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Digital Orbit of Collective Action: Switching Between Inclusive and Exclusive Modes of ICT in FridaysForFuture

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Abstract: *This study analyzes how ICT-based social movements manage the paradoxical challenges of being open and closed at the same time. For this approach, we conducted a qualitative study of a large-scale netroots movement organized primarily through online media, namely, FridaysForFuture. Our findings reveal that FridaysForFuture's digital infrastructure is based on three spaces of digital interaction, which we refer to as spheres. These spheres can be distinguished as national, local, and external spheres that build on one another. Within these spheres, dynamics of digital coordination unfold, which we describe as "open." However, despite the appearance of openness, restrictive characteristics also emerge, which we label as "closed dynamics." In each sphere, FridaysForFuture members work toward specific goals through open dynamics, while addressing problems through closed dynamics. This study contributes to research on ICT-based coordination, digital mechanisms, and social movement structures by demonstrating the transformative effects of ICTs on organizing forms.*

Keywords: ICT, digital mechanisms, paradoxes, digital infrastructure, social media, netroots movement.

1 Introduction

Collectives, social movements, and social activists are defined as groups that engage in collective action without institutionalized channels (Briscoe & Gupta, 2016). By utilizing information and communication technologies (ICTs), these groups can rapidly diffuse tactics (van Laer & van Aelst, 2013) and operate on a large scale with loose structures (Bennett, 2003; Massa & O'Mahony, 2021). This paper adopts the definition of ICT that "although the term ICT is broader and includes relatively conventional technologies (e.g. telephone), we use this acronym here only with reference to digital technologies" (van de Donk, Loader, Nixon, & Rucht, 2004, p. 20). Notable movements such as the Arab Spring exemplify the role of ICT in collective action, where more than 445,000 users generated 7.48 million tweets within just one week (Bruns, Highfield, & Burgess, 2013).

Contrary to the view of social movements as purely destructive, the resource mobilization theory introduced the concept of social movement organizations (McCarthy & Zald, 1977). These bureaucratic, complex, and formal entities involve "leadership, administrative structure, incentives for participation, and a means for acquiring resources and support" (McAdam & Scott, 2002, p. 6). Research on collective action demonstrates how grassroots activities, initially seen as disruptive or deviant, can evolve into formalized and even bureaucratic social movement organizations (Claus & Tracey, 2020). Such organizations differ from other types of organizations through their diverse actors, shared membership definitions, and a collective aim to resolve political or cultural conflicts (Diani, 1992). These features—including loose, informal membership definitions, conflict-driven motivations, and a shared collective identity—are not only shaped by emerging ICTs but are intensified by the rapid pace of change and the distinctive tensions that arise as a result.

Scholars have debated the extent to which ICT affects social movements, particularly its potential transformative power (Earl, Hunt, & Garrett, 2014a). Traditional research suggests that ICT-supported collectives are merely accelerated and expanded in scope, without being fundamentally altered (McCarthy & Zald, 1977). However, studies on ICT-based organizations argue that these technologies significantly transform organizational practices and structures (Earl et al., 2014a). In this study, we explore how ICT-based social movements navigate coordination and governance challenges while simultaneously exhibiting both open and closed characteristics.

Studies beyond research on social movements, such as those on open strategy (Dobusch, Dobusch, & Müller-Seitz, 2019), digital networks

(Massa & O'Mahony, 2021), and organizational identity (Kozica, Gebhardt, Müller-Seitz, & Kaiser, 2015), have revealed processes that, while seemingly contradictory, actually complement each other. While social movements are already viewed from an "open systems perspective, the importance of the organization's relation to its environment – social, economic, political" (McAdam & Scott, 2002, p. 6), we focus on openness in terms of access to sensitive information, participation, and decision-making (Dobusch et al., 2019), which supports coordination. We draw on these studies and their conceptualizations to analyze ICT-based social movements, emphasizing the challenges that arise as organizing and bureaucratizing processes become increasingly intertwined (McAdam & Scott, 2002). These processes and tensions, though seemingly opposing, complement one another and are referred to as paradoxes (Dobusch et al., 2019; Schad, Lewis, Raisch, & Smith, 2016). Paradoxes are defined as ongoing contradictions between interdependent elements in a dynamic and evolving manner (Schad et al., 2016). They highlight that opposing forces persist over time, suggesting an evolutionary relationship between thesis and antithesis, ultimately offering a perspective that shifts from a linear view to one that embraces holistic and cyclical dynamics (Lewis & Smith, 2022).

We use this paradoxical framework to examine the counteracting yet complementary processes to better understand how ICT affects the evolving and transformative nature of social movements. This dynamic and holistic view of paradoxes is essential for capturing the evolutionary processes of large collectives. For example, Dobusch et al. (2019) identify paradoxical traits in open strategy processes, showing that openness is often achieved through "closed qualities" (p. 364). In the ICT-based organization Wikimedia, a digital hierarchy is established where all members have access to view protocols, but not all can participate equally in decision-making (Dobusch et al., 2019; Kozica et al., 2015). Similarly, Massa and O'Mahony (2021) examine the hacktivist group Anonymous and uncover paradoxical features in their control mechanisms. Anonymous uses open-source software to welcome and guide new members but divert unskilled participants from critical processes through testing and classification (Massa & O'Mahony, 2021; Dobusch & Schoeneborn, 2015). These paradoxes prompt the question of how ICT-based social movements manage the challenge of being both open and closed simultaneously.

To address the research question, we conduct a case study of a prominent netroots movement—an online-organized movement—focused on the grand challenge of climate action. Van Aelst and Walgrave (2002) argue that "the balance of power and existing political structure is not likely to change" (p. 465). However, over the past five years, a significant social movement has emerged that has dramatically pressured political structures to change and advocate for climate action, with a strong reliance on digital tools. This movement is FridaysFor-Future (FFF). FFF began as a coordinated effort by students (Ramelli, Ossola, & Rancan, 2021), initiated by a 15-year-old Swedish student who skipped school to protest outside the Swedish Parliament. Since then, it has evolved into a global mass movement, marking a historic turning point in environmental activism (Ramelli et al., 2021; Svensson & Wahlström, 2023).

In analyzing FFF, we identify three spheres in which actors address specific problems and goals: the national sphere (i.e., collective body of national organs), the local sphere (i.e., conglomeration of all local groups), and the external sphere (also called the extra-organizational sphere, i.e., public representation of the movement). These spheres represent digital spaces, each with distinct communication tools, access rights, and responsibilities. Together, these digital spheres build on one another to form what we define as a collective digital orbit. The total sum of all these spheres constitutes the digital orbit. Newcomers to FFF enter the movement through the external sphere. The first publicly available point of contact is typically through social media, after which they may join the local sphere (i.e., city or local groups), and eventually, the national sphere (i.e., elected national bodies).

To progress through these spheres, participants must meet certain criteria, which we classify as attitudinal, attributable, and functional. Fulfilling the criteria of the outermost sphere is necessary to advance to the inner spheres. Starting with the attitudinal criterion in the external sphere—the outermost sphere of the movement—newcomers are drawn in through FFF's strong social media presence and are welcomed at digital events or protests. However, they must adhere to the values and rules set by FFF to be associated with the movement. This outer sphere represents the fight for association.

Next, the attributable criterion comes into play within the local sphere—the movement's middle sphere. In this sphere, members receive official FFF affiliations and the right to participate in

events. However, access to certain information is restricted and only productive members can access closed channels. The middle sphere thus represents the fight for information.

The innermost sphere, governed by the functional criterion, is reserved for officially elected national actors. These actors have access to the most sensitive structural information but have limited rights to edit or modify content based on their roles and functions. This innermost sphere represents the fight for editability and structure.

This study contributes to the literature on social movement structures and digital mechanisms within social movements by distinguishing the movement into defined spaces of bounded digital interaction (Bucher & Langley, 2016), which we label as spheres. Various digital tools and mechanisms are highlighted, demonstrating how goals are pursued and problems are addressed, thereby underscoring the non-transformative nature of ICT-supported collectives (McCarthy & Zald, 1977; Bruns et al., 2013). Additionally, this study contributes to the literature on paradoxical capabilities—specifically, the dynamics of openness and closure, movement participation, and ICT-based coordination (Dobusch et al., 2019; Massa & O'Mahony, 2021)—by shedding light on the transformative character of ICT-based collectives (Bennett, 2003; Earl et al., 2014a). This research identifies transformative features in the form of simultaneous open and closed dynamics across all spheres, functions, and roles within FFF.

