Blending Code and Cause: Understanding the Dynamic Motivations of Volunteer Developers in community-driven FOSS projects

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Abstract

Understanding the motivations of volunteer developers is crucial for the HCI community as it seeks to design sustainable, community-driven digital platforms. This study explores the dynamics of motivation among volunteer developers in the Foodsharing.de platform, a grassroots movement focused on reducing food waste through community engagement. By investigating the evolving motivations and challenges faced by these developers, our research highlights the unique blend of personal passion, technical skill, and social commitment that sustains their long-term involvement. Through interviews, observations, and participatory research, we uncover how developers balance their commitment to Free and Open Source Software (FOSS) with the platform's socio-ecological mission. Our findings emphasize the importance of fostering a supportive community, clear governance, and effective infrastructuring to manage motivation, frustration, and expectations. We discuss strategies to enhance volunteer retention, such as improving feedback mechanisms and recognizing contributions, which are critical for the sustainability of volunteer-driven platforms.

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CCS Concepts

• **Human-centered computing** → **Empirical studies in collaborative and social computing**.

Keywords

Volunteer Developer Motivation, Free and Open-Source Software (FOSS), Community-driven Digital Platforms, Infrastructuring in HCI

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1 Introduction

The sustainability of digital platforms, particularly those driven by volunteer developers, hinges critically on understanding the dynamics of their motivations. This is especially relevant in the context of Free and Open-Source Software (FOSS) projects supporting grassroots movements like Foodsharing.de, a platform aimed at reducing food waste through community engagement and collaboration. With over 450,000 registered users across more than 370 local districts, Foodsharing.de represents a significant example of how digital platforms can mobilize large-scale participation in a grassroots movement. HCI has manifested a growing interest in supporting these movements through socio-technical design that,

for instance, addresses challenges in user involvement, participatory design and decentralized decision-making [36, 37, 79].

Social movements rely significantly on volunteer contributions; however, sustaining volunteer motivation over time poses substantial challenges [15]. While existing research on FOSS communities often emphasizes static or initial motivations, it overlooks the dynamic and fluctuating nature of these motivations, which are shaped by various internal and external factors [33].

Our research seeks to address the following question: How do the dynamics of involvement and the management of motivations among voluntary developers influence the sustainability of a FOSS infrastructure like Foodsharing.de, particularly in the context of large-scale, resource-constrained environments? We contribute to this discourse by examining the motivations and frustrations of developers engaged with Foodsharing.de. Specifically, we investigate the unique challenges of sustaining developer engagement within a large-scale, volunteer-driven platform characterized by evolving infrastructure demands and user participation. Our focus lies on the dynamic nature of these motivations, analyzing how they adapt to the socio-technical environment and the platform's infrastructural demands.

We conducted interviews, observations, and participatory research activities, including a hackathon, to gain insights into developers' experiences. Our findings highlight a nuanced blend of motivations: a commitment to reducing food waste aligns with a passion for contributing to the FOSS movement. Unlike many FOSS projects, the primary objective here is not technological innovation but the reduction of food waste. Developers view their skills as a means to empower broader participation in food saving and sharing, thereby amplifying their collective impact. This enables them to merge an activity they enjoy, coding, with a meaningful social mission. Notably, some developers resume contributions after breaks caused by frustrations or external pressures, underscoring their enduring commitment. While prior research has explored motivations in food sharing (e.g., [92]) and FOSS development (e.g., [18, 41, 64, 93]), the intersection of software and a socio-ecological mission distinguishes this study.

Additionally, we identify specific 'points of infrastructure' within Foodsharing.de where the socio-technical systems, usually invisible [100], become evident, particularly through development releases that introduce new functions. These points of infrastructure are essential in understanding how motivations are influenced and managed. For instance, the ideological alignment between the FOSS ethos and the money-free principles of the Foodsharing.de movement reinforces developers' engagement but also highlights the challenges they face when their motivations are tested by the demands of maintaining the platform.

By examining the evolving motivations of Foodsharing.de developers, we provide a nuanced understanding of how to sustain volunteer-driven platforms. These insights are vital for designing interventions that can enhance the retention of volunteer developers, thereby ensuring the long-term sustainability of platforms that support social movements.

2 Related Work

2.1 New Social Movements

The study of new social movements has long been concerned with the mechanisms of large-scale mobilization, particularly in conflict situations and how these movements evolve over time. Key studies have examined the role of media in facilitating or hindering movement growth, as well as the life cycles of movements, from their inception to their decline (e.g., [21, 106]). More recent scholarship has shifted its focus towards contemporary issues such as climate change and environmental activism, reproductive justice, and disability rights, reflecting broader societal concerns (e.g., [13, 20, 40]). The intersection of social media and activism has become a critical area of study, exploring how digital platforms enable movements to scale their efforts, engage broader audiences, and sustain momentum (e.g., [68, 75]). However, alongside these more visible forms of activism, the concept of "quiet activism" has emerged [56]. Here, activism is constituted rather more in and through alternative practices rather than conflictual stances. Food activism (e.g., [80]), a form of quiet activism in Foodsharing.de, exemplifies this.

Sustaining volunteer involvement in these movements is a persistent challenge, as the success and longevity of a movement is often contingent upon the continuous engagement of its volunteers. Research has shown that the trajectories of social movements—whether they flourish or fade—are intricately linked to volunteerism (e.g., [22, 38]). This is particularly relevant to Foodsharing.de, where the platform's ability to achieve its socio-ecological mission depends on maintaining an active volunteer base.

2.2 Motivations for Volunteers in Grassroots Communities

The motivations of volunteers in grassroots movements have been extensively studied, with a focus on understanding what drives individuals to commit their time and energy to these causes. Volunteerism is often defined as a freely chosen and deliberate act of helping, sustained over time, without expectation of material reward [98]. This can include a strong identification with the movement's values, a sense of efficacy in contributing to the cause, and personal development through the acquisition of new skills and relationships [31, 97, 98, 103].

Volunteer motivations are dynamic, influenced by internal factors such as personal circumstances and external forces like shifts in a movement's focus or broader socio-political changes. Initially driven by altruism, volunteers may later seek recognition, community, or personal growth [3, 16, 113]. This highlights the critical need for strategies that adapt to these changing motivations to sustain volunteer engagement effectively.

Research on volunteer retention highlights the importance of recognizing individual contributions, fostering a supportive community, and ensuring that volunteers feel valued [9, 32, 70]. Vestergren et al. [108] conducted a systematic literature review indicating that volunteer activities can lead to significant life changes, often positive, such as increased empowerment and enhanced self-esteem [7, 53]. However, intense involvement may also result in burnout, leading to withdrawal from commitments. To maintain engagement and

reduce turnover, it is essential to evenly distribute workloads and implement mechanisms for rewards and satisfaction [72].

Despite this extensive research, there remains a notable gap in the literature concerning the sharing economy. Foodsharing.de represents a unique case where the ideological commitments of volunteers intersect with the practical demands of maintaining a large-scale, volunteer-driven platform. Understanding these dynamics is essential for developing strategies that can effectively sustain volunteer engagement in similar contexts.

2.3 Technology Use in Volunteer Communities

Although some volunteer communities may develop specific applications to help them meet their goals, most adopt and adapt a range of existing software, though they encounter limitations related to resources and expertise [76]. Unlike FOSS communities, where software development is the primary work activity (although within a larger ideological focus), other volunteer communities typically use technology as a tool to support their core work rather than as an end in itself. This can lead to difficulties in assembling, tinkering [107] and making use of their tools, particularly when the available software is not well-suited to their needs. These challenges can lead to inefficiencies in information management, adding extra burdens rather than streamlining efforts toward the community's actual goals [109]. Such data management is a kind of infrastructure work (see subsection 2.5) that can lack appeal, making it harder to keep volunteers motivated.

2.4 FOSS Communities

FOSS is a well-established phenomenon, having been around for over 25 years. It has also been the subject of a substantial amount of research [2, 17, 67, 86, 89, 102].

As Marois et al. [74] caution, it is a mistake to assume that "FLOSS is all the same; It is just one big thing, and we can make broad generalizations about FLOSS without context setting". Indeed, the term that they use (FLOSS) hints at a diversity of views about the underlying philosophy of open-source software development. Different groups, such as the Free Software Foundation, and those identified by Fitzgerald as 'OSS 2.0', bring varied values to the movement [30]. The 'L' in the term FLOSS is used to connote 'Libre' to emphasize the importance given to freedom of expression and action. Across this spectrum, however, there is a shared ideological commitment to freedom, not only in creating, modifying, and using software and other kinds of intellectual property but also in envisioning alternative ways of organizing work and society [77].

