token minting can be influenced by blockchain ledger's transaction price. In the pre-pilot survey, the Streamr community was inquired about if the community members would be willing to share their award tokens or to mint like tokens if there was a small transaction fee associated with them. The majority of respondents, 67.7%, answered that they would be 'willing' to share their Streamr Award token even if there was a small transaction cost involved, while 22.6% of respondents would 'consider' sharing it. Only 9.7% of respondents answered that they would not share their token if it involved a transaction cost. As the data shows, the community members actively minted 158 like tokens and also shared four award tokens. The cost of minting like tokens and sharing award tokens varied between 0.0023 USD and 0.045 USD during the pilot period depending on the underlying blockchain network congestion.

The award and the like token transaction data can be modelled into a network graph. When we look at the transactional data at the blockchain wallet level and form a network graph of which wallet owner has been given awards and which wallet owner have like tokens that refer to award tokens owned by other wallets, we can have another viewpoint to the activity of the Streamr community members during the pilot (Figure 25).

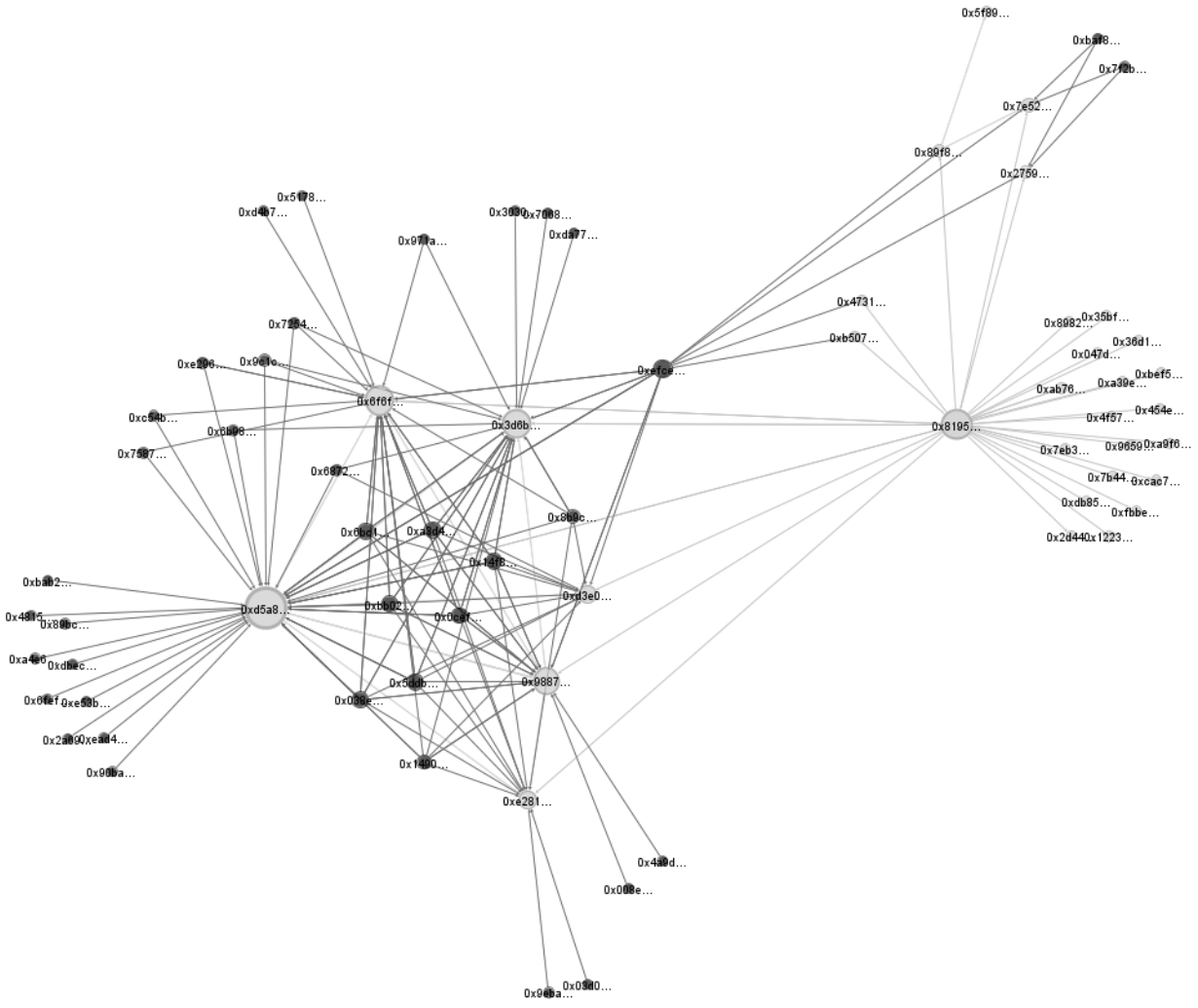


Figure 25. Directional one-mode wallet to wallet network graph (award and like transactions).

On the network representation, each node on the graph is a unique wallet determined by the wallet's public key. The nodes have been color coded. The grey node on the right side of the image is the wallet of the pilot operator that has given the Streamr Award to the community members. The cyan colored nodes are wallets that have received a Streamr award token. The black nodes are wallets that have not received a Streamr award but have minted at least one like token that refers to a Stream award. The size of the node has been adjusted on the basis of the node-degree metric, the amount of in-bound and out-bound connections to the node. The more likes the wallet has or the more award tokens the wallet has minted or shared, the larger the node is in the picture. On the graph, the nodes that have a lot of connections between themselves are grouped closer to each other, and the nodes that have fewer connections are grouped on the edges of the graph.

From the network representation, we can see that a few wallets that have gained awards have received likes from the majority of the wallets actively liking awards. Some wallets have only liked one or two wallets' awards, but there is a distinct group of nodes in the middle of the graph that have liked several awards held by several wallets.

On the right side of the graph is a group of wallets that have received a Streamr award token but have not received any likes. These are largely wallets whose awards are not visible on the Talko platform as that their wallet owner has not consented to the publication of the award token metadata. From the graph representation, we can also see that award tokens are being liked by other community members that haven't yet received an award token.

Conclusively, the fact that the Streamr community members actively minted like tokens and shared award tokens suggests that they were engaged in the process of allocating resources based on their preferences. However, it is unclear whether the allocation was optimal and efficient, as there is no information on whether the distribution of awards and likes accurately reflects the community's preferences and demand.

Survey Results. During the development and running of the pilot, two community surveys were conducted. As already mentioned in the previous section, the first survey was administered before the pilot experiment, between July and September 2022, and it received 31 responses. The second survey, focusing on the results of the pilot study, was administered during the pilot experiment, between January and February 2023; it received 85 responses.

The margin of error of the survey, given the sample size of 85 respondents with a 95% confidence level on the population size of the Streamr Community, determined by the number of discord members, was 10.6 percent. Each survey consisted of demographic questions, background questions on respondents' motivation to partake in the community, questions on how much time and in which way the respondents spent their time in the community, and questions related to the tokenized incentives and their effect on the community members and their activities in the community.

Between the surveys, some changes in the demographics of the respondents were noticed. In the pre-pilot survey, most respondents answered that they were either from Europe or North America, but in the pilot survey, most respondents answered that they were primarily from Asia, followed by Europe and North America. In the pre-pilot survey, the most common age bracket of the respondents was 30-39 years-old, followed by 40-49 years-old. In the pilot survey, the most common age bracket was 18-29 years-old, followed by 30-39 year-old.

Regarding respondents' role and expertise in Web3 projects, in the pre-pilot survey, the most common choices were business role, technical role, and research. In the pilot survey, the most common roles were token holder and web3 technology enthusiast. In the pre-pilot survey, the respondents primarily identified themselves to be at an advanced level of experience in their roles, whereas in the pilot survey, the respondents primarily identified themselves to be at an intermediate level of experience in their roles. In the pre-pilot survey, 77.4% of respondents had a university degree, either a bachelor's or master's, in comparison to the pilot survey's 68.2%.

In the pre-pilot survey, 77.4% of respondents had been part of the Streamr community for more than a year, and 19.4% had been part for less than a year, whereas in the pilot survey, 57.6% of respondents had been part of the Streamr community for less than a year, and 40% of respondents had been part for at least a year.

On both surveys, when asked in which ways they are active in the Streamr community, the majority of the respondents answered that they hold data tokens, followed by the choices of operating Streamr Network nodes, being just interested in the project, and making non-code contributions to the project. Less than ten percent of respondents answered that they wrote code for the Streamr project or used Streamr stack on their own projects.

When asked about how active the respondents had been last month on the Streamr community in the surveys, the majority of respondents answered a few hours a week. Between surveys, there was a slight increase in the relative amounts of respondents that answered that they spent 3-5 hours per week on the Streamr community. Most of the respondents answered that when they contribute to the Streamr community, they usually work alone. In the pre-pilot survey, 74.2% of respondents answered that they work alone, followed by 19.4% of respondents that at least sometimes work with other people. In the pilot survey, 62.5% of respondents answered that they work alone, followed by 30.6% of respondents that at least sometimes work with other people.

When asked whether the respondents had recently spent more time contributing to the Streamr project because of Streamr Awards, they indicated that they had. The average score of the answers was 3.7 out of 5. When asked whether they had spent less time contributing to other projects because of Streamr Awards, the respondents mainly answered that they had not, with an average score of 3.3.

Respondents mostly agreed with the statement that they had spent their time more effectively while contributing to the Streamr project because of Streamr Awards (average score 3.7 out of 5) and that metadata on Streamr Awards had helped them to identify community members for potential future collaboration (average score 3.9). The respondents mainly agreed with the statement that distributing Streamr Awards benefits the Streamr community, with an average score of 4.2 of answers.

Although the survey results contain some noise and inaccuracies, mainly related to the answers on received tokens and token transactions, the results generally indicate that Streamr Awards are seen as a benefit for the Streamr community. They motivate individual community members to contribute to the community, assist them in discovering where and how they could contribute to the community, and help them to use their time more effectively while contributing.

In summary, the survey results suggest that Streamr Awards have had a positive impact on Streamr community contributions. Respondents reported that they spent more time contributing to the Streamr project because of the incentives provided by Streamr Awards. They also reported that the metadata on Streamr Awards helped them identify potential collaborators within the community. Furthermore, respondents agreed that distributing Streamr Awards benefits the Streamr community. These findings suggest that Streamr Awards may have increased allocative efficiency within the community by incentivizing community members to contribute more effectively to the project.

Synthesis of the results. Overall, these results suggest that the Streamr pilot experiment on tokenized incentives was successful in improving allocative efficiency by increasing community engagement and incentivizing individuals to contribute more effectively to the Streamr Network. The pilot experiment on tokenized incentives, Streamr Awards, resulted in an increase in the number of community members and their activity levels on the Streamr Network. This indicates that the incentives were effective in motivating individuals to contribute to the community. The Discord data showed an increase in the number of active users and the number of messages sent during the pilot experiment compared to the pre-pilot period. This suggests that the tokenized incentives had a positive impact on the engagement and activity levels of the community members. The survey results indicated that Streamr Awards were seen as a benefit for the Streamr community. They motivated individual community members to contribute to the community, assisted them in discovering where and how they could contribute to the community, and helped them to use their time more effectively while contributing.

Limitations. Several limitations are present in this study. First, Streamr already had an established community since the beginning of the Streamr project. The ATARCA research project did not have the exclusive rights to conduct experiments with the Streamr community, and during the Streamr Community Case pilot period, another experiment called Stream Team was conducted by the Streamr Marketing and Communications team.

Second, the Streamr Community Case pilot did not have a control group. Although the use of a control group was considered during the design phase of the Streamr pilot, it was decided that dividing the community into two groups, the pilot group and the control group, was not feasible. Streamr has a tight knit community and dividing it into two could potentially have caused a backlash (and ethical concerns) among the core community members.

Third, defining a community contribution in this case was elusive. It was not possible to establish definite boundaries for what a community contribution is or what it should be during the pilot design phase. Instead, a more subjective and abstract approach was taken to establish what constitutes a community contribution during the pilot. The lack of an exact definition for a community contribution means that we are unable to measure the exact change in community contributions before and after the pilot.

