INTERNATIONAL JOURNAL OF MULTIDISCIPLINARY: APPLIED BUSINESS AND EDUCATION RESEARCH
2026, Vol. 7, No. 6, 2761 – 2770
http://dx.doi.org/10.11594/ijmaber.07.06.30

Research Article

How Streaming Music Reduced Audio Piracy

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Article history:
Submission 30 May 2026
Revised 16 June 2026
Accepted 23 June 2026

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ABSTRACT

The article traces the evolution of digital music distribution from the era of physical piracy to contemporary legal streaming models. It situates this transformation within the broader framework of Industry 4.0 and the sharing economy highlighting how technological change, widespread connectivity, and new organizational models have reshaped relations between creators, intermediaries, and users.

The study reviews key stages of online piracy, including BBS systems, FTP, peer-to-peer networks such as Napster, and digital music stores, and then examines the emergence of streaming platforms like Spotify as a disruptive innovation in access-based music consumption. Particular attention is paid to subscription and freemium models, algorithmic personalization, and the shift from owning files to on-demand streaming, which together significantly reduced the profitability and appeal of illegal music exchange.

The article concludes that streaming services have become one of the most effective instruments in curbing music piracy.

Keywords*: Innovation, Intellectual property, Online piracy, Streaming*

Introduction

The exchange of intellectual property in Poland of the 1990s, took place mainly at computer marketplaces where CDs, games, and hardware were commonly traded outside official distribution channels. Alongside legal distribution, there were large companies marketing audiovisual content without regard for licensing fees or the royalties due to artists. The 1994 "Act on Copyright and Related Rights" [1] contained provisions which created a legal framework for combating this phenomenon [2]. Direct exchange of goods was largely eliminated, and the illegal exchange of intellectual property migrated to the internet for many years.

Following the introduction of the legislation, the sharing of music content migrated entirely online, primarily to peer-to-peer networks. While this activity remained illegal, the inherent difficulty in identifying users of such networks rendered law enforcement agencies ineffective in combating this form of piracy.

The triumphant return of the "resource sharing" philosophy (understood as part of the so-called Industry 4.0 concept) only became possible following the market launch of devices that are constantly connected to high-speed

How to cite:
Szczyrba, M. (2026). How Streaming Music Reduced Audio Piracy. *International Journal of Multidisciplinary: Applied Business and Education Research*. *7*(6), 2761 – 2770. doi: 10.11594/ijmaber.07.06.30

internet. Thanks to that innovation, the scale of illegal exchange was significantly reduced. The emergence of business initiatives based on streaming music (also films, and games), along with widespread adoption of a "freemium" model, meant that the illegal exchange of audiovisual goods online simply became unprofitable.

The considerations in this article are an attempt to demonstrate the impact of the market success of projects based on streaming music content (such as Spotify, Apple Music, Deezer, Youtube Music, Amazon Music) on curbing the phenomenon of illegal online file sharing.

Resource sharing

Resource sharing is one of the elements of the dynamic digitalization of the world around us and one of the pillars of the definition of the concept of Industry 4.0, which covers a wide range of technical innovations implemented in many areas of life (Gajdzik & Grabowka, n.d.). The notion first appeared at the Hannover Messe trade fair in 2011 as a vision of a "new industrial revolution" taking place in the digitalized world. Initially, debate on this concept was based on the example of the changing German economy. However, 2016 brought a triumphant success for the concept of Industry 4.0 as it was incorporated into the motto of the World Economic Forum in Davos ("Mastering the Fourth Industrial Revolution") (Pfeiffer, 2017). The common denominator of this change is technological progress – integration of systems, development of networks, coexistence of people and digitally controlled machinery, and wide use of the internet, huge databases, and information technologies. This change is also visible in the production process, especially its last stage, i.e., the final product, where the application of collected and processed data leads to greater innovation, efficiency, productivity, and product customization, which in turn increases the commercial potential of the product (Cellary, 2019).