FOSS's ideological compatibility with nonprofit organizations, social justice initiatives, and community activism has led many of these groups to adopt FOSS tools for their work [105]. The motives for adopting FOSS applications may combine affordability, a shared communitarian ethos, and their independence from large, for-profit software companies. Moreover, FOSS has been tailored for specific social activism purposes, such as disaster relief or mapping reports of political violence [105], supporting people with diabetes [51], and enabling community decision-making [49]. A study on OSS for Social Good contributors found that personal alignment with a project's wider goal was a major reason for participation [48]. Adoption of FOSS "not only reduces barriers for individuals to participate with one another", but also supports "a core aim of classic redistribution theories of social justice" [105]. The success of a FOSS project is closely linked to the number of active contributors, with larger developer communities generally associated with more successful outcomes [63, 78]. Even though organizations with commercial interests are increasingly involved in FOSS projects [54, 81], Stewart and Gosain [104] highlight the critical role of volunteers in them, noting that "without people donating their efforts voluntarily, an [open-source software] project has little chance of success". This reliance is especially critical for projects like Foodsharing.de.

Volunteer-driven FOSS projects face numerous challenges, particularly in attracting and retaining contributors [6, 93]. High turnover is a significant concern, with studies indicating that many volunteers leave within a year of joining a project [28, 95].

While traditional models often categorize contributors into core and peripheral developers, recent studies suggest a more complex dynamic. Episodic volunteering—where contributors engage sporadically yet make meaningful contributions—has emerged as a critical factor in the sustainability of FOSS projects [5]. Recognizing these diverse patterns of participation is essential for effectively managing and supporting volunteer efforts.

The motivations of FOSS developers have been broadly categorized into intrinsic and extrinsic factors. Intrinsic motivations include the enjoyment of the work, creativity, and a sense of belonging to the community, while extrinsic motivations often relate to career advancement, skill development, and external recognition [69, 95]. However, this dichotomous characterization has been critiqued for oversimplifying the complex and fluid nature of motivation in FOSS communities. Freeman [33] argues that motivations are dynamic and context-dependent, often evolving in response to the individual's life circumstances and the specific tasks they undertake within the project. Other scholars [62] emphasize that intrinsic and extrinsic motivation may not fully capture the complexity of what drives contributors. They argue that motivation should not be viewed in isolation, as OSS developers are also influenced by the social context of the project, its ethical alignment with their values, and even a sense of purpose in life. These broader motivations can be particularly compelling for people who choose to develop code for social good and for causes they believe in [48].

One of the key challenges in FOSS communities is managing developer frustration, which can arise from a variety of sources [94, 112]. Bad or ineffective communication is frequently cited as a significant source of frustration in software development, encompassing issues such as negative comments on code reviews, microaggressions, and even cyberbullying, all of which can drive developers away [90]. Additionally, disagreements over decision-making processes can exacerbate these frustrations [91]. Filippova and Cho [29] categorize conflicts in FOSS projects into several types—normative, process, task-related, and affective—and examine their impact on developers' intentions to stay involved. Their research reveals that normative conflicts, such as ideological debates, have the most significant impact on retention, as they often cause developers to feel less aligned with the team. Ke and Zhang [59] show that developers stay in a project if they perceive their contributions as important and meaningful. Other researchers have identified various intrinsic

and extrinsic motivations as key determinants of developer retention, including identification with the project [4] and its community [27], opportunities for continuous learning [14, 96], ideological convictions [104], and the status within the community [47]. Effective strategies for retaining developers include fostering a supportive and inclusive community, providing opportunities for continuous learning and development, recognizing and valuing all contributions, and addressing social interaction barriers, while also offering clear, constructive feedback, which is particularly crucial for newcomers who may struggle with the technical and social complexities of FOSS projects [4, 60, 101].

2.5 Infrastructuring

Organized forms of volunteering are enabled by infrastructures, which are typically taken for granted and 'just are' [99]. However, a socio-technical lens reveals the complex entanglement of physical, informational, and human activities that 'make' an infrastructure [55]. Infrastructures are thus characterized by relationality, as originally argued by Star & Ruhleder [100]. From a socio-technical perspective, an infrastructure does not just exist as a static substrate on top of which other things are running (e.g., data on the Internet) but it continuously becomes, i.e., it is continuously and dynamically recreated, maintained, and modified in relation to organized human activities.

Understood as something one does rather than a thing, HCI scholars have embraced the notion of infrastructuring [57, 99], referring to the ongoing and often invisible work that sustains the functionality and usability socio-technological systems [71]. Infrastructuring is an open-ended and everyday activity that involves both local/short-term (meeting the needs of a specific context) and shared/long-term (future developments and resilience) perspectives [58]. This involves never-ending negotiations and balancing of short-term and long-term priorities. FOSS projects exemplify intentional instances of infrastructuring, particularly as open-source software encourages design-after-design [85] activities through aspects such as extensibility, tailorability and maintenance [42].

Infrastructures stop being taken for granted and become visible either when they break down or during moments of innovation. These 'points of infrastructure' [82] are relevant because they impinge on people, objects, and other elements linked through an infrastructure. From a design perspective, infrastructures become resilient and sustainable if and when the interaction of the technical components (hardware, software, networks) and the social elements (user practices, organizational structures, cultural contexts) that form systems are recognized [82]. Jo et al. [55] argue, in the context of food sharing and commoning in community fridges, that ‚bonding' social capital is important in preventing infrastructure breakdown, echoing the findings of Magis [73] and Rashed et al. [84]. They point out that the use of existing information infrastructure (in this case existing social media websites) can support human infrastructure, i.e. "the arrangements of organizations and actors that must be brought into alignment in order for work to be accomplished" [[66], see also [83]].

In summary, previous research has shown that FOSS projects, often run entirely by volunteers, must find ways to keep their volunteer developers motivated to continue working. The concept of infrastructuring is a useful lens to investigate these efforts, as the sustainability of the human infrastructure [66] is a determining factor in the sustainability of the information or technical infrastructure [11].

Our research extends existing literature by connecting FOSS development with offline grassroots activism. Unlike typical FOSS projects, Foodsharing developers often participate not for intrinsic interest in software development, but to support the mission of combating food waste. This dual focus enables an exploration of the intersection between online technical work and offline community engagement. By analyzing the dynamic relationship between voluntary developers and local activism, we contribute to understanding how these infrastructures foster collaboration, sustain volunteer engagement, and support the broader goals of grassroots movements addressing socio-ecological challenges.

3 Foodsharing.de

3.1 Background on Foodsharing.de

The Foodsharing.de platform is rooted in the Foodsharing movement, which started in Germany in early 2012. Its primary goal was to prevent food waste by collecting surplus food from various sources and redistributing it to the community. Initially coordinated through decentralized coordination methods, the movement launched its website in December 2012. Since 2016, the platform has been open-source, with a team of around five volunteer developers working to improve the system. These efforts include refactoring the code to enhance accessibility for other developers and implementing new features, such as those aimed at promoting fairness. As of November 2024, about 440,000 users are registered on the platform. While legally owned by the association "foodsharing e.V.", the platform strives to operate under democratic governance led by its user community.

Users are assigned distinct roles within the platform. Upon registration, users become Foodsharers, allowing them to share food via 'food baskets'. To participate in food pickups, users must become Foodsavers by passing a quiz on Foodsharing rules, completing introductory pick-ups, and undergoing verification by a district Ambassador (who, similarly, have passed another quiz and are usually elected). These Ambassadors play a crucial role in managing district operations, including the verification process, coordination of activities, and establishing partnerships with local businesses. Verified Foodsavers can then join online store teams, where they are responsible for collecting all surplus food during designated times. The store team is a core feature of Foodsharing.de. Each store has a virtual representation on the platform with information about the store, including address, contact details, pickup schedule, and surplus food policies. Virtual store representations are managed by store coordinators, not supermarkets. This space also serves as a team hub, where Foodsavers can see their team members, communicate, and coordinate activities. Foodsavers can assign themselves to specific pickup slots.