5. PILOT CASE: FOOD FUTURES

5.1. The context and purpose of the pilot

The Food Futures pilot experiment was set up to integrate an anti-rival blockchain solution into a digital ecosystem to help solve the tragedy of the commons contributing to global warming. To further develop and illustrate our theorizing, we designed a non-profit voluntary governance tool that provides a means to implement Ostrom's principles of polycentric governance, while taking our new concepts of negligibility and anti-rivalry into account.[5] We implemented our case study within the context of a university course on sustainable consumption and partnered with the local university dining caterer. We used participatory design to learn from our subjects. Our pilot aimed to investigate whether subjects who voluntarily opted into the Food Futures polycentric governance system made comparatively more sustainable choices than their peers who ate at the same dining venue on the same dates. We ran three trial experiments: 17 March-5 May 2022, 7 November-16 December 2022, and 16 January-5 March 2023.

[5] Ostrom, Elinor. 2009. "A Polycentric Approach for Coping with Climate Change: Background Paper to the 2010 World Development Report." Policy Research Working Paper 5095. World Bank, Development Economics, Office of the SeniorVice President and Chief Economist October.

Ostrom, Elinor. 2010. "Beyond markets and states: polycentric governance of complex economic systems." American economic review, 100(3), pp.641-72.

Our experiment aimed to determine whether participants using the Food Futures platform would increase sustainable food consumption choices in comparison to university cafeteria customers not participating in the experiment. The Food Futures team partnered with Unicafe, a university cafeteria in Helsinki, to increase the allocative efficiency of sustainable meals that aligns with the cafeteria's goals and the dietary aspirations of its customers. To enable evidence-based decision-making towards sustainable consumption, the Food Futures team developed a Food Wellbeing and Sustainability Index, which reflected the sustainability impact of protein sources on various variables. These variables were categorized into three levels of threshold — Green, Yellow, and Red. A green threshold level indicates plant-based protein sources as the most sustainable. Yellow represents less polluting animal-based protein sources e.g., fish, chicken, and eggs. Red products represent the most polluting protein sources e.g., beef, cheese, and pork.

The Food Futures experiment was built to achieve the following. First, it was designed to ameliorate the tragedy of the commons, which we analyze to in part result from "negligibility." Negligibility refers to actors' sense that regardless of what actions they take, no one can make an observable impact on the transnational, or even the local, public good of sustainable consumption. Second, Food Futures navigated between market solutions and centralized governance structures to develop a digital community that abates the unsustainable environmental impact resulting from everyday meal choices. Participating in the community constructed by our digital platform was voluntary and occupied a space between top-down governance and individualistic competitive markets. Third, Food Futures introduced a mechanism design that navigates the challenges of achieving incentive compatibility and efficient resource allocation in conventional market design structures (Prize Committee, 2007).[6]

[6] Prize Committee (2007). Mechanism Design Theory – Scientific background on the Sveriges Riksbank Prize in Economic Sciences in Memory of Alfred Nobel 2007. Compiled by the Prize Committee of the Royal Swedish Academy of Sciences. Available: https://www.nobelprize.org/uploads/2018/06/advanced-economicsciences2007.pdf

5.2. Allocative efficiency in the pilot

Our experiment aimed to determine whether participants using the Food Futures platform could increase sustainable food consumption in comparison to university cafeteria customers not participating in the experiment. The Food Futures team partnered with Unicafe — a university cafeteria in Helsinki — to increase the allocative efficiency of sustainable dining that aligns with the cafeteria's goals and dietary aspirations of their customers. To enable evidence-based decision-making towards sustainable consumption, the Food Futures team developed a Food Wellbeing and Sustainability Index, which reflects the sustainability impact of protein sources on various variables which were categorized in three levels of threshold — Green, Yellow, and Red. A green threshold level indicates plant-based protein sources as the most sustainable. Yellow represents less polluting animal-based protein sources – fish, chicken, and eggs. Red products represent beef, cheese, and pork, which are the most polluting protein sources.

Given that the overall purpose of our intervention was to reduce carbon emissions (and potentially other forms of environmental degradation), we defined increased allocative efficiency in terms of reduced CO2e (carbon dioxide equivalent) gas emissions. We treated acts of sustainable consumption, in the form of lower CO2e footprints per meal served, as positive externalities. Positive externalities are the impacts that private transactions, such as consumption with excessive carbon emissions, have on third parties. In contemporary geopolitics, these externalities often can be the impact of the economies of developed nations on the weather patterns affecting lesser developed nations in the equatorial belt. We further analyzed the tragedy of the atmospheric commons as a negligibility problem. In this situation, no individual's consumptive changes can alter the collective outcome, thus signifying a breakdown in collective rationality.

In conclusion, our experimental intervention provided a means to Measure, Record, and Validate every individual's sustainable consumptive choices. Our impact metric measured individual users' levels of sustainability; we recorded this data into our database shared with users, and users' sustainable acts were validated with our sNFTs. Since the tokens are minted in congruence with acts of CO_2 abatement, they directly measure and record allocative efficiency.

5.3. Methods to co-design and assess the pilot

Design phase. The Food Future's team worked from April 2021 to February 2022 to design the tokenized system, software, and blockchain to implement in the initial trial pilot beginning in March 2022. Our design phase incorporated the core research team as well as participants in workshops we held to facilitate getting to know the needs of those consumers interested in sustainable consumption. We drew on academic research on the sustainability transition, data visualization, economic externalities, and polycentric governance to ground the theoretical basis for our pilot experiment design. As well we integrated the software and blockchain toolkit developer into our design process to ensure the technical feasibility and efficacy of our proposed solution to collective action failures involving anti-rival goods.

As we were working in an academic research environment an important component of our design process was to ensure that the experimental implementation was compliant with not only with GDPR standards but as well the university's ethical review process. Being in dialogue with the university research ethics team encouraged us to identify all the data we would be asking subjects for consent to use and to ensure that all users' data passing through our digital platform was secure and that participants' privacy rights were ensured.

Our initial design process had two main prongs. One was to build a digital ecosystem that would serve the aim of solving the focal problem of the atmospheric tragedy of the commons by achieving allocative efficiency in the form of reduced greenhouse gas (GHG) emissions.[7] This involved a service design process mapping out users' journeys, and also making a game theoretic analysis of the tokenization system suitable for converting the challenges of (a) an individual's negligible impact, and (b) the risk that others will not contribute into a win-win scenario.

Simultaneously we worked to ensure that the experimental design would not only test the functionality of our distributed ledger solution, but that we would be well-positioned to gather the data to test whether our intervention was effective in achieving allocative efficiency. Thus, the experimental design went hand-in-hand with the development of the minimal viable prototype that we implemented in March 2022.

[7] Note that GHG emissions and CO2e emissions refer to the same concern of climate change resulting from human activities.

By the end of our design phase, we had a working token minting system grounded on an algorithm that issued tokens as a function of sustainable consumption choices in a measurable way. We had the rudiments of the Measure, Record, and Validate solution developed, as a way to address the atmospheric tragedy of the commons and to counter individuals' negligible impact and worry that acting alone will fail to achieve sufficient GHG reduction consistent with the 1.5°C lifestyle and the Paris Climate agreement. We also identified the data necessary for the digital ecosystem and blockchain system to achieve its goals. Our experimental design worked in a fashion to integrate the data used to test allocative efficiency into the information directly accessible to ecosystem members.

Piloting Phase. Our piloting phase involved three experimental trials, in the spring of 2022 (March-May), in the fall of 2022 (November and December), and winter of 2023 (January through March). As our experimental phases drew subjects from an online course, we registered subjects and followed their completion of the experimental trial. This gave us an exact sense of the number of our participants who were then divided into three cohorts corresponding to Trial 1, 2, and 3.

The first pilot phase differed from the second two because we held in-person workshops with participants to improve our minimal viable (MVP) prototype design. We held well-structured workshops that progressed over seven weeks with a total of seven one-hour meetings. This coincided with the online format of the Sustainable Consumption course from which experimental subjects were recruited. At any time during the pilot experiment participants could opt out of the experiment and adopt an alternative means of receiving university credit for the course.

The full report on our first pilot experiment and its detailed structure to achieve participatory design is publicly available.[8] The design workshops covered the following topics: Onboarding, journey mapping, persona building, index feedback, and incentive feedback. Throughout these workshops we had "safe space" rules in place to ensure that participants felt comfortable and that no privacy concerns or personal identity issues were breached. We kept detailed records of each week's activity as well as the outcomes of those activities. Each session aimed to learn about users' experiences with a particular feature of the Food Futures platform and digital ecosystem so that we could integrate feedback and lessons learned into the second prototype which was used for the next experimental trials. We identified means to improve the interface with users' digital wallets during onboarding. We learned of ways that our data visualization could be improved. We also learned about what recognition and validation systems worked for the subjects. These findings allowed us to improve the UX/UI experience in the next working prototype of the platform.

In the following two trials we asked participants to complete voluntary surveys which replaced the in-person workshops. We continued seeking user feedback throughout all of our trials. We posed the following types of questions to users through anonymous surveys:

- If the onboarding and first steps on the Food Futures platform prototype are usable
- If the Food Wellbeing and Suffering Index is straight-forward to interpret[9]
- If it is easy to validate meal choices by taking pictures
- If it is trouble-free to interpret the visualization of personal and collective statistics on individuals' sustainability impact
- If FoodPrint tokens balances are accessible
- If home validation functionality is effective
- If there are any other unintended obstacles, errors, or possible improvements

[8] https://atarca.eu/wp-content/uploads/Mooc-report-Aug-1.pdf

[9] Originally the index was the 'Food Wellbeing and Suffering Index,' but we received overwhelming feedback that this was overly negative and thus have switched to using 'Food Wellbeing and Sustainability Index.'

The Food Futures research team met regularly throughout the design process to consult on preliminary findings and to integrate important information into development. This was particularly crucial for any operational bugs in the software, and for users' privacy concerns setting up and using their digital wallets. Throughout the experimental periods, IT support was available via email. We also held regular weekly or bi-weekly meetings with the developer to ensure that findings were immediately integrated into platform design and technological innovation.

5.4. Description of the implementation and UX design

Initial design targets. A few primary and secondary features were considered important for the platform. The primary features were:

1. Allowing users to assess food product sustainability by using the Food Wellbeing and Sustainability Index (particularly, communicating CO2, material footprint and water footprint).
2. Enable users to decide and register their food choice by validating their cafeteria meal choice.

Further on the platform will issue tokens for more sustainable meal choices and allow users to monitor their accumulation. Additionally, the basic use of such a platform requires several standard functionalities such as, login and sign-up, informational intro screens, and a list of UniCafe lunch restaurants. The secondary and gradually implemented functionalities were:

- Impact visualization. Individual and collective impact visualization, and the individual impact compared to the Finnish average and the 1.5-degree target regarding food consumption.
- Home validation. A feature created for the platform to be accessible everywhere in Finland regardless of location and accessibility to UniCafe lunch cafeterias.

Furthermore, we focused on the platform's usability by aiming to make it friendly, playful and encouraging. The goal was to create an actionable digital environment for more sustainable food consumption.

MVP. The MVP launched in Spring 2022 included a welcoming landing screen and three key features: lunch menu, impact history, and wallet (Figure 26).

