



A 'Musk effect' on Funkwhale? Growth Dynamics in a Fediverse Audio Streaming Platform

¿Un «efecto Musk» en Funkwhale? Dinámicas de crecimiento en una plataforma de streaming de audio del Fediverso

Alberto Quian, Xosé Soengas-Pérez
Universidade de Santiago de Compostela, España

KEYWORDS

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ABSTRACT

The Fediverse has emerged in response to structural patterns of abuse and power imbalances in centralized social platforms. Mastodon is the most popular federated project, but alternatives exist, such as Funkwhale in audio streaming—an open, decentralized alternative to Spotify. This study analyzes Funkwhale's evolution from 18 May 2022 to 18 May 2023, a period marked by Elon Musk's acquisition of Twitter (renamed X), impacting social ecosystems. We conducted a longitudinal descriptive analysis of aggregate data from the-federation.info using Z-tests, Pearson correlation, and the Herfindahl-Hirschman Index. Results indicate that Funkwhale represents a modest fraction of the ecosystem (~10,000 users, 145 nodes) compared to the Fediverse (~22,000 nodes, 12 million users), yet grew 42% in nodes and 39% in users, mainly after Musk's takeover on 27 October 2022. Growth correlates with Fediverse trends, with infrastructure growth more synchronized ($r^2=0.717$) than user adoption ($r^2=0.523$). Z-tests show significant growth acceleration post-November 2022 ($p<0.01$). Geographic analysis reveals moderate concentration ($HHI=0.1725$), European dominance, and presence in 20 countries. Despite Funkwhale's niche position as an audio-based platform, its growth patterns are consistent with a broader spillover associated with the so-called 'Musk effect,' suggesting an indirect reconfiguration of attention and participation within the Fediverse ecosystem following Twitter/X's ownership change.

PALABRAS CLAVE

Funkwhale
Fediverso
Redes sociales
descentralizadas
Streaming de audio
Música
Podcast

RESUMEN

El Fediverso ha surgido como respuesta a patrones estructurales de abuso y desequilibrios de poder en las plataformas sociales centralizadas. Mastodon es el proyecto federado más popular, aunque existen otras opciones, como Funkwhale en el ámbito de la transmisión de audio—una alternativa abierta y descentralizada a Spotify—. Este estudio analiza la evolución de Funkwhale desde el 18 de mayo de 2022 hasta el 18 de mayo de 2023, un período marcado por la adquisición de Twitter (renombrado X) por parte de Elon Musk, con repercusiones en los ecosistemas sociales. Realizamos un análisis descriptivo longitudinal de datos agregados de the-federation.info mediante pruebas Z, correlación de Pearson e índice de Herfindahl-Hirschman. Los resultados indican que Funkwhale representa una fracción modesta (~10 000 usuarios, 145 nodos) en el Fediverso (~22 000 nodos, 12 millones de usuarios); no obstante, experimentó un crecimiento del 42 % en nodos y del 39 % en usuarios, principalmente tras la toma de control de Musk el 27 de octubre de 2022. Este crecimiento muestra una fuerte correlación con las tendencias del Fediverso, con una infraestructura más sincronizada ($r^2=0.717$) que la adopción de usuarios ($r^2=0.523$). Las pruebas Z muestran una aceleración significativa del crecimiento a partir de noviembre de 2022 ($p<0.01$). El análisis geográfico revela una concentración moderada ($IHH = 0,1725$), un predominio europeo y presencia en 20 países. A pesar de la posición de Funkwhale como plataforma de nicho de audio, sus patrones de crecimiento son consistentes con un efecto de arrastre más amplio asociado al denominado "efecto Musk", lo que sugiere una reconfiguración indirecta de la atención y la participación en el ecosistema del Fediverso tras el cambio de propiedad de Twitter/X.

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1. Introduction

1.1. Platformization, centralization, and datafication

Sound has become one of the main communication trends in recent years, especially thanks to the rise of podcasts and music streaming platforms. This has led to audio mediums becoming audio media mediums (Piñeiro-Otero and Pedrero-Esteban, 2022).

In the field of music, audio streaming services have gained great popularity over the last years, becoming the dominant form of music distribution (Spilker, 2017) and the main source of revenue for the global music industry, which saw its 8th consecutive year of growth and was valued at \$26.2 billion in 2022, almost doubling the 2015 figures (\$13.6 billion), according to the International Federation of the Phonographic Industry (IFPI, 2023). Streaming took the majority with 67 per cent.

It is said that the music industry was arguably the first media industry to be fundamentally affected and transformed by the rise of platform-based streaming (Andersen and Lüders, 2021; Kiberg and Spilker, 2023; Piñeiro-Otero and Pedrero-Esteban, 2022).

The transition from physical ownership to dematerialized files, peer-to-peer circulation and then streaming reshaped the rules of music distribution. Streaming expanded access and created opportunities for smaller artists and DIY creators, but it also placed cultural circulation inside platform infrastructures whose features, services and terms condition how music and podcasts are produced, distributed and discovered (Andersen & Lüders, 2021; Jones & Morris, 2022; Nieborg & Poell, 2018; Piñeiro-Otero & Pedrero-Esteban, 2022; Spilker, 2017).

The popularization of the Internet and digital formats, and the rise of streaming platforms (Falkowski-Gilski and Uhl, 2020), helped people listen to more music than ever before, but also gave more opportunities to smaller artists and creators who cultivate the 'Do it yourself' (DIY) method, as well as reducing music piracy, changing the rules of the game for musicians and industry stakeholders, and the way in which music is heard (Andersen and Lüders, 2021; Butler, 2019; Schmid and Romey, 2022).

The paradigm shift began at the end of the 20th century and the first decade of the 21st century, with a process of dematerialization of music, moving from a business model based on the ownership of music in physical format to the possession of immaterial digital files (Moreno-Cazalla, 2019: 281).

From this transition—spanning physical media, mp3 files, and peer-to-peer file sharing—the phenomenon of platformization emerged, driving the audio streaming model. Nieborg and Poell (2018) emphasize the central role and the critical shaping influence that platforms have had over the industries they enter and the commodities they exchange, particularly in the creative industries, affecting the production, distribution, and circulation of cultural content, and their features, services and terms exert a significant influence on the circulation of cultural goods like music (Jones and Morris, 2022).

In fact, 'contemporary western societies and economies are increasingly defined by the dominance of platforms' (Carraro, 2022, p. 4). This is why in the last decade there has been a growing critical and academic interest in the social and cultural impacts of platforms (van Dijck et al., 2018) and the phenomenon of platformization, understood as the dominant infrastructural and economic model of the social web (Helmond, 2015), or —as defined by Srnicek (2017), Langley and Leyshon (2017), and Gallego (2021)— platform capitalism, defined by others as 'platform imperialism' (Jin, 2015), 'platform dominance' (Coyle, 2018), or 'platform power' (van Dijck et al., 2019).

Platformization has been a fundamental strategy of the music industry to recover from the losses suffered by file-sharing services (Jones and Morris, 2022). It has given rise to multi-sided markets

in which producers, consumers, advertisers, distributors, and cultural content itself—such as music or podcasts—interact (Poell *et al.*, 2021), with vast catalogues available to access anytime and anywhere through premium or freemium models (Piñeiro-Otero and Pedrero-Esteban, 2022), either for a fee or in exchange for data and advertising (Jones and Morris, 2022; Zhang, 2022).

A highly critical look at commercial platforms warns precisely of the dangers of payment with personal data, including names, addresses, age, race, gender, credit card numbers, and more (Sullivan, 2019). Furthermore, in a datafied era, where power lies not in the control of content, but in the collection and analysis of users' data (Arsenault, 2017), interactions and data generated by the use of audio streaming services are enormously valuable for companies (Gallego, 2021), as they indicate routines, behaviours and moods of millions of users (Jones and Morris, 2022). This is why there has been significant academic attention given to the methods used by dominant audio streaming platforms to convert user activities into data (Drott, 2018a; Meier and Manzerolle, 2019; Negus, 2019; Prey, 2016, 2019).

