

Can the Digital Surpass the Analog: DAB+ Possibilities, Limitations and User Expectations

Przemysław Gilski and Jacek Stefański

Abstract—Radio is by far the most accessible medium. With its mobility and availability, it attracts listeners by its simplicity and friendliness. The present information situation is characterized by the convergence of computers, mobile devices, telecommunication and broadcasting technologies and the divergence of different ways of delivering and storing media. Consumers are overwhelmed by new electronic gadgets appearing every year. They are astonished by new technical innovations that are being designed to ease their life and change their habits. Even the broadcasting sector itself is facing significant changes, especially a growing competition between the private and public sector. This article reviews the current status of analog and digital broadcasting technologies. It analyzes a case study of user expectations related with today's digital media, particularly radio transmission. We discuss the principal possibilities, limitations and user expectations related with digital audio broadcasting, as well as the economic, technological, regulatory and frequency management factors.

Keywords— audiences, broadcasting, DAB+, digital audio broadcasting, electronic media, radio, telecommunications

I. INTRODUCTION

WITH over two billion receivers operating worldwide, radio transmission is by far the most accessible medium. It has been a part of our lives since the 1920s and has become one of the most trusted and friendly mass media. Today, its popularity is still strong, despite the outcome of many information media, including television, mobile telecommunications and the Internet. In order to transform the radio into a viable medium of the 21st century, it will have to migrate from analog to digital technology domain. It will have to adopt to new means and ways of delivering content, as well as new transport and distribution mechanisms, including terrestrial, satellite and cable communications.

Analog radio is characterized by a predefined set of transmission standards for both AM (*Amplitude Modulation*) and FM (*Frequency Modulation*) terrestrial broadcasting worldwide. In the digital domain, diverse economic interests have led to a multitude of transmission standards for audio broadcasting.

One of the first digital terrestrial broadcasting technology, successfully developed and marked, is the DAB (*Digital Audio Broadcasting*) system. Actively supported by the EBU (*European Broadcast Union*) and widely promoted by the

WorldDAB forum. With an increasing range of receiver terminals that are becoming more affordable, the DAB system has been adopted for terrestrial broadcasting as a replacement for analog FM technology.

II. THE BEGINNING OF RADIO TRANSMISSION

Until the rise of broadcasting technology after 1920, the major application for radio transmission was wireless telephony. At the beginning of the 20th century, rescue operations coordinated by radio telegraphy proved its worth.

A new and quite popular use of radio came a few years after these maritime accidents. In 1916 Frank Conrad, an amateur radio enthusiast and Westinghouse engineer, began regular broadcasts of music from his Pittsburgh home. Other amateurs in the area were able to tune in to his transmission. Westinghouse realized there existed a vast potential market for broadcasting and in November 1920 the company established the first commercial radio station, KDKA. Other local broadcasters had been licensed earlier but not as commercial radio stations. By 1923 more than 500 stations were on the air and by 1929 there were over 4 million radio receivers in use in the United States. Europe and other parts of the world were not far behind. One of the first radio stations, founded in 1932, was the BBC (*British Broadcasting Corporation*). In 1933 Edwin Armstrong invented frequency modulation, a transmission technique that greatly reduced fading and static effects. By 1940 Armstrong had set up an FM broadcast network in the northeastern US.

World War II brought another advance in electronics technology that would eventually be applied to communications, the radar. The British physicist, Sir Robert Watson-Watt, introduced the first practical radar system in 1935 and by 1939 the British military established a network of radar stations to detect air and sea aggressors. In the same year two British scientists, Henry Boot and John T Randall, developed a significant advance in radar technology, the resonant cavity magnetron. The magnetron was capable of generating high-frequency radio pulses with large amounts of power, thus permitting the development of microwave radars.

In September 1940, the British military decided to share its radar technology with the US. The Americans moved quickly and opened the Radiation Laboratory at MIT under the leadership of Lee DuBridge. Radar proved crucial to the Allied war effort and by 1943 the Allies were using radars for early warning, battle management, airborne search, night interception, bombing, and anti-aircraft gun aiming. Wartime radar work yielded important peacetime dividends, especially in the fields of television, FM radio and VHF (*Very High Frequency*) and microwave communication. Today, most kitchens in the developed world use a cavity magnetron in their microwave oven for warming up leftovers [1].

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III. ANALOG AND DIGITAL RADIO TRANSMISSION

At the decline of the 19th century, Guglielmo Marconi conducted his first experiment with wireless telegraphy. Nowadays, two centuries later, analog AM and FM emission standards have achieved technical and operational maturity. Radio transmission reaches over two billion people each day, offering listeners a wide variety of speech and music programs.

However, Nicola Tesla, inventor best known for promoting alternating current power systems, experimented with radio in 1894 and conducted his wireless transmission experiments before Marconi. That is why Tesla should be considered as the biggest pioneer in radio transmission and broadcasting technology. He predicted the mass use for wireless communication over long distances and was also the first person to invent a radio-controlled boat model using FM modulation. By analyzing granted patents it was proven, that Tesla, and not Marconi, invented the wireless radio transmission.

Currently, analog broadcasting standards are failing to provide the audio quality and additional data that people expect in the age of electronic mobile devices. Furthermore, the frequency band for radio emission becomes saturated. The reception quality suffers from interference between mutual transmissions. In many countries worldwide, there is simply no room or additional radio stations and services, due to the lack of free resources.