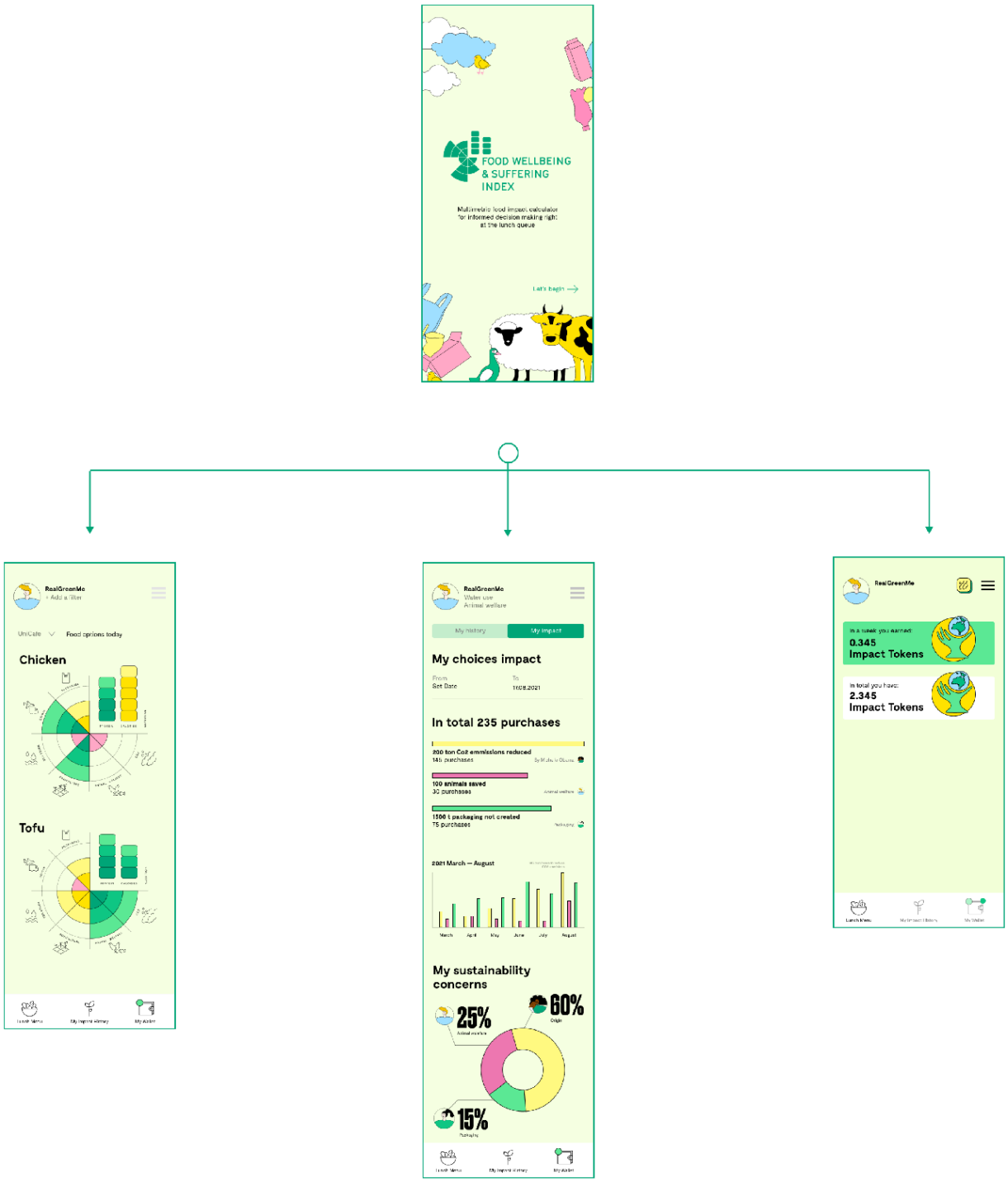


Figure 26. The main features of the MVP: lunch menu sustainability data; individual impact history; digital wallet.

During onboarding (Figure 27), users were welcomed and asked to make informed meal choice decisions and take sustainability actions together. The platform then recommended that they create a profile to track the history of their own actions. Lastly, users were encouraged to select personal sustainability concerns which would generate a self-curated index to help them compare food items. Initially, the short-listed variables were:

1. Origin: How far did the product travel to reach me?
2. Agriculture: Conventional, sustainable, or organic farming?
3. Water use: How water-intensive was farming?
4. CO2: How much carbon emissions did it emit?
5. Packaging: Non-recyclable, recyclable, or biodegradable?
6. Animal welfare: Did it cause animal suffering and, if so, how much?
7. Lastly, they could also choose nutrition-related variables such as protein and calories.

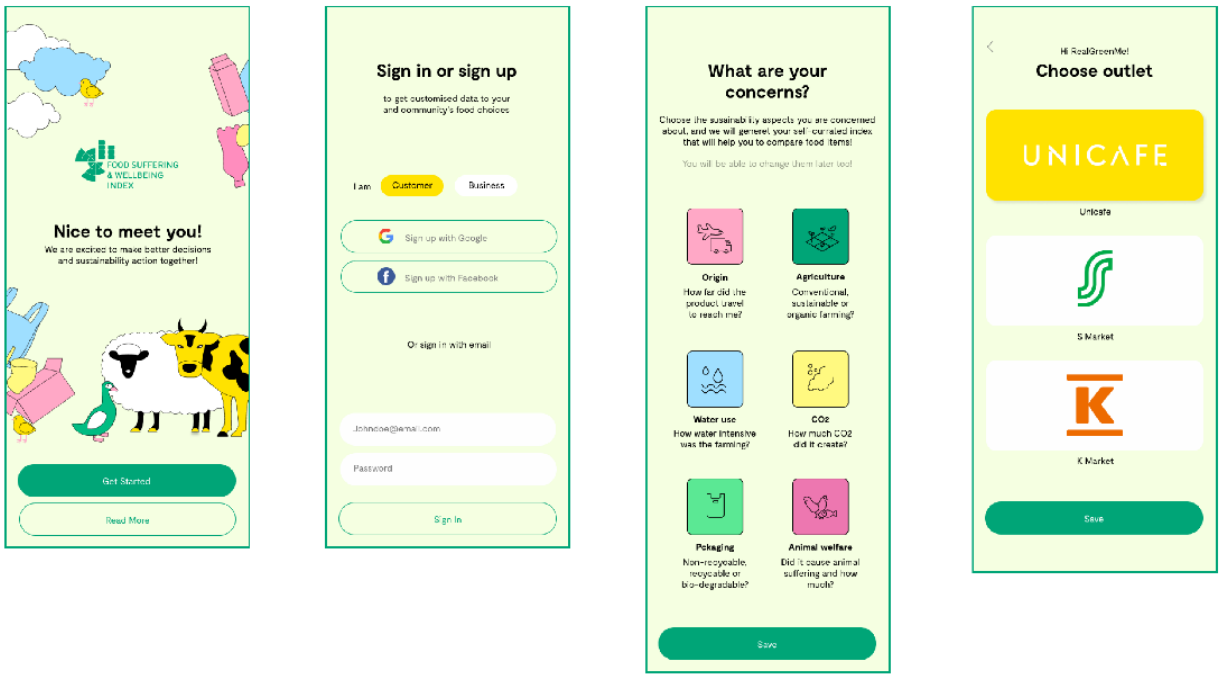


Figure 27. The onboarding process.

The meal selection screen acted as the home screen of the platform. Here, users could choose their preferred meal by reading the index curated based on their predefined personal concerns. Next, the meal choice was verified, which was a crucial step, and the Food Futures team did several iterations to narrow down the best solution. The idea was to scan a unique QR code after the meal selection. However, this method relied solely on trusting that users verify their true selection. As we feared, some users validated their meals as green despite having chosen a red or yellow meal. However, due to the lack of feasible alternatives, our team ran the first pilot using this method, illustrated in Figure 28.

Figure 28. The meal selection process.

The impact visualization was not implemented during the first pilot when testing the MVP. Instead, the first pilot within the Unicafe premise focused on the visualization desired for viewing the individual and collective impact. Since the MVP was based on the personal concerns feature, the users could view the impact created based on individual variables. For example, x number of animals saved, x kgs of plastic saved from going into waterways, or x kg of carbon emissions prevented from going into the atmosphere. However, it turned out that aggregating this kind of data was beyond the team's resources, and therefore it was deemed infeasible at the time. Instead, the team studied reliable data sources for CO2 footprints in Finland, such as the 1.5-degree lifestyle targets by Sitra (Figure 29).

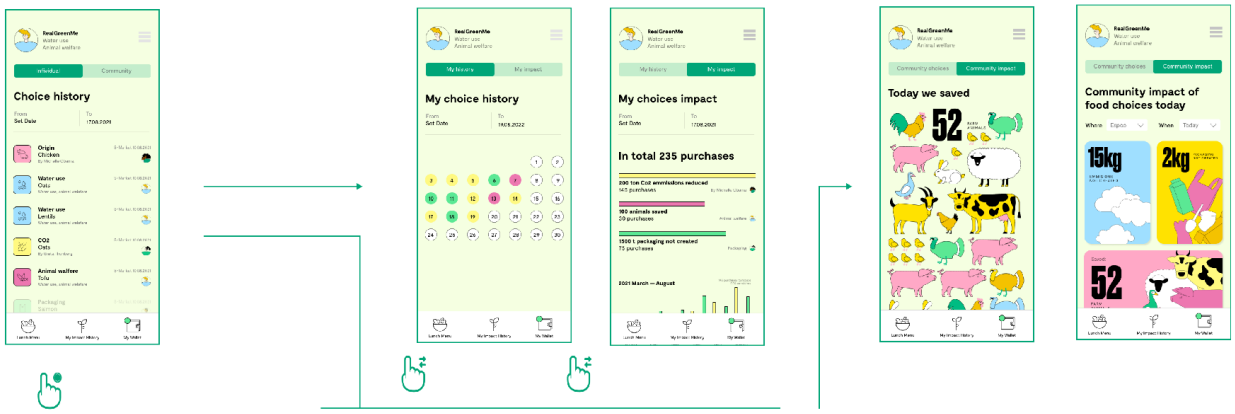


Figure 29. The impact generated by food choices visualized on the MVP platform.

The last key feature of the solution was the ability to connect with like-minded people and form communities around mutual concern for specific variables. By empowering users to participate in fundraising, NGO volunteering, and other ecosystem conservation initiatives, Food Futures aimed to bridge the gap between ideologies and actions beyond the scope of meal choices (Figure 30).

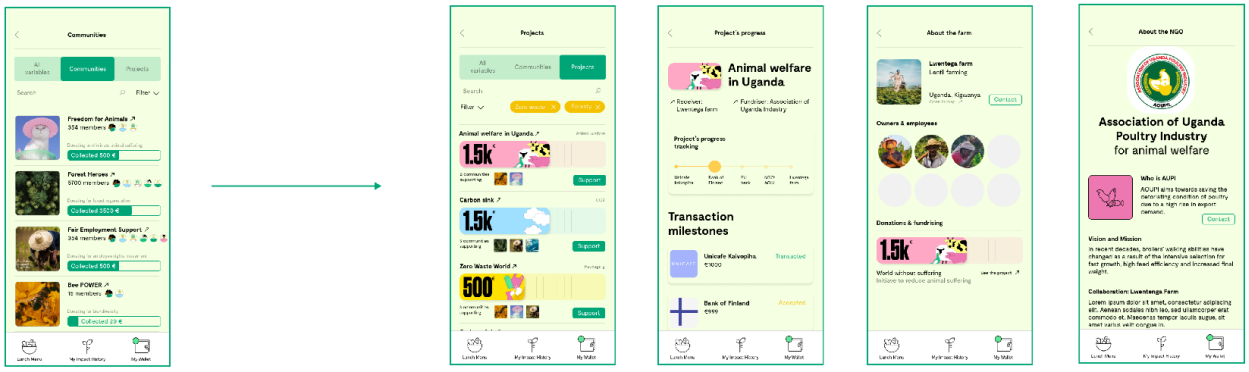


Figure 30. The community-building process.

The feedback gathered during the first pilot provided insight into the platform's potential. Some of the key insights were:

- *Platform as an educative tool.* Users formed a consensus on the MVP being an educative platform that provides a deeper understanding of sustainability. Hence, we decided to collaborate with the University of Helsinki to develop a massive open online course (MOOC) available to everyone.