A large amount of the coordination processes around saving the food waste is therefore situated on the platform. The platform also offers several other ways for users to engage, such as scheduling

and coordinating events, participating in discussions at regional or supraregional levels, and joining topic-specific working groups. One of these working groups is the product team, where users can discuss and provide feedback on platform features (see also [50]). The governance structure can also be seen in 1.

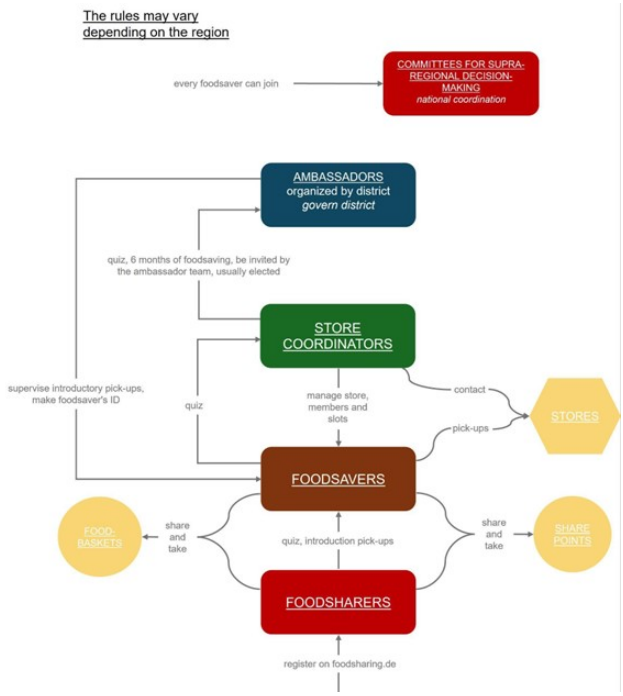

Figure 1: An organigram of Foodsharing.de

In recent years, the Foodsharing.de movement has seen increasing professionalization, evidenced by the establishment of paid roles such as a data protection officer and treasurer. The Foodsharing board is actively pursuing additional paid positions to enhance operational support and ensure sustainability. A donation campaign has been initiated to fund various aspects of the movement, while community discussions are focused on introducing volunteer allowances for board members and specific working groups, including IT. This shift reflects an effort to balance volunteerism with structured financial support.

3.2 Previous research on Foodsharing.de

3.2.1 Motivations of Foodsharers. Rombach and Bitsch [87] explored the motivations of food sharing community members, identifying three categories: ideological motivations, identificational motivations, and instrumental motivations. Foodsharing.de, they suggest, discourages instrumental motivations. Instead, members' willingness to engage should reflect their strong identification with the movement and commitment to its anti-waste ideology.
In contrast, Schanes and Stagl [92] categorized motivations into emotions and morality, identity and community, rewards, social influence, and instrumentality. They found that emotional responses to food waste, coupled with positive feelings from food-saving activities, were key motivators. They also noted instances of members benefiting economically, although this was less commonly acknowledged. Social connections also played a significant role, with many joining due to relationships with existing members.
While Rombach and Bitsch primarily focus on members' general commitment to anti-consumerism and anti-waste ideals, and Schanes and Stagl emphasize food-waste responses and emotional satisfaction in food-saving activities, our study uniquely examines how motivations evolve over time among developers specifically working on the Foodsharing.de platform. We investigate how sustained and dynamic engagement is influenced by the socio-technical challenges and governance needs of the platform.

3.2.2 Food Sharing, Foodsharing.de, and SHCI. Food sharing communities have garnered attention within Sustainable HCI (SHCI) for their potential to enhance communal food sharing through digital platforms, spanning initiatives such as web-based food networks [83], urban food-growing communities [44], communal gardens [111], community-supported agriculture [65], redistribution events [8, 25], and food commons [55]. Davies and Legg [19] further explored the role of ICT-mediated urban food sharing initiatives, analyzing their global distribution, the types of food shared, and their social, economic, and environmental impacts.
Early research by Ganglbauer et al. [34] highlighted the role of social networking in the community's development and sustainability, showing how online platforms complemented Foodsharing.de by facilitating broader discussions and transitioning between global ideologies and local actions. More recent studies have focused on community building as essential to sustainable food practices. Engelbutzeder et al. [25, 26] examined the complexities of sustaining these communities, particularly regarding fairness and justice, and the role of digital platforms in fostering connections. They note tensions between the broader use of Foodsharing.de and tools like Telegram, which better support localized, community-based interactions and argue that ICT must balance scalability with localized practices to effectively address global challenges.
Recent studies [50] further explored the role of intermediaries in the Foodsharing.de movement, highlighting their role in connecting users and developers. These intermediaries are critical in aligning technological developments with community needs, but they also face challenges in managing the platform's growth and resource constraints.

4 Method

4.1 Authors' positioning

The two main authors are food activists dedicated to promoting sustainable food practices. Actively involved in the German Foodsharing movement and a local Foodsharing community, they support the development of ICTs that enhance sustainability. Their work is closely linked to the grassroots movement, where they participate in and shape the initiatives they study. The other co-authors have also significantly contributed to our understanding of evolving motivations and sustainable volunteer participation.
Our research approach aligns with the principles of action research, which is particularly suited for working "with people experiencing real problems in their everyday lives" [43]. This methodology involves ongoing collaboration with both local and supraregional

communities to iteratively develop activist-community interventions tailored to the specific needs of the Foodsharing.de platform and its users. As action-oriented researchers, we engage in continuous "cycles of inquiry" [43], involving planning, action, and reflection, while leveraging academic resources to support local initiatives.

Since 2015, Author2 has been involved in the movement, initially collaborating with developers on the global expansion of foodsharing concepts and later focusing on local community initiatives. Author1 joined the platform's IT support team in early 2023, addressing technical issues and enhancing communication between users and developers. This combined engagement in both technical and community aspects positions us as intermediaries, facilitating dialogue and supporting the platform's evolution.

4.2 Data Collection and Analysis

The data utilized in this paper comprises two sets of interviews conducted between February and June 2023 and between April and August 2024. Additionally, insights were drawn from field notes generated during numerous meetings within both the local community and developer community, discussions in the product team forum, and observations from a hackathon. We approached developers through their primary communication platform, Slack. Following a general post in the main developer Slack channel, three developers agreed to participate in interviews and further suggested additional developers or key stakeholders for potential interviews. Our approach combined convenience and snowball sampling methods. With one exception, all contacted developers consented to participate in an interview.

During the initial round of interviews, our focus was on understanding the collaboration between developers and users of the Foodsharing.de platform. Developers were queried about their journey to the developer community, their areas of work, their workflow, and their perceptions of communication between developers and users.

In the subsequent round of interviews, we delved deeper into what motivated developers to initially join the project, what factors contributed to their positive feelings, and what sources of frustration they encountered. We also inquired whether the developers had experienced any decline in motivation during their voluntary engagement, if they had ever considered ending their involvement, and if their motivations had evolved over time. Given the gradual professionalization of the movement, we also sought the interviewees' perspectives on the prospect of receiving compensation for their contributions. In total, we conducted nine interviews with five developers. D1, D2, D3 and D5 were interviewed twice. All interviewed developers were male. Interviews had a mean length of about 89 minutes, with the shortest being 58 and the longest 186 minutes long. Interviews were held in German, except for D4, whose interview was conducted in English. The interviews were recorded and transcribed. Quotes have been translated from German to English.

In addition to our interviews, we organized a hackathon in April 2024 with developers from Foodsharing.de and a related FOSS project, Karrot.world. Understood as a form of meta design [24], its intention was to foster collaboration and communication between developers and users. Invitations were distributed both in relevant online forums and at offline meetings. Participation from users was minimal, with few joining either in person or during online discussions – an aspect we will reflect on in Section 6.2. During the hackathon, we asked the participants what motivated them to work for the respective movements, and what frustrated them. Additionally, we held discussions with the developers and members of the Foodsharing.de community. These discussions focused primarily on how to improve the collaboration with users and how to improve beta-testing. Finally, we organized a cooking evening in collaboration with the local community to foster connections and strengthen relationships between local users and developers. Data from the hackathon was gathered through field notes and photos of the pinboards used to aggregate the developers' answers.

