Kotha, Tejas; Amadae, S.M.; Rossi, Matti

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ENGAGING CONSUMERS IN SUSTAINABLE BEHAVIORS USING BLOCKCHAIN APPLICATIONS

Tejas Kotha

S M. Amadae

Matti Rossi

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Research Paper

Kotha, Tejas, Aalto University, School of Business, Espoo, Finland, tejas.kotha@aalto.fi

Amadae, S.M., University of Helsinki, Helsinki, Finland, sm.amadae@helsinki.fi

Rossi, Matti, Aalto University, School of Business, Espoo, Finland, matti.rossi@aalto.fi

Abstract

Tracking and goal setting are popular approaches in the personal health and fitness industry . In this paper we use a similar approach to assist users in their journey for a more sustainable lifestyle, starting with food. We employ Action Design Research (ADR) methodology to develop an application and subsequently propose design principles for developing blockchain-based applications for assisting users on their path to eating environmentally friendly food. The path to a sustainable lifestyle can be hard as individuals often do not realize their personal impact towards achieving a net zero carbon future. To address this shortcoming, this study conducts an ADR experiment to create affordances for users to learn, create impact and realize that they are not alone in this journey thus motivating users to a sustainable lifestyle. The design principles that emerged from the project are design for categories and labels, design for measuring collective impact, and design for rewards and redemption.

Keywords: sustainability, anti-rival, sensemaking, design research, blockchains

1 Introduction

On September 25, 2015, the member states of the United Nations adopted the 2030 Agenda for Sustainable Development for the future of the people and the planet. The resulting 17 Sustainable Development Goals (SDGs) set by the United Nations were a call for urgent action by all countries igniting intense discussions on sustainability and the critical role that digital technologies would need to play in achieving it. This emphasis on sustainability has facilitated a paradigm shift in the global discourse, putting the need for sustainable practices at the forefront of a diverse range of domains including individual choices, public policies, technologies, and businesses.

Sustainability is a multifaceted and complex concept that encompasses various environmental, economic, and social issues (Malhotra et al., 2013). Over the past couple of decades, IS has been instrumental in assisting organizational transformation projects aiming at resource optimization, mitigating harmful outputs, lowering emissions, and creating strategic capabilities to meet economic and environmental sustainability goals (Malhotra et al., 2013; Melville, 2010). “Green IS” has been steadily growing as an IS research stream in recent years, engaging in sustainable practices across organizational structures, such as automation, optimization, transparency of information flows, social signaling, and sustainable practices with the use of decision support systems (Jenkin et al., 2011). To that extent, much of the green IS outcomes are at an organizational level (Jenkin et al., 2011). Although a minority, several notable works focus on individual behaviors and grassroots efforts (Biørn-Hansen & Håkansson, 2018; Loock et al., 2013; Seidel et al., 2017).

There has been a growing interest in blockchain use cases for the food supply chain due to its ability to enhance trust by improving transparency, security, durability, and integrity (Feng et al., 2020; Treiblmaier & Garaus, 2023). It has been noted that to increase their competitiveness, retailers in the

food sector must communicate their product quality and efforts clearly. Sustainability and food quality labels go a long way to increase the purchase intentions of consumers as food labeling is considered the third most important attribute for a product choice, after price and procurement method (Sigurdsson et al., 2022). Most of the previous studies focus on sustainability labeling, but there is not much research on providing consumers with actionable sustainability insights into their consumption patterns and impact in the food sector. To address the above research gap, we propose the following research question:

RQ: How to identify, track, and improve sustainable food consumption patterns among individuals?

We take an Action Design Research (ADR) approach (Sein et al., 2011) to design a mobile application (digital artifact) that is innovative and purposeful to address the specific problem at hand (Hevner et al., 2004) by allowing users to record their consumption habits, in return giving them actionable insights to reflect upon and overtime nudge them towards more sustainable consumption habits. The result is a set of design principles for conscious and sustainable habit-building practices. Thus, responding to the IS community's call for effective IS design to influence environmentally sustainable human behaviors (Melville, 2010).

The rest of the paper is organized as follows: in Section 2, we will introduce the related work on environmental sustainability, blockchains, and concepts of identity that we identified to be important for the study. Section 3 presents the ADR methodology, and the empirical case setting, and goes through the ADR cycles of the artifact. Section 4 demonstrates the results and reflections from the study. In Section 5, we present the proposed design principles. Section 6 engages in the discussion of the design principles and finally, the conclusions of the work in Section 7.

