NEW TECHNOLOGIES IN SOCIAL AND MARKETING COMMUNICATION

Edited by SŁAWOMIR GAWROŃSKI, MARCIN SZEWCZYK, ŁUKASZ BIS

New technologies
in social and marketing communication

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Introduction

This publication is the second scientific monograph published as a result of the Multimedia & Communication in Education & Science project, carried out within the framework of the Academic International Partnership Program. It was being implemented from 2019–2022 by the School of Computer Science and Management in cooperation with Pan-European University n. o. (Slovakia), Vidzeme University of Applied Sciences (Latvia) and the College of Entrepreneurship and Law (Czech Republic). Researchers, teaching staff and students (3rd level of education) from all four institutions were involved in the project.

The publication has been published in both hard book cover copy and an electronic form to reach the international scientific community as widely as possible and to disseminate the research work also to companies in the field of new communication technologies and entities that educate in these areas. The scope of the publication includes such topics as IT development, artificial intelligence, augmented reality, virtual reality, e-commerce, big data, chatbots, voice search, interactive content, smart bidding in Google Ads. The individual texts in this monograph refer to the above-mentioned issues, moreover, they do so basing on current data and research that had been conducted in recent years.

All in all, this publication, referring primarily to the use of new technologies in social communication and marketing communication, is an internally varied work, primarily due to its diverse research approaches, original and up-to-date results, as well as a diverse and in-depth range of conclusions, opinions and evaluations of researchers. In our opinion, it provides a good basis (as precise as it is the-

matically broad) for further work in the field of new communication technologies.

We hope that, according to our assessment, this monograph will be well received by theoreticians and practitioners of new communication and media technologies, social communication and marketing communication due to its timeliness, evocation of new concepts and trends, as well as addressing issues relevant at the level of modern media communication.

Sławomir Gawroński, Marcin Szewczyk, Łukasz Bis

Comparative analysis of development trends in the Internet media market in the Czech Republic and the Slovak Republic

Marcel Lincényi[1], Ivana Bulanda[2], Jaroslav Světlík[3]

Abstract: The main goal of the research study was a comparative analysis of the development trends of the Internet media market in the Czech Republic and the Slovak Republic for the continuous period from 2010 to 2019. The authors analysed the development of the media market in both countries based on the development of Internet advertising. Among other things, the research showed a gradual increase in Internet media in the Czech Republic and the Slovak Republic in 2010–2014, with a gradual slowdown in the growth of real Internet users in 2015–2019. The research also showed a clear trend of growth in Internet advertising in both monitored countries, which was higher in the Slovak Republic than in the Czech Republic during the observed period.
Key words: media, Internet, Czech Republic, Slovak Republic, analysis, advertising, attendance

1. Introduction

Internet of Things (IoT) is a rapidly growing technology that has drastically contributed to the Industry 4.0 realization. IoT pursues to pervade our everyday environment and its objects, linking the physical to the digital world and allowing people and "things" to be con-

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2 PhDr. Ivana Bulanda, PhD., Department of Marketing, University of Entrepreneurship and Law, Všpp a.s. Praha, ivana.bulanda@vssp.cz, ORCID: 0000-0002-4633-3789.
3 Prof. Ing. Jaroslav Světlík, Ph.D., Department of Marketing, University of Entrepreneurship and Law, Všpp a.s. Praha, jaroslav.svetlik@vssp.cz.

nected anytime, anywhere, with anything and anyone ideally using any network and service[4]. The Internet has significantly influenced the development in the world and is now regarded as the main communication channel – an information medium, which triggered massive changes in the area of trade, marketing and communication[5]. The Internet can convey information and in such form as – audio and video recordings and the quality that traditional media fail[6]. Several authors point to the growing importance of social media in the business world and in the lives of individuals[7,8]. Social media is one of the fastest growing communication technologies in the Internet environment[9]. Social media marketing refers to Internet-based online media

4 Lampropoulos, G. & Siakas, K. & Anastasiadis, T.: *Internet of Things in the Context of Industry 4.0: An Overview*. International Journal of Entrepreneurial Knowledge, 7(1), 4–19. https://doi.org/10.2478/ijek-2019-0001, p. 4.