- *Enabling consistent use in the future.* Most users wished to continue using the platform after the pilot ended. However, they agreed that the QR code scanning aspect of the user journey needs to be simplified. Therefore, the Food Futures team sought alternative means to verify the meals. Users also showed enthusiasm towards using the platform outside of the Unicafes. Based on this feedback, the team added a 'home validations' feature, which could validate meals eaten outside of the Unicafes.
- *Redeeming the tokens.* While the sustainability-enthusiast user groups were happy to continue using the platform due to intrinsic motivation, the sceptics and the new adaptors of climate-friendly meals wished to receive some recognition or reward to keep up their sustainable actions. One way to encourage this would be to offer access to food leftovers upon collecting a certain number of tokens. Users also showed interest in gaining discounts at sports and wellbeing centres. The users were not enthusiastic about community events due to lack of time to commit to such activities.

Current UX. The latest version of the platform includes several adjusted features. The welcome screen is similar to that of the MVP but selecting personal concerns was removed due to the inability to feed reliable data into the platform (Figure 31).

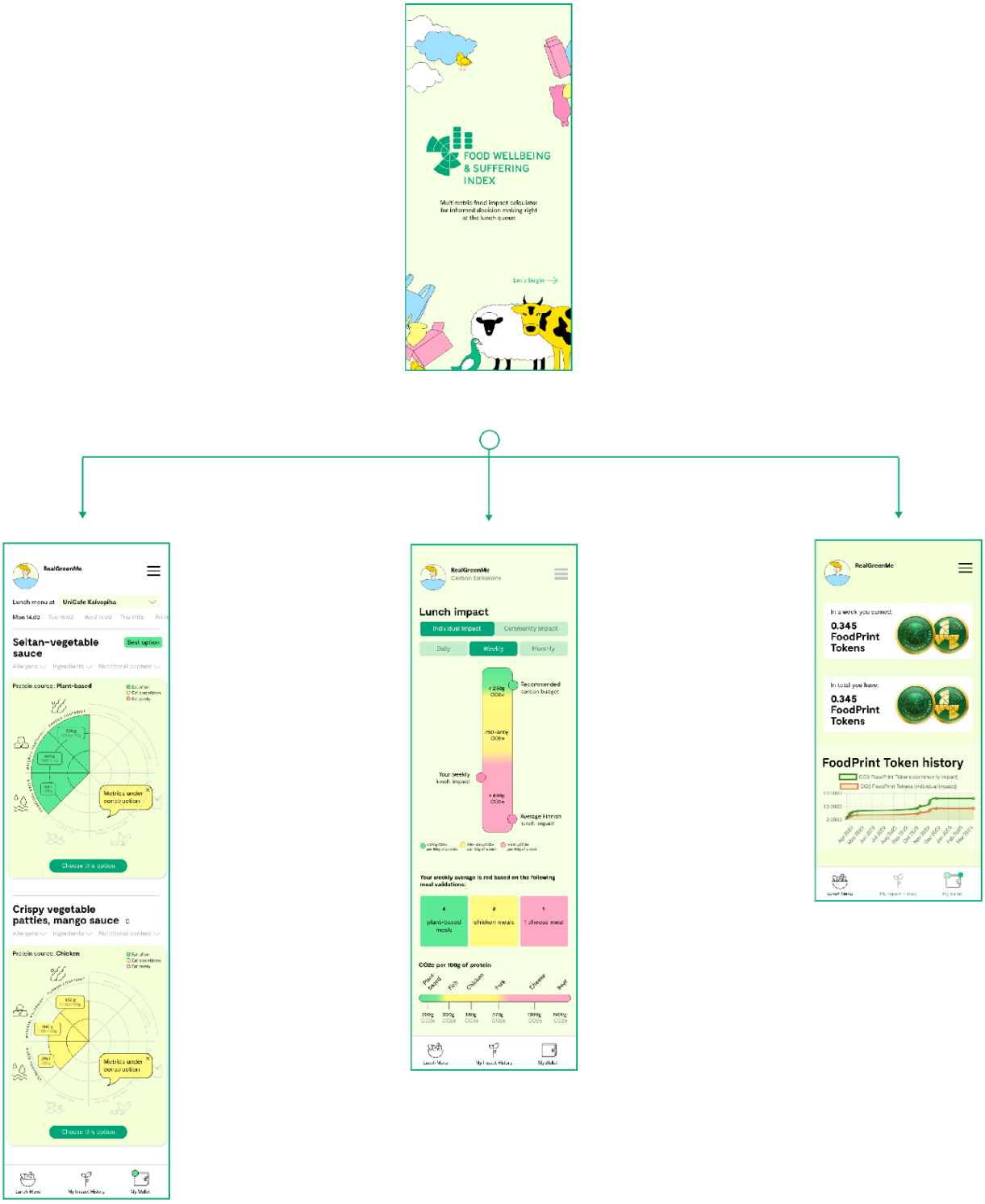


Figure 31. How the main features UI have evolved: Meal Sustainability Data; Individual Impact History; Digital Wallet.

Based on the feedback, we wanted to create an experience independent from the MOOC. For this reason, we tried to include as much self-explanation as possible. The onboarding screens show sign-in/signup, followed by a description of the platform, including the aim, key features and the role of blockchain technology on the platform (Figure 32). Many users asked for clarification on the use of crypto wallets. Therefore, we included a screen that clarified that the crypto wallet is detached from users' bank accounts.

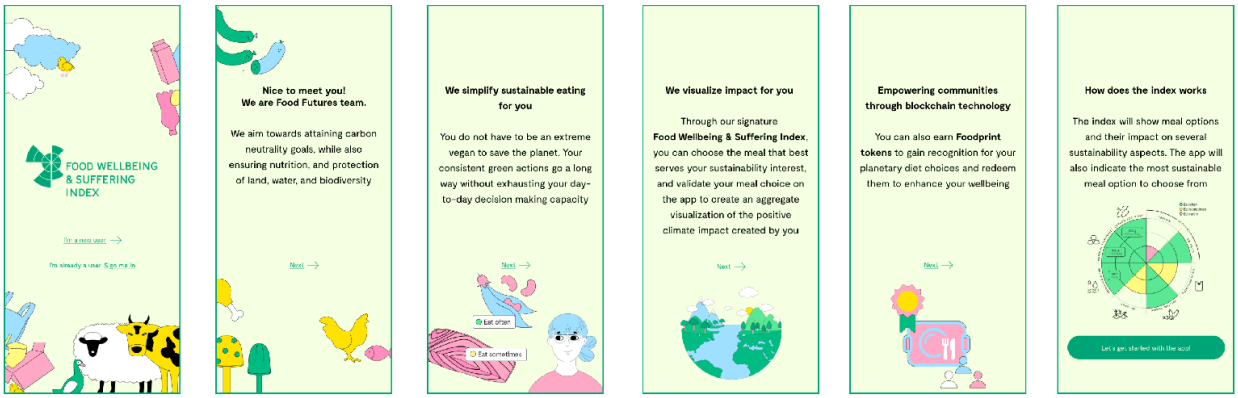


Figure 32. The new onboarding process.

The home screen remains similar. We added several Unicafes to the platform and launched the home validation feature. Alongside this, we successfully implemented photo verification to validate the meal choice (Figure 33).

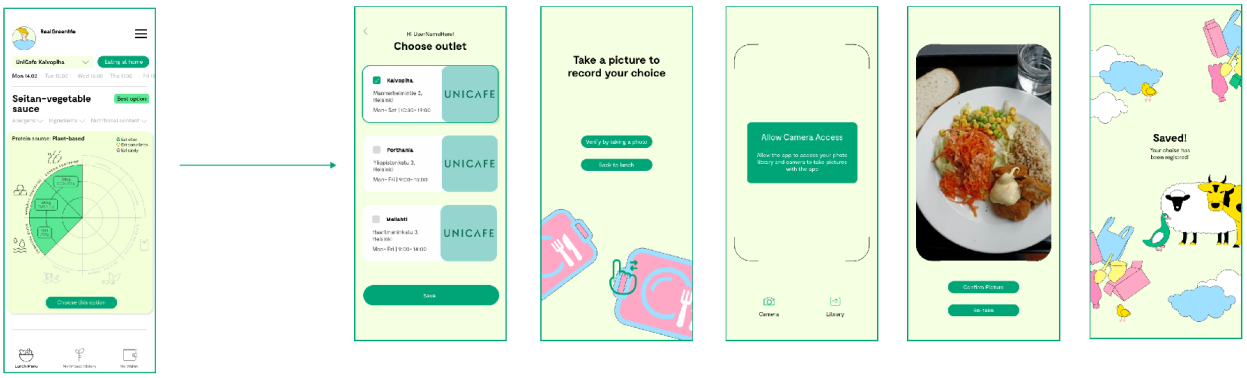


Figure 33. The new meal selection process: original menu data; additional venues; meal option selection; invitation to take photo of meal; confirmation of meal photo; confirmation meal data uploaded.

We could not generate data on the impact created for all the previously planned variables. Instead, we narrowed the impact history to the carbon footprint alone, which was further divided into impact history at the individual and at the collective level. For the individual level, we used the concept of 1.5 degree lifestyles in measuring carbon emissions, giving users a comparative visual on their choice history and a comparison to the average Finn. For the collective level, we introduced the pie chart experience so that users could get an overview of their impact compared to other visitors at Unicafe over a week. Lastly, the users can view their meal choices in a calendar view. All these views are shown in Figure 34.

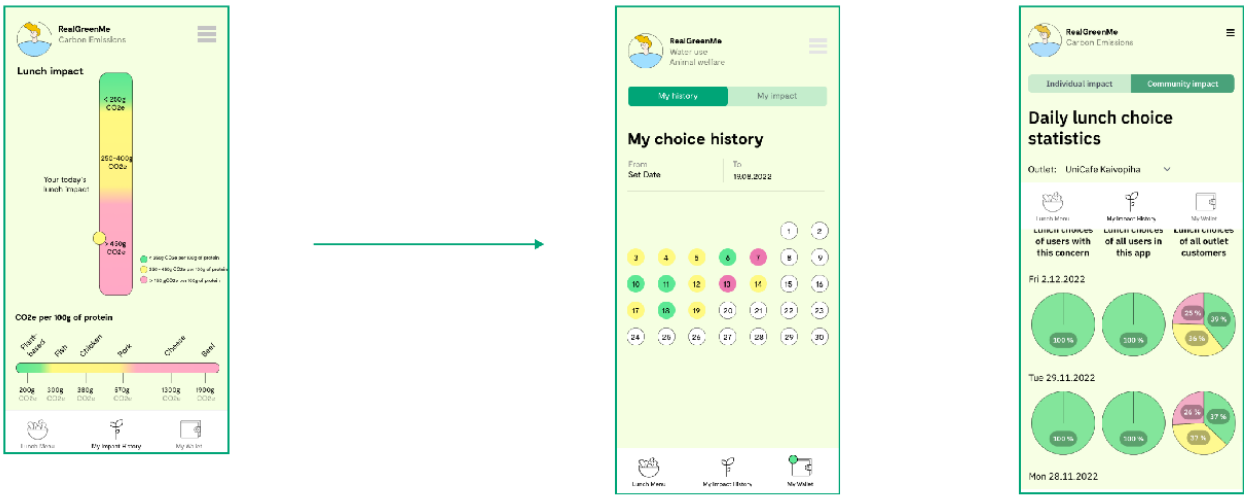


Figure 34. The new impact-tracking features: Individual Impact; Individual Impact History; users' Collective Impact compared to other venue customers.

In the latest version, we have also added the FoodPrint token feature. The validations at Unicafe are called Foodprint tokens, and those earned through home validations are called 'proxy tokens'. The Foodprint token history, shown as a line graph, enables users to compare their individual with the community impact (Figure 35).

Figure 35. The impact and token history as shown on the platform.

The platform has been evaluated several times throughout the project. Both by focus groups, and individual testing reported by surveys. The prototype has reached all of the predetermined target features. Using the platform, cafeteria customers can conveniently learn about the sustainability of different food options, compare specific meal choices, and register and validate their individual decisions. Additionally, users receive tokens for more sustainable food choices and can monitor them. Furthermore, users can see the collective impact of all users compared to the average UniCafe visitors not participating in the experiment. Finally, users can see their individual impact compared with the Finnish average and the 1.5-degree lifestyles target.