FM radio services were originally planned in the 1950s and 60s for fixed reception. Users who use a stationary device with an antenna installed outdoors obtain better quality than those with portable or mobile receivers. However, the majority of people listens to radio with exactly portable and mobile devices, equipped with a simple whip or telescopic antenna. In many areas, this results in degradation of FM reception quality. The reception quality can also vary inside large constructions, such as multistory buildings. This attenuation of the signal is caused by many internal reflections from walls and other buildings.

When listening on a portable or mobile device, the radio signal may be also affected by the so-called shadowing effect, related with blocking or screening the signal by tall natural or manmade objects such as hills or buildings which lie in a direct line between the transmitter and receiver. For motorized people, the quality and strength of a FM radio signal degrades with increasing speed.

That is why the main objective of today's international broadcasters is to design and implement novel services based on the most up-to-date delivery systems. It can be either a terrestrial or satellite system, or even a combination of them.

IV. DIGITAL COMMUNICATION TODAY

In the past, radio and the record album were thought to herald the death of live music performance. The VHS (*Video Home System*) and cable television were supposed to end film, whereas photography was supposed to replace painting. None of these innovations led to the end of other previous technologies or forms of art. Instead, they contributed to its spread and helped to create new audiences. The same is with the Internet and other popular electronic media. Electronic media technologies connect people from diverse backgrounds

and provide them with information that otherwise might be unavailable. Today, in the digital world, communication technologies are common in everyday life. These technologies introduce benefits, including almost unlimited access to information, educational resources and entertainment.

V. THE EVOLUTION OF MEDIA

The main factor of the evolution of media are social and cultural changes, as well as technological, particularly related with digitization and convergence of media. Currently available communication services are considered to be in the intermediate phase of their development. All existing media are considered as new or new-media-to-be, as traditional analogue services are being changed into digital.

Media evolution can be examined in terms of technology, economy and culture. From a technological point of view, the limits of existing technology leads to the search for new technological solutions and ultimately the emergence of new technologies. From the economic point of view, either old business models have become unsatisfactory, so the emergence of a new technology requires the development of a new business model that will make it sustainable and profitable. However, diffusion of the new business model leads to an increase in competition and a decline of the margin of profits. From the cultural point of view, social changes lead to new demands for additional or updated services.

The evolution or transformation of traditional media, such as print, film, radio or television, into new media takes place when:

1. Traditional existing media no longer deliver a satisfactory service, for different technological, economical or cultural reasons.
2. Technological innovations change so much, that older notions no longer apply.
3. New forms of media have emerged, with new concepts and audiences.

Some say that all media will one day turn into new media, so the distinction between old and new is only temporary [2]. Newly emerging media did not replace older media, though they have modified their functions and content.

VI. CONTEMPORARY RADIO TRANSMISSION

Nowadays, radio transmission suffers from an increasingly strong competition from other broadcasting and non-broadcasting media, especially television and Internet streaming, as well as mass-storage media.

The first popular mass-storage media was the vinyl disc and the magnetic tape. Their successor, the CD (*Compact Disc*), was the first digital medium to offer high quality in the domestic marketplace. Also new formats have emerged, including DAT (*Digital Audio Tape*), DCC (*Digital Compact Cassette*) and MD (*MiniDisc*), but they did not gain as much popularity. Nowadays, any audio or audio-video content can be stored and shared using a flash drive, HDD (*Hard Disk Drive*), SSD (*Solid-State Drive*) drive, or even an online cloud platform.

A. Terrestrial Broadcasting

Since the 1980s, digital radio broadcasting suffered from a lack of worldwide standard agreement. Different countries

adopted different standards either in place of existing AM or FM services, or in different frequency bands. The most common terrestrial digital radio systems include:

- Eureka 147 DAB described in ETSI 300 401 [3] standard and coordinated by the WorldDAB forum. Its successor, DAB+ (*Digital Audio Broadcasting plus*) [4], offers new features such as a better audio coding algorithm and additional error protection. The rest of the standard has remained unchanged.
- DRM (*Digital Radio Mondiale*) has been designed as a substitute for analog AM and FM radio transmission. It utilizes the same spectrum resources and radio channels. Its updated version, called DRM+ (*Digital Radio Mondiale plus*), covers the VHF range.
- United States HD Radio, a registered trademark for the IBOC (*In-Band On-Channel*), offers digital radio on top of existing analog AM or FM services.
- Japanese ISDB-T (*Integrated Services Digital Broadcasting – Terrestrial*), which provides the listeners with a near CD quality.

B. Satellite Broadcasting

Radio broadcasting by satellite is not a new idea. The main motivation for this type of broadcasting is clearly a high coverage area, since it is possible to cover a continent just with one satellite. The other issue is that the transmitted signal is available to practically all receivers immediately after launch. In case of terrestrial broadcasting, most often there is a set of regional stations connected to a central station. Due to the difference in distance and landform, a delay fix has to be taken into account. Another issue is the economic side, as it may take many years to construct a terrestrial network that will achieve comparable coverage.