Interviews were analyzed by Author1 and Author3 using thematic analysis [12]. We primarily employed an inductive approach at the semantic level. This means that themes were identified based on the explicit or surface meanings of the data, without searching for deeper, latent constructs beyond what participants explicitly stated. Following Braun and Clarke's framework, our process involved organizing the data to highlight patterns in semantic content and summarizing these patterns descriptively. From this foundation, we moved toward interpretation by theorizing the significance of these patterns and their broader implications in relation to prior literature (e.g., [48, 69, 95]). Regular exchanges between Author1 and Author3 facilitated reflection on the identified codes and ensured a broader perspective on potential patterns. We found two themes relating to motivation in the data set (Foodsharing-related and FOSS-related motivation) as well as recurring themes of developers finding new motivations during their commitment, becoming frustrated, stopping their commitment, and finally re-engaging.

4.3 Ethical Considerations

Our research followed the ethical standards established by the university affiliated with the primary authors. This included securing participant anonymity and obtaining all required permissions for using the data. Participants were fully informed about the study's goals, their involvement, and their right to withdraw at any point, and they provided their informed consent. We ensured confidentiality by anonymizing all participant data and securely storing all research materials. Pseudonyms were used for participants.

5 Findings

The dynamics of motivation among volunteer developers in Foodsharing.de reveal a complex interplay of intrinsic and extrinsic factors that influence their commitment and engagement over time, fluctuating in response to various challenges, including frustrations with feedback mechanisms, lack of recognition, and conflicts over decision-making processes. The following sections explore these dynamics in detail, covering the progression from initial motivations to newly found motivations, the causes of decreased motivation, breaks in commitment, and strategies for volunteer retention.

5.1 Bridging Food Saving and FOSS Motivation

The journey of our interviewees typically began with their initial registration on Foodsharing.de, driven by a commitment to reducing food waste or finding a legal alternative to dumpster diving. Most developers' involvement with the IT team evolved naturally from this initial registration, as they encountered the "In IT? We need you" button on the website or responded to calls for help in the forums on the platform. A notable exception is D4, who was introduced to the development side of the platform at a Foodsharing gathering in Italy, where website development was part of the agenda. With a background in other FOSS projects, D4 was particularly drawn to Foodsharing.de because it empowers individuals to make a tangible impact in the real world—a mission that resonated with his values.

The progression of the other developers, from simply registering on the platform to actively joining the IT team, illustrates a significant expansion of their motivations. Initially, their involvement was motivated by a desire to reduce or eliminate food waste, which aligned with the broader Foodsharing cause. Over time, a dual commitment emerged: beyond addressing food waste, they developed an interest in contributing to the FOSS movement, embracing open-source principles within the Foodsharing platform itself. In doing so, the developers carefully thought through how their improvements to the platform could better support Foodsharers and Foodsavers, ultimately enabling more food to be rescued and shared. This dual commitment not only reflects their alignment with open-source values [18] but also underscores the importance of sustaining the FOSS infrastructure that supports Foodsharing.de's operations. Developer's contributions, from building new features to maintaining existing systems, ensure the platform's adaptability and longevity. This evolution reflects the deeper motivations that drive their engagement. As one developer put it, demonstrating the synergy between personal growth and community impact:

"I've never programmed this intensively and continuously before, and it's amazing to see the constant progress in what you learn. I simply enjoy it, especially knowing that my work has an impact [on saving food] and benefits such a large community. That genuinely motivates me." (D3)

5.2 Foodsharing.de-related Motivations

While initially driven by the desire to engage in food-saving activities, some developers soon shifted their focus towards enhancing the platform itself. This transition was often motivated by a desire to support the community's food-saving efforts through technological improvements. For example, D2 emphasized his goal of optimizing the website to facilitate better organization of food pickups:

"So, the ultimate goal is to be well involved in IT, to design the platform in such a way that people can organize the pickups well, so that more can be picked up." (D2)

Similarly, D1 sought to address a lack of community on the platform through his code contributions, aiming to foster stronger community bonds and reduce conflicts by promoting fairness:

"I believe for me, [community building] was often a motivation. From the beginning, I saw that the Foodsharing Community is already quite large, and community building doesn't really take place. Because the bigger it gets, the more anonymous it becomes, and honestly, for me personally, and in many things I programmed, for example, this voting tool, I made sure that it helps people develop a bit more of a sense of community [...]. Maybe it helps indirectly to promote the community a bit, by ensuring fairness, then people have fewer opportunities for conflict." (D1)

D5 mentioned that he initially joined the IT team after identifying some user experience issues that he wanted to address to improve navigation and usability for participants.

5.3 FOSS-related Motivations

For some developers, their involvement was also driven by FOSS-related motivations. D3 joined to improve his coding skills and create tools and software that are free for anyone to use. D1 viewed his work as a form of resistance against capitalist approaches to software development:

"So I think [...] one reason why I do this is that I'm not a fan of this consumer mindset, where you always want to get exactly what you want. Instead, if you feel that things are not as you wish, then you have to really help shape them. That's what we ultimately do in development, and especially what I do." (D1)

During the hackathon, developers expressed that they enjoyed the opportunity to "make use of [their] skills to tackle issues [they] care about" and to "combine engineering and social change" (Field Notes, April 2024). The desire to "help people work together" further reinforced this blend of technical skill and social commitment. By merging these motivations, developers contribute to the sustainability of the FOSS infrastructure that underpins Foodsharing.de. This sustainability hinges on their ability to resolve underlying technical challenges, develop new features, and ensure that the platform aligns with both user needs and open-source values.

D2, who is active in both the IT department and various supraregional working groups, highlighted his enjoyment in troubleshooting and improving the platform, which led him to join the support team. He also appreciated the flexibility in his commitment, noting that even with multiple roles, he retained the freedom to take time off as needed.

5.4 Newly Found Motivations

After joining the IT team, many developers found new motivations. For instance, D3, who began in the support department, discovered a passion for programming, driving his continued engagement. Similarly, D1, initially focused on saving food, realized he could contribute more effectively as a developer. After moving to a new city and feeling less connected to the local Foodsharing community, he shifted his focus to development.

D1 also emphasized the importance of the friendly and supportive atmosphere within the developer team, which made him feel welcomed from the very beginning:

"And in that sense, it's kind of like a family—maybe that's a bit of an exaggeration. But since we're a small team where everyone helps each other and makes sure we treat each other nicely, from the very beginning I felt in good hands." (D1)

This sense of camaraderie was, to some extent, acknowledged by all developers as a positive aspect of the team dynamic. For D1, becoming a point of contact for certain aspects of the code further solidified his sense of belonging and pride in his contributions. He

described how being recognized for his expertise and receiving requests for assistance from other developers made him feel valued and competent:
"[I receive appreciation] mostly not in words, but practically in terms of work. People say, 'Yes, that's a good change you made,' or indirectly, in the sense that they see me as a point of contact. For example, if [another developer] messages me saying, 'I'm working on this, you know your way around this topic, can you help?' To me, that is also a form of appreciation because it shows they see me as competent." (D1)
Similarly, D5 found motivation in the positive feedback he received from the community, particularly through his interactions in the product team forum. This ongoing appreciation from the user base reinforced his commitment to the project:
"I feel like I receive an incredible amount of appreciation from the community. [...] I definitely get the sense that, for example, in the product team, a lot of people are really happy with what I do, and they express that from time to time. And that's really nice—it's wonderful." (D5)