2 Theoretical Foundations and Related Work

Food Futures project is funded by the European Union’s Horizon 2020 and focused on imaging a new accounting system based on anti-rivalry to promote an efficient economy of digital goods with the help of blockchain technology. At the core of the project lies the seminal work of Nobel Laureate Elinor Ostrom on polycentric governance and the negative subtractability of anti-rival goods (Ostrom, 2010). Digital goods such as music and art are anti-rival in nature. The more they are shared, proliferated, and consumed, the more the consumptive gain of the users which can lead to further positive externalities. Such forms of anti-rivalry are hard to achieve when it comes to currencies, as they naturally tend to be rivalrous in nature because of scarcity and their zero-sum nature. In order to achieve positive externalities i.e., sustainable consumption using community engagement, we identified some key concepts and technological innovations that lay the foundation of our case project. We provide a brief overview of the meta-principles and concepts from green IS and consumer research that guided our implementations.

2.1 Sensemaking in environmental sustainability

Sensemaking as a concept inspires the advancement of the social-constructionist perspectives and process-driven models in organizations. In today’s digital environment, there is no dearth of data, but much innovation lies in our ability to make sense of data and produce the active construction of actionable insights through language (Sandberg & Tsoukas, 2015). Sensemaking in the case of environmental sustainability involves engagement in communicative actions revolving around sustainability (Seidel et al., 2013).

Sensemaking is a process of interpreting and acting on cues that are attained from the ecosystem and given initial meaning (Weick, 2015). This process involves selecting and simplifying relevant cues, creating a coherent narrative that makes sense of them, and using that narrative to further guide the user's actions and interpretations (Weick et al., 2005). In doing so, the narrative then becomes a shared understanding among the sense-makers (Weick et al., 2005). To make sense of the cues, sense-makers need to assign labels and categories to them. This way, the users can stabilize their understanding and

find common ground with others (Weick et al., 2005), and imagine a sense of community and belongingness (Anderson, 2006). Sensemaking also requires acting on assumptions that link the abstract and the concrete. Sensemaking starts from the immediate actions, local context, and concrete cues and then asks ‘‘what is the story here?’’ and ‘‘what do I do next?’’ (Weick et al., 2005) When users recognize the issues that are looming and the impact they have, they can anticipate future scenarios and act effectively.

It has been observed that IS can facilitate cognitive activities that aid in understanding the complexity of the environmental sustainability transformation (Seidel et al., 2013). When it comes to individual practices, the ability to reflect and make sense of them is highly determined by exposure to and interaction with sustainability-related information. Such affordances create space for influence and action capabilities in a network for sustainable practices in the form of logistics and resource consumption (Seidel et al., 2013).

2.2 Blockchains

Blockchains are decentralized, transactional database technology that facilitates validated, tamper-proof transactions across the network (Beck et al., 2018). In the past few years, blockchains have evolved beyond cryptocurrencies in the form of non-fungible tokens (NFTs) and decentralized autonomous organizations (DAOs) with the introduction of freely executable smart contracts by Ethereum in 2014. These categories of blockchains have been seen as enablers for sustainability by enhancing transparency in supply chains (Chapron, 2017; Treiblmaier & Garaus, 2023), resource management, healthcare (Gammon, 2018), and incentivizing circular economies and clean energy (Rijmenam & Ryan, 2018). Blockchains are yet to attain widespread adoption, but there have been various implementations by the open-source community and the industry both at the protocol and application layers that have far-reaching impacts. The IS community needs to engage in theorizing blockchain interactions through rigorous empirical work through several paradigms such as behavioral, design, and economics (Rossi et al., 2019). Our project realizes this call by presenting an innovative use case for blockchains at an individual and societal level in the scope of UN SDGs. It is to be noted that our utilization of blockchains is not to disrupt the supply chain of the food network but to emphasize an individual’s journey of sensemaking and actions for sustainability can be enriched.

Digital tokens enabled by DLTs disseminate access, ownership, and information without central entities who act as "trusted third parties" (regulators and intermediaries). The term non-fungible token (NFT) comes from the economic principle of non-fungibility which associates any commodity with a sense of uniqueness and value. The idea here is that these possessions are unique, non-divisible, and not interchangeable. NFTs thus have emerged as crypto-collectibles that possess unique and verifiable properties in their current mainstream usage due to the prohibitive cost associated with tampering that ensures their resistance to deception, thereby enhancing their credibility as signals of wealth (Chaffer & Goldston, 2022).

Taking a step aside from the mainstream cryptocurrency and NFT ecosystem where one could buy and transfer NFTs at whim, this ADR project imagines a different approach, where these composable (the ability to bundle with other NFTs) and redeemable tokens are bound to one’s identifiers on the blockchain. Thus, they reward one’s ability to attain the tokens (NFTs or cryptocurrencies) and not the tokens themselves. In doing so, the tokens, although stripped of their monetary value in contrast to traditional blockchain tokens, have the potential to offer far more personal, intimate, and psychological value. The tokens do not only become scarce and hard to collect but also become souvenirs and allow for more trustful and lasting engagements with the token holders. Ethereum’s co-founder, Vitalik Buterin critiqued the mainstream tokens that have plagued the ecosystem to become signals of wealth disregarding the skill it takes to acquire them (Buterin, 2022). The resulting concept is that of soulbound NFTs, which, once acquired, are non-transferable, validating the assumption that certain criteria have been met for attaining them. Non-transferability in this context also comes with the facet of anti-rivalry which means these tokens are subject to increasing returns to shared use just like software and data (Cooper, 2006; Hakanen et al., 2023; Weber, 2005).