2 Coordinative and organizing processes using ICTs in collective action

2.1 ICT-supported and ICT-based forms

Studies analyzing ICT-supported forms often do not capture the transformative effects of ICTs on organizations and collectives, instead focusing on increased accessibility and scale (McCarthy & Zald, 1977). This is commonly referred to as the "scale change" argument (Earl et al., 2014a, p. 27). For instance, researchers have examined the "Battle in Seattle," an anti-WTO mobilization in 1999 that used the Internet to coordinate large-scale protests, and the Arab Spring in 2010, a series of uprisings across much of the Arab world (Earl et al., 2014a; Earl, Hunt, Garrett, & Dal, 2014b; Garrett, Bimber, de Zúñiga, Heinderyckx, Kelly, & Smith, 2012). These movements, sustained by big data, illustrate the impact of social media and ICTs, as seen during the Arab Spring when "7.48 million #egypt tweets from more than 445,000 unique users" (Bruns et al., 2013, p. 8) were recorded on Twitter in just one week in late 2011. Over the past few decades, social media and other digital tools have supported organizational and collective ambitions in various ways, such as through hyperlinked networks and campaigns (Bennett, 2003), flash activism, and meso-mobilization (Earl et al., 2014a), with social media playing a central role (Fahmy & Ibrahim, 2021; Earl et al., 2014b). These figures offer a glimpse into the effects of ICTs on collective action. However, discussions have primarily focused on protests facilitated and accelerated by ICTs, rather than on the coordination processes that rely on ICT infrastructure (Earl et al., 2014a).

ICT-based forms represent a new structure that not only expands and accelerates organizational methods but fundamentally alters them (Earl & Kimport, 2011). Earl et al. (2014a) argue that there is a need for "new theorizing because existing models fail to hold – even with modifications" (p. 11) and criticize that "scholars failed to cordon the debate using precise conceptualizations of technology use" (p. 26). While ICT-based organizational forms are relatively new subjects of debate, there has been minimal research on ICT-based social movements. This raises an important question: How do ICT-based social movements navigate the paradoxical challenges of being both open and closed at the same time?

2.2 Opportunities and challenges of ICTs in collective action

Much research has focused on both the positive and negative effects of ICT on collective forms. Van Laer and van Aelst (2013) argue that while ICT can create weak ties, the rapid growth it induces is often followed by an even faster decline in support. Although information is more accessible than ever, it remains "difficult to differentiate accurate information from fabrication" (Garrett, 2006, p. 22). Furthermore, the ability to coordinate both nationally and globally using ICT benefits not only social movements but also their challengers and opponents to the same extent (Garrett, 2006). Interestingly, ICT can also complicate decision-making processes in open structures, with the "core social movement problem" (Earl et al., 2014b, p. 14) remaining information overload on one hand, and slow, low participation rates that foster "slacktivism" (Earl et al., 2014a, p. 25) on the other. These consequences highlight that "the rapid development of new applications of – especially digital – communication technologies constantly challenges the research agenda" (van de Donk et al., 2004, p. 2).

We are aware of the merits and shortcomings of ICTs in forms of collective action. However, a fundamental understanding of how they affect the coordination and organization of large social movements, which heavily rely on digital technologies, is still lacking. These opportunities and challenges not only reveal distinctive characteristics but also contribute to highlighting the transformative effects of ICTs. To overcome such ICT-induced challenges, forms of collective action implement unique coordination processes. Therefore, we draw on research from other ICT-based organizational forms to further investigate these processes.

2.3 Open and closed dynamics as paradoxical mechanisms of ICT-based organizing forms

Since coordination and organization in ICT-based social movements is a novel area of research, we utilize studies that focus specifically on other ICT-based organizational forms and draw from theory-building frameworks on paradoxes (Poole & van de Ven, 1989; Lewis & Smith, 2022). Most research describes ICT characteristics as open, easily accessible, collective, and diffuse (van Aelst & Walgrave, 2002; Bennett, 2003). These effects include the rapid spread of tactics (van Laer & van Aelst, 2013), the enhancement of collective identity (van Aelst & Walgrave, 2002), increased legitimacy and openness (Dobusch et al., 2019), the creation of open digital networks to foster engagement (Massa & O'Mahony, 2021), and the facilitation of looser structures (Bennett, 2003). Digital technologies, therefore, act as catalysts for the rise and functioning of social movements, substantially increasing the scope and speed of their activities rather than representing a completely new phenomenon.

However, recent studies have revealed that these same ICT-based organizational forms exhibit seemingly contradictory dynamics, characterized by closed, concentrated, and less accessible features (Dobusch et al., 2019; Massa & O'Mahony, 2021; Dobusch & Schoeneborn, 2015). Consequently, ICT-based forms of organization embody both open and closed qualities. These tensions are defined as paradoxes (Kozica et al., 2015; Lewis & Smith, 2022). Although much research has examined paradoxes in traditional contexts, such as corporate governance through authority and democracy (Sundaramurthy & Lewis, 2003) and management science (Schad et al., 2016), scholars have developed this concept as a theory-building framework (Poole & van de Ven, 1989; Schad et al., 2016). They analyzed ambiguous, uncertain, complex, and dynamic topics (Lewis & Smith, 2022) and captured contradicting requirements (Schreyögg & Sydow, 2010) in organizational and social theory, including digital networks (Massa & O'Mahony, 2021) and organizational identity (Kozica et al., 2015). We build on this theoretical framework, which embraces dynamic and ambiguous processes, and apply insights from other ICT-based organizational forms to analyze ICT-based social movements.

Research has examined both the outward-facing characteristics related to environmental interactions and boundary development (Schreyögg & Sydow, 2010), as well as internal processes such as strategizing (Dobusch et al., 2019). The "blurring" of boundaries (Schreyögg & Sydow, 2010, p. 4) occurs due to the broad range of activities, and the flow of information and knowledge, facing a turbulent, complex, and volatile environment. Revealing open qualities in internal processes, Dobusch et al. (2019) examine the strategizing processes of Wikimedia, which "strives for openness as a general principle" (p. 349). Wikimedia is described as "a partial organization" (p. 187), with paid employees on one hand and a large number of volunteers on the other (Kozica et al., 2015). With a goal of general openness, Wikimedia includes about 120,000 volunteers and incorporates openness-promoting mechanisms such as highly transparent digital protocols and online workspaces (Kozica et al., 2015), as well as "wiki technology, an information technology that enables collaborative authoring" (Dobusch et al., 2019, p. 344). Similarly, Massa and O'Mahony (2021) analyze the hacktivist group Anonymous, identifying how dynamics that facilitate participation help integrate and guide newcomers to digital platforms, projects, and current operations without requiring formal membership. Newcomers' enthusiasm is channelled into the organization through cultural and practical guidance provided by experienced "veteran" members (Massa & O'Mahony, 2021, p. 21). Informal members use social media and published Wiki protocols and norms to recruit and mobilize new participants. Newcomers undergo a process of receiving cultural and practical information, guided by veterans through open-source websites (Dobusch & Schoeneborn, 2015) like the Low Orbit Ion Cannon, the Gigaloader, or open forums, and participate in current events, or "operations" (Massa & O'Mahony, 2021, p. 20).

However, sustaining such large ICT-based organizing forms requires a complementary dynamic, "balancing paradoxical tensions" (Schreyögg & Sydow, 2010, p. 19). Dobusch et

al. (2019) describe this as “certain forms of closure [which] may be necessary to achieve desired open qualities” (p. 343) or “closed qualities” (p. 364). In the case of Wikimedia, these closing dynamics are defined by the extent to which members are permitted to participate, which is regulated through various rules and regulations (Kozica et al., 2015). A digital hierarchy is created to enforce exclusivity, where higher ranks have greater decision-making authority and access (Dobusch et al., 2019). Similarly, Anonymous exhibits closing dynamics, ranging from testing new participants’ skills to shaming newcomers for non-compliance, to control access to critical organizational processes (Massa & O’Mahony, 2021; Dobusch & Schoeneborn, 2015). By classifying new members as “surface members, [with] relegated to mundane tasks” (p. 1060) and thus limiting their digital access, Anonymous establishes a structure that secures organizational integrity and productivity (Massa & O’Mahony, 2021). Consequently, newcomers are directed away from certain operations, allowing veterans to focus on expert tasks without interruptions from novices (Massa & O’Mahony, 2021; Dobusch & Schoeneborn, 2015).

2.4 Summary of coordinative and organizational procedures in ICT-induced organizing forms

Traditional research shed light on the applicability and usage of ICT-supported organizing forms (McCarthy & Zald, 1977). ICTs have been shown to be effective in accelerating and expanding organizing efforts, utilizing various digital mechanisms that suggest seemingly limitless openness (van Laer & van Aelst, 2013; Bennett, 2003). Research on ICT-supported organizing forms dismissed their transformative impact on organizational structures (Earl et al., 2014a). Recent studies have shifted focus to organizing forms that are entirely based on ICTs, revealing that this boundless openness is accompanied by closed qualities (Dobusch et al., 2019; Massa & O’Mahony, 2021). These paradoxical characteristics—openness enabled through closeness or control without overt control—highlight the need for “new theorizing” (Earl et al., 2014a, p. 26) and emphasize the transformative nature of ICTs.

Given the scarcity of studies on ICT-based social movements, we investigate how these movements operate. Specifically, we aim to understand how social movements address the paradoxical challenges of being both open and closed simultaneously.