5.5 Decrease of Motivation During Their Commitment

Throughout their involvement, many developers encountered significant demotivating factors that challenged their ongoing commitment. This became particularly evident during the hackathon, where several developers noted that the space provided to list frustrations was insufficient to capture the full extent of their concerns.
One major demotivator was the nature of feedback from the community. D3 expressed frustration over feedback that was often too vague or merely consisted of complaints without constructive suggestions. D1, who frequently collaborated with D3, elaborated on how such feedback could lead to deep dissatisfaction:
"Every now and then, there are situations like that, and there have been in the past. The most recent one I can think of was when I made some changes to the search function, and then many people in the product team were very dissatisfied, and I took the brunt of it. And then I started to wonder, why am I doing this?" (D1)
D3 also explained that he would have liked to use the hackathon as an opportunity to strengthen his collaboration with the user community by receiving direct feedback on his design ideas. He expressed dissatisfaction with the lack of engaged users, who only sporadically joined the meeting and were less interested in development (Field Notes, April 2024). However, several local users contributed to the hackathon by assisting with food provision, cooking, and other logistical support, suggesting a different kind of engagement with the event.
A lack of feedback from the Foodsharing.de board also emerged as a significant frustration. D3 voiced concerns that, despite the board's legal responsibility for the platform, they were not adequately involved in the development process, leading to a disconnect between the developers and the governing body:
"Yes, I feel that the responsibility—we have a very strong responsibility on the platform, but legally, it's the board that's liable. So why shouldn't they be involved? That's just my opinion. It's not like they should say, 'You must do this right away.' But why can't we share our requests with each other?" (D3)
Another source of frustration was the lack of proper documentation for developers, which made onboarding new contributors challenging. To address this, D4 took the initiative to create documentation to ease the process for newcomers:
"My goal at the beginning was to work with [the platform] to enable other people to work with it. So to make it easier for a developer to arrive and ideally a developer comes, there is a feature they want to add or has been decided should be added or a bug to fix and they can get on with it. And that wasn't the case at the beginning at all. [...] And so I sort of built up the environment that I would want for doing that and trying to communicate along the way." (D4)
In addition to improving documentation, some developers also worked on refactoring the website to streamline the development process. However, this crucial work often went unnoticed by the community, as refactoring typically involves behind-the-scenes improvements. This lack of visibility can be a source of frustration for developers, as their efforts to enhance the platform's technical foundation are not always recognized or appreciated by the broader user base.
Negative sentiments can also impact motivation. This was exemplified by an incident where a frustrated developer, feeling unappreciated due to the slow acceptance of his numerous merge requests, lashed out in the Slack channel, creating a toxic atmosphere:
"Regarding the incident with [a former developer] about two years ago, he contributed a lot and created numerous merge requests, more than we could review. He somehow didn't feel properly appreciated. Unlike some others before him who simply left when they felt the same way, [he] didn't just say he had enough and left. Instead, he spent three days writing harsh insults in the [Slack] channel. It really escalated, and that was a time when I thought I didn't want to continue. There needs to be a pleasant atmosphere [...]." (D1)
D1 explained that this developer's frustration led to a breakdown in team dynamics. Although the team temporarily refocused on mutual well-being, they eventually reverted to a more professional but detached environment where personal feelings were rarely discussed.
Conflict also arose around the extent to which the community should be involved in IT-related decision-making. While some developers advocated for a highly democratic process, others felt that the community's involvement was excessive and occasionally counterproductive. This tension was highlighted by D5, who reflected on a specific conflict regarding a new feature that a developer implemented despite overwhelming community opposition:
"And I also realized, okay, if these are the possibilities I have in IT—if I have concerns and can express them with arguments and there's simply no counter-argument, and the entire community agrees with me, at least in the product team everyone who was asked—there was such an overwhelmingly clear vote from the community, with everyone saying they didn't want it in that form, and it's still implemented anyway, then why am I even doing this stuff?" (D5)
These various sources of frustration—ranging from unconstructive feedback and lack of documentation to interpersonal conflicts and tensions over decision-making—contributed to a decrease in motivation among developers, challenging their continued involvement with the platform.

5.6 Halting and Returning: Developers' Re-engagement

Except for D4, who quit developing for Foodsharing.de in 2020, all interviewed developers reported taking breaks from their involvement, ranging from short pauses to extended periods of inactivity. These breaks were largely driven by the frustrations previously discussed, such as unconstructive feedback, lack of appreciation, and internal conflicts within the developer team.

However, not all developers returned from these breaks. Among those who did, their reasons for coming back often reflected a mix of both their original and newly discovered motivations. For instance, D1 felt compelled to return due to unfinished business and a commitment to completing projects:

"I think a somewhat strange motivation for me is the feeling that I want to finish certain things. We've started so many things, especially with updating the code. I have this sense that I want to follow through with it. If I were to say now, 'I don't feel like it anymore, I'm quitting, I'm moving on to something new,' I would feel like I was leaving things unfinished and, in a way, abandoning this small team." (D1)

Similarly, D5 was motivated to return because he recognized that there were still many aspects of the platform that needed improvement. He felt that his contributions were crucial to easing the burden on the already small development team. Despite having a conflict with another developer, D5 chose to set aside personal differences for the sake of the project's overall success:

"And I'm well integrated into Foodsharing, and I have [...] the feeling—this might be a bit drastic, but it's going a bit to the dogs if I don't help out. I mean, we are already far too few people." (D5)

D2, on the other hand, found that during any break he took, he quickly grew bored and realized that he *"just can't do without [Foodsharing]"* (D2). This suggests that, for some developers, their commitment to the platform is deeply ingrained, making it difficult for them to stay away for long periods.

5.7 Measures for Volunteer Retention

Given the small size of the developer team, retaining volunteers for as long as possible is crucial. This requires ensuring that their motivations outweigh the frustrations they experience. Many developers highlighted that receiving feedback, both from fellow developers and users, plays a key role in sustaining their motivation. Users can express their appreciation through the forum or by awarding 'trust bananas,' which are displayed on the user's profile.

Developers emphasized that feedback from familiar people holds more significance than from unknown users. D5 elaborated on this, noting:

"So, because when I highly value someone's perspective on the platform and I enjoy asking them for their opinion because I'm genuinely interested in their point of view and feel that it helps me in my assessment—when these people tell me that they appreciate how I do things, of course, that means more to me." (D5)

Additionally, D5 mentioned that his visibility within the product team working group made him more prominent to the user base, resulting in him receiving a disproportionately large share of positive feedback:

"I feel that, especially in the product team, I receive a disproportionately large share of the appreciation. Even though appreciation is probably not a limited resource, it often seems like I am the one doing everything the community wants, while others are just doing 'something' and not receiving any recognition. This perception is definitely not accurate, as the others are also doing very important work, but it is sometimes less visible to the outside." (D5)

This disparity in visibility may explain why D3, who focuses on less visible tasks like refactoring, felt underappreciated by users. Fostering constructive feedback from familiar sources, such as intermediaries [50], could be an effective strategy for improving volunteer retention. Intermediaries not only serve as bridges between developers and users but also provide a trusted channel for delivering feedback that motivates developers. By reducing the developer team's workload and ensuring user concerns are addressed, these roles are crucial for sustaining Foodsharing.de's volunteer-driven operations. D2 exemplifies this intermediary role, describing it as follows:

"I tend to side more with the users. I'm both in the product team and familiar with the application across the entire platform, but I can also understand how programming works. I can create an issue. So, people like me, who are somewhat experienced, are really needed to bridge that gap." (D2)

In early 2024, the Foodsharing e.V. board, which holds legal responsibility for Foodsharing.de, launched a fundraising campaign aiming to raise €100,000 to support education, local associations, supraregional working groups, the creation of a coordinating center, and the IT department. During our fieldwork, we observed that the topic of salaried positions was a point of discussion among developers. While one developer included a link on his profile for users to tip him for his work, another expressed that being paid would not significantly increase his motivation to contribute more than he already does:

"I might feel like I absolutely have to implement this feature or that feature or put in certain hours into the project because I am getting paid." (D3)

Another developer expressed concerns about the pressure and expectations associated with paid work:

"We considered [paying developers], but it is not [interesting] for me, because I would immediately feel pressured again. I didn't leave my profession for nothing; the constant demands and expectations eventually became too much for me. I want to choose my own projects. I like helping people, but they shouldn't have the expectation that I will just do it when they ask, or question why something is not done. [...] As soon as you get paid, people automatically have a different mindset; it's somehow strange." (D2)

In contrast to other developers, D5 was open to receiving a modest salary. Currently unemployed, he noted that without financial support, he could not continue his commitment to Foodsharing.de for much longer:

"In my ideal scenario, people would receive what they need. So, I'm not asking for a programmer's salary for my tasks here, nor do I want to earn €1,000 a month. But I would like to be able to pay my rent without having to worry about it. And I would like my health insurance to be covered without having to handle that myself. And if I could manage to take a short trip once a year, that would be cool too. These are not unreasonable demands in my opinion, but they are currently not being met." (D5)

In conclusion, perspectives on extrinsic motivations, such as monetary compensation, vary widely among developers and are influenced by their individual living situations and reliance on financial support within a capitalist system.