This philosophy creates a completely new type of relationship between customers and product suppliers. It addresses the need to cooperate and share previously unused resources, as a result of which they can be utilized more effectively (Paczkowski et al., n.d.). Resource sharing brings about a fundamental change in organizational and distribution models and – possibly even more importantly – in the way people think (Rinne, n.d.). Humans' natural tendency to cooperate in small groups (e.g., within a family) is now transferred to and materialized in business organizations. Interestingly, sociologists recognize a simultaneous process of family ties weakening or even disappearing. Thus, the kind of relationships traditionally resulting from social ties or kinship can now be seen between producers, customers, and service providers.

In a report on resource sharing, the consulting company PwC drew attention to the ambiguity of this concept. Despite the numerous benefits of resource sharing, users of digital goods tend to share them not because they do not fully use them but because they are intangible (PwC, n.d.). Contemporary technical possibilities and the ubiquity of fast network connections make it relatively easy to allow people to use intangible goods legally or... not entirely legally. The growing popularity of streaming services makes the latter option no longer worthwhile.

Online file sharing

The digital exchange of intangible goods is as old as the internet. At its inception, the internet was not thought to be a commercial venture—quite the opposite. However, a large group of users of the World Wide Web has always been committed to the idea of "freedom of information." In other words, they believed that everything that can be found on the internet is common property. This, in turn, has resulted in permanent infringements of the intellectual property of creators and distributors of multimedia content, i.e., "digital piracy," a phenomenon that is still common on the internet.

As early as in the "pre-internet" times, communities of personal computer users were already developing and improving methods of "sharing IT resources." Data was exchanged via telephone lines, and the centers which offered these shared resources were so-called BBS's (Bulletin Board Systems). The emergence of data exchange systems connected to telecommunications networks and offering interactive two-way communication began the era of the

"information society," understood as a community based on information industries (Ito, 1992).

The increasing popularity of the internet pushed the development of the exchange of digital resources in a completely new direction. Network users who were engaged in the illegal exchange of legally protected content suddenly gained new communication tools. The first of them, used almost since the dawn of the internet, was FTP—File Transfer Protocol. Its characteristic feature is its flexibility, which allows for the transfer of various types of files between various types of computer systems, regardless of the operating system installed on them (Kozierok, 2005).

A breakthrough in the development of internet "resource sharing," i.e., the exchange of computer files, was the launch of Napster in 1999. This simple piece of software, created by a 19-year-old student, Shawn Fanning, revolutionized the sharing of computer resources with other network users: all you had to do was select a directory containing music files on your hard drive to give the whole world access to its contents. Soon, Napster became the main tool for distributing files, especially music, which resulted in a series of lawsuits, the most public of which was brought against Napster by the famous rock band Metallica. The social effects of the emergence of Napster turned out to be pervasive. After a few months, this software had attracted a community of 10 million users. At the time of its judicial liquidation, just over a year after it started operating, it had over 50 million users (Bregmann, 2001). Legal action taken by major record companies led to the closure of Napster, but they were unable to stop the uncontrolled development of new ways of "sharing" copyright content, including software such as Kazaa or eMule, or HTTP-based services like Rapidshare or Megaupload. All these computer data distribution channels served one purpose: the exchange and distribution of all kinds of files.

Copyright materials distributed outside of the legal circulation constitute only a part of this data stream, but it is hard to estimate how big it is. The extent of this phenomenon has been researched by companies that analyze network traffic. In a report published by MarkMonitor in January 2011, the number of internet users' "visits" to sites described as "suspected of offering pirated content" was estimated at 146 million per day (MarkMonitor, 2011). Organizations dealing with online copyright protection estimate that 8% of all websites are "pirate" websites (offering access to illegal software, files, or tools to obtain them) (Business Software Alliance, 2009). Another 17% of websites were identified as distributing software that may expose the user to loss or damage of their computer system or installation of undesirable content on it. The total value of illegal software available on the internet is estimated at 63bn USD (including 618m USD on the Polish-language internet) (Business Software Alliance, 2012).