3 Case study

In December 2018, a 15-year-old Swedish student initiated a solo protest in front of the Swedish Parliament, sparking the largest social movement in recent history focused on climate action. This global mass movement marks a pivotal moment in environmental activism (Ramelli et al., 2021; Svensson & Wahlström, 2023). The first global strike on 15 March 2019 alone mobilized over 300,000 people across more than 220 cities in Germany and 1,789,235 participants worldwide (ipb, 2019). FFF Germany quickly emerged in northern cities like Bad Segeberg shortly after the movement had gained momentum in Sweden. Since then, the movement has mobilized over 14 million demonstrators worldwide (FridaysForFuture, 2021).

FFF is a netroots social movement with a vast global reach, aiming to fundamentally reshape social, economic, political, and environmental norms. This form of collective action has the potential to demonstrate the power of change, draw attention, trigger resource (re-)allocation, and stimulate further growth by leveraging various digital mechanisms (Massa & O’Mahony, 2021; McCarthy & Zald, 1977). However, the movement has sparked significant controversy, with some stakeholders labelling it a "rebellion of the privileged" (Zeit, 2020), portraying it as a homogenous, elitist group reflecting a narrow societal perspective (Focus, 2021). Such critiques underscore not only internal tensions within the movement but also broader societal disputes about climate change. As the effects of climate change grow increasingly urgent, FFF has positioned itself as a legitimate force in the fight for environmental justice, achieving great political success and global recognition (Tagesschau, 2023). Yet, it also stands at the center of public debate, with some viewing its disruptive tactics as necessary and others perceiving them as destabilizing to political and social norms (Focus, 2021). This tension is exacerbated by a growing dissonance within the movement itself, where peaceful demonstrations associated with FFF are contrasted against more radical actions, further contributing to societal divisions (NDR, 2022). The coexistence of these approaches not only highlights internal contradictions but also mirrors larger societal splits regarding how to address climate change.

FFF transcends national and jurisdictional borders, with at least one FFF-related event taking place in every United Nations member state. For the purposes of this study, the empirical

Table 1: Summary of the observation data

Event	Number of units	Field notes	Cities
Team meetings	12 / 35h	30	Greifswald, Berlin, Dortmund, Freiburg
Council meetings	4 / 15h	8	Greifswald, Berlin
Demonstrations	24 / 57h	29	Greifswald, Berlin, Köln, Dortmund, Freiburg, München
Other events	14 / 32h	18	Greifswald, Berlin, Dortmund, Freiburg, München
Digital meetings & lecture	5 / 5h	5	FFF Germany
Total	**59 / 144h**	**90**	

Table 2: Summary of the netnography data

Medium	Number of units	Pages A4 PDF
WhatsApp	2 chats	20
Telegram	10 chats	29,218
YouTube	349 videos/ 60,5h	2,188
Instagram	5,422 posts	4,994
Twitter	3,576 twitter media	2,314
Total	**9,359 chats/videos/posts**	**38,734**

analysis focuses on Germany, which hosts the highest number of FFF-related events in Europe and the second highest worldwide, following the United States. As of now, FFF Germany consists of 679 local groups and 27 national working groups, all of which are digitally interconnected.

3.1 Data collection

We approached the field with the broad aim of understanding ICT mechanisms and the digital infrastructure, analyzing the national landscape of FFF Germany. Following an initial national assessment, we selected a small number of local cases for deeper investigation, balancing simplicity with the need for systematic comparison.

To familiarize ourselves with the selected cases, we began by collecting publicly available data as our first step. This included 40 newspaper articles (137 pages), 95 FFF Wiki articles (545 pages), 12 FFF Pads (FFF protocols; 78 pages), and 14 structural papers (legislative documents; 239 pages).

In the second step, during late 2019, we joined publicly accessible WhatsApp and Telegram groups across Germany. Simultaneously, we observed FFF groups in which publicly available data indicated the greatest significance. This focus on significance allowed us to narrow the cases for further scrutiny, based on three factors: the emergence of early local FFF groups, great structural influence on both the local and national FFF bodies, and unique caesuras, such as creative ICT usage, specific challenges, or local group terminations.

The first factor highlights local groups that initiated early FFF-related actions, such as in the northern cities of Bad Segeberg, Greifswald, and Kiel. The second factor emphasizes influential German cities, including Berlin, Köln, München, and Dortmund, which significantly shaped national organizing structures. The third factor identifies unique cases with distinct characteristics, as seen in Gelsenkirchen, Freiburg, and Dresden.

At least one city from each factor was visited, resulting in 144 hours of observations and 90 pages of field notes. Table 1 presents an overview of the observational data.

Despite adhering to traditional qualitative triangulation methods, this study focuses on a novel tool for data collection and analysis: netnography, also referred to as "new social media research" (Kozinets, 2015, p. 3). This method serves as a key tool for acquiring data related to digital communication exchanges, practices, and interaction styles (Kozinets, 2015). It is particularly well-suited for the complex and

Table 3: Summary of the formal interview data

Region	FFF member	Function	Minutes of interview	Pages A4 PDF
Bad Segeberg	LA	Main-organizer	33:30	13
	LT	Main-organizer	48:00	19
Köln	MZ	Organizer	24:55	12
	FA	Delegate	34:45	16
	TS	Member	35:25	15
	AX	Admin	29:55	14
Kiel	NO	Member	25:21	13
	EE	Main-organizer	39:22	18
	VT	Co-founder	39:00	18
Greifswald	FN	Main-organizer	35:44	18
	FE	Main-organizer	43:23	21
	SN	Organizer	27:43	10
Dortmund	JS	Organizer	40:31	17
	AX	Admin	62:29	23
	LA	Admin	43:57	19
	ME	Admin	36:04	19
	TE	Main-organizer	61:35	36
Berlin	LH	Organizer	26:04	13
	MN	Founder Bot WG	56:37	18
	JS	Admin	43:54	17
	PO	Admin	32:51	16
Freiburg	LA	Admin	47:32	27
	TL	Founder	33:00	20
	HN	Main-organizer	29:03	24
Gelsenkirchen	LE	Admin	29:15	19
Dresden	MN	Admin	31:02	15
	CA	Founder	43:26	22
München	FA	Organizer	40:15	17
	TA	Admin	49:20	25
No local group	AY	Founder FFF App WG	51:32	29
Total	**30**	**7**	**1175:30**	**563**

dynamic case of FFF, utilizing the "born in the Web" (Kozinets, 2015, p. 245) approach. Over a span of three years (from December 2018 to November 2021), 38,734 pages of digital data have been gathered. This data was sourced from various social media and digital platforms, including Telegram, WhatsApp, Twitter, Instagram, and YouTube, representing a scale of data collection and analysis "that would have been unimaginable just a few years ago" (Garrett et al., 2012, p. 223). Table 2 provides an overview of the netnography data.

The final stage of our research involves conducting semi-structured interviews with various key participants. These interviews include founding members of local or national groups, main organizers (integral to every event), organizers (members of the core team), administrators or admins (responsible for monitoring platform communication), delegates (representing local groups at the national level), spokespersons of working groups (WGs), regular members (those who participate in meetings and events), and demonstrators (those who participate occasionally or at least once). Each role brings its own unique challenges and perspectives regarding the implementation of ICTs. In total, we conducted 30 formal interviews, resulting in 582 pages of transcripts. Additionally, we conducted 28 informal interviews, which produced 28 pages of supplementary material. To protect the anonymity of participants, particularly given the sensitive political nature of our research, we refer to each participant using randomly selected initials when quoting them. Table 3 provides an overview of the interviewees, their roles, and the local groups they represent.

3.2 Data analysis

ICTs not only transform organizing structures but also necessitate changes in data collection methods and analytical techniques (Garrett et al., 2012). To comprehensively analyze this “moving target” (van de Donk et al., 2004, p. 2), we conduct data analysis in two cycles, resulting in a structural and a procedural view on the collective action within FFF.

In the first cycle of analysis, we focus on identifying and categorizing the digital spheres within FFF. This involves gathering a range of qualitative data from netnography, interviews, FFF legislative papers, and our own observations. By coding this data, we identify patterns of interaction, grouping them into digital spheres or “spaces—bounded social settings, characterized by social, physical, temporal, and symbolic boundaries” (Bucher & Langley, 2016, p. 594). Specifically, we analyze distinct modes of interaction that are set apart from other activities within the movement. This step entails a detailed examination of interactions across different digital platforms, which allows us to identify three digital spheres: national, local, and external.

In the second step of the first cycle, we explore the goals, problems, and approaches within each of these spheres. Our coding process here involves focusing on both the goals and the challenges members described during interviews, online discussions, and within FFF legislative papers. This iterative process of comparison across different data sources enables us to uncover interdependencies between the spheres, which culminate in what we describe as the digital orbit. This structural view presents how goals and challenges manifest and interact across the interconnected spheres, providing a foundational understanding of the movement’s configuration. Table 4 provides our data structure and empirical evidence. In the second cycle of analysis, we shift our focus to uncover the specific coordination mechanisms within each digital sphere. Through this analysis, we identify that FFF’s digital coordination mechanisms operate in two complementary modes: an inclusive mode that encourages open participation and an exclusive mode that restricts access. Netnographic data from social media channels highlights expansive inclusive actions (e.g., mass tweets), while simultaneously enforcing restrictive rules on what information could be shared online. Additionally, FFF maintains both open and restricted or closed chats on various messaging platforms. Even physical meetings exhibited open and closed dynamics, with general invitations for local meetings but limited accessibility based on designated roles.