5 Bulanda. I. et al.: *Slovak consumers from generation Y and their shopping behavior on discount portals*. In: International Scientific Days 2018: "Towards Productive, Sustainable and Resilient Global Agriculture and Food Systems". Conference Proceedings, Nitra May 16-17, 2018. Praha: Wolters Kluwer, 2018. ISBN 978-80-7598-180-6, p. 275–287.

6 Vavrečka, V. & Mezuláník, J.: *Digital marketing communication tools in the process of implementation of marketing strategy of the tourist area Jeseníky – East*. In Marketing Identity – Digital Life part I., Trnava: FMK, ISBN 978-80-8105-779-3, p. 374–388.

7 Ferencakova, L. & Gajdka, K. & Netek, V. & Kapoun, P.: *Engaging customers on Facebook coffee shops' brand – fan pages*. In International Journal of Entrepreneurial knowledge, 2020, Vol. 1, No. 8, p. 65–75. ISSN 2336-2952. Available at: https://www.ijek.org/index.php/IJEK/article/view/110/95

8 Rybanská, J. & Košičiarová, I. & Nagyová, Ľ.: *Negative psychological aspects of consumer behaviour in the digital age*. In: Matúš, J., Petranová, D. (eds.): Marketing Identity – Digital Life – part II. Trnava: Faculty of Mass Media Communication, University of SS. Cyril and Methodius in Trnava, 2015, p. 220–232. Available at: https://www.ceeol.com/search/article-detail?id=477563

9 Kádeková, Z. & Holienčinová, M.: *Influencer marketing as a modern phenomenon creating a new frontier of virtual opportunities*. In: Communication Today, 2018, Vol. 9, No. 2, p. 90–104. Available at: https://www.communicationtoday.sk/influencer-marketing-as-a-modern-phenomenon-creating-a-new-frontier-of-virtual-opportunities/

in which individuals with common interests, goals, and practices engage in social interactions constructing personal profiles and sharing information and experiences[10].

The Internet in Central Europe is still growing, as it is becoming part of the life not only of the young generation, but of almost the entire population[11]. The authors therefore decided to focus on describing the main development trends of the Internet market in the Czech Republic and the Slovak Republic, which will be analysed on the basis of Internet media visit rate and the volume of Internet advertising.

2. Literature Review

Although the Internet is a very dynamic environment, the Internet media market in Slovakia has been stable in recent years, as evidenced by the fact that in the top twenty there are practically the same web portals, only their order sometimes changes.

For the analysis of the volume of Internet advertising in the Czech Republic in the years 2010–2019, we will use data from the survey of advertising performance of Internet advertising, which is carried out for SPIR by the Median agency. Association for Internet Development in the Czech Republic, z.s.p.o. (SPIR) is a professional association operating in the field of the Internet since 2000. At present, the membership base of the association consists of 46 members. In

10 Švajdová, L.: *Modern Marketing Communication in Tourism*. In: Journal of International Business Research and Marketing, 2019, vol. 4, no. 2, p. 20–23. Available at: https://www.researchgate.net/profile/Bojan_Obrenovic/publication/335517257_Modern_Marketing_Communication_in_Tourism/links/5d6a1515485150886013ba7/Modern-Marketing-Communication-in-Tourism.pdf

11 Civelek, M. & Gajdka, K. & Světlík, J. & Vavrečka, V.: *Differences in the usage of online marketing and social media tools: evidence from Czech, Slovakian and Hungarian SMEs*. In: Equilibrium. Quarterly Journal of Economics and Economic Policy, 2020, Vol. 15, No. 3, p. 537–559. Available at: http://economic-research.pl/Journals/index.php/eq/article/view/1810

addition to conducting a unified widely respected research of traffic and sociodemographic profile of Internet visitors NetMonitor, implements the project of monitoring Internet advertising AdMonitoring, analysis of the impact of advertising campaigns AdAudit, professional conference on Internet marketing IAC[12].

For the analysis of the volume of Internet advertising in Slovakia in the years 2010–2019, we will use the data of the Association for Internet Advertising (IAB Slovakia), which is the largest association for Internet operating in the Slovak digital market, which operates a single independent audited ranking of Slovak Internet media. 2007 annually evaluates the volumes of Internet advertising. IAB Slovakia data on Internet advertising volumes consist of the media-net-net value of advertising on IAB Slovakia member servers and a qualified estimate of IAB Slovakia's revenues from Slovak and international non-member servers[13].