For over 20 years, the illegal exchange of digital goods has been a serious problem recognized by the Polish justice system. The criminalization of computer piracy is based on the provisions of the Penal Code and the Act of 4 February 1994 on Copyright and Related Rights. The Penal Code includes four types of prohibited acts: illegally obtaining a computer program (Article 278 §2 of the Penal Code), misappropriation of property rights (Article 284 of the Penal Code), theft of a computer program (Articles 291–293 of the Penal Code), and computer fraud (Article 287) (Act of 06.06.1997, 1997). The catalogue of prohibited activities associated with computer piracy is supplemented by the provisions of the Act on Copyright and Related Rights. The provisions contained therein have the nature of a special tort in relation to the norm of Art. 115 section 3 of this Act, which specifies "other infringement of someone else's copyright or specific related rights in order to obtain a financial advantage." Penal sanctions under the Act in question apply to the distribution of illegal copies of a computer program (Article 116 of the Act), preparation to commit a crime through unauthorized reproduction of a program (Article 117 of the Act), and receiving stolen goods, i.e., acting as an intermediary in the trading of illegal copies of a computer program (Art. 118 of the Act). Acts committed "professionally" or directed or organized by the perpetrator are

subject to ex officio prosecution under the copyright law (Art. 122 of the Copyright Law in connection with Art. 116(3), Art. 117(2), and Art. 118(2) of this Act).

Interestingly, inventions intended for direct file exchange have often been created "in good faith." Shawn Fanning, the creator of Napster, was looking for a way to share files with friends and chat online with them at the same time (Levy, 2000). The application he wrote was not a technological novelty as it simply combined elements that had long existed on the internet (Lessig, 2005). The idea of the service was based on the already mentioned and forgotten principle of "internet freedom"—the conviction that the internet is a platform for the unrestricted and free exchange of thoughts, views, software, and creative output (Blichiewicz, 2013). Similar ideals inspired the creators of Kazaa—Jaan Talinn, Janus Fris, and Niklas Zennstrom—who made history a few years later by releasing Skype, another piece of groundbreaking software. The dynamic development of file sharing systems was a response to a "market need," understood as millions of internet users' need for simple and effective tools for free file exchange.

Spotify and other legal streaming services

The idea of how to use legal resource sharing to sell music was developed by the Swedish company, Spotify. However, it is impossible to understand the success of Spotify without looking back on the earlier developments in the online digital music industry.

Online music distribution became possible thanks to the development of audio data compression algorithms. By cutting out so-called "moments of silence" and frequencies inaudible to the human ear, the size of files recorded as "tracks" on CDs could be reduced almost tenfold. At the turn of the millennium, files of several megabytes in size were perfectly compatible with the capacity of external data carriers used at the time: memory sticks, pocket music players, or the first external hard drives. The "mp3" audio compression algorithm (codec) was developed by scientists from the German scientific network, Fraunhofer (Fraunhofer Institute for Integrated Circuits, n.d.). The history of the algorithm's creation is still awaiting scientific analyses, but it is definitely worth underlining the revolutionary importance of mp3 compression for music sales on the internet (Haring, 2000). Of course, the mp3 format was neither the only nor the best way to compress sound, but it remained the most popular one for a long time. It first appeared in 1991 and was developed by two German engineers, Dieter Seitzer and Karlheinz Brandenburg, who were looking for methods of transmitting music files over telephone lines. The first song encoded into the mp3 format was Suzanne Vega's "Tom's Diner." The creators of the format, keen fans of the singer, chose an a cappella version of the song to demonstrate to sponsors the power of the algorithm they had created.

An equally important moment in history was the first "leak" of a complete album in mp3 format on the internet; the victim was the band Depeche Mode and their album "Songs of Faith and Devotions." Any attempts to stop the spread of this material in the CompuServe network were, of course, unsuccessful. The year 1999 brought the first offer of a music album that was legally available for paid download via the internet. David Bowie's "Hours" was made available for download for $18 two weeks before the "classic" CD version was distributed (Keppler, n.d.).