Data from netnography, interviews, FFF legislative papers, and our observations underscore the integration of open and closed mechanisms across all FFF spheres. The inclusive modes of ICTs are directed toward achieving the sphere-specific goals identified in the first data analysis cycle, such as fostering open (digital) participation. Conversely, exclusive modes of ICTs aim to address challenges, such as restricting access and editing rights.

We identify three distinct criteria that characterize the interplay between inclusive and exclusive modes within each sphere (see Tables 5, 6, and 7 for our data structure and empirical evidence):

Table 4: Data structure and empirical evidence for the structural perspective

Data examples from archival data, netnography, and interview data	First-order codes	Second-order codes	Aggregated dimension
• "[Protesters on] all […] accounts: snapchat, YouTube, Instagram, Twitter, Facebook […]" [Freiburg chat log]	Members	External sphere	Digital orbit of collective action
• "[…] aiming at external communication" [TE, admin Dortmund]	Goals		
• "We would like to increase our reach on social media […] to reach even more people" [Freiburg chat log]			
• "Transmitting the image and an impression of what we're doing" [LA, main-organizer Bad Segeberg]			
• "[…] flooding the network to draw attention" [Dresden chat log]			
• "Again and again […] groups were raided" [AX, admin Köln]	Problems		
• "Similar group like parties […] hijack FFF and are possibly dangerous and harmful" [FFF Germany chat log]			
• "[…] within the first few days to the fact that it was completely hijacked by some idiots. Those then posted agitation, and that meant we had to fight back […] in a tough fight" [CA, main-organizer Dresden]			
• "[Members] responsible for funding, register demonstrations, post on social media, print flyers" [EE, organizer Kiel]	Members	Local sphere	
• "[…] maximal information access" [FFF Germany chat log]	Goals		
• "[…] there we receive information and decide how to participate, depending on the current topic" [TA, admin München]			
• "[…] regarding the information access […] we try to enact as much transparency as possible" [FA, organizer München]			
• "In order to plan we dissolved an orga-group which has become quite unproductive […] In order to get into the group, contact me or come to our meetings: you should be willing to put more effort and work [when joining]" [Berlin chat log]	Problems		
• "The problem is […] 10 people mainly organize and most of us just participate in co-organization" [LA, admin Freiburg]			
• "hundreds storming into the group and that of course extremely overwhelmed" [MN, admin Dresden]			
• "Conference of Delegates [CoD], Conference of Working Groups [CoWG], Communication Task Force [CTF]" [FFF website]	Members	National sphere	
• "We still want more structure […] and urge our fellow campaigners to leave WhatsApp" [Köln chat log]	Goals		
• "There […] one group with all the links to all telegram groups" [Berlin chat log]			
• "It is super important that every local group fills out the Pad! […] to help in the nationwide orga-group" [Köln chat log]			
• "[…] in order to start working one needs to be legitimized" [FA, organizer München]	Problems		
• "You need legitimation for almost everything" [TL, founder Freiburg]			

Table 5: Data structure and empirical evidence for the procedural perspective – External sphere

Data examples from archival data, netnography, and interview data	First-order codes	Second-order codes	Aggregated dimension
• "[…] large distribution is extremely important for a movement like Fridays for Future" [Berlin chat log] • "[…] common social media platforms such as YouTube, Instagram, Twitter, Facebook" [FA, organizer München] • "Instagram and Twitter mostly […] during corona we used more YoutTube" [AX, admin Köln]	Reaching out all people	Inclusive dynamics	Attitudinal criterion in external sphere
• "Tweetstorms from 12 p.m." [Dresden chat log] • "Please ensure […] to really hype up on social media" [Berlin chat log]	Creating hype		
• "[…] when we plan an event we announce it on Instagram, Twitter, and Facebook" [FA, organizer Köln] • "Twitter is an important thing politically […] Instagram is solely for advertising" [FE, main-organizer Greifswald] • "[…] Facebook and Instagram regarding external communication" [SN, organizer Greifswald]	Utilizing every social media outlet for specific functionality		
• "We […] have worked out an extensive netiquette as a consequence of the trolling and spam attacks of the last few weeks. […] we will act according to the rules laid down from now on" [Berlin chat log] • "Problems with [political party], we had rules that no party shall show their flag, they showed it anyways" [TL, founder Freiburg] • "rules were violated […]" [Berlin chat log]	Executing behavioural rules from national level	Exclusive dynamics	
• "Please spread the above two-part message through all channels (internal concerns of the movement) in all […] groups and e-mail distribution lists, but if possible not yet via Twitter, Facebook etc." [Berlin chat log] • "There was a recommendation from the national level that we should avoid plenary meetings for now, because shortly after, the lockdown was announced" [AX, admin Dortmund]	Recommending do's and don't's		

Table 6: Data structure and empirical evidence for the procedural perspective – Local sphere

Data examples from archival data, netnography, and interview data	First-order codes	Second-order codes	Aggregated dimension
• "WhatsApp and Telegram are used as information channels" [FE, main-organizer Greifswald] • "[…] theoretically, information should be presented objectively" [AY, founder app WG] • "[…] there, information was provided […] and I could get in touch with other people" [TA, admin München]	Providing information	Inclusive dynamics	Attributable criterion in local sphere
• "That is the creation of communication channels" [AY, founder app WG] • "Slowly, the interactions become productive […] thanks to open source" [National level chat log] • "[…] so that the communication among each other runs smoothly" [AX, admin Köln] • "[…] with many hands a lot of communication to elaborate expertise collectively" [EE, organizer Kiel]	Enabling communication		
• "We have split the main group into: general discussion, mobility, nutrition, energy, package, communication, social question, society, politics, other" [FFF Germany chat log] • "We should pay attention to the discussions […] lead to anything productive or end up in hot air" [FFF Germany chat log] • "[…] I think *here* we should limit ourselves to organizational matters and questions among *us*" [Berlin chat log]	Splitting communication channels according to group specific topics	Exclusive dynamics	
• "[…] admin rights or passwords […] even the account could be stolen" [MN, founder messenger WG] • "[…] to become admin, one need to come to our plenaries, become part of the local group" [CA, main-organizer Dresden]	Requirement of proving trustworthiness		
• "Don't waste your time with this […] Simply inform the admins […] via PM and wait" [FFF Germany chat log] • "Botcreator: the bot bans people automatically, which is saved on an external databank […] 200 messages per second can be used as a filter criterion" [FFF Germany chat log]	Administrators & FFF bots banning unproductive members		

Table 7: Data structure and empirical evidence for the procedural perspective – National sphere

Data examples from archival data, netnography, and interview data	First-order codes	Second-order codes	Aggregated dimension
• "Using Slack, we have all our people on a single server, thus Slack is solely used for organization purposes, the organization team internally, externally we don't use Slack at all" [FA, organizer München] • "Without that FFF Köln would be impossible, that is a pad generator of FFF, a file […] many people can write at the same time" [FA, organizer Köln] • "During the conference it is important to have access to the Pad. […] That's the only way to have your say at the conference" [Berlin chat log]	Centralizing coordination	Inclusive dynamics	Functional criterion in national sphere
• "We examine the information we need, we are legitimized to do so" [JS, admin Berlin] • "Nationwide, everything actually takes place via conference calls […] with all representatives from all LGs" [CA, main-organizer Dresden] • "Online votes, simply a link forwarded to every one else" [EE, organizer Kiel]	Overall inspection rights		
• "There is no possibility that an unauthorized person can do things on their own" [JS, admin Berlin] • "[…] People responsible for social media are entitled to manage within their scope of action [solely] regarding social media" [AX, admin Dortmund]	Defining structuring rights according to scope of action/function	Exclusive dynamics	
• "The WGs, in order to start working, are legitimized through our plenary" [FA, organizer München] • "We [social media WG] are legitimized to be in the Twitter position and of course it can happen any time that we are no longer legitimized […]" [AX, admin Köln] • "WGs and […] TFs on the national level have a scope of action, which has to be legitimized. In this scope of action, they are entitled to work autonomously, such as financial groups regarding finances […]" [AX, admin Dortmund] • "That's how the CoWG [national organ] emerged, through legitimized WGs" [VT, co-founder Kiel] • "Within WGs no documents are deleted, such basic rules and codes of conduct are technically defined […] Thus, people get together as a WG on the national level and have to have their structural process legitimized" [AY, founder App WG]	Legitimizing structuring rights & scope of action		

- **Attitudinal criterion in the external sphere**: FFF engages the public through various social media platforms. However, only individuals who conform to FFF's values, rules, or guidelines are allowed to officially participate.
- **Attributable criterion in the local sphere**: All local groups can officially participate in FFF events, but FFF limits information to productive members only.
- **Functional criterion in the national sphere**: National-level actors have access to sensitive nationwide information, but only those with legitimate authority are granted editing or structuring rights.