UX evaluation. Some users have described the platform as very user-friendly, while some would prefer improvements in the UX design to make it more educational and flawless. Regarding its attributes, users have described the platform as visually encouraging, friendly and optimistic. In the following section, we report the data gathered through surveys during two rounds of MOOCs in autumn 2022 and spring 2023. The shortlisted questions shared in this section compile the user feedback on critical touch points when using the platform, including:

- The onboarding process
- Intro pages
- Setting up the wallet
- The usability of the Food Wellbeing Index
- Meal validation

- Impact visualization

For all surveys requesting answers on a scale from 1 to 5, 1 refers to the lowest value, and 5 to the highest. Responses were gathered from 56 users. The onboarding process was neutral or positive for most users (Figure 36). However, during the pilot we learned that, for a significant share of users, the most challenging aspect was connecting to the crypto wallet. They also pointed out that using the prototype on the Opera browser felt restrictive.

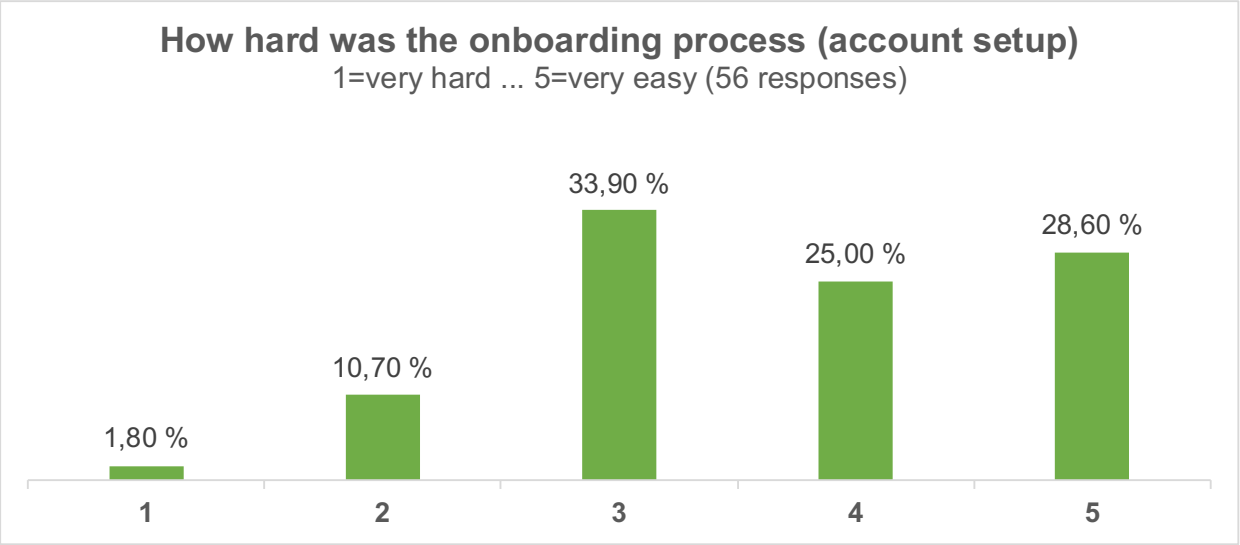


Figure 36. Survey responses to the onboarding experience.

According to the survey, the intro pages were quite clear (Figure 39). While 68.5% of 54 participants responded that setting up the digital wallet was not challenging, there were some commonly addressed challenges (Figure 37). Those were, for example, the confusion about downloading a new browser, the fear of the wallet linking to banking details, and the lack of clarification on the need for a wallet in the first place.

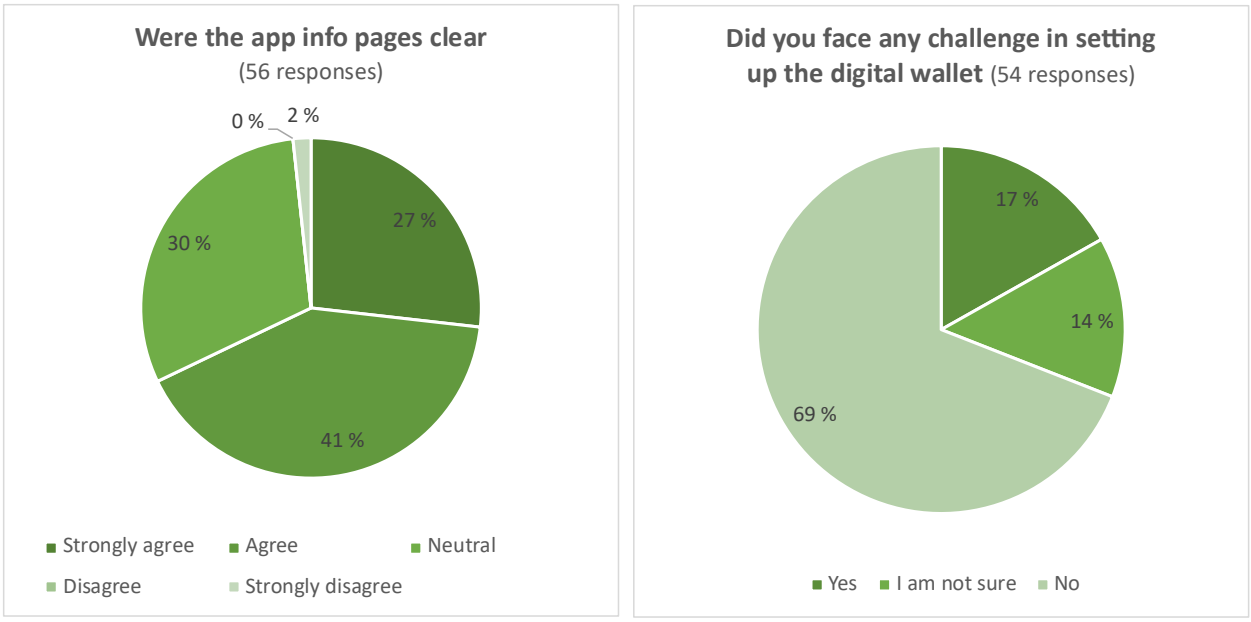


Figure 37. Survey responses to intro pages (left) and setting up the wallet (right).

Overall, most participants had a neutral or slightly negative experience when interpreting the index (Figure 38). One of the participants suggested that "The red segments of the index should be visually bigger than the green ones. Now it feels counter-intuitive." Several users requested a more in-depth explanation of the index, for example, by highlighting the data on each variable and the reason for their categorization as either red, yellow, or green. Some suggestions to improve this communication were to create a video tutorial or to include a 'read more' option for users curious to dig deeper.

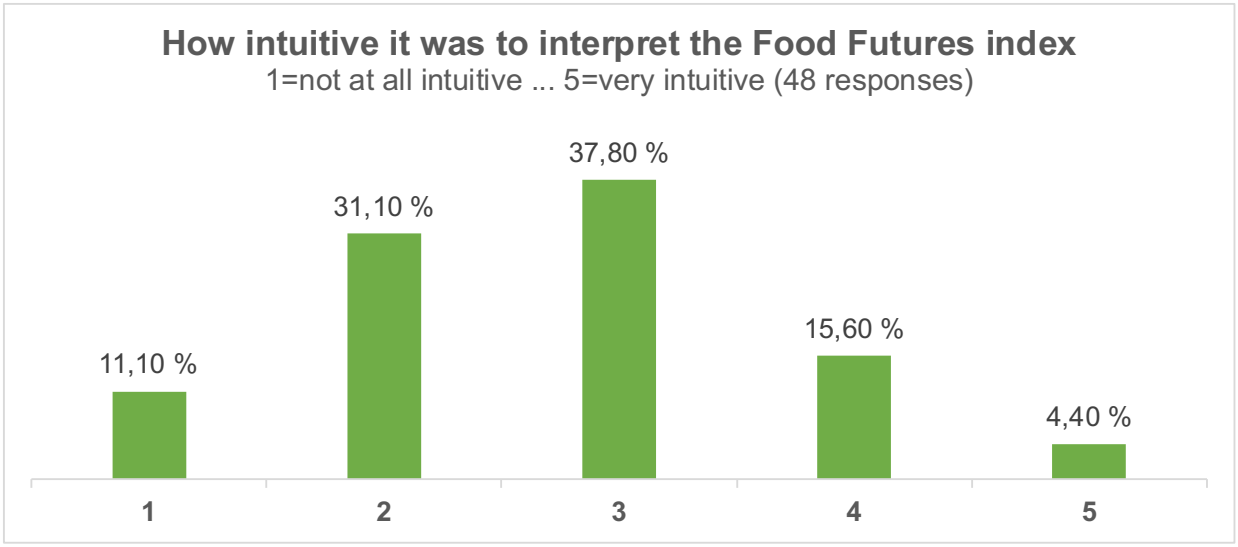


Figure 38. Survey responses to the Food Wellbeing Index.

39% of 46 users responded that they could validate the meal by uploading a picture. Some participants requested to include the feature of uploading pictures through the phone gallery. Since building new habits takes time, users would appreciate the convenience of validating their meals when it best suits them.

Most users reported that the 1.5-degree lifestyle visualization was easy to understand (Figure 39). However, the section that included data on the grams of protein and its association with carbon emission needs further clarification. One user explained by saying, “It is hard to understand, is 100g of protein the same thing if I eat 100g of protein product or 100g of protein-based product? Do I need to eat vegetables until I reach the 100g of protein [for] it to be equivalent to CO2e counted with proteins?”. Based on such feedback, we can see that users would like more information to support their understanding of carbon targets.

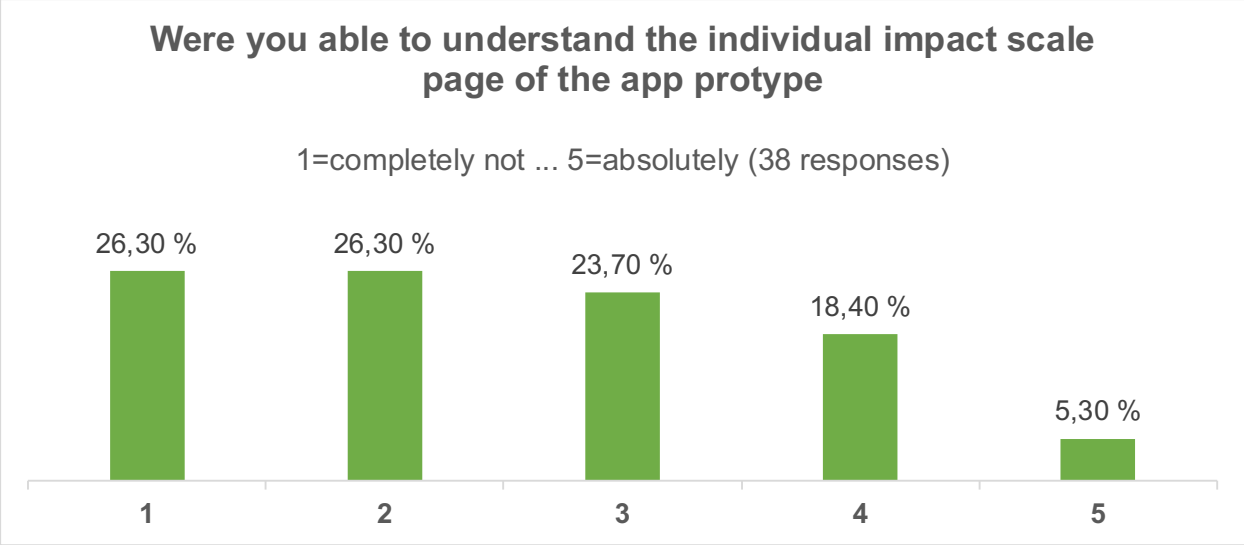


Figure 39. Survey responses for interpreting the individual contribution to impact targets.

The participants had a more neutral experience of understanding the collective impact (Figure 40). While some users reported having trouble navigating to the page, others suggested making the visualization easier to comprehend.