The most popular satellite digital radio systems include SiriusXM and World Space. However, in order to receive satellite radio programs, a clear line-of-sight condition between the satellite and a radio receiver has to be provided. In most cases, portable and mobile reception in indoor environments is not possible. Therefore, some researchers insist on developing hybrid satellite-terrestrial systems, aimed at achieving high coverage for portable, mobile and fixed receivers in all types of reception environments.

C. Webcasting

The Internet is an increasingly popular mean of conveying audio content to the general public. Audio streaming services are gaining more and more popularity, with thousands of radio programs available on-demand. Broadcasters are investing heavily in the Internet since nearly all of them have a dedicated mobile application, service or website. In some cases, the major drawback of streaming platforms is their insufficient quality, because in order to listen to high-quality audio content one must purchase a premium account.

Users expect their mobile or desktop devices to provide high-quality connectivity and performance all time. Depending on the service being used, they have varying expectations, the perceived quality does not rely only on the mere speed of a wireless or wired connection. The subjective assessment is based on a combination of factors such as speed, smoothness or latency. Service providers know, the better the experience, the longer and more frequently users will consume content [5].

VII. DIGITAL AUDIO BROADCASTING

The Eureka 147 DAB system has been developed in the 1980s by a European consortium composed of broadcasters, manufacturers, network providers and research institutes. Its main goal is to provide high-quality digital audio and data broadcasting services. It focuses not only on fixed reception, but also portable and mobile reception with simple whip antennas, as well as fast-moving objects such as cars. The system can operate in severe conditions, including dense urban areas. The DAB system is now considered as fully free, it can be manufactured and utilized by any interested third party as long as it fulfills the license conditions.

DAB has several advantages over conventional analog AM and FM broadcasting services. The main benefit is that it can offer higher sound quality compared with analog transmission, indistinguishable from that of the CD. Furthermore, compared with analog, digital broadcasting is nearly free from interference [6].

A. Spectrum Efficiency

The next advantage is that DAB is more spectrum efficient, which means that it is possible to increase the number of radio stations. A single FM radio station occupies a block of 250 kHz, whereas in DAB about 12-15 radio stations can be placed in one 1.5 MHz block. This means that digital DAB radio is at least two times more efficient than analog FM radio. With the advance in audio coding techniques, it will be possible to carry even more radio programs in the future.

Furthermore, due to the use of a SFN (*Single Frequency Network*) architecture, all transmitters cover a particular predefined area with a set of programs on the same nominal frequency, that is in the same frequency block. As a result, the problem of having to retune the radio when traveling from one point to another is eliminated. The desired station will be available on the same frequency everywhere within a nationwide or regional serving area.

B. Flexible Bitrate

The DAB system is a highly flexible and dynamically reconfigurable system. It can accommodate to a large range of bitrates up to 192 kbps. Of course, the higher the bitrate, the better the quality of the audio signal. However, higher bitrates mean that there will be less radio stations in a single frequency block, called the multiplex. Publications on this topic can be found in [7]-[8]. Naturally, some broadcasters will be particularly interested in using especially low audio bitrates per audio channel.

C. Data Services

The DAB broadcasting system, aside from transmitting audio signals, can also be used to carry a large variety of either associated or independent data services in the form of text, still picture or video images. The digital platform offers much more than just audio transmission. These additional services can include:

- Information about the music piece being played, i.e. lyrics, title, author, album cover.
- Various types of entertainment and news, including upcoming events, weather forecast, traffic information, or even stock exchange quotations.
- Advertisements and sale campaigns.

Currently, the majority of broadcasters focus on implementing services such as:

- DLS (*Dynamic Label Segment*) – text information of length up to 128 characters. It requires a simple 2-line alphanumeric text display with 32 characters in each.
- SLS (*SLideShow*) – sequences of still pictures, their order and presentation time are generated by the broadcaster. In particular, this service has the biggest potential to increase advertising revenue.
- EPG (*Electronic Programme Guide*) – a schedule very similar as in TV, which helps the user to find, select and listen to a desired radio station. It can also automatically record or set a particular programmed station. A schedule may be send several days in advance by the broadcaster or updated in any time in order to reflect the changes on air.
- TPEG (*Transport Protocol Experts Group*) – a protocol for traffic or travel information, used to inform about road conditions and traffic jams. It can provide messages in the form of either text, synthesized speech or graphically.

D. Consumer Devices

Many users might be misled by the number of interpretations of the term ‘digital radio’. Almost all households that receive digital TV, whether by cable, satellite or terrestrial transmission, also receive a number of radio stations with that service. That is why listening to a radio station through the TV set may be considered by some as one form of digital radio services. A second form is listening to the streamer radio station on the Internet – this can be also regarded as digital radio. However, it does not mean that every newly bought receiver will enable to tune in to a digital terrestrial radio program.

Currently, there are numerous radio receivers available on the market, some of them described as hybrid receivers. As the term ‘multimedia’ refers to two or more types of media, e.g. audio and video signals, every hybrid device enables to receive radio programs transmitted in two or more techniques, e.g. analog and digital broadcasting. However, this does not mean that with every bought hybrid receiver a user can listen to analog FM and digital DAB transmission, because digital broadcasting can be referred to DAB as well as Internet streaming. That is why it is crucial to acquaint with the technical specification of every purchased device in order to avoid any disappointment or misunderstanding.