Often in-app/in-game achievements tend to stay within the realms of the platform infrastructure which means aspects of our digital identities and pride objects remain segregated across different platforms despite being extraordinarily rich data profiles. Blockchains provide the underlying infrastructure to enable innovative solutions for user ownership and management of their digital assets. Thus, the ADR team decided to experiment with blockchain as the underlying infrastructure for the application to imagine the possibilities digital asset infrastructures could offer.

2.3 Pride and Co-creation of Self

"Pride-object" refers to both material objects and immaterial experiences that can invoke a sense of pride for an individual (Ahuvia et al., 2018). Pride can be defined as an emotion that is triggered by an individual's positive self-reflection and evaluation (Carver et al., 2010). For a sports fan, it could be a jersey or a hat of their favorite sports team, for a university student it can be their student caps and badges on their student overalls that signify their active student life and allegiance to their guilds, for some, it could be some talent or being good at something, and for players, being able to cross a certain level or possess a rare item that ties them to a sense of pride and often, achievement. It is also important to note that physical co-presence or possession is not often a necessity for a rich sense of imagined communities (Anderson, 2006). In this case, NFTs due to their nature of being unique, verifiable, and digitally listed, have the potential to become digital signals of self-expression, competence, habit, and a high sense of belongingness towards similar changemakers. This becomes extremely relevant in creating digital products/apps that use NFTs as social nudges to develop a habit or competency. Sense of competency and achievements, and the ability to demonstrate to others, are important reasons adults engage in various endeavours (Dahl & Moreau, 2007; Mochon et al., 2012). The ability to demonstrate and share one's pride objects creates an opportunity for "co-construction" of self through the process of social feedback and affirmation (Halttu & Oinas-Kukkonen, 2017).

Identity construction is seen by many to be one of the core properties of sensemaking that distinguishes it from basic cognitive psychology and needless to say, affects other aspects of sensemaking (Weick et al., 2005). How we perceive ourselves influences our actions and interpretations, which in turn shapes how others perceive us, which can reinforce or challenge our identity. Our identity is thus partly dependent on others. Leaning on Foucault, it can be said that we construct the self "with the help of others" (Foucault et al., 1988). Thus, interactions on digital media can be considered as a joint project that offers consumers the opportunity for "co-construction of self" with others, both through an affirmation of the self and an extended self in the digital space (Belk, 2013).

3 Research Design

3.1 Methodology

We use the Action Design Research (ADR) methodology introduced by Sein et al., 2011 for developing the design principles for the Food Futures project. ADR approach provides an effective method and framework to generate knowledge capable of solving a class of problems through emerging design principles (Sein et al., 2011). The ADR approach allows one to carry out projects wherein the artifact informs both research and practice (Mullarkey & Hevner, 2015). This is achieved when researchers and practitioners iteratively and authentically collaborate to shape the artifact (Haj-Bolouri et al., 2018). ADR approach allows the production of prescriptive knowledge in the form of design principles that can be generalized and formalized for solving a class of problems. These design principles emerge through the iterative BIE (building, intervention, and evaluation - Stage 2 in Figure 1) cycles in the context of organizational settings through active collaboration between the researchers (ADR team) and the stakeholders. The ADR framework is illustrated in Figure 1.

The resulting artifact is ingrained with theory and thus can organically evolves through several cycles of BIE over time rather than being static (Sein et al., 2011). ADR aims at the construction of an

Information Systems (IS) artifact that emerges and seeks to understand the interwoven nature of the artifact and the organization in a real-world scenario (Haj-Bolouri et al., 2018).