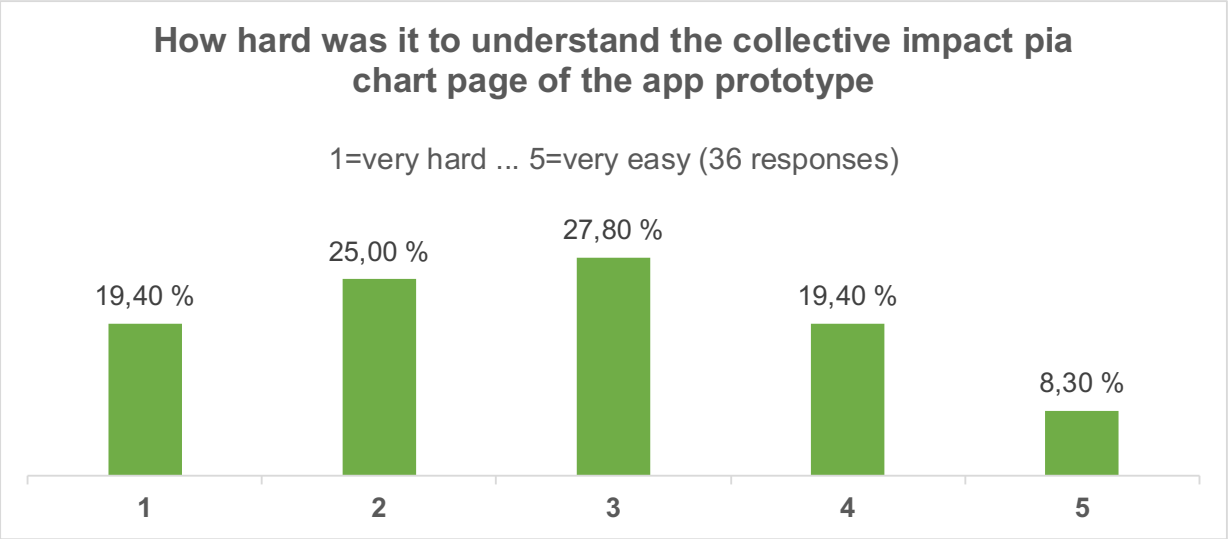


Figure 40. Survey responses for interpreting the collective contribution to impact targets.

In summary, the process of onboarding needs to be simplified. It currently involves downloading the Opera browser, which is not enticing for many users. Instead, if the platform is made available in an app store, this part will be much more convenient., and connecting the crypto wallet will also be simplified. We can also conclude that the platform needs several layers of information embedded in it to cater to the curiosity of various kinds of users. By and large, Food Futures users perceive the platform to be educational and would like a detailed description of the variables, their significance, and the data processing. As far as consumer empowerment is concerned, more than fifty-five percent of the participants found impact visualization motivating; furthermore, more than seventy percent find it inspiring to see their impact compared to the Finnish average. We can enhance this feature by being more descriptive about the carbon targets and their relation to the quality of meal servings.

Almost sixty percent of the participants reported their interest in continuing to use the platform after the completion of the MOOC. Making it into a stand-alone platform available in various app stores would be a great motivation and convenience for continued usage. Approximately seventy-three percent of participants voted for its availability for public use. Additionally, the ability to redeem the earned tokens would escalate their interest in continued usage. Other suggestions included receiving phone notifications around lunchtime that could remind users about the platform, linking it to the phone gallery, and in-depth explanations.

5.5. Results of the pilot

In this pilot, allocative efficiency was defined as achieving more sustainable meal choices and a lower carbon footprint due to the intervention of the Food Futures platform. Subjects consented to the participation in the experiment which enabled the aggregation of meal selection data from all users. Additionally, the vendor shared with us the data of all meals served throughout the period that each of the three trials ran. We were able to show that users made more sustainable meal selections against the control group, which was all the other venue diners. We supplemented our data collection with voluntary surveys about the UX, as well as about subjects' dietary habits and reactions to using the platform.

The pilot gathered data determining the number of meals from each category (green, yellow and red) selected by participants. Table 5 contains the data of the number of users and meal validations in Unicafe diners and at home during the three trials.

Table 5. Registered students and course completions in the trials.

Trial	Number of users	Unicafe validations	Home validations
1	12	28	N/A
2	17	49	88
3	31	45	162

The Trial 1 data was from the initial pilot with 12 sustainability course students who participated in an in-person workshop held at the university cafeteria venue. The low number of validations reflected that some phone models were not able to validate meal selections (a problem that was fixed in Trial 2). As illustrated in Figure 41, The Food Futures users demonstrably selected more sustainable meals than those selected by the other venue diners on the same days.

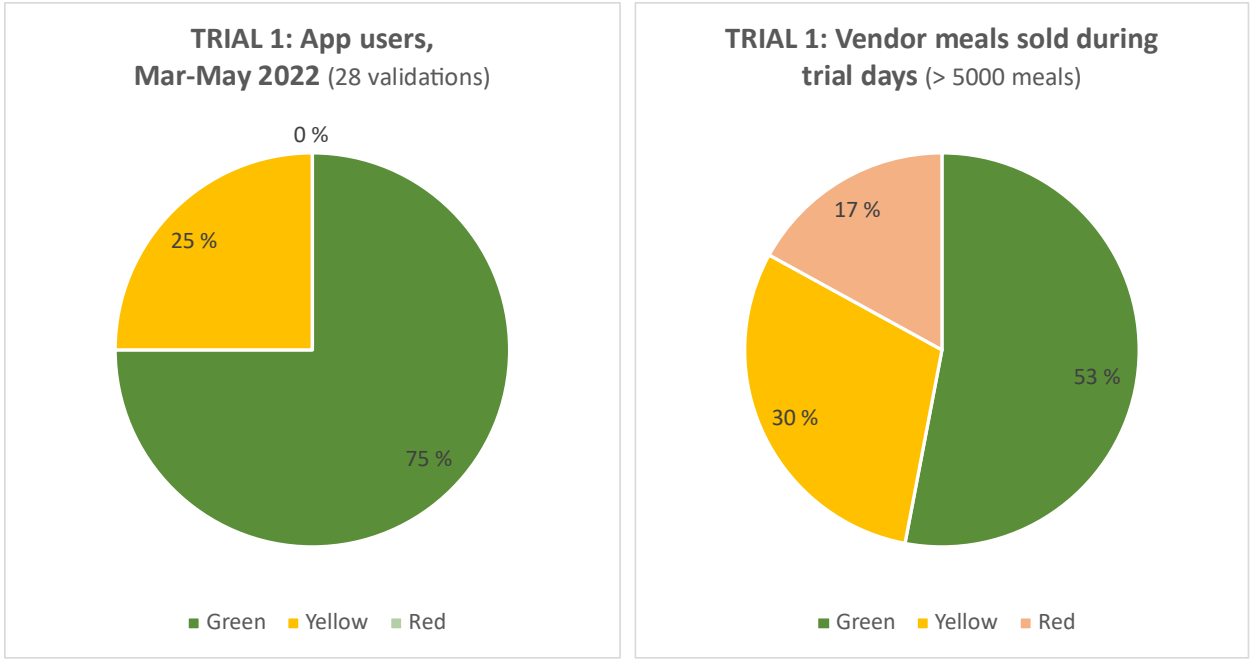


Figure 41. Food Futures users' meal choices compared to vendors' total meal sales in trial 1.

Trial 2 data included meals validated at the university cafeteria venues as well as at home. The data was collected from 17 participants. As illustrated in Figure 42, Trial 2 shows the same result as that obtained in Trial 1; The Food Futures users clearly chose more sustainable meals than the other venue customers.

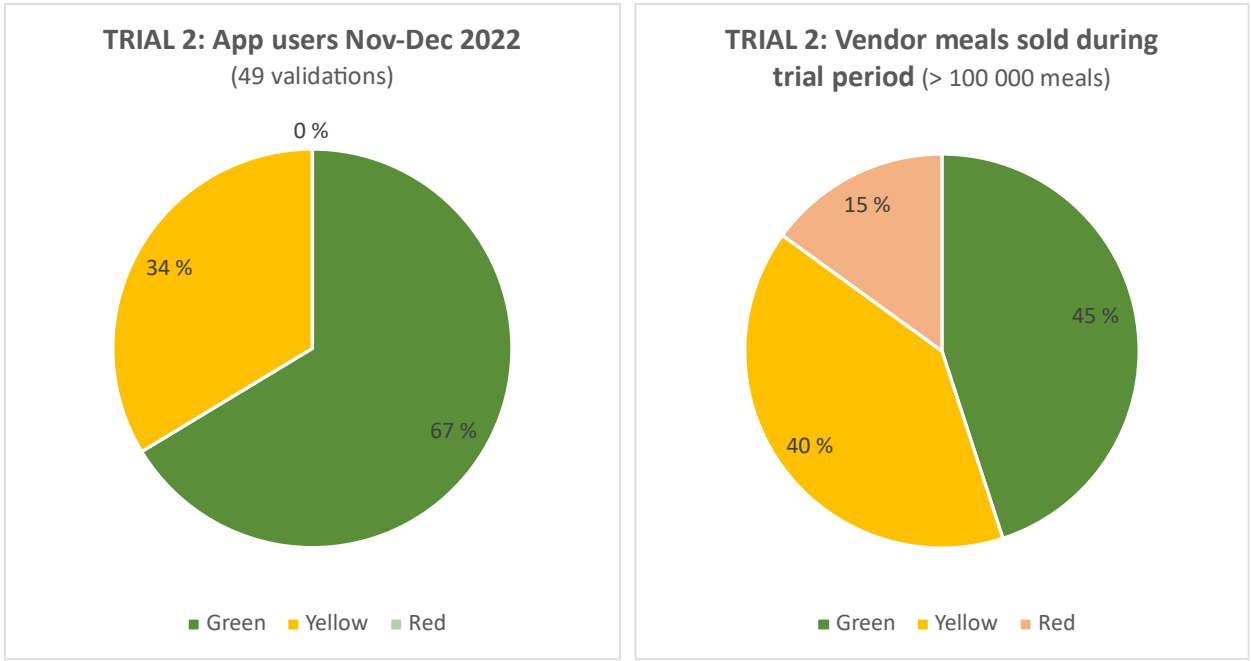


Figure 42. Food Futures users' meal choices compared to vendors' total meal sales in trial 2.

To visualize the comparison between participants and students in general, the one venue that reliably served the most sustainable meals throughout was isolated. Even when comparing the data of platform users with that greenest, lowest carbon footprint, university cafeteria venue, the subjects still consistently made more sustainable meal choices, as illustrated in Figure 43.

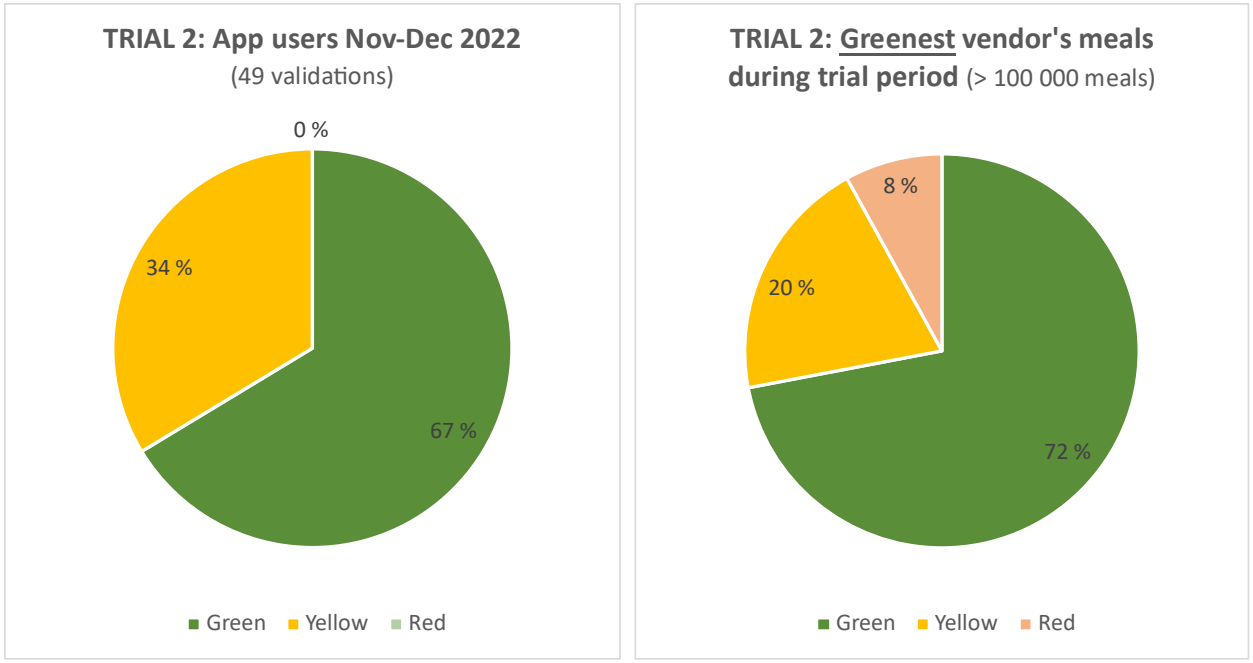


Figure 43. Food Futures users' meal choices compared to greenest vendor's total meal sales in trial 2.