The dominant digital mechanism in the external sphere is the use of social media, which functions in two complementary ways: attracting as much attention as possible (inclusive mode) while simultaneously distancing itself from non-conforming individuals based on FFF culture and rules (exclusive mode). In line with this attitudinal criterion, FFF formally incorporates new members by including them in statistics, reports, and official FFF social media accounts. This represents the first and outermost layer of the digital orbit required for membership.

In the local sphere, the dominant digital mechanism is messaging platforms, which are divided into open channels—providing short-term information accessible to anyone (inclusive mode)—and restricted channels—providing long-term

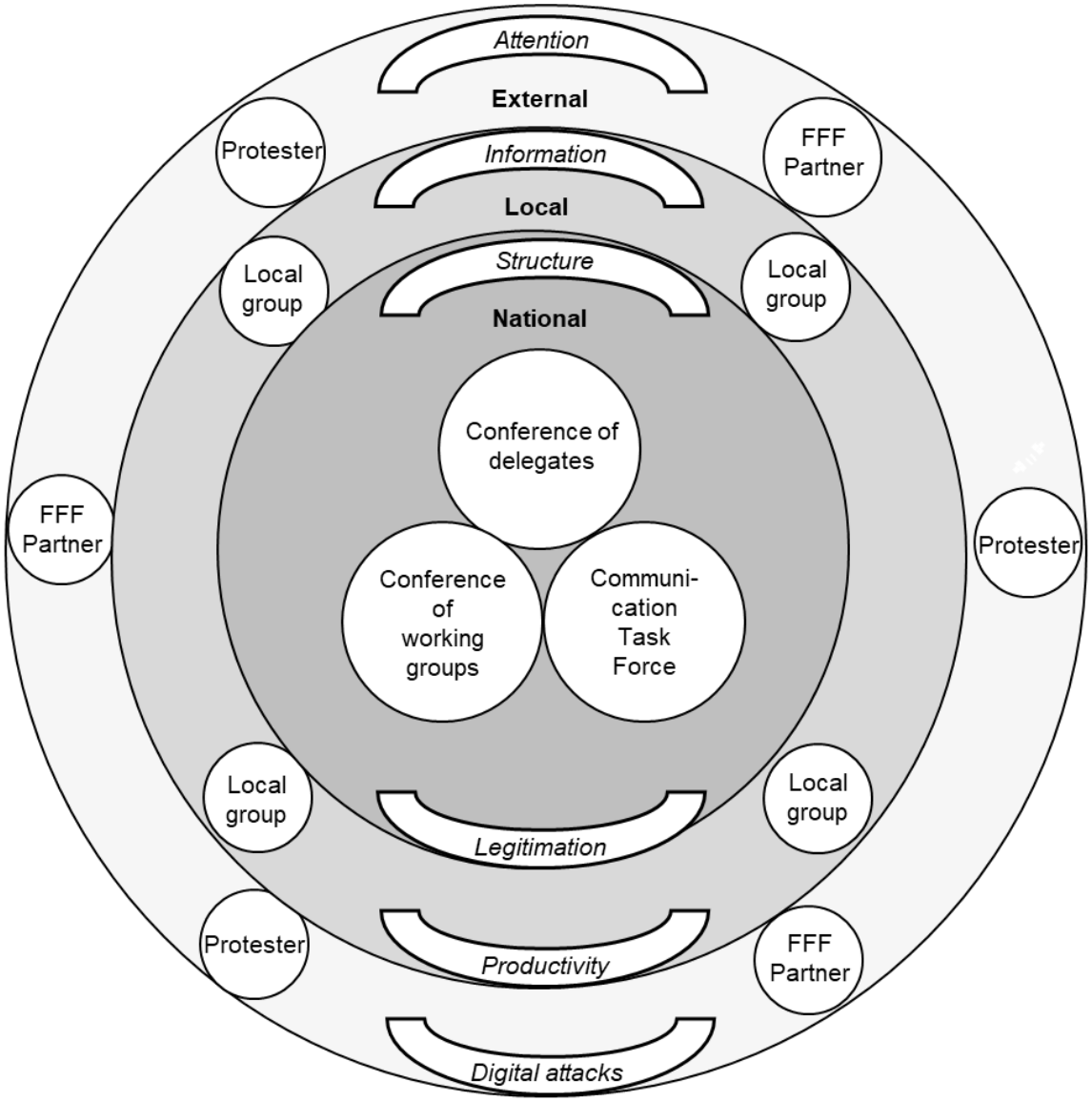

Figure 1: Structural perspective on the digital orbit of collective action

information reserved for selected, productive members (exclusive mode). This attributable criterion grants FFF-associated members further access to sensitive information, but only after they have demonstrated trustworthiness and productivity. This forms the second, middle layer of the digital orbit, following the fulfillment of the first, attitudinal criterion.

The final dominant digital mechanism of the most protected and restricted sphere, the national sphere, is the FFF digital infrastructure. Actors of this innermost sphere must be elected at the local level. The digital infrastructure offers access to a central digital repository where most information, FFF legislative processes, and rules are available to all national actors (inclusive mode), while also defining branching digital groups with varying levels of editability rights (exclusive mode). This functional criterion permits each actor to view all centralized information but restricts their ability to edit. This constitutes the last and innermost criterion of the digital orbit, with the prior fulfillment of the attitudinal and attributable criteria.

In summary, the first data analysis cycle provides a structural view of the FFF movement, outlining distinctive goals and problems across the spheres. The ICT inclusive modes focus on achieving sphere-specific goals, while exclusive modes address sphere-specific challenges. The second cycle of data analysis offers a procedural perspective, revealing the interplay of inclusive and exclusive ICT modes and distinct coordinative criteria, highlighting the paradoxical nature of governing and organizing mechanisms.

4 Results

We categorize three digital spheres that collectively form a digital orbit of collective action. Each sphere consists of members, goals, and problems, which together depict its *position* within the digital orbit of FFF from a structural viewpoint. Building on this position, we derive inclusive and exclusive modes as a second step. Inclusive ICT modes aim at the sphere-specific goals, while exclusive modes seek to solve sphere-specific problems, depicting the *dynamics* of the digital orbit from a procedural viewpoint. Participation in the outer spheres is a prerequisite for access to the inner ones. In this way, the spheres build upon one another. Thus, access to the innermost national sphere requires meeting both the attributable criterion from the local sphere and the attitudinal criterion from the external sphere. Figure 1 provides an overview of the structural digital orbit.

4.1 External sphere

4.1.1 Position in the digital orbit

The FFF movement refers to the outermost sphere as “external” [TE, admin Dortmund] or extra-organizational sphere. This sphere is the FFF movement in the broad sense and contains no sensitive or critical information.

Entrants of the external sphere are interested *protesters* and *FFF partners* who are mobilized for certain events.

The *goal* within this digital sphere is to “*reach the most people*” [SN, organizer Greifswald], via “networking within alliances” [FA, organizer Köln].

Problems arise when hostile entrants within this sphere *attack*, infiltrate, hijack, and propagate their own, mostly highly politicizing, agenda, resulting in the outcry:

“There were problems with hostilities […]. We do not want any political flags” [FA, organizer München]!

Although neither critical structural (as found in the national sphere) nor personal information (as shared in the local sphere) is disseminated within the external sphere, the FFF movement still called for protection, this time concerning the reputation because “groups were hijacked” [AX, admin Köln] and “FFF was attempted to be defamed” [AX, admin Dortmund]:

“We need to consider that FFF demonstrations have a really good reputation, a reputation so parents likely let their children join” [national level chat].

Strict rules in the otherwise open external sphere arose from an incident in 2019 when first safety mechanisms and digital infrastructures emerged. Intruders belonging to an extremist political party managed to pass through the external into the local sphere, wreaking havoc along the intrusion and being responsible for the dissolvement of a local group in Gelsenkirchen.

Hostile political members participated in group activities and acquired an increasing number of members with similar ideologies, which resulted in:

“A three-quarters majority, initiating a new delegate election and only putting their people into office” [AX, admin Dortmund].

Hostile political actors exploited the digital platforms of FFF Gelsenkirchen to install sympathizers into positions of authority, such as admin

roles. These new admins were then able to exclude members, who did not align with their views, from the official FFF Gelsenkirchen group. This takeover resulted in the "delegitimization at the federal level and founding anew" [AX, admin Dortmund]. Consequently, the original FFF Gelsenkirchen group was officially delegitimized, and a new group had to be formed, leading to "two local groups in Gelsenkirchen, one consisting of [hostiles] and the other of 'decent people'" [LE, admin Gelsenkirchen]. Following incidents of bot attacks, spammers, and intrusions, FFF implemented the attitudinal criterion in the external sphere to disassociate from non-conforming members. This led to the exclusion of members not only from physical meetings, plenaries, and demonstrations but also from any FFF-related digital groups or channels to safeguard the movement's reputation.