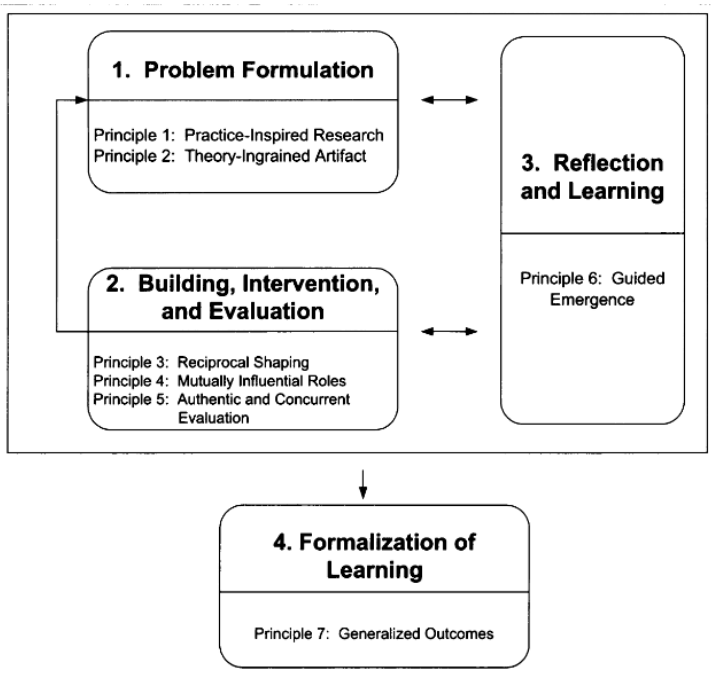

Figure 1. ADR Method: Stages and Principles (Sein et al., 2011)

In this study, we implement a mobile application (progressive web application) that allows users (students in this case) to record their meal consumption at university restaurants and by doing so, visualize the impact they have created in terms of CO_2 footprint along with their community by choosing more sustainable meal choices. This design study was part of a larger research project, ATARCA (Accounting Technologies for Anti-Rival Coordination and Allocation) aimed to study the anti-rivalrous property of data. The solution was supplemented with a MOOC (Massive Open Online Course), offered from March 2022 to May 2022 and again from November 2022 to March 2023, that focused on 'Sustainable Consumption'. This allowed the project team to involve participants in the design, development, and feedback for the artifact over several iterations. The solution was then evaluated with feedback forms and user surveys from participants of the ADR study. This research makes a valuable contribution to the existing body of knowledge in information systems (IS) by enhancing our understanding of the utilization of blockchain infrastructure. Moreover, it has practical implications, as it stimulates the exploration of consumer-oriented blockchain applications that extend beyond traditional economic markets.

3.2 The Food Futures Application

The Food Futures app emerged as part of a larger Sustainable Consumption project under ATARCA. The project aims to build an effective Distributed Ledger Technology (DLT) accounting system to measure, record, and validate individual contributions toward environmental sustainability (by habitually shifting to sustainable lunch options). At the face of it, it is a simple mobile application that aims at doing two things for the consumers: 1. Sensitize them about the impact of how different classes of food sources in the food they consume have an impact on environmental sustainability. 2. Allow them to measure the impact of their consumption choices over time in a cooperative community, thus empowering the realization of a collective impact on environmental sustainability.

Figure 2. Screenshots from the landing pages of the Food Futures application

Essentially, the users can set their goals and concerns related to sustainability during their onboarding based on which their whole experience with the app develops. The user's journey with the application starts even before they visit the restaurant. The application serves as a restaurant and menu discovery platform to decide on the restaurant that they might want to eat at. The researchers partnered with UniCafe, a student restaurant chain in the Helsinki metropolitan area, and in doing so, UniCafe provided the data necessary to provide a menu of daily food options and their sustainability metrics based on the Food Wellbeing and Sustainability Index (FWSI) developed as part of the project (Jumite, 2022). The index classifies the meal based on carbon, material, and water footprints of the protein sources because they have been recognized for having the most significant environmental impact (Huan-Niemi et al., 2020)). The menu is made to be interactive, allowing the users to explore the individual impact metrics for each meal option and be suggested the most sustainable option for the day as seen in Figure 2.

Upon deciding, once the user goes to the restaurant of their choice and buys the meals, they enter the choice and submit a photo of the meal for the researchers to verify the entry and approve the corresponding rewards. In further ADR cycles, this step would be integrated with the restaurant's payment infrastructure to remove the manual entry and human verification steps. In doing so, the transaction gets recorded on the blockchain and gets reflected on the user's profile along with their previous history and the overall impact of that community as seen in Figure 3.

Figure 3. Screenshots from individual history and impact pages

This accounting system allowed us to further implement a token system using Ethereum-based tokens that reward the positive contributors. The uniqueness of these tokens from regular cryptocurrencies and NFTs is that they are non-transferable, allowing us to create an anti-rival good that could be redeemed (not transacted) as the ecosystem on the supply side grows with free meals/coupons/sustainable products for certain milestones (Hakanen et al., 2023). In further ADR iterations, the researchers are investigating how restaurant partners can engage users in challenges to have more sustainable meals at their restaurants to get more of the tokens which can further be redeemed in a secondary marketplace as shown in Figure 4. Thus, the development of a whole ecosystem beyond food where the users could reap the rewards of their contribution to a more sustainable world.