When analyzing the data of the home validations in trial 2, it can be seen that the Food Futures users ate at least as sustainably as the university cafeteria's customers, as illustrated in Figure 44. Notably, as the university cafeteria is committed to serving meals with no higher than a 0.5kg CO2e footprint, the users validating at home made selections in aggregate with a similar and sometimes even higher level of sustainability than the total number of meals served at the socially responsible cafeteria.

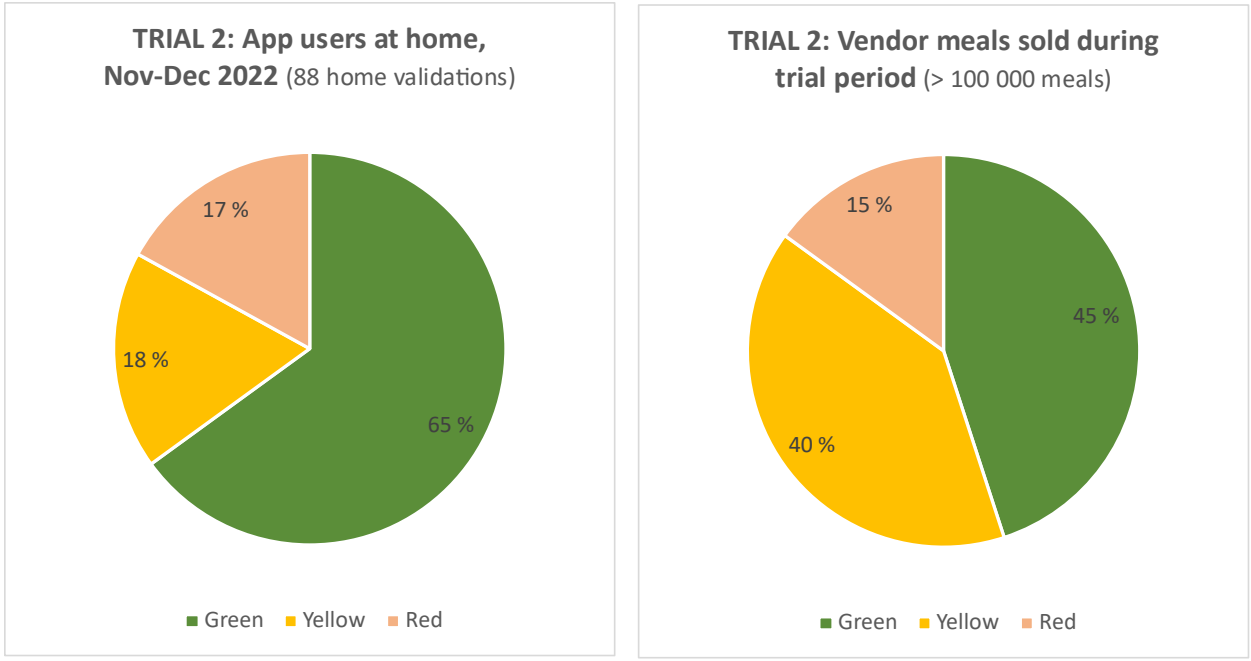
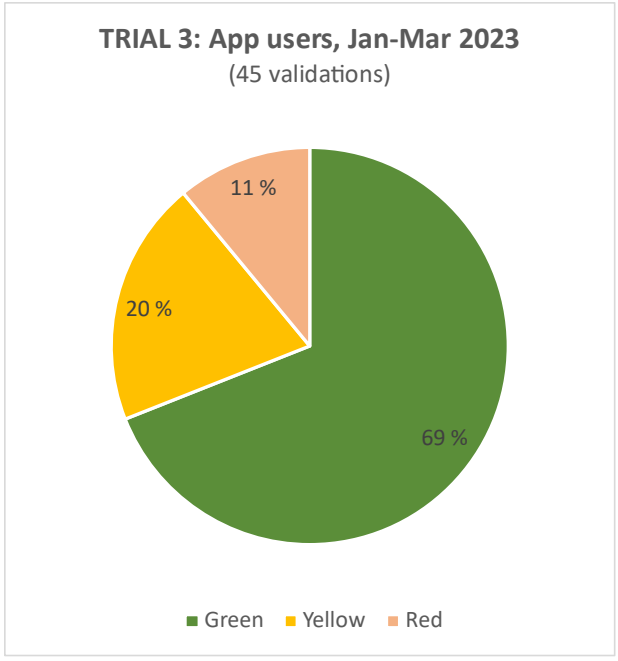


Figure 44. Food Futures users' meal choices at home compared to vendor's total meal sales in trial 2.

Trial 3 results had 31 subjects and repeated the patterns exhibited by Trials 1 and 2. As illustrated in Figures 45 and 46, the users validating meals in the university cafeteria venues made more sustainable meal choices in aggregate than did the other venue customers. Also, while preparing meals at home the users made more sustainable meal choices in aggregate than did the other venue customers.



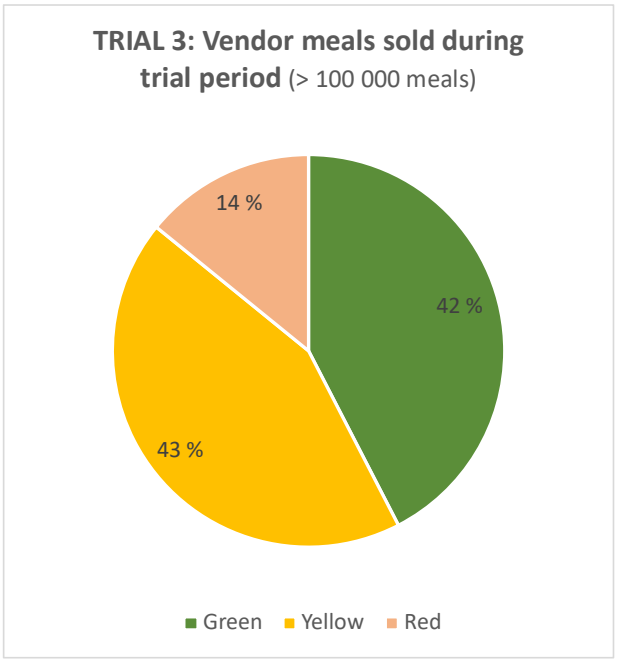
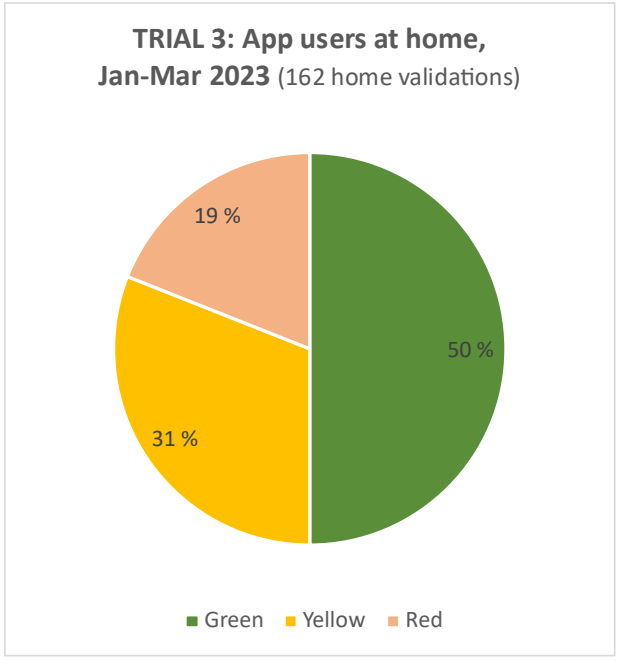


Figure 45. Food Futures users' meal choices compared to vendors' total meal sales in trial 3.



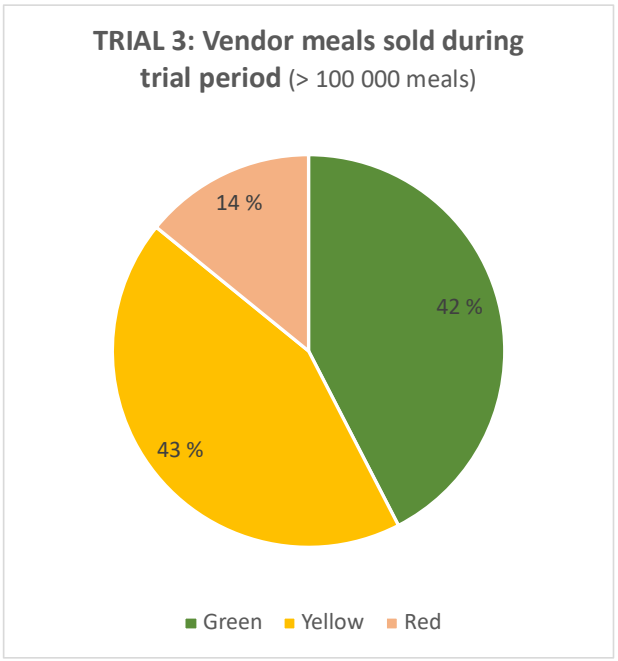


Figure 46. Food Futures users' meal choices at home compared to vendor's total meal sales in trial 3.

In order to buttress our findings from meal selections, we conducted voluntary surveys to learn more about our subjects' meal choices. We posed question directed at understanding subjects':

1. Motivations
2. Dietary histories
3. Potential for compensatory action
4. Future interest in using the Food Futures platform

Regarding motivations, we learned that a majority of respondents reported that it is motivating (55,3%) to see the actual collective impact of Food Futures platform users. Respondents found it motivating (70,4%) to see the sustainability impact of their meal choices contrasted against the sustainability impact of the average Finnish citizen. The graphic that resonated the most in terms of motivating action was the thermometer (54,2%) reflecting the level of sustainability of meal choices, as illustrated in Figure X. (it operated on a daily, weekly, and monthly basis).

For the questions about the dietary habits that subjects had prior to and during the pilot experiment we learned the following. Less than 25% reported a plant-based diet, indicating 75% of the respondents ate animal products. Only about 12% of the respondents reported actively eating a wholly plant-based diet during the experiment. In a question asking whether participants had tried a plant-based diet in the past, approximately 43% had done so for over a year, roughly 1/3 had never tried a plant-based protein diet, and roughly 20% had done so for less than one month. From this we are able to conclude that our study included numerous individuals who were not dedicated vegans, and the highest level of vegan participation in our trials was less than 50% of our subjects.

We also were curious to learn if subjects might choose to eat more sustainably while using the Food Futures platform while later selecting to eat less sustainable meals. Although not many responded to this question (8 participants), the ones that did reported taking no compensatory action (7 participants), and one individual reported possibly eating more fish or chicken during other meals.