4.1.2 Attitudinal dynamics in the external sphere

The *inclusive mode* of this digital sphere "aims at external communication" [TE, admin Dortmund], achieving the *goal of reaching the most people*:

"Social media is used for public representation such as YouTube, Facebook, and Twitter" [LH, organizer Berlin].

FFF achieves immense media attention via "hashtags to flood social media" [Berlin chat]:

"We have an Instagram account, so we can reach most of the others […]. And also a Facebook account to, yes, mostly reach older people" [VT, co-founder Kiel].

"Twitter and Instagram to advertise demonstrations" [FE, main-organizer Greifswald].

FFF uses social media outlets specifically to target potential new members, "having various functions which are fulfilled by certain accounts" [LT, main-organizer Berlin], such as "tweetstorms" [Berlin chat], and "a livestream on Instagram" [Freiburg chat], figuring out that "Instagram and Facebook algorithms support posts significantly more […] when networked together" [Freiburg chat].

The *exclusive mode* grapples with the *problem of digital attacks* and emphasizes value-driven ground rules, legislated in the national sphere, with published recommendations such as do's and dont's:

"What is this group for? You can: Ask questions and answer them […] you should not: Share faces, names, or personal data; insider or scene-specific information" [Köln chat].

These rules educate entrants in cautious behavior such as "not to share the link via social media […] only doing that with information groups so that bots do not bother" [Dortmund chat] and warn them about imminent attacks and distress:

"Attention: Currently many botnets are joining FFF groups" [Köln chat]!

Entrants who disregard FFF rules are digitally disassociated. Digital disassociation occurs in the form of excluding people from digital occasions, such as digital protests, deleting comments on public outlets, and blocking accounts on social media:

"We do not want anything to do with them" [FE, main-organizer Greifswald].

The interplay of dynamics of the external sphere describes the outermost criterion upon which inclusive and exclusive modes interfere, that is, the attitudinal criterion. FFF reaches entrants through multiple social media outlets, a "tool of mobilization" [FA, organizer Köln]. However, FFF limits association, and therefore official participation, according to the attitudinal criterion, hence conforming with FFF values. FFF disassociates with non-conforming entrants, mostly "conspiracy theorists or right-winged people" [MZ, organizer Köln]:

"They have repeatedly failed to comply" [FA, organizer München].

"We clearly distance from them" [LA, admin Dortmund].

The more new entrants align with FFF values and rules, the more events they are invited to, and the greater their ability to participate, marking the *fight for FFF association* in this external sphere.

4.2 Local sphere

4.2.1 Position in the digital orbit

We describe the *local sphere* as the *conglomeration of all local groups*, thus every city, district, or county with a "FFF" prefix, such as FFF Köln or FFF Berlin. This sphere contains important information about local organizers, elections, results on votes, protocols, and meetings.

The *goal* of this digital sphere is to *distribute sufficient information* and encourage members to introduce new ideas. This is particularly expressed in the "wish for a prolific discussion

culture" [national level chat]. FFF local members seek "faster publication of information" [TE, admin Dortmund], because "that is the only way to work productively" [Berlin chat]. This sphere is characterized by searching for productive members who can manage and distribute vast amounts of information.

Problems arise when idle or *unproductive* members join and slow down the processes. Many local groups are concerned about productivity because only "three people know what they do and the rest just slacks around" [FN, main-organizer Greifswald]. Unproductivity is a main reason for frustration at the local level with a call "to not let such [slacking] people paralyze the discussions that are very necessary" and openly asking "why do I only need one or two provocateurs to 'de-rail' the whole forum" [national level chat]?

Local members must at least meet the attitudinal criterion from the external sphere (aligning with FFF values) to join open groups. Entrants from the external sphere have minimal access to information about local organizers or procedures. Additionally, more critical local information is shared only with selected individuals who have demonstrated productivity and trustworthiness through access to restricted local groups:

"At least visit two plenaries to get into a local group" [MZ, organizer Köln].

"Truly interested participants are invited to a real discussion group" [JS, admin Berlin].

4.2.2 Attributable dynamics in the local sphere

The inclusive dynamics of the local sphere focus on achieving the *goal of distributing relevant information* through a diverse range of *messengers*, such as WhatsApp, which serves as a rapid and "very spontaneous" [LA, admin Dortmund] communication tool:

"Playing a big part in the beginning of FFF […] actually it contributed heavily to [first] steps of mobilization" [LA, admin Dortmund].

Signal is considered an essential and secure messenger, "basically the secret working medium" [LA, admin Dortmund]. Other messengers, such as Telegram, are used "for everything involving long-term" [AX, admin Dortmund], "allies and WGs" [FA, organizer Köln].

Open channels, which are programmed to provide short-term goal-oriented information, are mostly "as low a threshold as possible" [AX, admin Köln]. They are accessible to any FFF conforming member with the information displayed to anybody who joins:

"Can you, on the one hand, switch the group to public, and on the other make the chat history visible to new members" [Kiel chat]?

Such open channels, as in WhatsApp, Signal, or Telegram, are free to join, and entrants have certain rights regarding posting texts, pictures, or links, participating in dialogue and discussions.

Exclusive dynamics seek to solve the *problem of increasing unproductivity*. They are characterized as closed for non-organizing members or "groups where no one, except for admins, is able to message" [MZ, organizer Köln]. These restricted groups, such as core-organizational groups or the local WGs, limit information to protect themselves from unproductive or disruptive members:

"A safety mechanism […] to establish closed groups" [FA, organizer München].

"Establish an entry group where they are filtered out" [FN, main-organizer Greifswald].

Even open WhatsApp, Signal, and Telegram channels incorporate exclusive mechanisms primarily from admin interventions, when participants stray from productive discussions to meaningless distractions:

"This is not a platform for exchange but an organizational [tool]" [Köln chat].

"Kick people who are constantly discussing trivial things that do not bring any progress" [national level chat].

Admins reacted to the call for more organized online groups:

"After a few more people expressed their dissatisfaction with the information content of the chat, I ask […] to delete discussion posts and to mute/ban repeat offenders" [FFF Germany chat].

However, as time went on, the call for "more structured, clearer, and therefore more effective" [FFF Germany chat] chats became louder and "all areas became dependent on digital helpers" [Köln chat]:

"Inform admins of the discussion group to kick people out when they are spamming, trolling, discriminating… If required promote more admins for discussion groups" [Berlin chat].

"Actually we have a nationwide ban list […] where banned people trying to join a group are kicked immediately" [JS, admin Berlin].

More information rights are given according to the attributable criterion, thus proving productivity. Interested entrants are "solely publicly invited to our plenaries, but access to our closed groups is gained when attending the plenary session, which emerged from a necessity," [FA, organizer München] or as MN, founder messenger WG, clarifies:

"Messenger is always a sensitive issue at FFF. But actually, if everyone can just come in, it quickly becomes unproductive."

The interplay of dynamics depicts the ability of every local member to participate in events, discussions, and various online groups within various messengers (given that the attitudinal criterion from the external sphere is fulfilled). However, local groups restrict this information based on the attributable criterion. As a result, unproductive members receive less or restricted information due to the division between closed and open groups:

"In our local group, there are 5 closed and 5 open groups with 200 entrants each" [CA, main-organizer Dresden].

Local groups further restrict information by banning and kicking people from groups through admin interventions when unproductivity is perceived to be high:

"That is what the admins are for, to enable a prolific discussion" [national level chat].

By December 2020, within one year, FFF groups had reported 15,617 admin notifications, of which 2,996 led to admin commands (i.e., warnings, kicks, or bans). These interventions were centrally recorded and communicated to 179 online groups and 218 admins for updates [Köln chat]. The division into two channels and extensive admin interventions protect online groups from unproductive disruptions. Consequently, only productive members receive further information about events, results, and local processes. Most local groups require new members to undergo a "fight for trust" [CA, main-organizer Dresden], with these members then vying for information rights. The more productive a member is perceived to be, the more information is distributed to them.

4.3 National sphere

4.3.1 Position in the digital orbit

Actors of the innermost sphere, *the national sphere*, consist of *FFF incumbents* from national platforms, depicting the hardest sphere for newcomers to enter. This sphere contains the most sensitive structural data. FFF office-holders and representatives interact as official national incumbents. FFF incumbents, platforms, and structures are documented in the official FFF legislation (so-called "StruPa"):

"Every local group is independent and self-administered […] and determines their own delegates. […] The conference of the delegates (CoD) is a central interface for the exchange between the local group and the national level […] The communication task force (CTF) organizes internal communication […] Every WG has to define its own competencies, which in turn has to be approved by the CoD […] The conference of working groups (CoWG) is a collective mouthpiece of the WGs. Its tasks involve […] the control of CTF members" [StruPa v.1.0].