In order to receive DAB radio signals, consumers will be obliged to purchase a new receiver. Most of the available devices also contain analog AM or FM circuits. They do not differ much in dimensions or weight from classical analog receivers. Some of them offer additional Internet connectivity possibilities or even a color screen for displaying additional data and multimedia.

The digital radio system offers many advantages over existing analog systems, including:

- Higher sound quality and a more stable reception.
- Simpler program selection tools.
- Services designed as a mixture of classical radio transmission and additional data services, with multimedia as well.
- In the long run, smaller and less expensive devices.

However, we still lack mobile devices, such as smartphones and tablets, with integrated modules enabling reception of terrestrial digital audio content. It is important that the technical capabilities of today’s devices match the features of current and future possibilities that DAB or other digital broadcasting standards have to offer.

VIII. SWITCHING FROM ANALOG TO DIGITAL

Most broadcasters and governments believe that just as most consumer electronics migrate from analog to digital technology, radio will eventually become digital as well. The development of digital radio is very viable, with some countries having a large number of digital radio services available across the whole nation, while other have just a few services.

Within the Internet era, it seems that radio will only survive as an independent medium as long as it goes digital. In the presence of many multimedia services, digital radio should remain freely available in a user friendly way. The success of implementation relies not only on the technological and scientific progress, but also many non-technical factors, including:

- How aware the listeners are of DAB and the features and possibilities it brings.
- How attractive and available are DAB programs to them.
- How can DAB ease or help listeners in everyday life.
- How can DAB coexist with other popular media, mainly television and the Internet.
- How can DAB change the way of perceiving radio as an attractive medium.
- How well is a particular city or country covered with the digital signal.
- How can DAB help the public and private broadcasting sector to enhance their offer.
- How affordable is a DAB receiver and what revenue will it generate for manufacturers and resellers.

Furthermore, from an engineer’s perspective, what are the long term benefits and spectrum savings related with the migration from analog to digital radio. In order to provide a seamless transition between digital and analog radio reception, the system delay should be taken into account when the receiver switches between DAB and FM simulcast programs. It is necessary to monitor the delay of both types of transmission, especially when signaling the current time information.

A. Analog vs Digital Broadcasting

One of the key attributes of traditional analog radio is the ability to receive it in a number of locations, as well as a number of different portable radios located around one household, on a personal stereo or in a car. Currently, it is also possible to listen to digital broadcasted or webcasted radio on many household or portable devices. Recently, different digital radio systems have been developed which replicate all the attributes of analogue radio with a set of additional multimedia services; the DAB system is one of them.

DAB was considered as a potential replacement for analogue FM radio. Like FM, it would offer comparable or higher sound quality, with a range of both national and regional stations.

The advantages that digitalization has to offer is:

- A greater number of radio stations.
- Easier tuning of radio sets.
- Additional information displayed on the screen of a receiver device.

Additional data transmitted alongside the audio signal include numerous multimedia, which make the radio receiver a more sophisticated device, capable of receiving graphical information with an additional ability to store and replay recorded audio content.

Furthermore, DAB requires allocation of new frequency space and a reorganization of the broadcasting system, from one based on allocating particular frequency channels to individual stations, to another in which a wide frequency channel is allocated to a multiplex operator, which then carries a number of radio stations simultaneously on that channel. For the broadcaster, the introduction of DAB requires the conversion of its transmitter network to simulcast existing services, or the negotiation for the carriage of such services with the new multiplex operators. At the same time, the increased capacity of DAB implies that those same services will be competing with a host of new stations carried on the various multiplexes [9].

B. Possibilities of Implementation

A common worldwide transmission standard for digital radio, rather than a national or continental one, would be most preferred. A global standard would lead to mass production of radio receivers, bringing their price to an affordable level for all people. It would also lead to an open market competition, resulting in a wide variety of receiver features and quality.

Of course, DAB or DAB+ is not the only perspective as an AM or FM substitute, nor is it the only competitor. There are many terrestrial and satellite technologies that deliver audio and other content to listeners, including the Internet, DRM, World Space, etc.

While DAB satisfies most requirements of the public and commercial broadcasting sector, i.e. audio quality, performance, spectrum efficiency and interoperability, we must ask is there a global possibility for a success on the market. The interest in DAB, including the cultural and economic circumstances, varies considerably from one country to another. That is why the introduction of DAB requires a combined and synchronized action by all major players on both the national and international level [10].

The coverage of new terrestrial broadcasting services grows rather slowly, but steadily. In order to speed up these investments, it is common to use existing transmitter sites where possible. When talking about the migration from analog to digital broadcasting, the cost of real investments is much higher. Aside from efforts made by manufacturers, it requires a modernization of radio studios, as well as production and archiving facilities.

Of course, simulcasting or migration will affect both the broadcasting and retail markets. The consumer demand for new content and equipment will fuel the audio and electronic industry. New business environments will emerge and the radio industry will grow faster.

C. The Broadcasting Market

The radio market has always been a conglomeration of individual public or commercial companies, focused on meeting the needs of local communities. This pluralism has led to a significant growth at both regional and local levels. In terrestrial broadcasting the industry relies on a group of players, including:

- Content providers – journalists and producers of radio programs and additional content.
- Service providers – network operators and device manufacturers.
- Listeners – the most important chain link, for whom all these efforts are conducted.