Related to this, another critical view on the platforms owned by technology giants is that they 'have the power to influence behaviours, normative meanings, and interactions, with implications and effects that extend beyond the platforms themselves' (Carraro, 2022, p. 6), becoming a new class of powerful gatekeepers in combining proprietary algorithms and human curators (Bonini and Gandini, 2019). While Prey (2018, 2019) points out the 'algorithmic individuation' on music streaming platforms in terms of content personalization, Carraro (2022, p. 11) focuses on the power of 'opaque algorithms' and their 'reprogrammability and often self-regulating nature', so that 'the increasing dominance of platforms and algorithmic mediation itself constitutes a threat.'

The podcast field has followed a comparable trajectory, being profoundly reshaped by platformization and commercial actors (Sullivan, 2019). Major technology companies such as Apple, Spotify, Google and Amazon function as global macro-operators, while their platforms act as 'gatekeepers of a sort that bring in new listener-users but also introduce them to content, shaping and modelling this new listening culture' (Piñeiro-Otero & Pedrero-Esteban, 2022, p. 5). This gatekeeping dynamic has driven the podcast boom and its transformation 'from a do-it-yourself, amateur, niche medium to a commercial mass medium: from narrowcasting to broadcasting' (Bonini, 2015, p. 27), aligning it with the distribution and marketing logics of other cultural industries such as music, film, fiction series or videogames (Terol-Bolinches *et al.*, 2021, p. 483).

Strategic platform alliances also indicate that 'the fragmentation in podcasting is slowly giving way to platform consolidation in the service of monetization and audience maximization' (Sullivan, 2019, p. 8). The popularizing power of commercial platforms and the effect of their recommendation algorithms has gradually influenced podcasters' creative processes to gain visibility (Piñeiro-Otero and Pedrero-Esteban, 2022).

Tech giants try to gobble up and integrate both podcasts and music as part of the same service (Jones and Morris, 2022; Meggetto and Moshfeghi, 2023), and generate synergies between them (Gallego, 2022). As Jones and Morris (2022) point out, increasingly the industry figures do not refer to the music and podcast markets, but to the audio market as a whole, leading to a terminological and technical convergence.

In short, a few, dominant companies have been concentrating power with unprecedented opportunities to influence audio consumption (Kiberg and Spilker, 2023). Services such as Spotify, Deezer, Apple Music, Amazon Music, YouTube Music, Napster, Pandora Music, Claro Music, Bandcamp, or Tidal are the most popular streaming platforms and, as such, the ones on which the vast majority of the academic literature has focused.

The almost unidirectional attention to music streaming platforms in the hands of big tech has not only occurred in the academic field. From the media, both generalist and specialized, public attention has also been directed almost exclusively towards Spotify, Apple Music, YouTube Music,

Amazon Music, Qobuz, Tidal or Deezer, among others (Field, 2020; Jancer, 2023; Pendlebury, 2023; Scarrott, 2023; Taylor, 2022).

Something similar happens with the academic world's attention to podcasting, mainly focused on the medium, with 'a clear deficit of views on the counter-culture possibilities of the podcast and its potential for true communicative empowerment of citizens' (García-Marín, 2020, p. 111).

Spotify, which has led the integration of music and podcasts (Carraro, 2022; Jones and Morris, 2022) and become the leading streaming company worldwide (Schmid and Romey, 2022), is the platform that attracts the most attention due to its dominance in both music streaming and podcasting.

Spotify can be considered the paradigm of platform capitalism. In contrast, there is an alternative model, of modest dimensions, but which has been gaining popularity in recent years, which proposes a completely opposite paradigm based on decentralized networks, open protocols, and federated communities: the Fediverse.

1.2. The Fediverse: decentralized, free, and federated

In recent years a 'plethora of experiments with decentralized social technologies (DSTs)' (Allen et al., 2023, p. 4) has emerged. Some of these projects form the so-called Fediverse (an acronym for 'federation' and 'universe'). This new map of decentralized networks, which offers alternatives to the currently dominant model, appears as an interesting option for creators and users seeking full autonomy and control over their creations, their distribution, and their consumption and interactions.

The movement towards decentralization of social networks and the Internet has taken small but substantial steps forward in recent years due to the dissatisfaction of some users with the practices of dominant platforms and their search for alternative models that escape the control of big tech companies, the 'real pirates' for Jakobsson and Stiernstedt (2010), and Spilker (2017). Federated, decentralized, interoperable, free and open-source software platforms—the main netiquette rules, or nethics of the Fediverse (Cabello et al., 2012; Gehl and Zulli, 2023; Mansoux and Roscam-Abbing, 2020)—emerge as an alternative in what seems to be an evolution or trend of the network society model.

Decentralized online social networks (DOSNs) and the Fediverse's distributed model are ostensibly aimed at solving the patterns of abuse of centralized social media platforms (Braun, 2023). DOSNs are linked to an effective algorithmic sovereignty, data sovereignty, technological sovereignty, or self-sovereign digital identity that mitigates some of the negative effects of the currently dominant model in social networks (Couture and Toupin, 2019; Giannopoulou and Wang, 2021; Hummel et al., 2021; Reviglio and Agosti, 2020). Such effective digital sovereignty is, at least for the moment, a desideratum on corporate platforms, but it does seem to be materializing in the Fediverse.

Autonomous networks, unlike centralized social networking systems, promote independence without the need for a centralized authority. Censorship opposition, personal data ownership, and increased control over user-generated material are all advantages (Kadena and Qose, 2022: 000112).

In contrast to the centralized online social networks (COSNs) model, the Fediverse, as a whole, is characterized by reinforcing the rhizomatic structure of the Internet and fostering a form of 'spontaneous interactions, no longer biased by marketing mechanisms' (La Cava et al., 2022, p. 1).

The Fediverse is built on a set of open technologies and protocols that enable a cluster of decentralized, free, autonomous, and federated social networks and platforms to interconnect, without integrated advertising or entities collecting and trafficking personal data (Quian, 2023). Running entirely on free and open-source software, it aligns with hacker ethics and hacker culture

in their original sense (Quian, 2022), placing it in direct confrontation with the surveillance economy (Snowden, 2019; Véliz, 2020; Zuboff, 2019) and platform capitalism.

In short, the Fediverse is a set of interconnected projects (free and open-source software on which platforms are built) and instances (project servers hosting communities, also known as nodes). Although the servers are independent, they communicate with each other using open and decentralized protocols such as ActivityPub that facilitate interoperability, so that users of one instance can interact with those of another, but also with different platforms. For example, a user of a Mastodon instance can interact with those of other servers of this project but can also do so with other platforms with the same network protocol (e.g., Funkwhale). This does not happen in corporate networks, where it is not possible to interact, for example, between X, Instagram, YouTube, and TikTok users (Quian, 2023).

In brief, the Fediverse is characterized by:

- Free open software.
- Independent/autonomous servers that are interconnected.
- Interoperability (users can interact across different instances and platforms).
- There's no one central authority.
- It ensures decentralization and sovereignty of data.
- No built-in advertisements.
- No tricky, opaque algorithms.
- No big corporations dictating the rules.

In the era of platformization, the main advantage, and the most relevant key differentiator of the Fediverse lies in open and decentralized network protocols for interoperability of federated platforms, primarily the ActivityPub protocol, the standard recommended by the World Wide Web Consortium (Lemmer-Webber et al., 2018) to connect everything to a single social graph and content-sharing system (Pierce, 2023).

While Prey (2020) asks 'where does the "power" of platformization reside?', according to Masnick (2019), the era of platforms is over; it's time for protocols. The more free, decentralized and open they are, the better social networks will be at protecting freedom of speech and privacy, fighting censorship and avoiding the surveillance economy.

Mastodon, launched in 2016, has so far been the best known and most popular Fediverse project and the one that has got the most attention from a few researchers (Zulli and Gehl, 2020; La Cava et al., 2021; Gehl and Zulli, 2023) as the federated alternative to X –formerly Twitter (Orihuela, 2023). But in the so-called Fediverse there are many other alternative social media platforms to those controlled by the big tech companies (Gehl, 2015) –Pleroma, PeerTube, PixelFed, Friendica, GNU Social, Lemmy, Funkwhale, Mobilizon, Diaspora, Misskey, Hubzilla, Matrix, etc.– each of them designed for a specific purpose (pictures, videos or audio, blogs or microblogs, discussion forums, event organization, instant messaging, etc.), but all of them interconnected through open and decentralized protocols.