The first systemic revolution in the world of digital music was started by Apple. Taking advantage of its market position and a large number of devoted fans of the brand, it created iTunes, a "digital music store." Any song in Apple's database of 17 million songs could be purchased for 99 cents. The service was associated with the iPod pocket music player, which had already proven to be a market hit. Apple, as the first market player, created a kind of "ecosystem": to update the database of songs in one's iPod player, it was necessary to use iTunes, and songs legally purchased via iTunes could not be listened to on any other portable music player. The absolute innovation of this approach was the combination of two groups of customers: buyers of Apple computer equipment and music lovers. This simple synergy brought incredible market success. iTunes was launched on April 23, 2003, and within 5 days, 200k digital copies of the single "Stuck in a Moment You

Can't Get Out Of" by U2 had been sold. Interestingly, the single was not a new song, coming from an album released over 2 years earlier (0.5 million traditional CDs sold during the first week of distribution). This phenomenon showed the huge demand for legal digital distribution of music files. For many years, the white in-ear headphones so characteristic of the iPod player were associated by consumers with absolute novelty and an unconventional approach to market challenges. Following the example of Apple's solution, other online stores offering legal songs encoded in MP3 format became common in the first decade of the 21st century.

The second revolution, resulting in a complete revaluation of business models related to the distribution of digital music, was brought about by the appearance of the Spotify service, which can be considered as matching the basic assumptions of Industry 4.0, i.e., widespread digitalization, exchange of large amounts of data, involvement of artificial intelligence in creating individualized offers and, last but not least, the resource sharing that is mentioned in the title of this article. Spotify decided to change the digital way of enjoying music. In 2006, it created a music distribution model based on a monthly subscription fee. It created a system in which there are no files as such, as even "offline" users do not have full access to the musical resources on their devices and therefore cannot copy them illegally, which was the biggest Achilles heel of online mp3 music stores. The basis of the Spotify ecosystem is "data streams" sent "on demand" to specific devices in the network—smartphones, computers, or TV sets. In Spotify's philosophy, its gigantic database of music (over 100m songs) is available "immediately" to anyone interested. This immediate access to the selected music is what is so striking. Spotify uses artificial intelligence that "predicts" what a user's next choice will be, thereby downloading more songs to short-term memory that are available "immediately." An equally important element of the Spotify system is personalization. Each user is given the opportunity to create playlists of songs they are interested in. Algorithms examine listeners' tastes and provide them with new music of a similar kind. The system also features algorithmic recognition of song lyrics (in English), so the user has access to the lyrics of their favorite songs. To make the experience even more attractive, songs are played with a so-called "canvas" visible on the screen (short thematic videos referring to the content of the song).

A major advantage of Spotify's ecosystem is the presence of artists "on the other side" of the interface and their possible engagement in preparing content for listeners. A special "Spotify for Artists" site provides creators with tools to help them present their songs more attractively or even sell and distribute gadgets promoting their releases. From the business point of view, this approach displays elements of a social network site model, namely limited communication with artists, and tools for service users to build their own collections of songs (so-called "playlists"). The commercial success of the Spotify system (and similar ones) is also animated by the participation of artists in the creation of "special content." Artists also get tangible benefits: a fixed royalty for every stream of their songs. The Spotify model has curbed the dominance of huge record companies, which were the main beneficiaries of the traditional models of music distribution. A huge proportion of the music available on streaming services is provided by independent artists and intermediaries. Bypassing large distribution and promotion companies is possible thanks to intermediaries like TuneCore and RouteNote, which publish content on streaming services and assist in obtaining payment. They also provide creators with several basic analytical tools that allow them to constantly monitor changes in the popularity of released content.

The most important element of Spotify's global expansion is its "freemium" model, which offers two types of service access: free and paid. The former provides users with access to the entire library of music but introduces some limitations, such as mandatory audio advertisements, a restricted number of track skips per day, and reduced playlist creation functionality. The paid version offers unlimited access without any additional restrictions (Gunzel & Holm, 2017). In 2019, out of 232 million users, almost 40% chose the

subscription (paid) model. The rest stayed with the "free" version.

Most of the solutions developed by Spotify have been replicated by other streaming platforms which followed the example set by this Swedish company. The largest of them belong to the giants of the technology market: Apple (Apple Music) and Google (YouTube Music). However, there are also some independent platforms like Tidal, Deezer, or Boomplay, which is very popular in Africa. These have replicated Spotify's combination of a subscription model with a "freemium" service, and they also offer additional tools for content creators.

The dark side of the streaming world

Obviously, business models that provide streaming distribution of music content are not risk-free. There is scope for abuse on the part of both consumers of digital goods and creators interested in "quick commercial success."