Of course, the current business model allows to create new partnerships across the industry, leading to a greater competition and development in the market [11]. However, there is a slight lack of interest from the commercial sector when it comes to migrating to DAB.

The major cause of insufficient sales of DAB receivers is clearly:

- The lack of consumer awareness and interest.
- The distraction caused by many available electronic products, including mobile phones and tablets.
- A limited offer and high initial price of consumer devices.

Due to the wide possibilities of regionalizing radio programs, there is a possibility that some radio stations will not have such a wide coverage as they used to have in analog radio. In fact, their reach might initially decrease. This will surely increase the competition between commercial players, who may have to share a single multiplex, as higher transmission quality leads to the decrease in the number of radio stations. Once DAB gains popularity and recognition, the potential for a financial gain will continue to grow.

IX. USER EXPECTATIONS SURVEY

There are scientific papers and reports concerning the popularity of different electronic media, including the three most popular among them, that is radio, television and the Internet. They provide a comprehensive snapshot of young people's use of electronic media from early childhood through to teenage years, and parent's views about that media use. They focus on understanding the role of media and communications in the lives of children, young people and families [12]. Other [13] analyze a range of electronic resources, including video-based instructions, that are used to promote cyber safety to young people at school. They focus on programs that use electronic media in Internet safety initiatives in schools. Authors analyze preferences and basic user activities, but none of them focused on digital broadcasting systems.

Bearing in mind that DAB+ has been launched in our country over two years ago, we decided to carry out a survey considering user expectations. We have asked a group of 100 people, consisting of students of our University. The surveyed students represent a group of young people between 18-25 years old. It seemed quite interesting to learn what are their particular needs and expectations related with popular electronic media, especially analog and digital radio transmission. The study was conducted in April 2015 in the

form of a questionnaire, consisting of open and closed questions with single and multiple choices. Each student filled the questionnaire individually before starting classes.

A. Audibility

In the group of 100 surveyed students, 72% of them listens to radio regularly (Fig. 1), where 53% of them prefers Internet radio, so-called streaming, 43% chooses analog radio and 4% digital radio (Fig. 2).

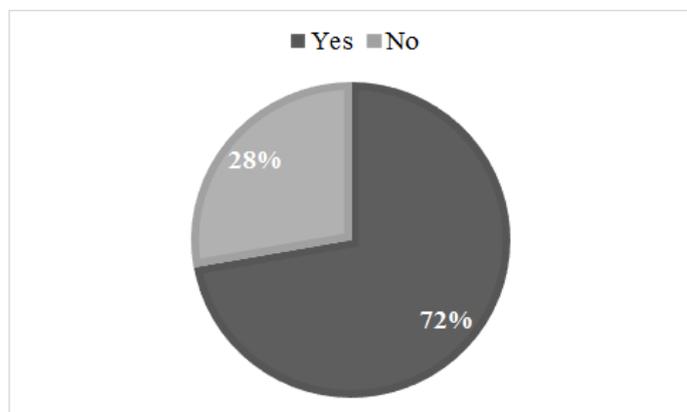


Fig. 1. Radio audibility.

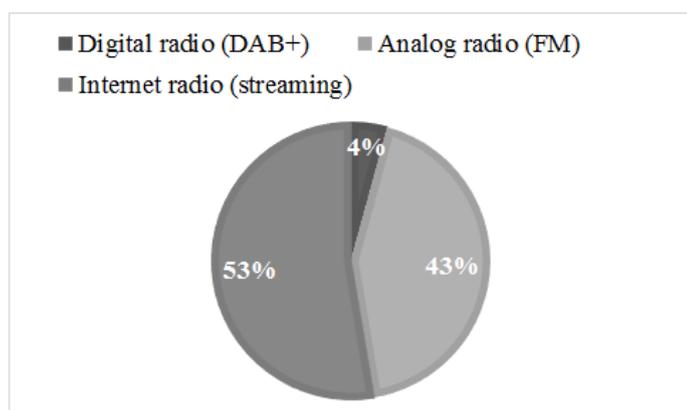


Fig. 2. Popularity of Different types of radio broadcasting techniques.

It should be noted that for many years, the mayor way of modernizing and developing radio, was the Internet. It raises a question – should radio stations, present in many streaming platforms in the global network, be considered as competition for either analog or digital broadcasting transmission.

When it comes to streaming of audio content, the quality depends on many factors, including the type of medium (wired or wireless), its bandwidth, bitrate and network load, which is proportional to the number of simultaneously active users. In case of mobile devices like smartphones or tablets, a crucial factor is the limit of a mobile data plan. On the other hand, both analog and digital broadcasting are always available in the so-called ether. Terrestrial broadcasting is freely available for anyone and puts less stress on the mobile device, which is clearly visible in the extend of battery life. Furthermore, the quality remains the same, regardless of the number of active users.

Another issue is still a small number of available digital radio receivers on the market, either mobile or stationary. Nevertheless, it seems to be just a temporary state, since these types of devices will gain interest of both manufacturers and resellers.

When it comes to the most popular genres, which resembles the profile of a radio station, 41% declared rock, whereas other genres such as metal, electronic music, rap, classicist music gained 13%, 15%, 11% and 12% respectively.