The *goal* is *to establish a* "very centralized" [FFF Germany chat] *coordinative organ*, with the aim of "having everything at one place" [LA, admin Dortmund]. Each actor within this sphere has an equal right to view sensitive information, but only after conforming to FFF values in the external sphere, proving productivity in the local sphere, and being elected in the national sphere. FFF documents their final results and key excerpts in legislative papers, outlining FFF norms and rules such as "public lists with all WGs, delegates, and local groups" (StruPa v.0.9), the frequency of actors required to "give account and in-depth reports" (StruPa v.1.2), a communication tool to "provide a public telegram channel" (StruPa v.1.5), and the shared belief that "all members are treated equally and […] act basic democratically" (StruPa v.1.8). This sphere is characterized by the search for legitimized incumbents and establishes common rules for every other sphere.

Problems concern the *legitimation* of editability or structuring rights. Such critical rights are cautiously given for a defined scope of action:

"At the national level […] you always have a self-formulated scope of action that you have to legitimize" [AX, admin Dortmund].

„You had to write a legitimation paper […] to define the tasks and the scope of action […] and then the delegates vote" [MN, founder messenger WG].

National actors need to fulfill the criteria from the local sphere, thus the attributable criterion (i.e., productivity), and the external sphere, thus the attitudinal criterion (i.e., conforming to FFF values), to be considered for election as CA, main-organizer Dresden, describes:

"You need to be there for a certain amount of time and complete the tasks and move the group forward."

Members of the local sphere and entrants from the external sphere have no access to most sensitive processes without elected positions. Such sensitive processes involve digital contributions in the form of nationwide Pads, a tool to collectively and simultaneously work on a digital means, as FA, organizer Köln, ensures:

"There are no Pads in public groups because too many […] could (re-)write it" [FA, organizer Köln].

4.3.2 Functional dynamics in the national sphere

Inclusive dynamics within the national sphere pursue the *goal of a centralized coordinative digital infrastructure*. Many processes are transferred into one digital stream, allowing every national actor to view any procedure within the major ICTs:

"We needed to create a safe platform, which unites everything" [national level chat].

"Only the delegates have access to the nationwide Pads. They can pass on information there" [CA, main-organizer Dresden].

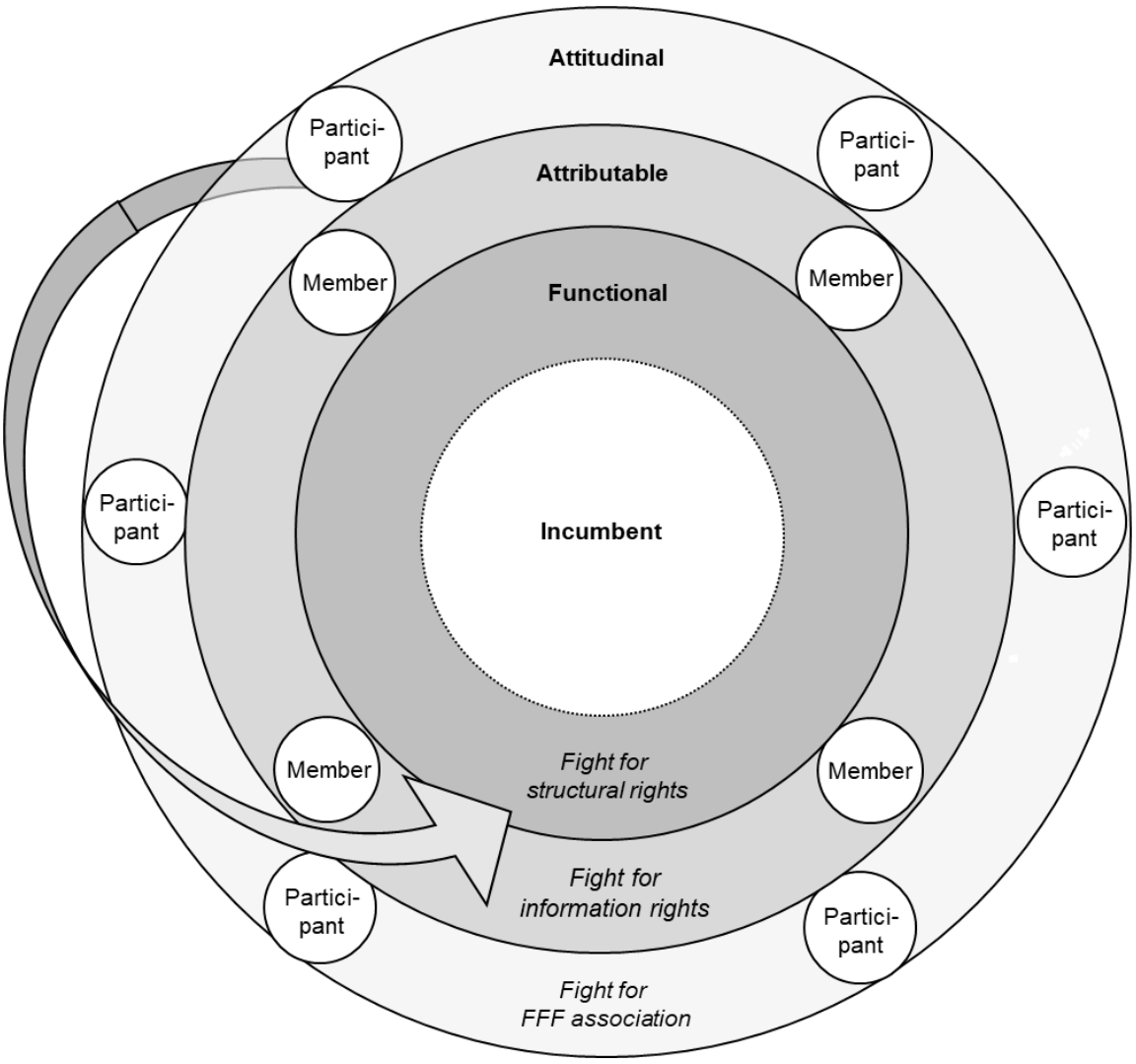

Figure 2: Procedural perspective on the digital orbit of collective action

Hence, Pads, a tailor-made open-source software, form an important coordinative digital tree trunk that "saves all the protocols" [CA, main-organizer Dresden] and merges many digital tasks and processes into one common outlet. This inclusive mode of inspecting all relevant data is further supported with programmed "FFF clients" [ME, admin Dortmund].

Exclusive dynamics address the *problem of legitimation* by limiting editability rights according to the function a national actor bears, as CA, main-organizer Dresden, explains:

"The Pads are often linked to one another via a great deal of nesting, which means there is a main Pad and many Sub-Pads and so on […] everything is branched out like a tree structure."

"You can find an overview of all important Pads in our Pad of the Pads" [FFF Wiki delegates].

The Interplay of dynamics describes every national actor's access to "the main Pad" [CA, main-organizer Dresden]. Only specific officeholders can edit restricted Sub-Pads, such as delegates and spokespersons. "Creating several groups" [LH, organizer Berlin] secures sensitive data and restricts editability to legitimated FFF officeholders only, marking the *fight for editability or structuring rights* in this national sphere.

5 Discussion

This paper begins with an open approach to analyzing the digital landscape of FFF Germany, a widespread grassroots movement addressing the grand challenge of climate action. Researchers have debated extensively the degree to which ICT influences collective processes and organizational structures. Research on ICT-supported organizations argues that ICT primarily promotes openness and accelerates existing forms of organization without fundamentally altering them (Bruns et al., 2013; McCarthy & Zald, 1977). However, scholars focusing on collective action and social movements highlight the need for new theoretical frameworks, as traditional approaches fail to capture the unique challenges and characteristics (Earl & Kimport, 2011; Earl et al., 2014a).

This study offers two perspectives on ICT-based social movements. First, from a structural viewpoint, ICT is utilized to expand the movement's scale and configure its structure, consistent with research on ICT-supported forms of organization (McCarthy & Zald, 1977; Bruns et al., 2013). Figure 1 illustrates this structural perspective. Second, from a procedural viewpoint, ICT fundamentally transforms organizing structures in a paradoxical way, aligning with research on ICT-based organizing forms (Earl et al., 2014a; Earl & Kimport, 2011). More recent studies have identified similar paradoxical dynamics in other ICT-based organizations (Dobusch et al., 2019; Massa & O'Mahony, 2021; Kozica et al., 2015). We draw on this conceptualization of paradoxical qualities to explain simultaneous open and closed modes and refer to them as inclusive and exclusive dynamics. These dynamics interact within each digital sphere, with each distinct sphere building upon the other. Figure 2 depicts the procedural viewpoint, showing how the movement progresses from the outer spheres toward the inner ones.

5.1 Describing the configuration process: A structural perspective on digital spheres

5.1.1 Implications for research on social movement structures

The findings of this study identify three spheres, which are defined as bounded digital spaces where interaction modes are distinct from other activities (Bucher & Langley, 2016). Together, these spheres form a digital orbital model that represents the digital structure of FFF Germany (see Figure 1). This structure highlights the organizational features of ICT-based social movements, including digital hierarchies and clearly defined goals. Digital mechanisms and tools, therefore, serve to configure and scale the movement (McCarthy & Zald, 1977; Bruns et al., 2013). As a result, FFF leverages ICT as a tool to establish its digital structure in a configurative way. This structural perspective on ICT-based social movements aligns with existing research on ICT-supported forms, where ICT impacts are seen as instrumental rather than transformative (McCarthy & Zald, 1977).