6 Discussion

In the findings, we uncovered the dynamic and evolving motivations of volunteer developers within the Foodsharing.de platform, highlighting the interplay between their commitment to both technological development and social impact. Below, we explore key themes: the blending of motivations, the dynamics of developer involvement, and the strategies they use to manage motivations and frustrations. We also consider strategies for supporting and retaining developers, considering the roles of intermediaries, governance structures, and monetary compensation. Finally, we employ the concept of infrastructuring, examining how the ongoing, often invisible work of maintaining socio-technical systems underpins the sustainability of the platform and its community.

6.1 Developer Engagement: Blending Motivations, Managing Dynamics, and Strategic Support for Retention

This section provides a deeper exploration of how volunteer developers within the Foodsharing.de platform navigate their roles. We examine how their motivations evolve, the challenges they encounter, and the methods they use to sustain their involvement. Additionally, we consider the broader implications for supporting and retaining these developers.

6.1.1 Blending Motivations. The motivations of volunteer developers in Foodsharing.de are diverse and evolve with their engagement. While many initially join to help combat food waste, deeper involvement often leads to a broader commitment, including contributing to the FOSS movement and embracing its ideologies. Their work within the IT team enables them to scale their impact, blending social and technological goals.

Developers in Foodsharing.de see their coding work not as an isolated FOSS effort but as a means to enhance the platform's capacity for food-sharing, aligning technical contributions with broader social goals. This reflects wider trends in FOSS communities, where contributors are often motivated by principles of openness, collaboration, and social justice [105]. For instance, D2 joined the IT team to improve the platform's food-saving functionality but later developed a deeper interest in FOSS. Similarly, D5 focused on socio-ecological transformation, while D1 emphasized community-building and fairness, exemplifying the blend of technical expertise and social commitment that sustains involvement.

These developers are motivated by the alignment of their personal values, skills, and the community's needs, a sentiment captured in their description of "combining engineering and social change" mentioned above. The ability to combine personal interests, such as coding, with a meaningful social impact emerged as a powerful motivator for long-term engagement. This is consistent with findings from volunteer studies that emphasize the importance of aligning volunteer roles with personal values and competencies to ensure sustained engagement [31, 97, 98, 103].

This blending of motivations underscores the importance of recognizing and nurturing the diverse reasons why developers choose to contribute. While some are driven by intrinsic satisfaction, others value extrinsic rewards such as monetary compensation, calling for flexible systems that accommodate diverse needs while maintaining the platform's volunteer ethos. A supportive environment is critical for enabling these motivations to evolve, ensuring sustained engagement despite changing personal or professional circumstances. Traditional FOSS analyses, which often prioritize software development as the main goal [5, 104], must be adapted for projects like Foodsharing.de, where socio-ecological impact takes precedence. As Marois et al. [74] caution, the diversity within F(L)OSS projects requires nuanced approaches to understanding motivations and structures. Foodsharing.de exemplifies this, blending open-source principles with unique socio-ecological objectives, reflecting the broad spectrum of FOSS philosophies from libertarian to collectivist practices [1].

6.1.2 Dynamics of Involvement. The dynamics of involvement among Foodsharing.de developers are characterized by a progression from initial engagement to deeper involvement, often accompanied by the discovery of new motivations. Developers typically begin their journey with a specific goal in mind, such as improving the platform's functionality or addressing user experience issues. As they become more integrated into the team, they often find additional reasons to stay involved, such as the enjoyment of programming or the positive feedback from the community.

However, this dynamic involvement is not without its challenges. Developer motivation fluctuates based on feedback, recognition, and team dynamics. For instance, D3 expressed frustration over vague or negative feedback, which sometimes led to dissatisfaction and a temporary halt in his involvement. On the other hand, the sense of camaraderie within the developer team, as highlighted by D1, played a crucial role in sustaining their commitment despite these challenges.

A significant challenge identified by developers is the issue of unclear governance within the Foodsharing.de project. This mirrors issues faced by other volunteer-driven FOSS projects, where governance can influence contributor retention [23, 81]. Furthermore, there are differing opinions on the need for a more inclusive and transparent governance structure. Some developers believe that increasing transparency and openness in decision-making processes could address frustrations related to reliability and ensure that all voices are heard. However, others prefer to maintain the current structure, expressing concerns that too much openness could slow down decision-making. Additionally, the atmosphere within the developer team plays a crucial role in maintaining motivation and commitment. A positive, supportive environment can enhance collaboration, while a negative atmosphere can lead to disengagement [29].

The dynamic nature of developer involvement suggests that continuous engagement strategies are needed to address the evolving motivations and challenges faced by developers. Ensuring that developers feel valued and that their contributions are recognized can help mitigate the risk of disengagement and promote long-term commitment to the project.

While this study emphasizes developer retention, attracting new

volunteers is equally vital for sustaining the platform and its movement. However, newcomers to FOSS projects often encounter significant technical and social barriers, such as setting up development environments, navigating poor documentation, and understanding the project's social dynamics. These challenges, identified by Steinmacher et al. [101], align with our previous findings on Foodsharing.de [50], which highlight the critical role of structured support in overcoming these barriers and sustaining participation. Furthermore, the successful integration of newcomers depends heavily on established community members. Ducheneaut [23] highlights the importance of newcomers "[establishing] strategic links with key members of the project", as these connections significantly enhance their chances of success. Additionally, providing positive and timely responses to newcomers' inquiries can foster a welcoming environment and encourage ongoing contributions [52, 101, 110, 115]. Conversely, exclusionary practices or unconstructive criticism can discourage participation and lead to disengagement [61]. Thus, the onboarding process, comprehensive documentation, and fostering a supportive community atmosphere are essential to sustaining the flow of new contributors.

6.1.3 Managing Motivations and Frustrations. Developers in the Foodsharing.de project manage their own motivations and frustrations to sustain their involvement, which is crucial in a volunteer-driven environment with limited external support. These challenges are magnified by the large-scale, resource-constrained environment in which Foodsharing.de operates. With over 440,000 users and a small team of volunteer developers, the platform exemplifies the difficulties of sustaining an infrastructure with minimal financial and technical resources.

One of the primary ways developers manage their motivation is by finding intrinsic satisfaction in their work. For many, this involves focusing on the aspects of the project that they find personally fulfilling. D1 and D3 highlighted the importance of aligning their contributions with values like resisting capitalist software models or enhancing community cohesion. Focusing on deeper, personal motivations helps developers maintain their engagement despite limited external recognition or rewards [31, 98].

Developers often address frustrations, such as negative feedback or lack of recognition, through resilience and reframing strategies. For instance, D1 and D5 manage unconstructive criticism by setting personal benchmarks for success and seeking validation from trusted colleagues or specific users, rather than relying solely on broader community feedback. D1, in particular, found motivation by focusing on positive feedback from those whose opinions he valued, enabling him to stay engaged even in the face of broader community dissatisfaction.

Moreover, developers manage their expectations by adopting a realistic and flexible approach to their work. Many recognize that, in a volunteer-driven project, progress can be slow, and challenges are inevitable. D2, for instance, emphasized the importance of flexibility, noting that he enjoyed the freedom to take breaks when needed, which allowed him to return to the project with renewed energy. This flexibility in commitment helps developers manage burnout and maintain a long-term perspective on their involvement.

In addition, some developers manage their expectations around recognition and appreciation by focusing on the rewards of contributing to a meaningful cause. D1 expressed that being recognized as a point of contact for specific aspects of the code provided him with a sense of competence and value, even if broader community recognition was lacking. This internal sense of accomplishment helps developers stay committed despite external challenges.

Foodsharing.de developers demonstrate a high degree of self-management in navigating the complexities of volunteer engagement. By aligning their work with personal values, finding intrinsic satisfaction, and adopting flexible expectations, they are able to sustain their motivation and effectively manage the frustrations that come with contributing to a large, community-driven platform.

To attract and integrate new volunteers effectively, it is essential to prioritize well-structured onboarding processes and create an environment that welcomes participation. Research emphasizes the importance of documentation and task design tailored for newcomers, as these can help mitigate technical barriers and ease the learning curve for first-time contributors [101]. Additionally, fostering a sense of belonging and ensuring that new volunteers receive constructive, timely feedback can significantly enhance their engagement and reduce early dropout [52, 101]. Addressing these aspects not only supports the retention of new contributors but also strengthens the overall sustainability of the developer community.