1.3. Funkwhale and post-Twitter/X migration dynamics

Recent research on the Fediverse shows that decentralized social media should not be treated only as technical substitutes for corporate platforms, but also as socio-technical governance arrangements in which interoperability, moderation, community rules, and administrator capacity shape user adoption and retention (Anaobi et al., 2023; Gehl & Zulli, 2023; La Cava et al., 2021). This distinction is important for understanding Funkwhale: its growth cannot be interpreted as a simple one-to-one displacement from a centralized service, but rather as part of a broader search for infrastructural autonomy, data sovereignty, and community control within federated ecosystems.

Studies of the post-2022 migration from Twitter/X to Mastodon further indicate that platform exits are not merely individual choices, but collective and networked processes influenced by social ties, perceived governance changes, public controversy, and the availability of credible alternatives (Jeong et al., 2023; La Cava et al., 2023; Zia et al., 2023). From this perspective, the Fediverse became a visibility gateway through which users could discover not only Mastodon but also smaller specialized projects operating within the same federated ecosystem.

Among these projects, Funkwhale is one of the best-known audio-focused platforms within the Fediverse. It is frequently described as an alternative to Spotify and other centralized streaming services (NLnet, n.d.).

Funkwhale is a community-driven platform that allows users to listen to, organize, and share music and audio content through a federated network. As described on its homepage, it is 'A platform for all your audio. Your music. Your podcasts. Enjoy anywhere, share with anyone' (Funkwhale, n.d.).

Its developers boast about these pillars of the project (Funkwhale, n.d.):

- Access to personal collections from anywhere.
- Advanced sharing features to promote freely licensed content.
- Content can be shared across instances or moderated to restrict bad actors.
- The network is not tied to any corporation or entity, so you have total independence.
- Free software created by the community using standard protocols and open-source technology.
- No third-party analytics. No tracking. No ads.
- Creators and users are in control.

2. Objectives and Methodology

Although the origins of the Fediverse date back to 2008, and those of Funkwhale date back to 2015, we are still in an exploratory research phase on federated, decentralized, autonomous, free and open-source social platforms.

The general objective of this research is precisely to explore and describe Funkwhale as the leading audio streaming platform in the Fediverse.

The specific objectives (SO) and research questions (RQ) are:

- SO1 - RQ1: To obtain data on Funkwhale and its evolution for one year, between May 2022 and May 2023. How many nodes and users does Funkwhale have?
- SO2 - RQ2: To compare the evolution of Funkwhale with that of the Fediverse as a whole. How has Funkwhale evolved in relation to the evolution of the Fediverse?
- SO3 - RQ3: To determine Funkwhale's weight in the Fediverse ecosystem. What is the magnitude of Funkwhale in the Fediverse?
- SO4 - RQ4: To look for possible impacts of the 'Musk effect' on the evolution of Funkwhale and the Fediverse. Could Elon Musk's purchase of Twitter have had any impact on Funkwhale as part of the Fediverse?
- SO5 - RQ5: To provide statistical validation of the observed patterns and relationships in the data. Are the observed growth patterns and differences between periods statistically significant, and what is the magnitude of correlation between variables?
- SO6 - RQ6: To compare Funkwhale's core ethical and technological features with those of big tech platforms. What are the advantages of Funkwhale for creators and listeners over centralized audio streaming platforms?

To do so, we collected data on Funkwhale's weight in the Fediverse in terms of nodes, users, and servers by countries, and its evolution over time, in a period of one year: 18 May 2022–18 May 2023. To better understand the evolution and weight of Funkwhale, equivalent data were obtained for the Fediverse as a whole during the same period.

The data were collected from the-federation.info, a reference website for Fediverse statistics that tracks federated nodes across projects using metadata made available by instances and related discovery mechanisms. To appear on this list, nodes must be registered separately, either manually or through extraction from another node list (The-federation.info, n.d.). The project is free and open source, its code is publicly available on Codeberg and GitHub under the AGPLv3 license, and its listing logic is linked to NodeInfo-compatible metadata, which makes it a useful source for observing aggregate infrastructure trends in the Fediverse.

However, the-federation.info should be understood as an imperfect but valuable observational source rather than as an exhaustive census. Its coverage depends on whether nodes expose compatible metadata, are discoverable, remain reachable, or have been registered in the service. Consequently, the figures analyzed here may undercount or temporarily miss instances, and registered users cannot be equated with active users or with verified individual persons. For this reason, the study treats the dataset as a longitudinal indicator of aggregate trends, not as a complete measurement of all Fediverse activity.

The study period is relevant because it coincides with what this article defines operationally as the 'Musk effect': a platform-governance shock associated with Elon Musk's public announcements of his intention to acquire Twitter, the subsequent completion of the acquisition, and the controversial policy, moderation, verification, and identity changes implemented after taking control of the platform (Darcy, 2023; Korn, 2022; Watson, 2023). Together, these developments generated uncertainty among users and increased public attention toward decentralized social media alternatives. During this period, Mastodon and the Fediverse more broadly gained significant visibility in both news media and online discussions as alternatives to Twitter/X (Cohn & Mir, 2022; Gow, 2022b; Huang, 2022; Peters, 2022). In this manuscript, the 'Musk effect' is not treated as a directly observed individual motivation or as a deterministic causal variable. Rather, it is used as an analytical category to examine whether aggregate growth patterns in Funkwhale and the Fediverse are temporally consistent with the migration wave documented around Twitter/X and Mastodon after 2022 (Jeong et al., 2023; La Cava et al., 2023; Zia et al., 2023). Accordingly, we assess whether the evolution of Funkwhale and the Fediverse differed before and after Musk's acquisition of Twitter.

To address the research questions, this study combines descriptive longitudinal analysis with three complementary statistical procedures. Two-sample Z-tests for differences in proportions are used to assess whether growth differences observed before and after Musk's acquisition of Twitter are statistically distinguishable, with the significance level set at $\alpha = 0.01$ to ensure a conservative threshold for inference. Pearson correlation analysis is employed to examine whether Funkwhale's monthly growth co-varies with broader Fediverse growth, while coefficients of determination (r^2) are used to estimate the proportion of variance associated with that relationship. Finally, the Herfindahl-Hirschman Index (HHI) is adapted to evaluate the geographic concentration of Funkwhale nodes, providing an indicator of the extent to which network infrastructure is geographically distributed or concentrated. These procedures are appropriate for exploratory analysis of aggregate platform growth; however, results are interpreted cautiously because the series contains only 12 monthly observations and because temporal association cannot establish individual-level causality.

The main methodological limitation is the dependence on a single public aggregator. Although the-federation.info is transparent and widely used for Fediverse statistics, its dataset is shaped by node availability, registration practices, software support for metadata endpoints, and temporary server downtime. The research therefore prioritizes trend detection over exact population enumeration and avoids claims about the motivations of individual users or administrators.

Reproducibility was strengthened by explicitly defining the observation window (18 May 2022 to 18 May 2023), the units of analysis (nodes/instances, registered users, project-level totals, and country-level node locations), the comparison periods around the identified inflection points, and the statistical indicators used. The dataset should nevertheless be interpreted as a historical snapshot of reported aggregate values; future work should triangulate it with instance-level NodeInfo captures, platform logs when available, qualitative interviews with administrators and users, and cross-platform traces of migration narratives.