Finally, we set out to learn what factors would encourage users to keep using the platform after the experiment terminated. Almost 75% of respondents reported that they would like to see the Food Futures platform in the smartphone app stores. Additionally, just over half of our respondents reported that they would like to be able to redeem (in our case "share") tokens for goods or services related to wellbeing. As well, when asked what they would be interested in using tokens for, over half reported an interest in some type of discount at the university cafeteria.

Conclusion. In the Food Futures case, allocative efficiency was defined to be the coordination of communities to make sustainable meal choices, which can result in significant CO2e emissions reduction. The Food Futures pilot experiment demonstrated the potential for a tokenized Measure, Record, Validate system to achieve this goal. By providing users with information and validation systems in the Food Futures platform, we were able to motivate the community members to make more sustainable meal choices, thereby resulting in increased allocative efficiency.

The survey data gathered during the experiment provided important insight to the users' experiences. The data is not statistically significant, but still provides indicative evidence. Many of our participants reported that the information and validation system on the platform provides a clear and positive motivation force. This data strongly indicates that a large-scale experiment would be able to verify the efficacy of the technology in achieving more sustainable meal choices among subjects using the platform. Whether the platform has enabled any extended behavioral changes, or for a longer duration than the experimental trial, remains to be seen. More data gathered during this pilot can be found in Appendix A.

We stress that the Food Futures pilot use case serves as a feasibility study to show that it will be possible to carry out a large-scale randomized experiment to provide empirical evidence to test the potential for this polycentric governance tool to lead to sustained CO2e abatement. Additionally, this pilot experiment clearly shows a preliminary small data set documenting the potential for this governance tool to be effective in achieving allocative efficiency in CO2e emissions abatement. The anti-rival nature of our tokenized Measure, Record, Validate system is due to the negative subtractability of CO2 reduction, and the positive sum impact of achieving collective ecological security. Security is a positive sum good, and we are extending this concept from physical security from assault to physical security from inhospitable weather patterns leading to famine, drought, excessive heat, and flooding. We have prepared the textbook S*ustainable Consumption*[10] to explain the theoretical design principles underlying the Food Futures experimental design.

[10] Forthcoming, Aalto University, Science and Technology Series, March 2023

6. Discussion

The results of the Barcelona Green Shops, Streamr Community, and Food Futures pilot experiments demonstrate the role of sNFT-based incentives in improving community engagement, community work effectiveness, and thereby anti-rival value capture and allocative efficiency. The introduction of tokens facilitated users to participate in effective contributions to the Streamr Network and sustainable consumption practices in Green Shops and Food Futures. In all cases, the token-based incentives helped community members better allocate their resources in a way that supports their individual values and contributions to the community to reach community-specific goals and targets.

Each pilot experiment used co-design methods to include the users in the design process to improve the respective UXs. Furthermore, in all cases, the users made important contributions to the positive development of the services. The clear difference in functionality between the UIs, developed as part of the respective experiments, indicate that the platforms were truly customized to their specific context, as demanded by good service design practice. Additionally, all platforms still continue to be used and there are solid plans for their continued development.

6.1. A cross-case systems model for anti-rival value creation and capture

Based on the data gathered in the cases, a systems model emerges that highlights the key reinforcing loops contributing to increased anti-rival value capture and allocative efficiency.

R1: Incentivizing contributions. One of the key reinforcing loops identified in all cases is the role of incentivizing contributions (R1), as illustrated in Figure X. In the Green Shops case, token-based rewards incentivized sustainable supply and consumption practices in local shops, resulting in increased activity on the platform. In particular, the challenges proposed by the platform coordinators encouraging sustainable practices among the members were completed by a large number of participants, indicating a commitment to sustainability and a willingness to take concrete actions toward it. Similarly, in the Streamr Community case, the survey results indicated that the Streamr Award system motivated the community members to contribute to the project, and also enabled members to contribute more effectively—the tokens assisted the members in discovering where and how they could contribute. The Food Futures pilot results showed how the pilot participants opted in for sustainable meals and were able to overcome the negligibility problem of sustainable choice. In these ways, the R1 loop creates a self-reinforcing cycle (contributions-acknowledgements with tokens-increased motivation to contribute) that leads to engagement and increased allocative efficiency in the communities. Notably, the shareability functionality of the sNFTs increased the motivation not only on the individual but also on the community level through co-contribution rewards.

R2: Building recognition culture. Another reinforcing loop identified is building a recognition culture (R2), as illustrated in Figure X. The results from all cases provide evidence for this loop. In Barcelona Green Shops, the B2B platform fostered a sense of community ownership among shop owners. Shop owners were interested in sharing and learning together about sustainable practices and strategies. Similarly, in the Streamr Community pilot, the findings suggested that recognition possibility through tokenized incentives positively impacted the Streamr community, resulting in a culture of appreciation. Streamr community members actively minted ‘like’ tokens and shared ‘award’ tokens, and thereby collectively participated in enhancing allocative efficiency. In Food Futures, pilot users continued to use the meal reporting system after its introduction and appreciated the token-based visualization of community impact toward lowered CO2 emissions. Together, the case results suggest a reinforcing loop R2 that can increase the anti-rival value creation of the community: by allowing the possibility to recognize community members' contributions, the members feel valued, appreciated, and empowered, leading to culture of recognition and appreciation, a greater sense of shared ownership, and even stronger willingness to recognize contributions.

R3: Fostering collaboration. Finally, fostering collaboration (R3) is a reinforcing loop that connects the two previous loops. In the Streamr Community case, the members reported spending more time contributing to the project because of the incentives provided by Streamr Awards, and the metadata on Streamr Awards helped them identify potential collaborators within the community. Similarly, in the GreenShops case, the B2B and B2C platforms incentivized shop owners to collaborate and share information related to sustainability. The qualitative results indicated that the B2B platform generated positive incentives for shop owners to engage in conversations and share information related to promoting products with sustainability criteria and understanding customer sustainability needs. Food Futures worked with a slightly different logic as it was not about person-to-person interaction, but persons contributing together for the environment as whole through low CO2 meal selections. The Food Futures case was able to incentivize members to contribute despite the negligibility problem in large-scale collaboration; thus, the case suggests indirect support to the R3 as well.

In sum, the results of all cases provide evidence for the reinforcing loop R3 illustrated in Figure 47. Here, the strengthened collective culture of recognizing contributions leads to increased individual and team-level contributions which then further enhances the collective contribution recognition culture. The shareability function of the sNFTs holds a key role in this dynamic: sNFTs at the same time incentivize individual contributions, but also build a sense of community by recognizing co-contributions; this way, R1 and R2 become connected through increased collaboration. Conclusively, through R3, all cases were able to improve allocative efficiency by better aligning community work and resources towards community-specific goals and targets.

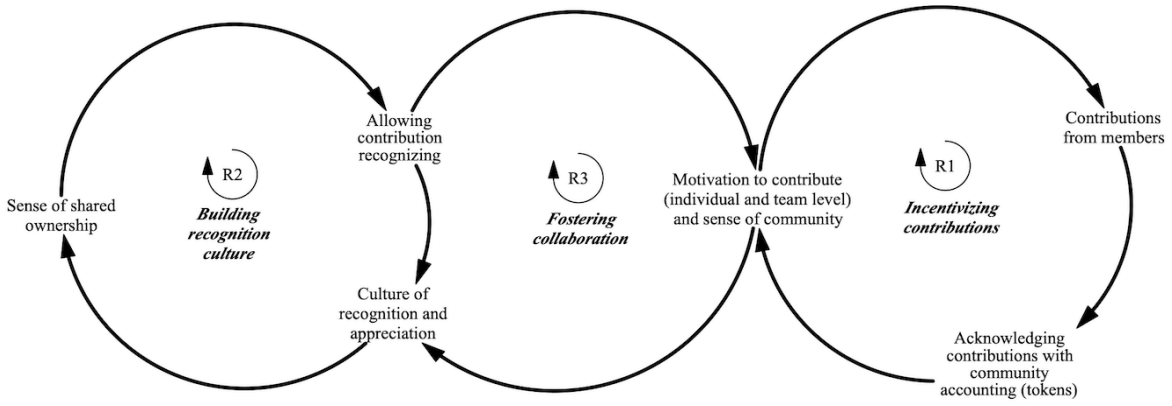


Figure 47. A cross-case systems model.

Capturing anti-rival value. The anti-rival value is captured throughout the systems model as the loops R1, R2 and R3 work together to incentivize contributions, build a recognition culture, and foster collaboration. In more detail, as described by the "R1: Incentivizing contributions" loop, token-based incentives encourage members to contribute more to the community and at the same time increase the tokens' value for the members and community in terms of coordinating community. Anti-rival value is captured through increased community (work) engagement.

In the "R2: Building recognition culture" loop, allowing contribution recognition enhances the culture of appreciation and fosters a sense of shared ownership among community members, leading to further recognition and appreciation of contributions. Anti-rival value is captured through an enhanced sense of shared responsibility.

Finally, the "R3: Fostering collaboration" loop connecting R1 and R2 encourages community members to work together and share resources, and promotes an anti-rivalrous approach to community collaboration. Such a collaborative mode of operation captures anti-rival value in the form of increased collective efficacy.

6.2. Contributions to the domain of anti-rival system UX development

These pilot experiments have been built to embed mechanisms utilizing a novel token standard. This makes it all the more impressive that all pilots were able to produce functional and iteratively developed platforms. Based on the data gathered as part of the UX evaluation before, during, and after the pilot experiments, a set of requirements emerge for designing the UX for community platforms using sNFTs as anti-rival tokens for indicating appreciation for the contribution by members. The main areas where special attention is universally needed are:

- *Transparency.* Information about the use of new technology, such as sNFTs needs to be readily available and accessible on the platform. Also, to increase trust in the community, the community rules, and the mechanisms by which the different types of tokens are minted need to be available in an easy format.

- *Accessibility.* In order to get the community started, the platform needs to be easy to use, and engaging for the users. This is especially important with regards to the onboarding process, where it may be necessary for users to set up their own digital wallet to be able to receive the tokens.
- *Impact.* The platform needs to support intuitive and easy tracking of the impact produced both by individuals and the community, as this was reported as an important incentive to keep contributing to the community.
- *Aesthetics.* Most users are used to advanced UX design and expect impressive levels of sophistication when it comes to the ability of platforms to visually express information and functionality. This also applies to users' ability to measure impact and expand their knowledge about the achievements of the community.

Additionally, each pilot experiments explored the option of further gamifying elements of their respective platform. The feedback implies that many users expected such features, but they were ruled out as overly resource-intensive and the platforms were therefore limited to the current format. We cannot conclude to what extent such added features had improved the UX.

The Streamr pilot proceeded to connect their Talko platform to Discord and Twitter, which some users may find a useful way of sharing their impact with peers outside the community platform. However, we lack the data to back up that claim. As these platforms stay open, there is a great opportunity to extend the list of important attributes in the future.

7. Conclusion

In conclusion, the pilot experiments of Barcelona Green Shops, Streamr Community, and Food Futures demonstrated the potential of anti-rival incentivization schemes, sNFT-based token systems, and related UX solutions to promote sustainable consumption practices, community collaboration, and resource allocation efficiency.

By incentivizing contributions, building recognition culture, and fostering collaboration, the experiments were able capture anti-rival value and promote collective efficacy in their respective controlled pilot environments. In particular, the shareability function of the ATARCA-developed sNFT standard played a pivotal role in the cases' dynamics, not only incentivizing individual contributions but also recognizing co-contributions, and building a sense of community ownership and responsibility. In addition, the data gathered through the UX evaluations highlighted the importance of transparent and accessible platform design, with special attention needed for impact tracking and simplifying complex incentivization structures.

While the results of the pilot experiments are promising, the technological readiness level of the cases is still low. Future research should build on the insights gained from these experiments to further explore the potential of sNFT-based incentives in promoting anti-rival resource allocation and collaboration. As a result of ATARCA, several new initiatives are already underway. Let us hope that the world will see many more of them in the future!

Declaration of AI and AI-assisted technologies in the writing process

During the preparation of this work the authors used OpenAI GPT3.5 model in order to improve English grammar and text flow. The authors take full responsibility for the content of the publication.

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