We carried out an analysis of the development of Internet media traffic in the Slovak Republic on the basis of the results of AIMmonitor, which provides data on Internet media traffic and the socio-demographic profile of Internet users. AIMmonitor measurement is realized through the system of gemiusAudience™, which main components are: the gemiusTraffic measurement system, which allows you to monitor the use of the website using collection scripts embedded in the source code of the site. This system measures the number of visitors (cookies), views (PV), time spent and movement on the site, as well as the technical parameters of the equipment used, etc. a pop-up panel that collects socio-demographic indicators of site visitors[14].

12 SPIR: *O sdružení* [online]. 2020 [25.2.2021]. Dostupné na: https://www.spir.cz/o-sdruzeni

13 IAB Slovakia: *O nás.* [online]. 2020 [25.2.2021]. Available at: https://www.iabslovakia.sk/o-nas/ IAB Slovakia. 2020. AIMMONITOR [online]. 2018 [25.2.2021]. Available at: https://www.iabslovakia.sk/aimmonitor/

14 IAB: *Slovakia*. (2020). Dáta IABmonitor. [online]. 2020 [25.2.2021]. Available at: https://monitor.iabslovakia.sk/

We analysed the development of Internet media traffic in the Slovak Republic on the basis of data from real users. For spatial reasons, we compared the individual years on the basis of data in January, in order to fulfil the basic rule of the research method to compare what is comparable. The authors are aware that when calculating the share of the Internet media market within individual months during the year, there were smaller deviations, either in decrease or increase, but these were not so significant, as the order of these Internet media did not change in any year[15].

3. Methodology

The main research goal was a comparative analysis of the development tendencies of the market of selected Internet media in the Czech Republic and in the Slovak Republic for the observed period in the years 2010–2019.

The secondary research goal was the analysis of the development of the size of the media audience of selected Internet media in the Czech Republic and in the Slovak Republic for the monitored period on the basis of data on Internet media traffic.

Another secondary research goal was the analysis of the development of the volume of Internet advertising in the Czech Republic and in the Slovak Republic in the years 2010–2019.

As part of further research planning and design, we preferred the concept of research questions, in which we identified one main research question (RQ), which we developed into three other specific research questions:

15 IAB Slovakia: *O nás*. [online]. 2020 [25.2.2021]. Available at: https://www.iabslovakia.sk/o-nas/ IAB Slovakia. 2020. AIMMONITOR. [online]. 2018 [25.2.2021]. Available at: https://www.iabslovakia.sk/aimmonitor/

Main research question: What were the development tendencies of the market of selected Internet media in the Czech Republic and in the Slovak Republic in the observed period in the years 2010–2019?

Specific research question 1: What is the development of Internet media traffic in the Czech Republic and in the Slovak Republic in the observed period?

Specific research question 2: What is the development of the volume of Internet advertising in the Czech Republic and in the Slovak Republic in the observed period?

Specific research question 3: What are the similarities and differences in the development tendencies of the market of selected Internet media in the Czech Republic and the Slovak Republic in the observed period?

3.1. Research methods

In the research, we have used a combination of several methods: economic analysis, comparative analysis, forecasting. As a part of the economic analysis, we analysed the monitoring of Internet advertising of all monitored advertising Internet media and also analysed real Internet users. As stated by Trampota[16], the analysis of advertising revenues, the so-called advertising monitoring is of a quantitative nature. The volume of advertising is one of the essential indicators according to which the degree of concentration in the media market (increasing the market shares of media operators) is assessed. After collecting statistical data, we further subjected these data to the process of verification, selection and classification.

Subsequently, in a comparative analysis, we compared individual data across the observed period in the years 2010 to 2020 and also within both countries. For a clearer presentation of the results

16 Trampota, T. & Vojtěchojvská, M.: *Metody výzkumu médií*. Portál. ISBN 978-80-7367-683-4.

of the comparative analysis, we processed the data in the form of graphs.

We further subjected the data to the analysis of time series, as well as to the analysis by Pearson's correlation coefficient, which showed us the identified statistical dependence between the development of viewership and the volume of Internet media advertising between the two countries.

Finally, we set a forecast of the behaviour of the Internet media market in the Czech Republic and the Slovak Republic for the coming years.

4. Empirical results and discussion

In this part, we analysed the development of Internet media traffic in the Czech Republic and in the Slovak Republic in the period under review. We also analysed the development of the volume of Internet advertising in the Czech Republic and in the Slovak Republic in the period under review.