Music can typically be streamed on different types of devices. These include personal computers with applications dedicated to services like Spotify. For some advanced users, "capturing" music from a streaming application and saving it as a file with no loss of audio quality is not a huge challenge at all. Some online research indicates that there is still a group of people interested in enjoying digital music offline in the traditional way. It is usually those people who engage in the practice of "capturing" streamed music.

In 2016 and 2019, the British Performing Rights Society (PRS) analyzed trends in "streamed music ripping." The review revealed an enormous increase (1,390%) in "stream-ripping," i.e., illegally ripping music directly from streaming channels. Probably due to their great popularity, the most frequently pirated platforms were YouTube Music and Spotify. According to a study published by MusicWatch (2019), in the USA, the phenomenon of illegal music downloads increased significantly in 2018, when the number of stream-rippers increased from 15 to 17 million year on year. The most efficient illegal users downloaded an average of about 112 files per year, which is equivalent to over 10 full music albums. The report's authors point to the economic reasons for this phenomenon and the desire to listen offline without having to subscribe. What is interesting from a social perspective is that both the education and income levels of stream-rippers tend to be high, which challenges the stereotype of piracy as the domain of less-affluent consumers. In the USA, 56% of stream-rippers are male, and 68% are aged 13–34. Nearly half (48%) of them earn between $75,000 and $199,000 per year. They often boast a college degree and are considered "white-collar."

The motivation and attitudes of stream-rippers draw an interesting picture of the public perception of the legality of this phenomenon. Research conducted in the UK identifies the following motives explaining why people "rip" streamed music:

- 37% of stream-rippers claim they want to have a particular piece of music but it is not attractive enough to buy.
- 28% of them believe that an app store suggested downloading an application for "ripping music."
- As many as 46% simply want to listen to music offline.
- 20% consider music to be too expensive (MusicWatch, 2019).

Platforms like Google, App Store, and YouTube do very little to educate and warn against copyright infringement. Therefore, if a given application can be found on these platforms, their users do not see any reason to question its legality.

Streaming platforms also fight against fraudsters who artificially generate hundreds of thousands of plays of songs and build so-called "streaming farms." This method involves using an army of bots (unattended programs pretending to be listeners of the streamed media) that automatically play songs repeatedly, thus multiplying the number of plays and generating illegal income. The average royalty per play on Spotify varies between $0.003 and $0.005 depending on the country. With a sufficient number of streams, the revenue paid out by streaming platforms can be a lucrative target for online fraudsters. There are stories of fraudulent attempts targeting Spotify. In 2017, for instance, a group of Bulgarian hackers generated nearly 500 unique identifiers (ISRCs) for fictitious songs by non-existent artists assigned

to Bulgarian popular music databases and placed them on two playlists on the service. Subsequently, algorithmic manipulation generated millions of virtual plays for both playlists, reaching well over 500,000 streams for each. It took the platform owners months to analyze this case, but they eventually identified the accounts associated with the playlists and shut down the illegal activity (Lee & Lee, 2023).

Although these threats still exist, music piracy rates have been steadily and regularly declining. In December 2021, the European Union Intellectual Property Office (EUIPO) issued a report on copyright infringements on the internet in 2017–2020; this is currently the most up-to-date report covering this area. All the data used in this report was collected and analyzed by several different bodies, one of the most important of which was MUSO (2024), a London-based company providing statistics on digital piracy. Another contributor to the report was the European Audiovisual Observatory, which provided statistical and analytical information on film, television, video/DVD, new audiovisual media services, and public policies related to film and television. This organization, supported by the EU's CREATIVE EUROPE program, has created the MAVISE database of on-demand television and audiovisual services operating across Europe.

The background for the comparisons and statistics was also provided by studies conducted by Eurostat in January 2020. The basis for the calculations was the number of so-called "average internet users," i.e., a sample of 284 million internet users in the European Union aged 16 to 74. The table below shows the dynamics of the availability of pirated content by category in 2017–2020. A noticeable decline was recorded in all areas, and it deepened with each subsequent analyzed year.

Table 1. Average monthly visits to piracy sites, divided into categories in 2017–2020 (annually). Source: own study based on the report of the European Union Intellectual Property Office, December 2021.