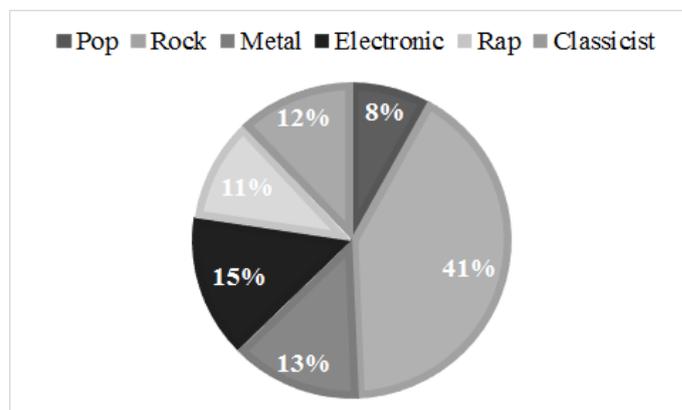


Fig. 3. Popularity of different music genres.

Surprisingly, only 8% declared pop as their favorite music (Fig. 3).

B. Mobile and Portable Devices

According to the study, a vast majority, being 91%, of students listens to music using a portable or mobile device (Fig. 4).

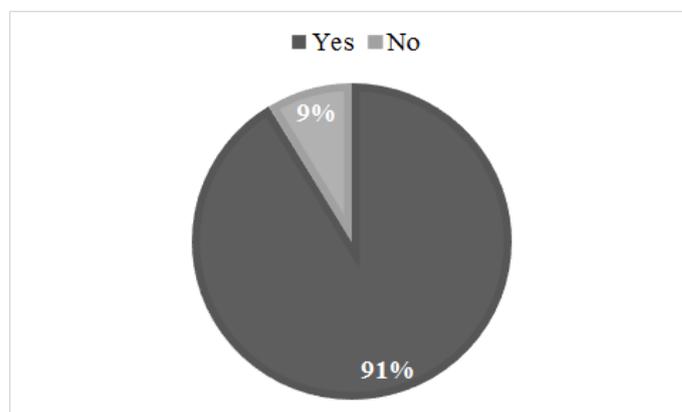


Fig. 4. Listening to music using a portable or mobile device.

Portable and mobile devices offer benefits that are not available for stationary ones. They provide new opportunities, including many additional services and a more flexible reception. As the market matures, there will be an increase in demand for new multimedia services.

The most popular device is the smartphone with 45%, whereas other devices such as laptops, MP3 and MP4 players acquired 20%, 17% and 10% respectively (Fig. 5).

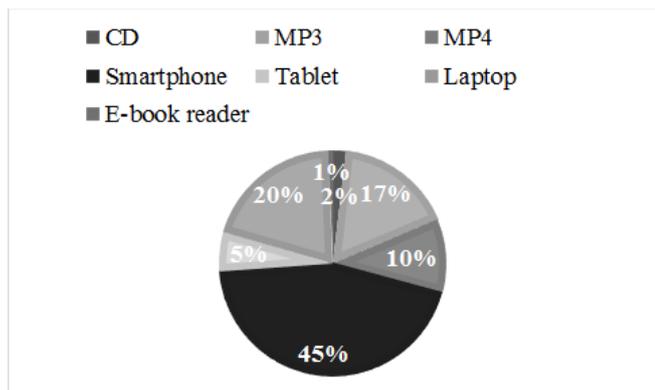


Fig. 5. Most popular portable and mobile devices.

Only 5% and less uses a tablet, CD player or e-book reader for this kind of activity.

C. Program Offer

Students were asked the following question – is it necessary, under current market situation, to introduce new radio programs. The answers divided quite fairly, 46% said yes, whereas according to 54%, the current program offer meets their needs (Fig. 6).

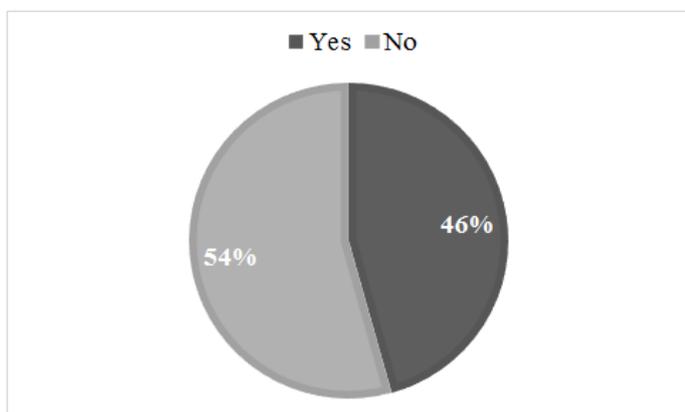


Fig. 6. Need for a broader radio program offer.