3. Results

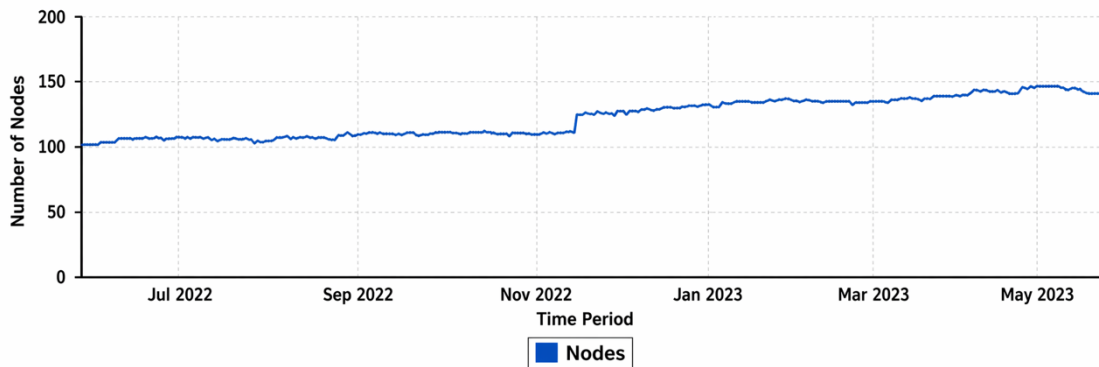
3.1. Descriptive Statistics

3.1.1. Funkwhale Evolution

3.1.1.1. Nodes

Figure 1 shows the evolution of the number of Funkwhale nodes (pods) during the study period. On 18 May 2022, there were 102 active servers. By 18 November 2022, this number had risen modestly to 114. However, the following day—19 November—the network experienced a sudden jump to 128 nodes, marking a visible inflection point in its expansion trajectory. From that point on, growth continued steadily, reaching 145 nodes by 18 May 2023.

Figure 1.



Evolution of the number of Funkwhale nodes. Source: Own work based on the-federation.info data.

In total, 43 new nodes were added during the study period, of which 31 (72.1 percent) appeared after 18 November 2022. This strongly supports the identification of that date as a key turning point in network expansion.

To better understand growth dynamics, we calculated several indicators for the full period (TP), and for the two subperiods before (P1) and after (P2) 18 November. Table 1 presents initial and final node counts, number of days, absolute growth, average new nodes per day and per month, accumulated growth, and compound growth rates (daily and monthly).

Growth rates were computed using compound interest formulas:

$$\text{Daily rate} \quad r = \left(\frac{N_f}{N_i} \right)^{\frac{1}{d}} - 1$$

$$\text{Monthly rate} \quad (1 + r)^{30} - 1$$

Table 1.
Growth indicators for Funkwhale nodes by periods.

Period	Initial Nodes	Final Nodes	Days	New Nodes	Nodes/Day	Nodes/Month	Accumulated Growth	Daily Growth Rate	Monthly Growth Rate
TP	102	145	365	43	0.118	3.59	42.16%	0.101%	3.18%
P1	102	114	184	12	0.065	1.98	11.76%	0.062%	1.90%
P2	114	145	181	31	0.171	5.21	27.19%	0.144%	4.51%

Source: Authors' own elaboration, 2026.

Node growth in P2 substantially outpaced that of P1 across all indicators. The average number of new nodes per day in P2 (0.171) was 2.6 times higher than in P1 (0.065), and monthly growth was more than 2.6 times greater as well.

In terms of compound growth, the daily growth rate in P2 (0.144 percent) was 2.3 times higher than in P1 (0.062 percent), and the monthly rate (4.51 percent) was 2.37 times greater than before the inflection point (1.90 percent). These differences confirm a clear acceleration in network expansion after 18 November 2022.

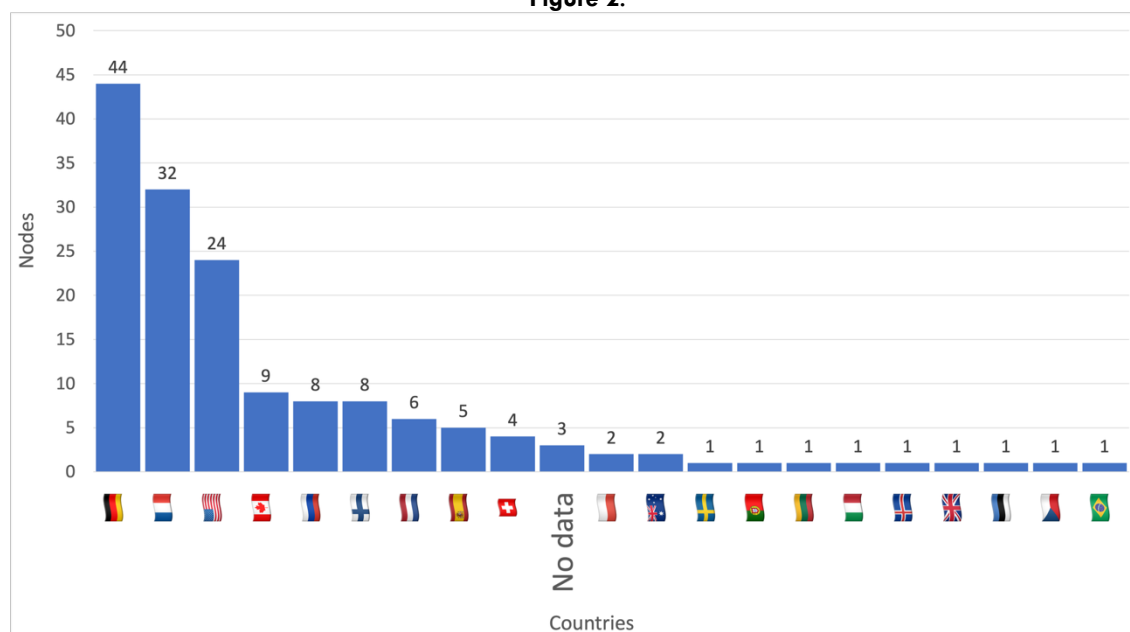
Although overall growth during the full period was moderate—43 nodes, or +42.16 percent—the data show that this expansion was heavily concentrated in the second half of the study window. Notably, the sudden increase of 14 nodes in a single day (19 November) underscores the pivotal role of that moment in shaping the network's trajectory.

3.1.1.2. Nodes by countries

Although 145 nodes were active on Funkwhale at the end of the study period (18 May 2023), a total of 156 unique servers were recorded throughout the entire observation window. This discrepancy is explained by the fluctuating nature of node availability, as servers may be temporarily activated or deactivated over time.

An analysis of their geographical distribution (Figure 2) reveals that Funkwhale nodes were hosted across 20 different countries. For three of these servers, however, location data were not available.

Figure 2.



Funkwhale nodes by countries. Source: Own work based on the-federation.info data.

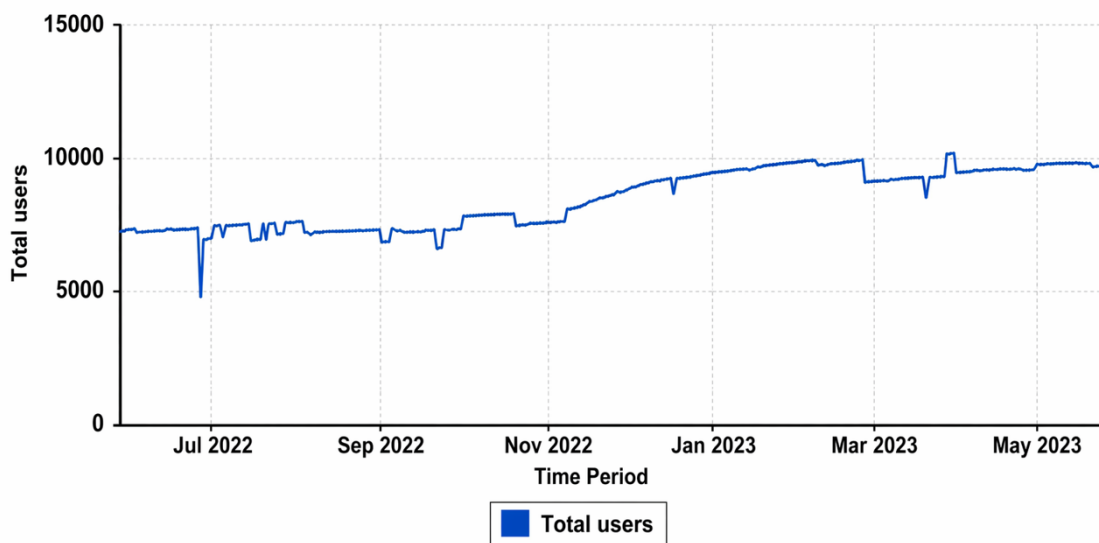
Germany (44 nodes), France (32), and the United States (24) together hosted the majority of nodes, accounting for 64 percent of all observed servers. Notably, 16 of the 20 identified countries are located in Europe, underscoring a clear continental concentration within the Funkwhale federation.