6.1.4 Strategies for Supporting and Retaining Developers. Retaining volunteer developers in resource-constrained environments like Foodsharing.de requires balancing intrinsic and extrinsic motivations. Leveraging developers' dual commitment to the socio-ecological mission and the FOSS ethos fosters alignment with their values and interests, promoting long-term engagement. Additionally, facilitating smoother reintegration after breaks—through clear documentation, open communication, and updates on recent changes—helps returning developers feel welcomed and supported, enhancing retention efforts.

Providing consistent and meaningful feedback is a key strategy for retaining volunteer developers, yet its effectiveness hinges on factors like its quality, timeliness, context, and source. Feedback from trusted peers or active community members, as valued by developers like D3 and D5, proves particularly motivating. Conversely, vague or overly critical feedback risks causing burnout and disengagement. To foster a supportive environment, platforms can implement strategies such as regular feedback sessions, celebrating milestones, and recognizing individual contributions, ensuring communication bolsters morale rather than detracting from it.

Another important strategy is the use of intermediaries to bridge the gap between developers and users. Previous research on Foodsharing.de has highlighted the critical role intermediaries play in connecting users and developers through unplanned but beneficial "serendipitous connections" [50]. Intermediaries ensure user feedback is constructive and clearly communicated while providing users with transparent explanations of developer responses. Evidence from this study underscores the importance of intermediaries in bridging technical and user perspectives. For instance, D2 and D5 often mediate between these groups, building trust by simplifying technical concepts and fostering a collaborative environment that sustains engagement.

Addressing governance within Foodsharing.de could enhance inclusivity and transparency. However, developers hold differing views on the current model. While some advocate for openness, others worry this might slow decisions or shift focus to short-term community preferences over long-term goals. A potential solution could involve a hybrid governance model, combining efficiency with community involvement. Clear decision-making guidelines, specifying when and how to incorporate community input, could clarify roles and responsibilities. Regular governance meetings, open to developers and community members, could foster transparency. Yet, past attempts of D2 to engage the product team in informal 'coffee meetings' about development topics have seen limited participation, suggesting the need for more structured approaches.

A positive team atmosphere is crucial for sustaining developer motivation and commitment. Addressing interpersonal conflicts constructively through mechanisms like mediation or peer support can prevent issues from escalating. Regular team-building activities—such as hackathons, social events, or collaborative projects beyond routine development—help foster camaraderie and strengthen bonds. These initiatives, whether virtual or in-person, contribute to a cohesive and supportive team environment.

The discussion on monetary compensation as a retention strategy revealed mixed opinions among developers. Some, like D5, were open to modest salaries to support their involvement, while others feared that financial incentives could undermine the volunteer spirit and introduce new pressures. This highlights the need for a nuanced approach to compensation that prioritizes intrinsic motivations while providing necessary support. As Foodsharing.de professionalizes, balancing structured support with the volunteer ethos that has driven the project is crucial. Retaining developers' autonomy and freedom in their roles is vital for sustaining their commitment.

In conclusion, supporting and retaining volunteer developers in the Foodsharing.de project requires a comprehensive strategy that addresses their evolving motivations, manages their frustrations, and fosters a supportive community environment. By blending intrinsic and extrinsic motivations and strategically managing the dynamics of involvement, Foodsharing.de can sustain its developer community and ensure the long-term success of the platform.

6.2 Infrastructuring for Change

As discussed in subsection 2.5, Infrastructuring refers to the ongoing and often invisible work that sustains the socio-technical systems supporting interactive technologies [99]. This process is not solely about the technical development of these systems but also involves the continuous interplay between technological infrastructures and the social practices they support [55]. Within the context of Foodsharing.de, infrastructuring is particularly evident in the platform's open-source nature, which enables community members to contribute directly to its evolution [42]. The above discussion of the dynamics of involvement—starting motivation, additional motivations that developed during engagement, frustrations encountered, halting of engagement, and eventual return—provide valuable insights into the infrastructuring process.

Relationality within infrastructuring is essential for understanding how Foodsharing.de operates as more than just a technological system. It is deeply embedded in the relationships among developers, users, and the broader community [100]. These relationships influence the platform's development and maintenance, as developer motivations and frustrations are tied to these interactions.

The initial motivation of developers often stems from a shared commitment to the platform's social goals. As developers engage more deeply with the platform, their motivations evolve, reflecting the dynamic nature of their relationships with other stakeholders. The frustrations they encounter often arise from relational challenges, such as misaligned expectations or insufficient support from the community, can lead to the halting of their engagement.

However, without strong relational ties – enabled through the socio-technical infrastructure that is Foodsharing.de – the infrastructure itself would cease to be continuously created. Ongoing meta design [24] as a form of social infrastructuring, which includes social events, effective governance mechanisms, and feedback loops, is crucial. These elements not only build and strengthen social relations but also help sustain the project. They need to be understood as a form of back-stage design or knot-working activities [10] that are as important as implementing the functional aspects of food saving and sharing.

Negotiations are a specific form of back-stage design that highlight the dynamic and ongoing exchanges that occur within the development, use, and maintenance of Foodsharing.de. These exchanges extend beyond technical interactions to encompass the continuous negotiation of roles, expectations, and rewards among developers, users, and other stakeholders. Central to infrastructuring work are negotiations of how local/short-term needs can be aligned with shared/long-term needs [58]. The potential introduction of monetary compensation for developers—an extrinsic motivation that has been debated within the community—illustrates such negotiations of needs. On one hand, offering payment could formalize certain aspects of the development process, potentially increasing accountability and attracting new contributors who are motivated by financial incentives (local needs). This could lead to more structured and predictable transactions, where the exchange of labor for payment becomes a key driver of engagement.

On the other hand, the introduction of money could also disrupt the existing relationality that has been primarily driven by intrinsic motivations such as a commitment to the platform's social mission (shared needs). Developers who were initially drawn to the project by a sense of purpose and community might feel that the ethos of volunteerism is being undermined, leading to tensions and potential disengagement [35, 114]. Moreover, the dynamics between developers and the community could shift if transactional modes, such as financial compensations, might create expectations of faster development cycles, greater responsiveness to user demands, or a redefinition of development priorities. This could exacerbate existing power dynamics, where some developers may feel pressured to prioritize tasks that align with the community's willingness to fund certain features or fixes, rather than focusing on what they believe is most beneficial for the platform's long-term sustainability.

In this context, negotiations within Foodsharing.de are not just about the technical refinement of the platform but involve a delicate balance between maintaining the relational, collaborative, and mission-driven spirit of the project and navigating the potential shifts that monetary incentives could bring. The ongoing debate

about whether and how to introduce financial rewards underscores the need for careful management of these transactional relationships to ensure that the platform remains a space where both intrinsic and extrinsic motivations can coexist without compromising the foundational values of the community.

Points of infrastructure within Foodsharing.de become apparent at specific instances where the usually invisible or taken-for-granted aspects of the platform's infrastructure come into focus [82, 100]. These points often emerge during moments of breakdown, innovation, or critical interaction with the platform. For instance, a technical issue that disrupts the platform's functionality can reveal underlying dependencies and prompt developers to address these critical points. However, points of infrastructure also expose power dynamics at play [20]. In the case of Foodsharing.de, they underscore the inherent disconnect between the development priorities of users and developers. While users may express their needs or desires for certain features, they have limited influence over the actual development priorities. Ultimately, developers choose what they want to work on based on their own motivations and preferences, often leading to tensions around who controls the direction of the platform's evolution. Similarly, moments of innovation, such as a significant update to the platform, bring to light the often-invisible work of maintaining and evolving the infrastructure. These points of infrastructure are also where negotiations about relational and transactional modes of collaboration converge, as developers and users must navigate the challenges and opportunities presented by these critical moments. Understanding these points is essential for supporting the platform's continuous evolution and ensuring that the socio-technical systems remain robust and responsive to the community's needs [58].

A particular point of infrastructure was the hackathon we organized in April 2024. While the collaboration between users and developers is not the main focus of this study, we examine it here as it is relevant to addressing the dynamics of developer motivation. Further insights into the user-developer relationship within Foodsharing.de have been previously explored in [50], which also highlights areas for future research. As suggested by Hellmann et al. [45, 46], users often feel ill-equipped to communicate effectively with developers, especially on technical issues, and the developers' direct communication style may be less approachable for some users. During the hackathon, a document was created to outline tasks that users could perform without coding skills, but it failed to generate additional contributions, as there were no responses after its posting in a supraregional forum. Pipek and Wulf [82] distinguish between infrastructure emerging from breakdowns and moments of innovation, and while the hackathon had the potential to be an infrastructuring event, or more specifically a moment of infrastructure innovation, users seemed to prioritize their participation in technical discussions less. This lack of engagement may stem from the perception that the platform's smooth operation diminishes the visibility of the ongoing infrastructuring work and the importance of user input.