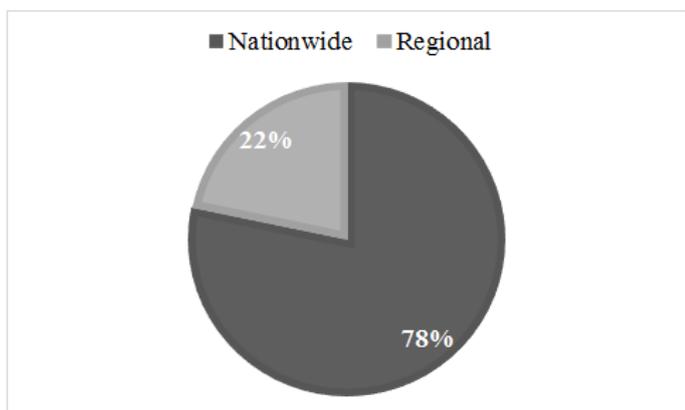


Fig. 7. Need for a new radio station.

Within the group of 46%, 78% of them declared that new radio stations should provide nationwide coverage, whereas 22% would prefer a new regional broadcast station (Fig. 7).

When it comes to the profile of a radio station, 50% of the surveyed group responded that they expect that broadcasters

should introduce new sounds into the current offer. On the other hand, 36% would prefer new music radio stations, whereas 14% would prefer an informative station (Fig. 8).

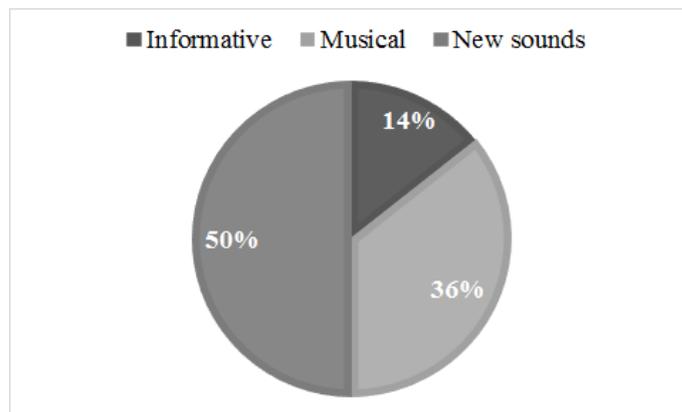


Fig. 8. Desired profile of a new radio station.

When analyzing the situation of European broadcasters one can notice, that the number and offer of local broadcast stations is much broader than nationwide stations. It could be assumed, that a smaller range should result in a smaller number of users. However, there is a possibility that lower costs of broadcasting in digital, compared with broadcasting in analog, will contribute to an increase in the activity on a regional level. This will enable local journalists and news agencies to pursue their passions in making news reports, which nowadays cannot be realized due to limited bandwidth.

D. Transmission Parameters and Additional Services

Users were asked to rank parameters that digital radio has to offer, according to their relevance (Fig. 9).

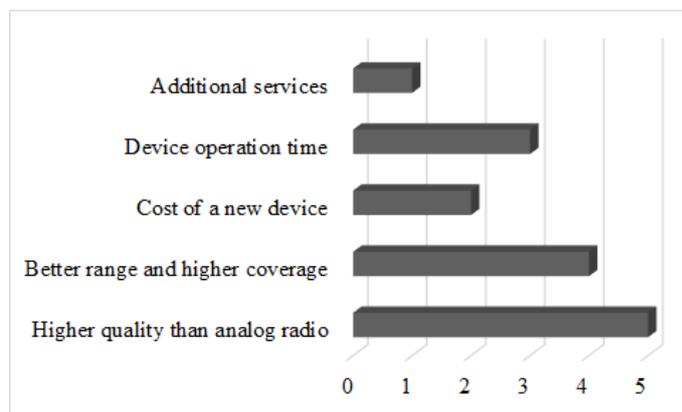


Fig. 9. Most significant parameters of digital radio transmission and consumer receivers (higher = better).

The highest priority was assigned to higher transmission quality with respect to analog radio. The later were related with a better range and higher coverage, device operation time, cost of a new device and additional services.

Considering additional services that DAB+ can offer, the most interesting were additional information (i.e. information about the title, author, album, etc.), traffic information, programmable recording, electronic program guide, weather forecast and slide show (i.e. the cover of a music album) (Fig. 10).

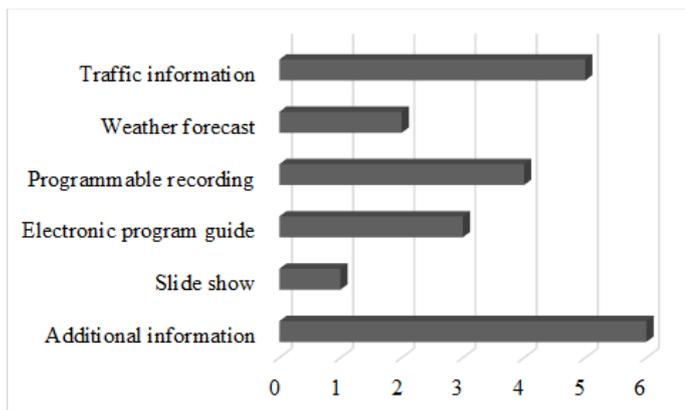


Fig. 10. Most significant additional data services (higher = better).

If supplementary traffic information would be freely available to anyone, 74% of the surveyed would use it. Therefore, future efforts should focus on combining DAB features with the GPS (*Global Positioning System*) navigation system, in order to inform the driver about current traffic condition or weather hazards.