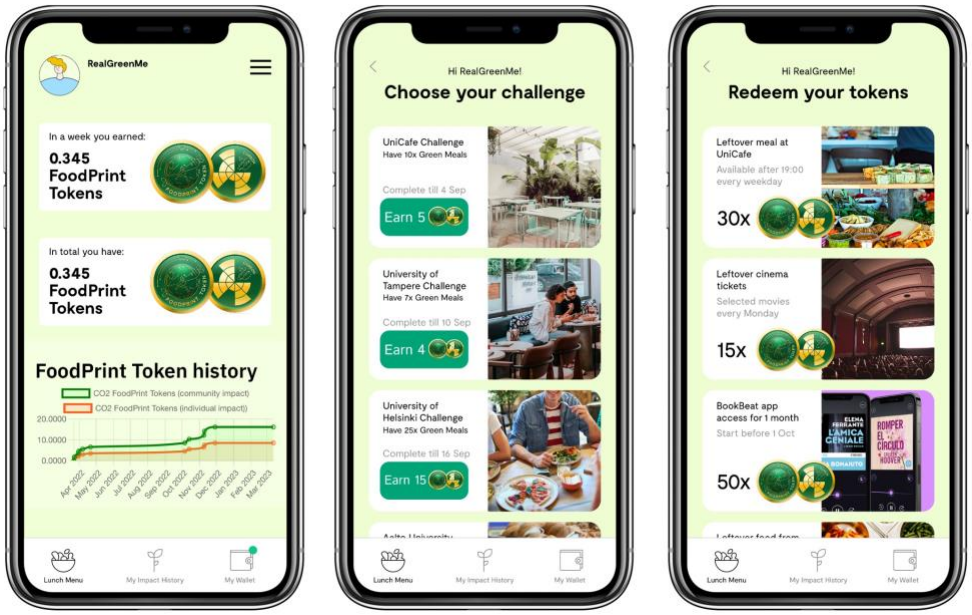

Figure 4. Screenshots from the challenges and rewards pages of the application

3.3 ADR Cycles

Although the research project is still ongoing, this study reports outcomes from two ADR cycles which were performed between March 2022 – May 2022 and Nov 2022 - March 2023. The cycles were implemented as prescribed in the generic schema for Organization-Dominant BIE, to focus on the stages of evaluation, reflection and learning, and formalization of design principles as learning outcomes. Sein et al., 2011 emphasize that in ADR, unlike other Design Research (DR) methods, "the evaluation is not a separate stage of the research process that follows building".

The nature and objectives of evaluation cycles differ where alpha is formative, and exploratory while beta versions are summative, value, and outcome-oriented (Sein et al., 2011). As the evaluation happens in several phases and at different milestones of building the artifact (as mentioned below), it is hard to have a controlled setting and the artifact emerges from the interplay of the researchers, the users, and the environment. For this project, the design and development phases were carried out by creating a mobile application (progressive web application) and the participants for the evaluation phase were students participating in the 'Sustainable Consumption' MOOC at the University of Helsinki. The student feedback was collected continuously throughout the lifecycle of the project from participants in the form of qualitative interviews in the field (when students went to try the alpha version of the application at student restaurants), outcomes of design thinking workshops as part of in-class activities, and survey data collected for the beta version from participants at the end of the MOOC. The cycles and their subsequent outcomes are illustrated in Figure 4.