YEAR	TOTAL	TV	FILM	MUSIC
2017	-10.9%	-2.9%	-18.9%	-23.5%
2018	-20.1%	-15.2%	-16.4%	-38.4%
2019	-6.3%	-1.0%	-4.7%	-30.2%
2020	-33.8%	-26.9%	-50.6%	-40.9%

What is particularly important for the article's considerations is the trend in music piracy, which decreased by 81% in the analysed period. The graph below shows the changes in each of the examined areas.

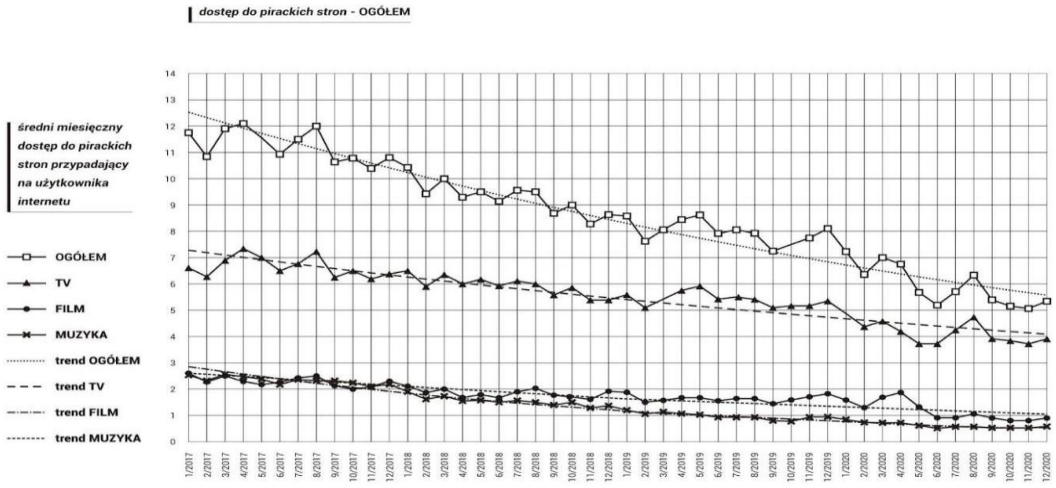

Fig. 1. Average monthly visits to piracy sites per user in EU countries by content type in 2017–2020. Source: own elaboration based on Eurostat.

Compilation and analysis of the data leave no doubt: music piracy has shown a steady downward trend in recent years, while TV and film piracy has shown a more changeable pattern. The graph below shows the evolution of music piracy in EU countries presented by content access method. While in 2017 the illegal downloading of songs took place using the four access methods in almost equal proportions, in 2020 stream-ripping became the dominant method, accounting for half of all illegal activities.

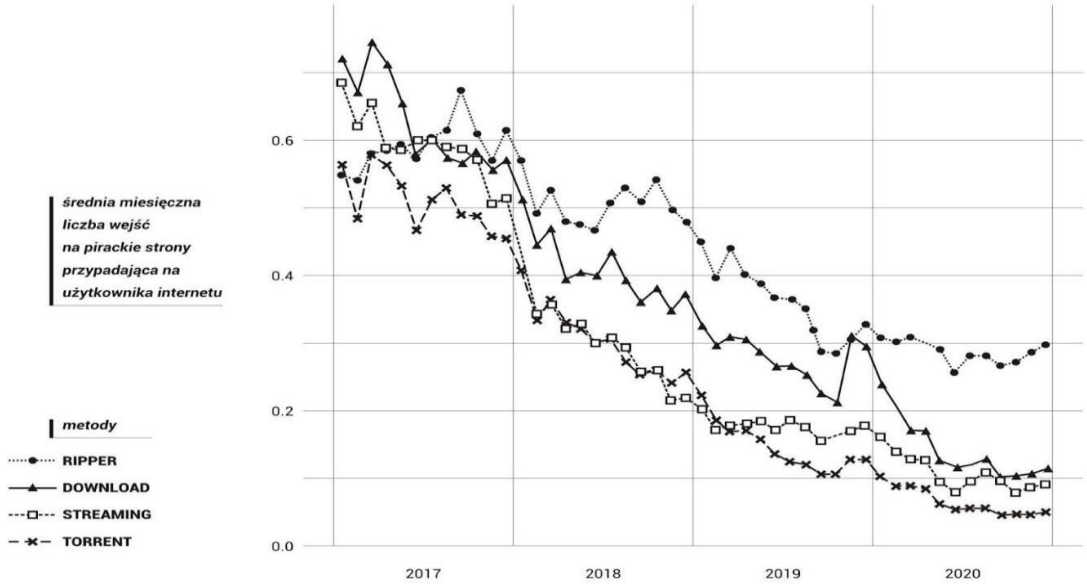

Fig. 2. Trends in music piracy (2017–2020). Source: own study based on the European Union Intellectual Property Office, December 2021.