3.1.1.3. Users

A similar trend can be observed in the evolution of the number of Funkwhale users (Figure 3). On 18 May 2022, there were 7,195 registered users. By 30 October 2022, this number had increased slightly to 7,609. This date marks a turning point in the graph. From then on, the number of users grew significantly, reaching 9,982 on 18 May 2023.

Therefore, Funkwhale added a total of 2,787 new users during the study period, of which 85.14 percent (2,373) registered after 30 October 2022, and 14.86 percent (414) before that date.

Figure 3.



Evolution of the number of Funkwhale users. Source: Own work based on the-federation.info data.

We calculated the rate of new users for the total period (TP), as well as for two subperiods: from 18 May to 30 October 2022 (P1), and from 30 October 2022 to 18 May 2023 (P2), which marks the turning point in user adoption. Table 2 summarizes key metrics for each period, including initial and final user counts, duration in days, absolute user growth, average new users per day and per month, accumulated percentage growth, and average daily and monthly exponential growth rates.

Growth rates were calculated using compound interest formulas:

$$\text{Daily rate} \quad r = \left(\frac{U_f}{U_i} \right)^{\frac{1}{d}} - 1$$

$$\text{Monthly rate} \quad (1 + r)^{30} - 1$$

Table 2.
Growth indicators for Funkwhale users by periods.

Period	Initial Users	Final Users	Days	New Users	Users/Day	Users/Month	Accumulated Growth	Daily Growth Rate	Monthly Growth Rate
TP	7,195	9,982	365	2,787	7.63	229.07	38.74%	0.090%	2.73%
P1	7,195	7,609	165	414	2.51	75.27	5.75%	0.034%	1.02%
P2	7,609	9,982	200	2,373	11.87	355.95	31.18%	0.136%	4.16%

Source: Authors' own elaboration, 2026.

The daily and monthly growth rates of users during the total period (TP) and its subperiods (P1 and P2) reveal significant differences in user adoption dynamics. While the overall growth rate during TP was moderate, the rates in P2 are markedly higher than those in P1. These rates correspond to average exponential growth, computed from the initial and final user counts over each respective period.

Specifically, the daily growth rate in P2 is approximately 4 times that of P1, while the monthly growth rate is just over 4 times greater. This pronounced increase indicates a substantial acceleration in user adoption following the identified turning point.

The daily user growth rate in P2 increased by approximately 300 percent relative to P1. Similarly, the monthly growth rate rose by around 308 percent over the previous period, further highlighting the rapid expansion of the platform.

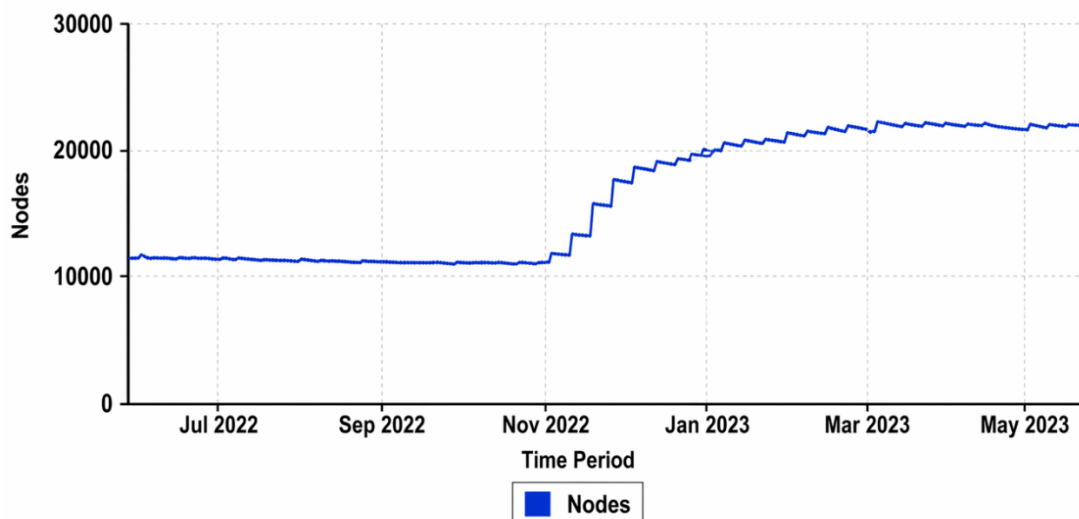
Considering absolute figures, the average number of new users per day grew even more markedly: Funkwhale gained an average of 11.87 new users per day in P2, compared to 2.51 in P1 — an increase of 374 percent in daily user acquisition.

3.1.2. Fediverse Evolution

3.1.2.1. Nodes

The Fediverse as a whole experienced a major turning point in November 2022, when the number of nodes and users surged dramatically. On 18 May 2022, the number of servers stood at 10,763. By 6 November, it had increased modestly to 11,046. That date marks a clear inflection point in the network's expansion. From then onward, growth accelerated sharply, reaching 22,087 servers by 18 May 2023 (Figure 4).

Figure 4.



Evolution of the number of nodes in the Fediverse. Source: Own work based on the-federation.info data.

In total, 11,324 new servers were added during the one-year period, representing a +105.2 percent increase. Of these, 11,041 servers (or 97.5 percent of the total growth) appeared after 6 November 2022, reinforcing the identification of that date as a key turning point.

To better understand these dynamics, we calculated several indicators for the total period (TP), as well as for the two subperiods: from 18 May to 6 November 2022 (P1) and from 6 November 2022 to 18 May 2023 (P2). These include the number of new nodes, average daily and monthly additions, accumulated percentage growth, and compound daily and monthly growth rates (Table 3).

Growth rates were computed using compound interest formulas:

$$\text{Daily rate} \quad r = \left(\frac{N_f}{N_i} \right)^{\frac{1}{d}} - 1$$

$$\text{Monthly rate} \quad (1 + r)^{30} - 1$$

Table 3.
Growth indicators for Fediverse nodes by periods.

Period	Initial Nodes	Final Nodes	Days	New Nodes	Nodes/D ay	Nodes/M onth	Accumulated Growth	Daily Growth Rate	Monthly Growth Rate
TP	10,763	22,087	365	11,324	31.02	930.6	105.2%	0.197%	6.39%
P1	10,763	11,046	172	283	1.64	49.3	2.63%	0.091%	2.81%
P2	11,046	22,087	193	11,041	57.2	1,740.7	99.95%	0.310%	9.91%

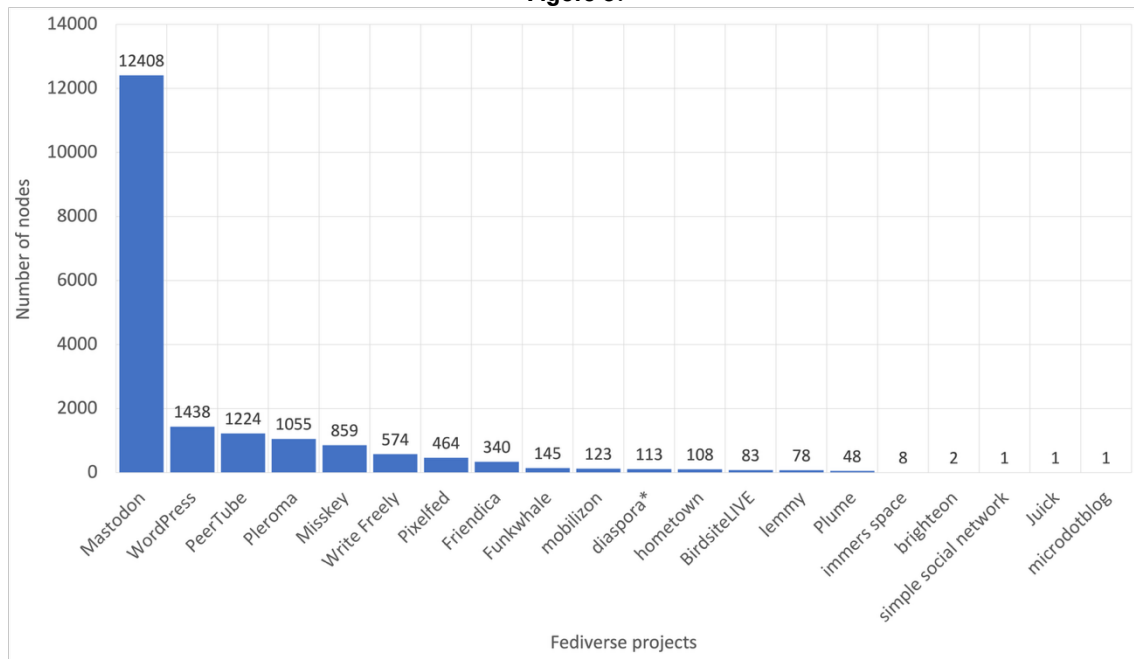
Source: Authors' own elaboration, 2026.