In each digital sphere, members focus on specific goals and challenges, employing tailored mechanisms to address them. The external sphere (protesters) gathers maximum attention; the local sphere (local groups) manages information distribution; and the national sphere (national organs) legislates to establish an organizational structure. Each sphere has a unique goal (attention, information distribution, and structure) and faces distinct problems (digital attacks, productivity, and legitimation), which FFF members tackle in different ways. To better understand ICT-based social movements, we examine both the organizational and structural elements (Earl et al., 2014b). The ICT infrastructure of FFF Germany demonstrates how these digital spheres interact with one another. We

refer to this structure as the digital orbit of collective action (see Figure 1).

5.1.2 Implications for research on digital mechanisms in social movements

This study also advances the understanding of digital mechanisms in social movements, highlighting the opportunities, challenges, and specific uses of various digital tools within legal boundaries. These include media channels (Bennett, 2003), viral campaigns, and flash activism (Earl et al., 2014b), while avoiding illegal activities like hacktivism (Earl et al., 2014a; Massa & O'Mahony, 2021). FFF encounters similar issues, affirming the theoretical basis of ICT-induced limitations. Many digital connections are weak, leading to a decline in support or engagement (van Laer & van Aelst, 2013). The problem of "endless meetings" (Massa & O'Mahony, 2021, p. 2) also appears in digital formats, hindering the movement's progress. A digital arms race emerged as opponents used botnets to infiltrate and disrupt FFF processes and discussions (Garrett, 2006), prompting the movement to defend itself. While these challenges test collective efforts, ICTs also offer solutions. The external sphere specifically addresses declining support (van Laer & van Aelst, 2013) by maximizing (social media) attention (Fahmy & Ibrahim, 2021). FFF tackles unproductivity through distinct communication methods and groups (Earl et al., 2014a), combined with extensive admin interventions. It also counters hostile botnets and spambots (Garrett, 2006) with custom programs and tools across various digital channels. Thus, each digital sphere employs ICTs as an organizing tool to address specific goals and challenges.

Finally, the structural perspective of the digital orbit illustrates how FFF establishes digital structures and configurations. In the early stages, this reflects an instrumental use of ICT, aligning with studies that suggest non-transformative ICT effects (McCarthy & Zald, 1977; Bruns et al., 2013). The configuration process unfolded in three phases:

First, the movement initially grew through social media interactions, aiming to attract as many people as possible. As new members joined and formed online groups, the second phase involved FFF overseeing and segmenting messengers and online chats to identify productive and trustworthy members. In the third and final phase, FFF centralized information from all groups into a unified infrastructure, establishing a national coordinating body (see Figure 1).

5.2 Describing the participation process: A procedural perspective on digital spheres

5.2.1 Implications for research on movement participation

In contrast to the structural perspective, which views ICT as instrumental, the procedural perspective reveals its transformative nature (Earl et al., 2014a). While the structural view illustrates the configuration of an ICT-based social movement and serves as the foundation for further analysis (see Figure 1), the procedural view highlights the ambiguous and transformative processes that occur beyond this configuration, balancing the internal tensions (Earl & Kimport, 2011; Bennett, 2003; Schreyögg & Sydow, 2010). Paradoxical processes in the innermost sphere depend heavily on open-source software (Dobusch & Schoeneborn, 2015), contrasting with the outermost sphere, which primarily relies on social media (Fahmy & Ibrahim, 2021). We identify and describe these paradoxical processes as inclusive and exclusive dynamics, drawing on the conceptualization of open and closed qualities from other digital organizing forms (Lewis & Smith, 2022). We begin by discussing the shared characteristics of inclusive dynamics, i.e., open qualities, before addressing the exclusive dynamics, i.e., closed qualities.

The open qualities of Wikimedia are evident in its shared technological platform, which uses transparent digital protocols and wiki technology for online collaboration (Kozica et al., 2015; Dobusch et al., 2019). This platform enables collaborative authoring, where changes and edits are visible and traceable by all members (Dobusch et al., 2019). Similarly, Anonymous develops an architecture based on participatory norms, where newcomers receive both cultural and practical information through open-source websites (Massa & O'Mahony, 2021; Dobusch & Schoeneborn, 2015). FFF's inclusive dynamics form a digital orbit with multiple spheres, where experienced members mentor and encourage newcomers, introducing them to various digital platforms. While Wikimedia employs Wiki protocols to support open qualities (Dobusch & Schoeneborn, 2015), Anonymous uses open forums and participatory events (Massa & O'Mahony, 2021). Similarly, FFF organizes open events and welcomes new members without requiring formal membership.

Similar to Wikimedia and Anonymous, potential FFF members must meet certain criteria, or *closed qualities*, to gain participatory rights within the ICT infrastructure. In Wikimedia, a

digital hierarchy exists where high-ranking members hold the most decision-making and participatory rights within established rules and regulations (Dobusch et al., 2019; Kozica et al., 2015). Anonymous creates a skill-testing system that distinguishes between interior and surface members, limiting access to critical processes and projects. This system secures sensitive data from irresponsible or unskilled members, while enabling expert members to focus on tasks without distraction (Massa & O'Mahony, 2021; Dobusch & Schoeneborn, 2015). FFF's exclusive dynamics similarly exclude unproductive or distrusted members, leaving only productive members to advance the movement. Just as Anonymous relies on veteran members (Massa & O'Mahony, 2021) and Wikimedia privileges its highest-ranking digital members (Dobusch et al., 2019; Kozica et al., 2015), FFF differentiates between surface members in the outermost sphere and higher-ranked members in the innermost sphere, granting rights accordingly.

5.2.2 Implications for research on the coordination of ICT-based social movements

This study also contributes to the analysis of coordination in ICT-based social movements. Exclusive dynamics emerged as a means to protect sensitive data and processes, with inner spheres being more secure than outer ones (Garrett, 2006). These exclusive dynamics help foster inclusive modes, allowing trustworthy and productive members to join and sustain the movement (van Laer & van Aelst, 2013). ICTs act as channels, directing productive newcomers inward and pushing unproductive or disruptive members outward (Massa & O'Mahony, 2021). Consequently, newcomers undergo a process of meeting specific criteria within each sphere (Dobusch et al., 2019).

This process begins in the external sphere with the *attitudinal criterion*, which involves conforming to FFF culture and rules to gain association. It continues in the local sphere with the *attributable criterion*, where individuals prove their productivity and gain trust to access further online platforms, groups, and information. The process culminates in the national sphere with the *functional criterion*, where individuals are elected and granted certain editability rights over structural data, as well as unrestricted inspection rights for all FFF data specified in legislation papers. These published legislative papers are binding across the movement, establishing FFF values and norms. New entrants from the external sphere are obligated to conform to these values and undergo the same participatory process (see Figure 2).

Within this orbital model, exclusive dynamics support inclusive dynamics, interacting across all spheres in various ways. The procedural view on the digital orbit outlines the FFF participation process, illustrating how people engage within set digital structures and how the ICT-based movement manages openness and closeness simultaneously. Particularly in the movement's later stages, this demonstrates the transformative effects of ICT and contributes to the call for new theorizing on ICT-based collectives (Earl & Kimport, 2011; Bennett, 2003; Earl et al., 2014a).

6 Limitations and Future Research

The social movement FFF portrays unique features and challenges, distinct from traditional organizations. FFF lacks classic characteristics such as clear membership conditions, which creates unique governance challenges and implications for ICT implementation. The key governing challenge we identify is the interplay of openness and closeness. While this study highlights the dynamics of open and closed mechanisms, we gather data from accessible and legal sources only. However, it is important to acknowledge that other social movements or collectives may enforce their convictions through illegal or hidden activities. FFF itself retains such confidential information, which points to an area where further analysis is needed.

Future research should not only continue to investigate the interplay between open and closed dynamics within social movements but also expand its methodological toolkit to access publicly inaccessible data. One effective approach to this challenge could be "going native" ethnography, where the researcher immerses themselves in the movement for an extended period to gain in-depth, firsthand understanding. While this study conducts interviews with core members, accesses internal documents, and employs netnography, the on-site research is limited in duration for each local group. Therefore, "going native" ethnography holds significant potential to uncover more informal and inaccessible data by embedding the researcher in one location for a longer period.

In addition, future studies could focus on understanding how social movements navigate paradoxes over time. For instance, research might delve deeper into how movements sustain or adjust their balance between openness and closeness as they grow, or as external pressures evolve. Longitudinal studies could track

the development of movements like FFF, revealing how digital and organizational structures transform as new challenges and opportunities emerge. Such studies could expand our understanding of how movements maintain their cohesion while managing the tensions inherent in collective action.

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