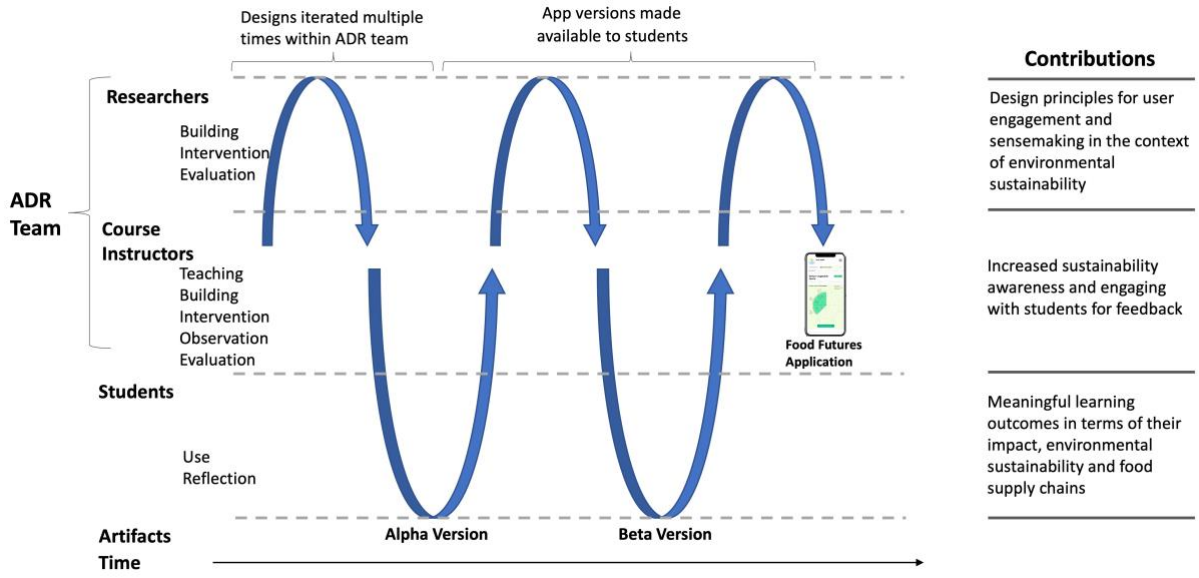

Figure 4. ADR Cycle: Schema from Food Futures BIE adapted from (Sein et al., 2011)

The participants of the feedback and design thinking workshops were from bachelor's and master's programs across disciplines like Environmental Science, Psychology, and Political Science allowing the researchers to tap into various perspectives on the whole nature of sustainable practices. Students who were in the capital region would meet with the researchers during lunch every Thursday for the span of the experiment period of one and a half months during the Alpha testing. Alternate course assignments were provided for students who chose not to participate in the experiment. In total, the project had 70 student participants who participated in the intervention and evaluation phases of the two ADR cycles.

The first ADR cycle was focused on visualization, scenario-building exercises, ease of using the application (UX Design), and the reward mechanisms of the application. This revealed some key insights for the researchers on how the users perceived the app: as an educational platform, appreciation and empowerment of their choices, comparative insights, and nutrition management; but also its potential of becoming a de-facto application for university cafeterias and developing an ecosystem for regular restaurant meals as well as indices being placed in front of the restaurant meals for visibility beyond the

application. Further concerns also revolved around the need for further simplification of the visualizations and data, the redemption of tokens, volunteering, and activism as part of community-driven activities, the need for defining healthy social norms, and the risk of widening the social gap and incentive-driven approach could lead to harmful outcomes for users with eating disorders.

The development of the beta version considered the feedback especially to ensure the categories and labels associated are easy to understand by binning different forms of visualizations into different tabs in the application for example, individual sustainability history and community impact could be accessed over different tabs. The meal options were labeled as either Green (eat regularly), Yellow (eat sometimes), or Red (eat rarely) to allow the simplest way to signal a sustainability choice. Similarly, impact visualizations on various levels of granularity, i.e., daily, weekly, and monthly were made to be much more comprehensible by allowing users to compare them with the aggregate results of fellow users of the app. To design for a more universal utility of the app, the users could now add details of the meals they prepared at home (although with no rewards) just so that they could track their daily progress.

The intervention of the evaluation phase of the beta version of the application happened over 2 months where the participating students were tasked with recording at least 8 meals during the experiment period. This time, the intervention was made such that they are in their natural environment and not with the course participants and researcher and the evaluations were done in the form of weekly questionnaires to understand the technicalities and usage patterns over extended periods.

The results of the second cycle of ADR noted the interest of students over time but allowed the researchers to understand how the students interpreted the visualizations and data presented in the application in an unsupervised fashion. Consequently, we analyze and formalize the learnings from both the ADR cycles in the following sections.

4 Reflections and Learning

The results of the ADR cycles could broadly be classified into two categories: 1. User experience design and 2. User consumption patterns. We discuss them briefly in the section below.

4.1 User experience design

The major onboarding challenge was using a mobile browser to run the progressive web application and to connect the Food Futures app to the blockchain-based wallet for their reward tokens. Approximately 70% of the users reported that they would be more interested if the wallet creation were simplified, and the app is published on the mobile app stores.

Many participants found FWSI intuitive and educational, and they wanted to learn more about the sustainability targets, nutritional values, and ways to create even larger impacts. The participants also suggested the need for better visual representations, ways to access more details, the use of simplified terminology, and scoring metrics.

4.2 User consumption patterns

Many users reported that seeing the collective impact of their choices over time was motivational and more than 60% reported that seeing their impact in comparison to the rest of the average was motivating. About half the users also reported that the meal data and the FSWI were educational.

The aggregate data allowed for a comparison between the dietary patterns observed at the beginning and later stages of the experiment. The findings revealed a significant decrease in the consumption of pork and cheese, as well as of lower-impact animal products chicken and fish. Notably, vegetarian diets which include dairy consumption, have experienced a decline. This shift could potentially be attributed to the designation of cheese (and other dairy farm products) in the "red" category within the Food Futures app due to the high CO_2 emissions involved in the production.