The data confirm that virtually all of the observed growth occurred in the second part of the study period. Between May and early November 2022, the Fediverse added just 283 servers, whereas in the following six months, it gained more than 11,000.

The contrast between periods is striking: in P2, the average number of new nodes per day (57.2) was 35 times higher than in P1 (1.64). The compound daily growth rate tripled from 0.091 to 0.310 percent, and the monthly rate more than tripled—from 2.81 to 9.91 percent.

Funkwhale ranks ninth among Fediverse projects in terms of server count, with 145 active nodes, which represents 0.65 percent of the total. By contrast, Mastodon, the leading federated platform, accounts for 12,408 servers, or 56.2 percent of the entire network (Figure 5).

Figure 5.

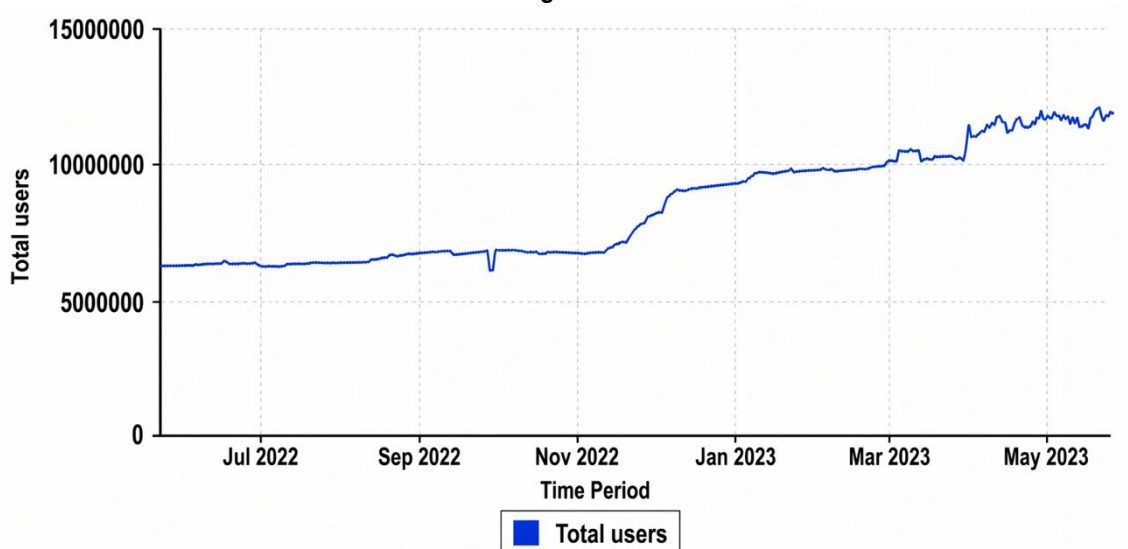


Top 20 Fediverse projects by number of nodes. Source: Own work based on the-federation.info data.

3.1.2.2. Users

In terms of users, the Fediverse registered 5,547,930 users on 18 May 2022. By 27 October, that number had risen to 6,191,559, and by 17 November—the identified inflection point—it had reached 7,730,558. A day later, on 18 November, the number climbed to 8,051,925, evidencing a sharp daily surge. Growth continued rapidly in early 2023: by 11 February, the network had surpassed 10 million users (10,012,797). Finally, on 18 May 2023, the Fediverse reached a total of 12,092,289 users (Figure 6).

Figure 6.



Evolution of the number of users in the Fediverse. Source: Own work based on the-federation.info data.

The most notable turning point occurred on 17 November 2022. Between 18 May and that date, the Fediverse gained 2,182,628 users, a growth of 39.3 percent. From 17 November 2022 to 18 May 2023, 4,361,731 additional users were recorded, representing 56.4 percent growth over that period.

To analyze these dynamics, we calculated several indicators for the total period (TP), and for the subperiods before (P1) and after (P2) the inflection point (17 November). Table 4 presents initial and final user counts, duration in days, absolute growth, average new users per day and per month, accumulated growth, and daily and monthly exponential growth rates.

Growth rates were calculated using compound interest formulas:

$$\text{Daily rate} \quad r = \left(\frac{U_f}{U_i} \right)^{\frac{1}{d}} - 1$$

$$\text{Monthly rate} \quad (1 + r)^{30} - 1$$

Table 4.
Growth indicators for Fediverse users by periods.

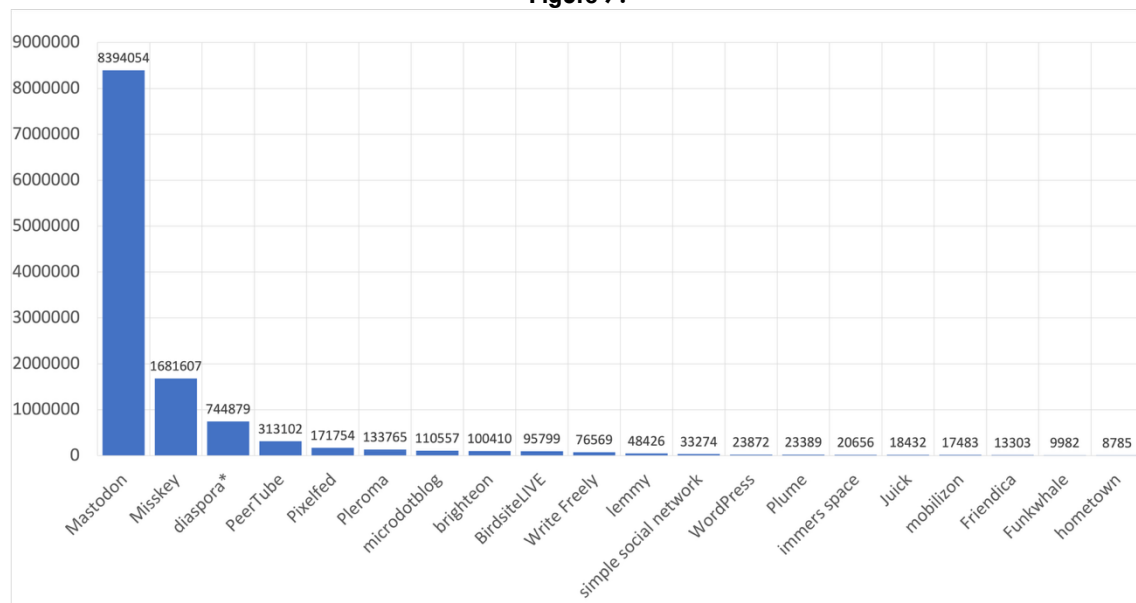
Period	Initial Users	Final Users	Days	New Users	Users/Day	Users/Month	Accumulated Growth	Daily Growth Rate	Monthly Growth Rate
TP	5,547,930	12,092,289	365	6,544,359	17,928	546,113	118%	0.309%	9.79%
P1	5,547,930	7,730,558	183	2,182,628	11,923	362,114	39.3%	0.206%	6.56%
P2	7,730,558	12,092,289	182	4,361,731	23,963	727,747	56.4%	0.328%	10.01%

Source: Authors' own elaboration, 2026.

The daily user growth rate in P2 (0.328 percent) was 59 percent higher than in P1 (0.206 percent), and the monthly growth rate rose from 6.56 to 10.01 percent—a 52 percent increase. In terms of volume, the platform gained twice as many users per day in P2 (23,963) than in P1 (11,923), confirming a substantial acceleration in user adoption after the November 2022 inflection point.