E. Broadcasting vs Streaming

The Internet is a very popular medium of sharing audio, particularly music, to the general public. Practically all broadcasting radio stations have their own website, simultaneously transmitting audio online. Due to spectrum limitations, the number of Internet streaming platforms and radios grows rapidly every year. According to the study, 80% of the surveyed students frequently use streaming platforms for listening to music (Fig. 11), with 92% of them being free services.

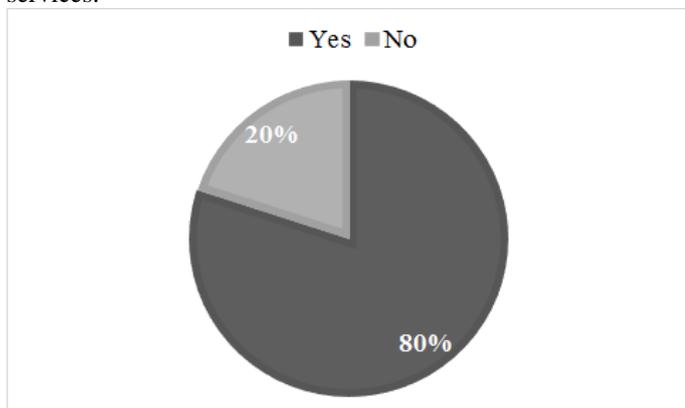


Fig. 11. Listening to music using streaming platforms.

Streaming platforms offer radio programs of both major traditional radio networks and newcomers, including larger media groups and smaller independent radio companies that have been left out of the analog environment. The main reason of using these type of services, instead of classical terrestrial radio transmission, is clearly the availability and ease of use (Fig. 12).

Users also responded, that streaming services provide a richer program offer and since they frequently use mobile devices, it is not any problem to choose a station on demand. Another issue is obviously a lack of analogous or similar offer in terrestrial broadcasting. Furthermore, in their opinion, in case of streaming platforms, commercial ads are less common.

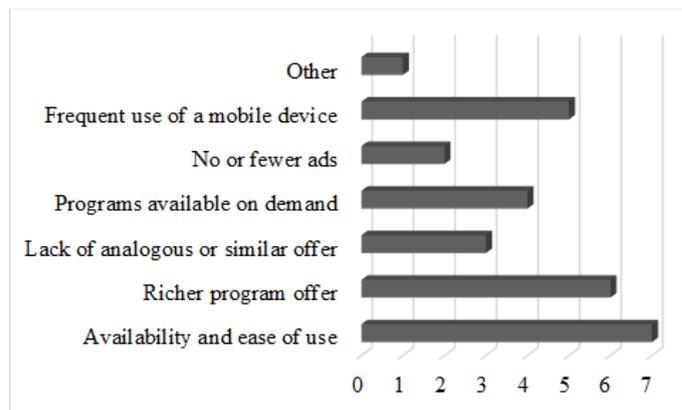


Fig. 12. Factors that attract listeners to streaming platforms (higher = better).

X. SUMMARY

A question arises, whether radio will maintain as an audio medium or a multimedia medium. Many alternative technologies of delivering content and information have emerged in recent years, with different advantages and disadvantages. As listeners we can be sure, that radio has and will have an impact on our lives as an important companion. Broadcasters will always aim to use the best possible means to reach the audience in the most effective way. The presented situation is still under development. While the radio industry is continually changing, the technological possibilities are changing even faster.

Can the digital really surpass the analog? All systems mentioned in this article have their strengths and weaknesses. Broadcasters should consider the future of digital radio broadcasting, in the context of other developing media that are potentially capable of providing high coverages and high quality services. Naturally, the first candidate are terrestrial and satellite systems, the second candidate is the Internet. At present, there are already thousands of radio stations available online, providing access to information worldwide. New and updated on demand multimedia services may also emerge with the development of next generation networks.

The DAB/DAB+ system, currently not only an European but also an international standard, has all that it needs to become a very successful product on the market. This potential has many reasons. Governments and public institutions are having a hard task of sharing the radio spectrum between existing and new broadcasters in a fair way. As a more efficient system, DAB+ can offer much more than standard analog radio, due to higher quality and an opportunity of delivering other data and multimedia services.

Broadcasters, journalists, manufacturers and network providers need to continue their mutual cooperation to investigate how digital radio can be used optimally for new applications which will be attractive for listeners. A closer cooperation between all key participants is required in order to obtain a more unified approach.

The main challenge for DAB+ still seems to be the identification of the most attractive useful data services, that would offer added value over existing FM radio services, considering the expectations of today's and future radio listeners. The choice and availability of different types of digital radio receivers is also expanding. New hybrid receivers,

combining different analog or digital reception technologies, could ensure higher compatibility and user satisfaction.

In many countries, there exist numerous local and community broadcasters, e.g. small stations covering the campus or a small village. Their strength is that they represent a low-cost solution and provide the local community with news and information. These small broadcasters also have the opportunity to migrate to digital radio just as any other broadcaster. However, local and community broadcasters have specific requirements, including small coverage, independent location and a limited budget. Digital radio has a wide variety of ways of defining the multiplex. The number of stations and their transmission quality can be shaped as desired. The remaining capacity could be split between numerous data and multimedia services. It is clear that different markets will develop diverse applications. Further study is required to determine the ideal strategy for introduction of any broadcasting technique.

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