The downward trends indicated by the studies above began to change again after 2021. As indicated by MUSO (2024), the number of piracy-related website visits increased to 10.8 billion between the first and third quarter of 2021, and it rose to 17 billion in 2023.

According to Wired and TechReport, 40% of piracy cases involved "stream-ripping" (University of Nebraska-Lincoln, n.d.). In its report, *Engaging with Music 2023*, the International Federation of the Phonographic Industry (IFPI, 2023) indicates that 29% of global music consumers admit to piracy, and this figure reaches 43% among listeners aged 16–24. In the same group, as many as 41–43% engage in "stream-ripping." In 2023, the estimated financial loss to the music industry in the United States alone amounted to over $12.5 billion (University of Nebraska-Lincoln, n.d.).

All organizations researching the phenomenon of piracy are asking the same question: Why are we returning to music piracy? The answer seems to be surprisingly simple: it is a matter of people's fatigue with subscription models, especially their rising subscription prices, fragmentation of music catalogues across various platforms (e.g., Apple Music, Spotify, Tidal), regional restrictions, and irritating ads. People are looking for alternative solutions and simplicity. Stream-ripping is fast, free, and, as research shows, easily considered legal.

Music organizations like the International Federation of the Phonographic Industry (IFPI), the Recording Industry Association of America (RIAA), and the British Phonographic Industry (BPI) keep fighting, filing lawsuits against stream-ripping services and demanding their closure. The spectacular shutdown of YouTube-MP3.org in 2017 is a prime example of the effects of their actions.

Stream-ripping organizations, however, are like the proverbial hydra: one gives way to another—more dispersed, decentralized, and difficult to track. In 2024, the IFPI began drawing attention to the fact that content obtained

through stream-ripping is being used to train generative AI models, which further exacerbates the dispute over data rights and the sources of data. Therefore, despite the enormous impact of the subscription models in curbing digital piracy, they do not seem to be a perfect solution. Moreover, the phenomenon of "stream-ripping" is increasingly viewed among the younger generation not as a violation of norms, but rather as a natural generational rebellion against the patterns imposed by music corporations.

Conclusion

The significant reduction in the exchange of illegal audiovisual files was caused by the emergence of legal (and affordable) streaming service providers. Services like Spotify, Apple Music, YouTube Music, and Tidal quickly conquered the market. The widespread availability of attractive multimedia content online, combined with the increased availability of broadband internet, eliminated the need for internet users to download music files. It also contributed to a decline in purchasing legal music as downloadable audio files. This development would not have been possible without a digital revolution, i.e., the development of widespread unlimited bandwidth for internet users.

The phenomenon of music piracy, which had long eluded the efforts of lawyers, law enforcement, and copyright protection organizations, virtually disappeared with the advent of attractive and innovative music players. These devices circumvented the need for users to manually search for and download music content onto a player or mobile phone. The creation of legal ways of obtaining digital content from the internet has reduced piracy significantly more effectively than tightening legal regulations. The legality of multimedia content available on streaming services is often strongly emphasized in their promotional campaigns.

Nowadays, there are at least several major players and tech giants operating on the music streaming market. However, the pioneers are still leading the way, introducing increasingly sophisticated artificial intelligence models that suggest new content and provide their users with new tools that make their streaming offers even more attractive.

The above-mentioned processes resulting from the technological revolution have not eliminated the phenomenon of music piracy, but it has been seriously and effectively reduced. The dark side of "resource sharing" still exists. OECD (2007) reports show that the scale of digital piracy may still be several times higher than the total value of all other (non-digital) counterfeit goods (OECD, 2007).

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