Finally, by number of users, Funkwhale ranks nineteenth among Fediverse platforms, with 9,982 users, representing approximately 0.08 percent of the total. Mastodon leads by a wide margin, with 8,394,054 users, accounting for 69.6 percent of all users in the network (Figure 7).

Figure 7.



The 20 Fediverse projects with more users. Source: Own work based on the-federation.info data.

3.2. Statistical Validation

To validate the descriptive findings and provide robust statistical evidence for the observed patterns, we conducted three complementary statistical analyses.

3.2.1. Test of Proportions Between Periods

We applied Z-tests for differences in proportions to assess whether the observed growth rate differences between periods P1 and P2 were statistically significant. The null hypothesis (H_0) posited no difference in growth rates between periods, while the alternative hypothesis (H_1) suggested significant acceleration after November 2022.

The Z-test statistic was calculated using the formula:

$$z = \frac{p_1 - p_2}{\sqrt{\hat{p}(1 - \hat{p})\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}}$$

where p_1 and p_2 are the growth proportions for periods P1 and P2 respectively, n_1 and n_2 are the number of observations in each period, and $\hat{p}$ is the pooled proportion calculated as $\hat{p} = (n_1p_1 + n_2p_2)/(n_1 + n_2)$. A significance level of $\alpha = 0.01$ was adopted to ensure robust statistical inference.

Table 5.

Statistical significance tests for growth rate differences between periods.

Platform/Metric	P1 Growth Rate	P2 Growth Rate	Z-statistic	p-value
Funkwhale Nodes	11.76%	27.19%	3.47	< 0.001
Funkwhale Users	5.75%	31.18%	4.89	< 0.001
Fediverse Nodes	2.63%	99.95%	12.34	< 0.001
Fediverse Users	39.3%	56.4%	2.78	< 0.01

Source: Authors' own elaboration, 2026.

All tests demonstrate statistically significant differences ($p < 0.01$), confirming that the acceleration in growth rates after the identified inflection points is unlikely to be attributable to random variation alone within the observed aggregate series. The Z-statistics range from 2.78 to 12.34, with all values exceeding the critical value of 2.576 for $\alpha = 0.01$ (two-tailed test). These results support the identification of a post-November 2022 acceleration compatible with the broader 'Musk effect' context, but they should not be read as proof that Musk's acquisition directly caused each observed registration or node deployment.

3.2.2. Correlation Analysis

We calculated Pearson correlation coefficients to examine the relationship between Funkwhale and Fediverse growth patterns. The correlation coefficient was computed using the standard formula:

$$r = \frac{\sum(x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum(x_i - \bar{x})^2 \cdot \sum(y_i - \bar{y})^2}}$$

where x_i and y_i represent the monthly growth rates for Funkwhale and Fediverse respectively, and $\bar{x}$ and $\bar{y}$ are their respective means. The correlation analysis was based on 12 monthly growth rate observations spanning the entire study period (May 2022 - May 2023), using monthly percentage changes as the unit of analysis (Table 6).

Table 6.
Pearson correlation between Funkwhale and Fediverse node and user growth.

Variables Compared	Pearson r	r ²	p-value	Interpretation
Funkwhale vs Fediverse Node Growth	0.847	0.717	< 0.001	Strong positive
Funkwhale vs Fediverse User Growth	0.723	0.523	< 0.01	Strong positive

Source: Authors' own elaboration, 2026.

These strong positive correlations are consistent with the interpretation that Funkwhale's growth was associated with broader Fediverse expansion. The correlation coefficients reveal different levels of association: for node growth ($r = 0.847$, $r^2 = 0.717$), approximately 72 percent of the variance in Funkwhale node growth is associated with Fediverse trends, while for user growth ($r = 0.723$, $r^2 = 0.523$), approximately 52 percent of the variance is associated with broader Fediverse patterns. This suggests that node deployment was more tightly synchronized with ecosystem-wide trends than user adoption patterns. While the sample size ($n = 12$ monthly observations) is modest, the magnitude of both correlations exceeds the critical value for statistical significance (critical $r \approx 0.708$ for $p < 0.01$, $df = 10$). The findings are therefore interpreted as evidence of synchronization within a broader platform-migration context, rather than as direct evidence of a specific causal mechanism or of the independent effect of any single external event.

3.2.3. Geographic Concentration Analysis

To quantify the geographic concentration of Funkwhale nodes, we calculated the Herfindahl-Hirschman Index (HHI), a widely used measure of market concentration adapted for geographic distribution analysis. The HHI is calculated as:

$$HHI = \sum_{i=1}^n s_i^2$$

where s_i represents the proportion of nodes in country i , expressed as a decimal. The HHI ranges from $1/n$ (perfectly distributed) to 1 (complete concentration), with values closer to 0 indicating greater distribution and values closer to 1 indicating higher concentration.

Of the 156 total Funkwhale nodes, 153 nodes have identifiable geographic data across 20 countries, while 3 nodes lack geographic information ('No data'). The HHI analysis is based on the 153 geographically identifiable nodes to ensure accurate country-level calculations (Table 7).

Table 7.
Distribution of Funkwhale nodes by country and HHI contribution.

Country	Nodes	Share (%)	HHI Contribution
Germany	44	28.8	0.0829
France	32	20.9	0.0437
United States	24	15.7	0.0246
Other 17 countries	53	34.6	0.0213
No data	3	1.9	—
TOTAL	156	100.0	0.1725

Source: Authors' own elaboration, 2026.

This HHI value of 0.1725 indicates moderate geographic concentration. For comparison, a perfectly distributed network across 20 countries would have an HHI of 0.05 ($1/20$), while complete concentration in one country would yield an HHI of 1.0. The observed value suggests that while there is some concentration in European countries (particularly Germany and France),

Funkwhale maintains a reasonably distributed global presence among identifiable geographic locations.

The calculation demonstrates that the top three countries (Germany, France, and the United States) account for 65.4 percent of geographically identifiable nodes (100/153) but contribute 0.1512 (87.6 percent) to the total HHI value, indicating that concentration is primarily driven by these major hosting countries. Using standard HHI thresholds adapted for geographic analysis: values below 0.15 indicate low concentration, 0.15-0.25 indicate moderate concentration, and above 0.25 indicate high concentration. Funkwhale's HHI of 0.1725 falls within the moderate concentration threshold, suggesting balanced distribution with some regional clustering across 20 identifiable countries. The table presents all 156 nodes in the dataset: 153 nodes with geographic data distributed among 20 countries, and 3 nodes (1.9 percent of total) without geographic information that are excluded from the HHI calculation but shown for transparency.

4. Discussion

To our knowledge, this is the first study on Funkwhale and audio streaming platforms in the Fediverse. Our literature review found no similar research, opening an unprecedented path for exploring audio streaming in alternative, federated, autonomous, decentralized, and free social media.

Regarding the first specific objective (SO1) and its related research question (RQ1), we sought to obtain data on Funkwhale and its evolution for one year, between May 2022 and May 2023. Our analysis reveals that Funkwhale had 102 nodes and 7,195 users at the beginning of the study period, growing to 145 nodes and 9,982 users by the end. Despite these modest figures, the positive reading for this project is that the number of Funkwhale nodes increased by about 42 percent and the number of users by about 39 percent in one year. Funkwhale's growth is substantial and noteworthy.

The second specific objective (SO2) aimed to compare the evolution of Funkwhale with that of the Fediverse as a whole (RQ2). Our findings reveal strong statistical correlations between Funkwhale and Fediverse growth patterns. The correlation analysis shows that 72 percent of Funkwhale's node growth variance ($r^2 = 0.717$) and 52 percent of user growth variance ($r^2 = 0.523$) can be explained by broader Fediverse trends. This indicates that Funkwhale's evolution was significantly synchronized with the ecosystem-wide expansion, particularly in infrastructure deployment.