Surprisingly, almost half of the users logged their meals from home. This showed the interest of users in the application to realize their impact even if they were not being rewarded with tokens. This

realization meant there is a growing need for creating more sustainability-oriented affordances for grocery products, frozen foods, and so on, beyond the cafe and restaurant practices that the app set out to intervene.

5 Design Principles

This study applied ADR methodology to derive design principles for promoting digitally mediated sustainable food consumption. Leveraging the literature on sustainability, game theory, and information systems, we conducted experiments to understand how users' consumption patterns might change with the aforementioned ensemble artifact. The qualitative analysis of participant interviews, user questionnaires, and observations during the fieldwork allowed us to identify and define three preliminary design principles for developing a mobile application for engaging users to monitor and shape their consumption patterns sustainably. The design principles are presented in Table 1 below.

Design Principle	**Description**
DP1. Design for categories and labels	The design for promoting sustainable food consumption in individuals should implement simple sustainability labels, charts, and signals easy to comprehend.
DP2. Design for realizing collective impact	The design for promoting sustainable food consumption in individuals should implement ways to reflect on the individual and community contribution to solving the problem.
DP3. Design for rewards and redemption	The design for promoting sustainable food consumption in individuals should implement ways to attain rewards (tokens or badges) and redeem them as a form of goal setting.

Table 1. Design Principles for a digitally mediated sustainable lifestyle

5.1 Design for categories and labels

Over the past decade, the demand for sustainable foods has been growing rapidly and for food retailers, it is no longer just about competitive advantage but a necessity to increasingly communicate with customers regarding the social, ecological, and ethical implications of consumer choices (Potter et al., 2021). Logos and labels become effective tools of communication regarding the aspects of sustainability to better guide consumer food choices (Siraj et al., 2022) especially when the time and energy that consumers put towards such choices is getting lower (Larsen et al., 2020). Essentially, the Food Futures app acts as an intermediary in reducing the search cost for the consumers by catering to their preferences and concerns thus reaching an optimal allocation of time and attention needed in making the decision and understanding their impact (Bakos, 1991). The use of standard visualizations such as categories and labels allow for consumers' sensemaking toward environmental sustainability (Seidel et al., 2017). It further initiates a cognitive process to interpret the experience and retain it to generate recurring behaviors. Feedback from the visualizations of the FWSI and 'Best option' label expresses the interest as follows:

"I like that the app ranks choices "best option" based on your concerns to help make a choice" (Student 1)

An essential aspect of sensemaking is the idea that individuals hold initial perceptions and understandings about actions. This initial sense can evolve in response to external stimuli individuals may encounter. It is hence essential to explore how these initial perceptions can be shaken and nudged with the help of these labels, for instance, towards a more environmentally friendly selection (Seligman 2000). We see evidence of this in our interviews with participants illustrated in the following quote:

"I was surprised about the fact that halloumi pasta had the worst index. Data made me feel better about my default choice of prioritizing vegan over vegetarian." (Student 2)

By incorporating design elements that are consistent and interactive, the Food Futures application informs and engages users in comparison and sensemaking to not only develop new insights but also question their previous assumptions regarding their choices.

5.2 Design for realizing collective impact

Motivation plays a critical role in one's commitment to a cause. Social identity plays a substantial impact on one's effort intensity and goal commitment (Ke & Zhang, 2009). Being able to realize and appreciate an individual's contribution to the collective impact of a certain group solves the problem of negligibility, the feeling that no individual's contribution to a collective outcome can result in a noticeable causal difference (Amadae et al., 2023, pp. 159-199). Collective actions in large groups tend to have more difficulties in cooperation. However, there is evidence of the effectiveness of small groups in driving collective action more effectively as in the case of social media as there is a lower cost associated with it and thereby, a provision of developing "social incentives" (Olson, 1971; Weimann et al., 2019). These social incentives could be material like in the case of food coupons, gifts, or awards from community leaders/the platform, psychological in the form of tokens, levels, leaderboards, or purely social in the form of face-to-face interactions, social events, etc. These tend to induce a sense of pride, achievement, and belongingness, thus further shaping how one perceives their social and individual identities (Ahuvia et al., 2018). The following comments from our workshop tell what one of the students found most motivating:

"I like the idea to have a social function on the app. E.g., meeting like-minded people and doing things *together"* (Student 3)

"Most motivating was the possibility to compare [self and average impact]" (Student 4)

The below anecdote from the student user also confirmed our assumptions of a Stag Hunt setting (Skyrms, 2001) for the application wherein users would cooperate given assurance of others' cooperation either virtually (above quote) or physically (below quote):

"Usually when I am eating with friends, I feel that I am affected by others' choices. If everyone is taking the vegan option, I'll probably take that as well" (Student 5)