Interestingly, rather than being an innovation point of infrastructure, the hackathon highlighted a (partial) infrastructure breakdown, because it made the disconnect between users and developers obvious. This raises important questions about the socio-technical dynamics of the platform's infrastructuring. Although the hackathon was intended to bridge this gap and encourage user engagement in the development process (i.e., innovation), barriers to participation became evident and warrant deeper reflection (i.e., breakdown).

The disconnect is significant when considering the relationship between developer motivation and the platform's socio-technical infrastructure. Developers who hoped for more user engagement during the hackathon noted that such collaboration could enhance their sense of connection and purpose, potentially improving their long-term commitment to the platform. Our experience with the hackathon highlights the need to explore infrastructuring strategies that align better with the diverse ways users engage with the platform. Future hackathons could incorporate structured onboarding sessions, hands-on activities, or informal opportunities to help users feel more confident participating in technical discussions.

The infrastructuring within Foodsharing.de is not merely a technical endeavor but a deeply social one, rooted in the community's collective motivations and practices. It exemplifies how open-source platforms can serve as a nexus where social goals and technological innovation coalesce, enabling the sustained engagement of both developers and users in a shared mission to reduce food waste. By framing infrastructuring through the lenses of relationality, negotiations, and points of infrastructure, we gain a deeper understanding of how these socio-technical systems are maintained and evolve over time, ensuring their long-term sustainability and impact.

Evolving kinds of participation of volunteers in the Foodsharing.de project are central to understanding how volunteers engage with the project over time. This diversity allows volunteers to explore new roles, beginning with hands-on tasks like collecting surplus food and gradually shifting 'up' toward management, organization, planning, or 'down' to infrastructuring tasks such as technology development and maintenance. While all forms of participation are essential for the project's sustainability, they often differ in visibility and perceived value. Managerial roles tend to carry more status, whereas infrastructural work is frequently undervalued and less visible. As volunteers deepen their involvement, they navigate both directions—moving 'up' into strategic areas and 'down' into the technical foundations that support the platform. For instance, a developer creating a voting tool engages in both abstract decision-making and the underlying technical work, highlighting how these layers are intertwined. Recognizing and valuing all types of participation, particularly infrastructural contributions, is vital for maintaining volunteer motivation and ensuring the overall health of the platform.

Drawing from the insights gained through our exploration of volunteer motivations within Foodsharing.de and resonating with contemporary research in the field, we propose several actionable points for HCI researchers and practitioners aiming to design and sustain community-driven digital platforms.

(1) Design adaptable systems that accommodate flexible engagement, role transitions, and autonomy in task selection. This would include appropriate feedback systems that incorporate opportunities for meaningful recognition of individual contributions.

(2) Ensure that technical contributions are aligned with the platform's social mission by fostering communication about social impact.
(3) Develop robust onboarding processes with clear documentation, beginner-friendly tasks, and constructive feedback. Foster connections between newcomers and experienced members to ensure lasting engagement.
(4) Design transparent, participatory governance structures, incorporating tools for open decision-making.
(5) Strengthen personal relationships, especially through empowering intermediaries to facilitate communication between developers and the community.
(6) Make maintenance work visible and transparent, while also developing tools for effective knowledge transfer, conflict resolution and moderation.

Applying these recommendations within the Foodsharing movement may enhance both the platform's resilience and its community cohesion. Platform administrators and board members play a pivotal role in establishing transparent, participatory governance structures and recognition systems that keep volunteers motivated and engaged. Intermediaries, who bridge the gap between developers and the broader community, also play a role in facilitating structured feedback, addressing potential conflicts, promoting a positive atmosphere within the developer community, and making the infrastructural work more visible. Platform developers, who handle technical updates and improvements, benefit from their work being aligned with Foodsharing.de's social mission, leveraging feedback and recognition systems to ensure their contributions are valued by the broader community.

A critical takeaway for us is the dynamic nature of developer motivations, shaped by both socio-technical infrastructure and the alignment between personal motivations and broader project goals. This alignment may be relevant in other resource-limited FOSS communities where volunteers balance personal interests with mission-driven objectives, such as environmental or social justice. It is evident that elements of our findings are specific to Foodsharing.de's unique socio-ecological mission, which emphasizes community well-being and environmental impact over commercial and, indeed, other incentives. For this reason we have characterized this specific social movement as involving 'quiet' activism [56]—the simple business of getting on with the redistribution of food on a daily basis and where there is little or no evidence of overt political challenge to wider societal issues. Foodsharing.de's infrastructure is deeply intertwined with practical actions in the real world. This materiality introduces unique infrastructural demands, as the platform must support not only digital coordination but also on-the-ground logistics and community interactions. Foodsharing.de intertwines technical infrastructure with social and ecological infrastructure, as seen in the daily use of tools to support food-saving activities and the social relationships that form around these practices. Foodsharing.de stands out among large-scale FOSS projects as one of the few platforms directly facilitating real-world, material activities—specifically, the physical rescue and redistribution of food.

6.3 Limitations

Numerous proposals for evaluating the quality of case study research exist, typically aiming to assess elements of validity and reliability despite taking various forms (see e.g. [39, 88]). Our approach, which involves triangulating insights from multiple sources and sharing an evolving code structure, addresses many of these considerations. A key consideration for reliability, however, lies in determining the extent to which our findings hold broader relevance. The unique socio-ecological mission of Foodsharing.de sets it apart from other FOSS projects, making it a particularly compelling context for study. We believe this setting holds significant potential for further investigation by ourselves and others, enabling meaningful comparisons and deeper insights.

One evident limitation is that this study only includes perspectives from developers who returned after a break, potentially overlooking factors influencing those who disengaged permanently.

Additionally, our use of convenience and snowball sampling may have introduced a sampling bias, as participants were primarily those who were active or well-connected within the developer community. This may have led to the underrepresentation of less engaged or peripheral members. An additional limitation is the lack of gender diversity among participants, as all interviewees were male. While this reflects the composition of the developer community in Foodsharing.de, it constrains our ability to explore how gender dynamics might shape motivations, frustrations, or engagement in FOSS projects.

Finally, the timeframe for data collection was relatively short, potentially limiting insights into long-term changes in motivations or collaboration practices. While we focused on themes of motivation, frustration, disengagement, and re-engagement, other aspects such as technical challenges or governance structures may not have been explored in sufficient depth.

7 Conclusion

This study illuminates the evolving motivations of volunteer developers engaged in the Foodsharing.de platform, an unusual intersection of FOSS development and socio-ecological activism. Our research reveals that the sustaining of volunteer engagement requires a deep understanding of the dynamic interplay between personal passions, technical expertise, and a commitment to socio-ecological causes. The developers are driven by a blend of intrinsic and extrinsic motivations, which shift as they navigate the technical and social aspects of the platform and its community. We have noted above how community engagement can be episodic. Volunteers come and go for various reasons, as we have seen.

The interests and motivations of volunteers are not static but change over time, as can the degree of effort that they can commit. A sustainable community needs to manage the interactional elements that inform these motivational shifts. Communities have a vital role in sustaining volunteer engagement. Developers who feel a sense of belonging and receive constructive feedback are more likely to remain committed. Conversely, a lack of appreciation, negative feedback, and unclear governance structures can lead to frustration and eventual disengagement.

Moreover, our study highlights the importance of infrastructuring—the ongoing, often invisible work of maintaining and evolving

socio-technical systems. Supporting this infrastructural work, both technically and socially, is essential for the long-term success of the platform and its broader socio-ecological mission.

In conclusion, the sustainability of volunteer-driven FOSS projects like Foodsharing.de depends on more than just the technical contributions of developers; it also requires a deep understanding of their motivations and the creation of an environment that supports their long-term engagement. By addressing the challenges of recognition, feedback, and governance, and by fostering a strong, supportive community, platforms like Foodsharing.de can continue to thrive and make meaningful contributions to social and environmental causes.

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