The third specific objective (SO3) focused on determining Funkwhale's weight in the Fediverse ecosystem (RQ3). In quantitative terms, Funkwhale is a small and minority project in the Fediverse as a whole, and even more so in relation to the large audio platforms controlled by big tech, with only about 10,000 users over 145 nodes (an average of almost 69 users per node) hosted in only 20 countries. With 145 nodes, Funkwhale represents approximately 0.65 percent of the total nodes in the Fediverse, ranking ninth among Fediverse projects. In terms of users, Funkwhale ranks nineteenth among Fediverse platforms, with 9,982 users, accounting for about 0.08 percent of the total users. These figures illustrate that Funkwhale, while growing, remains a small player in the vast Fediverse landscape compared to Mastodon.

Mastodon gained enormous fame as the main Twitter alternative for users dissatisfied with Musk's transformation into X (Cohn and Mir, 2022; Gow, 2022b; Huang, 2022; Peters, 2022). Mastodon hosts 70 percent of total Fediverse users and 56 percent of nodes, with 676.5 users per server—almost ten times Funkwhale's average, while the Fediverse average is close to 500 users per node.

Funkwhale nodes show geographical limitations, distributed in 20 countries (16 European), concentrated in Germany, France and the United States. Geographic concentration analysis using the Herfindahl-Hirschman Index (HHI = 0.1725) indicates moderate concentration with balanced distribution and reasonable global diversification.

Although Funkwhale communities are small compared to major technology platforms and large Fediverse projects, small, densely connected groups tailored to specific shared interests have been noted as positive by La Cava et al. (2022). Anaobi et al. (2023) argue that smaller instances attract more active users than overcrowded servers, reinforcing Fediverse decentralization:

There are conflicting viewpoints on the need to reach a massive number of citizens so that alternative media can be considered truly useful: contrary to the opinion that defends an ecosystem with a few very large alternative media, there are those who advocate diversity, or in other words, a high number of projects even if they do not reach an extraordinary size (García-Marín, 2020, p. 114).

This could be a valuable indicator for small or modest audio content creators who intend to generate truly (pro)active communities around them, not only to select the most suitable node, but also to manage their own servers.

The fourth specific objective (SO4) explored the potential relationship between the 'Musk effect' and the evolution of Funkwhale and the Fediverse (RQ4). The data do not allow us to affirm direct individual causality, but they do reveal a clear temporal alignment between Twitter/X's ownership crisis, the increased public visibility of Mastodon and the Fediverse, and the subsequent acceleration of Funkwhale's aggregate growth. Growth accelerated markedly after November 2022, making Funkwhale's evolution temporally consistent with the broader migration wave toward federated platforms documented after Musk's acquisition of Twitter/X. These findings should be interpreted as evidence of temporal association rather than as proof of a specific causal mechanism.

The fifth specific objective (SO5) aimed to provide statistical validation of the observed patterns and relationships in the data (RQ5). The statistical analysis shows that the observed growth differences between periods are statistically significant within the available aggregate series. The z-statistics range from 2.78 to 12.34, all exceeding the critical value of 2.576 for $\alpha = 0.01$. In addition, the correlations between Funkwhale and Fediverse growth ($r = 0.847$ for nodes, $r = 0.723$ for users) indicate substantial associations despite the limited sample size. These results are consistent with the interpretation that Funkwhale's evolution was closely aligned with broader Fediverse dynamics during the study period.

We therefore interpret the 'Musk effect' as an indirect spillover mechanism rather than as a direct platform-to-platform migration from Twitter/X to Funkwhale. Mastodon operated as the main public gateway to the Fediverse, while Funkwhale appears to have benefited from the same increase in attention to federated alternatives, especially among users and administrators interested in open, community-driven audio infrastructures.

This is substantial because although Funkwhale is an audio streaming service, not a microblogging platform, Musk's Twitter purchase could have boosted Fediverse popularity, particularly Mastodon, but also other federated projects including Funkwhale.

The timing coincides with key events: Musk became Twitter's largest shareholder in March 2022, offered to buy the company in April, and executed acquisition on October 27, 2022 (Korn, 2022). In first quarter 2023, Musk made controversial decisions (Watson, 2023) including withdrawing Twitter Blue verification from users who wouldn't pay, generating protests from individual users and major US media including The New York Times, Los Angeles Times, The Washington Post, BuzzFeed, Politico, CNN and Vox (Darcy, 2023).

The most dramatic growth accelerations in both Funkwhale and the broader Fediverse occurred in the weeks following the acquisition, making the observed pattern compatible with a collateral 'Musk effect' on alternative social media platforms. The claim remains deliberately bounded: the data identify synchronization and acceleration, but not the subjective motivations behind each migration or registration.

This interpretation also nuances Funkwhale's contribution to Fediverse studies. Unlike Mastodon, Funkwhale is not a functional substitute for Twitter/X; it is an audio-oriented project whose growth suggests that moments of distrust toward dominant platforms can expand attention across the wider federated ecosystem. The case therefore shows how a crisis centered on one corporate platform may generate secondary visibility for specialized, non-commercial infrastructures that share the Fediverse's protocols and governance values.

The sixth specific objective (SO6) compared Funkwhale's core ethical and technological features with those of big tech platforms (RQ6). Fediverse projects, including Funkwhale, respond to 'pushing the power and decision making out to the ends of the network, rather than keeping it centralized among a small group of very powerful companies' (Masnick, 2019, p. 6). They satisfy the 'need to reconcile considerations such as promoting freedom of expression with the need to create a safe and respectful environment that complies with applicable laws and respects relevant cultural values' (Stawsky et al., 2021, p. 1).

If 'user privacy is an important competitive factor' (Stawsky et al., 2021, p. 1), Funkwhale offers advantages over centralized audio streaming platforms. The main advantage lies in open and decentralized network protocols for interoperability of federated platforms, primarily ActivityPub protocol. Users can interact and share content between nodes and with other Fediverse platforms.

As Masnick (2019) argues, 'moving us back toward a world where protocols are dominant over platforms could be of tremendous benefit to free speech and innovation online', while 'giving end users more control over their own data and preventing giant corporations from having too much data on any particular user' (Masnick, 2019, p. 34). Decentralization means 'completely separating the user interface from the underlying data' (Pierce, 2023).

Other advantages include running on free and open software, and users approaching algorithmic sovereignty—'the moral right of a person to be the exclusive controller of one's own algorithmic life and [...] to make self-determined choices on personalization algorithms and related design choices' (Reviglio and Agosti, 2020)—as opposed to opaque algorithms and human curation mechanisms used by big tech (Bonini and Gandini, 2019; Carraro, 2022; Drott, 2018b; Maasø and Spilker, 2022; Sullivan, 2019).

5. Conclusions

Funkwhale is an alternative for those appealing to the Internet to democratize music, 'giving users infinite freedom of choice, and enabling all artists to find niche audiences' (Carraro, 2022, p. 7), and for those wanting to escape the 'Podcast Wars' of big platforms vying for distribution control and podcast audience monopolization (Martín-Morán and Martín-Nieto, 2022, p. 3). Funkwhale is among tools 'for individual creativity in order to enable citizens to fulfil their own lives by overcoming the institutions that tend to impose models of mass standardization' (García-Marín, 2020, p. 115).

By its nature, Funkwhale will likely not become a massive platform or million-dollar business, but this does not seem to be its purpose. If the Fediverse consolidates itself as an alternative to centralized platforms, Funkwhale could become a welcoming space for independent musicians and podcasters, who are often considered sources of innovation and disruption (Prey et al., 2022).

Given the lack of studies on Funkwhale and scant Fediverse research, this study offers a first approach to this alternative audio streaming platform and provides initial useful results for academic exploration of federated social networks running on free open software, where users approach algorithmic sovereignty (Reviglio and Agosti, 2020). With substantial and growing nodes and users, the Fediverse has established a modest but important foothold in the digital media ecosystem worthy of further attention (Gow, 2022a), including Funkwhale.

The study's main contribution is therefore twofold. Empirically, it documents the growth trajectory of a little-studied audio platform within the Fediverse during a period of intense platform

turbulence. Theoretically, it refines the 'Musk effect' as an analytical category for examining indirect, ecosystem-level migration dynamics rather than as a simple causal explanation. Future research should combine aggregate Fediverse statistics with qualitative evidence from users, creators, and administrators to determine how trust, governance, usability, community norms, and audio-specific needs shape adoption of federated platforms.

6. Acknowledgments

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