5.3 Design for rewards and redemption

In recent years pervasive and persuasive socio-technical systems have taken over every aspect of our lives. Putting in place rewards, social engagement, and gamification mechanisms at the center of our digital interactions by developing habits/rituals that make them come back repeatedly. These mechanisms indeed nudge users to change their attitudes and behaviors over time by functioning as a 'soft' power (Beer, 2017). These kinds of rituals have been extensively studied in "social games" wherein despite the repetitive mind-numbing chores, players derived a great deal of pleasure from digital activities and the social patterns of competition, collaboration, gratitude, and reciprocity that are architecturally embedded (Burroughs, 2014). Although, the focus is not on social games, engaging in digitally mediated social activities as mentioned above acts as "social incentives" (see DP2.) for participating and motivation towards a cause. Persuasive technologies are data-driven engines that can be best understood through the lens of immaterial labor where the consumers lose the clarity between labor and leisure (Dyer-Witheford & De Peuter, 2009) as these actions instill in them a sense of pride and achievement in doing such tasks. The following quotes from our workshop express what the students found to be a good reward mechanism:

"I could use the app if I was able to see data and got some reward. Food as a reward would be the best option to me" (Student 6)

"I could see myself using the app on a daily basis. I like the idea of being rewarded for continuous use of the app" (Student 7)

The use of DLT-based accounting allows the platform to validate every meal transaction securely and privately and distribute rewards in the form of tokens. These rewards tend to the human psychological needs for competency, autonomy, and relatedness (Deci & Ryan, 2000). The rewards by their nature are pride objects as users invest and express themselves through their choices. They could be purely forms of representation (milestone badges/levels), pegged to an institutional currency for a dedicated marketplace where restaurant partners could offer discounted meals upon meeting certain milestones or any combination of these. Unlike traditional platforms, blockchain tokens ensure a stronger sense of psychological ownership and pride as they allow the users to present their tokens across the internet wherever the wallet can be integrated. Thus, giving them more ways to share a part of their identity with their social circles.

6 Discussion

Upon performing two cycles of ADR, we developed three design principles: design for categories and labels, design for measuring collective impact, and design for rewards and redemption . Design Principle 1 (DP1, design for categories and labels) is based on the need to fruitfully notify the users of the environmental benefits/harm their choice has with the help of clear factors and the use of universally recognized colors such as green (environmentally conscious choice), yellow (consume in moderate amounts) and red (best to consume seldom, environmentally harmful choice). Design Principle 2 (DP2, design for measuring collective impact) motivates the users to continue their sustainable journey by showing the collective impact of the community they wish to participate in (friends/neighborhood/workspace). This nudges contributions from users as it assures participation from others and makes the choice a group project rather than a lonely endeavor. Lastly, Design Principle 3 (DP3, design for rewards and redemption) provides the users with gratification for their sustainable choices. This acts as another form of goal-setting mechanism to ensure that consumers are psychologically or even monetarily encouraged to make continuous sustainable choices day after day, thus developing a habit gradually.

DP1 is best attributed to sustainable consumer products and purchases as it only affects the decision-making of the consumer at the point of sale by effectively providing the necessary information whereas DP2 and DP3 can be generalized for broader lifestyle and identity-building exercises as they encourage more healthy and sustainable choices by acting as “soft powers” for developing long term transferrable habits to other areas of life such as consumption of resources such as water and electricity, sustainable mobility, etc. All the aforementioned interventions therefore function through raising awareness and empowering intentions into actions.

We reimagine a token ecosystem that diverges from our traditional understanding by developing anti-rivalrous counterparts that can recognize and hence achieve more positive externalities as the community grows. Food Futures allows this by positively reinforcing user’s sustainable behavior by rewarding tokens in the form of non-tradable but redeemable NFTs and cryptocurrencies while respecting consumer sovereignty and allowing them to be a part of the community they are closest to (Amadae et al., 2023). The project has also led to the formation of a new ERC-5023 (Marttila & Moravek, 2022) standard that is built on the same principles and will further unlock the community participation capabilities of the users in subsequent ADR cycles.

7 Conclusion

In this paper, we demonstrated how to identify, track, and improve sustainable food consumption patterns by designing the Food Futures application that aids users in making better consumption choices for the environment. We approached the research objectives by proposing three design principles: design for categories and labels, design for measuring collective impact, and design for rewards and redemption. The principles serve as guidelines for designers and practitioners on how to create interactions that engage in consumers’ sensemaking of sustainability practices using blockchain as the underlying architecture. These design principles emerged as a result of an ADR project, where researchers built a blockchain-based mobile application to assist users in making better meal choices

concerning sustainability. The ADR project is ongoing; hence the results are limited to two ADR cycles of this empirical case. Future ADR cycles would develop affordances for social features and engagements and lastly exploit the underlying blockchain and token ecosystem development to create a more sustainable ecosystem.

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