4.1. Analysis of development tendencies of the internet media market in the Czech Republic

4.1.1. Analysis of the development of the volume of Internet advertising in the Czech Republic

The volume of Internet advertising in the Czech Republic in 2019 reached more than 34 billion crowns. This is the highest volume of clients' investments in online advertising so far, with the largest year-on-year absolute increase of CZK 5.8 billion. Compared to 2018, this is a 20% increase, in which display advertising (+20%) and search advertising (+23%) contributed the most in absolute values. From the point

of view of the way of advertising space trading, the programmatic purchase of display advertising grew by 25%[1].

The volume of Internet advertising in 2018 reached more than 28 billion crowns. Compared to 2017, this is a 23% increase, in which display advertising and search advertising contributed the most in absolute values. The programmatic purchase of display advertising increased by 54%[2].

The volume of internet advertising in the Czech Republic in 2017 reached more than 23 billion crowns. Compared to 2016, this is an 18% increase, in which display advertising and search advertising contributed the most in absolute values[3].

The volume of Internet advertising in 2016 reached almost 20 billion crowns in list prices. Compared to 2015, this is a 31% increase, which is mainly due to increased investment in advertising in search, on content networks and the purchase of advertising space in the form of RTB[4].

The volume of Internet advertising in 2015 reached 15 billion crowns. Compared to 2014, this is a 3% increase, which is mainly due to increased investments in advertising on search and content networks, video advertising, RTB and mobile display advertising[5].

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1 SPIR: *Online byznys hlásí rekordní investice do reklamy: 34 miliard v roce 2019*. [online]. 2020 [25.2.2021]. Dostupné na: https://www.spir.cz/online-byznys-hlasi-rekordni-investice-do-reklamy-34-miliard-v-roce-2019

2 SPIR 2019. 28,6 miliard korun investovali zadavatelé do internetové reklamy v roce 2018. Více než polovina obchodů proběhla programaticky. [online]. 2019 [25.2.2021]. Available at: https://www.spir.cz/28-6-miliard-korun-investovali-zadavatele-do-internetove-reklamy-v-roce-2018-vice-nez-polovina

3 SPIR: Internetová reklama hlásí rekordní investice za loňský rok: více než 23 miliard korun. [online]. 2018 [25.2.2021]. Available at: https://www.spir.cz/internetova-reklama-hlasi-rekordni-investice-za-lonsky-rok-vice-nez-23-miliard-korun

4 SPIR: Internetová reklama hlásí rekordní investice za loňský rok: téměř 20 miliard korun [online]. 2017 [25.2.2021]. Available at: https://www.spir.cz/internetova-reklama-hlasi-rekordni-investice-za-lonsky-rok-temer-20-miliard-korun

5 SPIR: Zadavatelé v loňském roce investovali do internetové reklamy 15 miliard korun [online]. 2016 [25.2.2021]. Available at: https://www.spir.cz/zadavatele-v-lonskem-roce-investovali-do-internetove-reklamy-15-miliard-korun

The volume of Internet advertising in 2014 reached 14.6 billion crowns. Compared to 2013, this is a 10% increase, which is mainly due to increased investments in search advertising, banner display advertising and video advertising[6].

As in previous years, Internet advertising recorded a double-digit increase in 2013. According to the SPIR estimate, advertising expenditures in various forms of online promotion reached CZK 13.3 billion last year, and a further 15% growth is expected this year[7].

Expenditures on Internet advertising in 2012 exceeded 11 billion crowns. Compared to 2011, this is a quarter of the increase, which confirmed the position of the Internet as the most dynamic media type in advertising, accounting for 17% in the overall distribution of advertising investments[8].

Investments in Internet advertising grew again in 2011, with display and performance advertising remaining the most popular forms. Altogether, the Internet in 2011 earned almost 9 billion crowns from domestic advertisers[9].

In 2010, the Internet collected a total of 7.7 billion crowns from domestic advertisers. Last year, advertisers invested over CZK 4.5 billion in display advertising in the Internet, and in catalogue advertising it was CZK 985 million at list prices (so-called gross) prices. In PPC systems

6 SPIR: Zadavatelé v loňském roce investovali do internetové reklamy 14,6 miliard korun [online]. 2015 [25.2.2021]. Available at: http://www.inzertnivykony.cz/download/TZ_inzertni_odhady_SPIR_2014.pdf

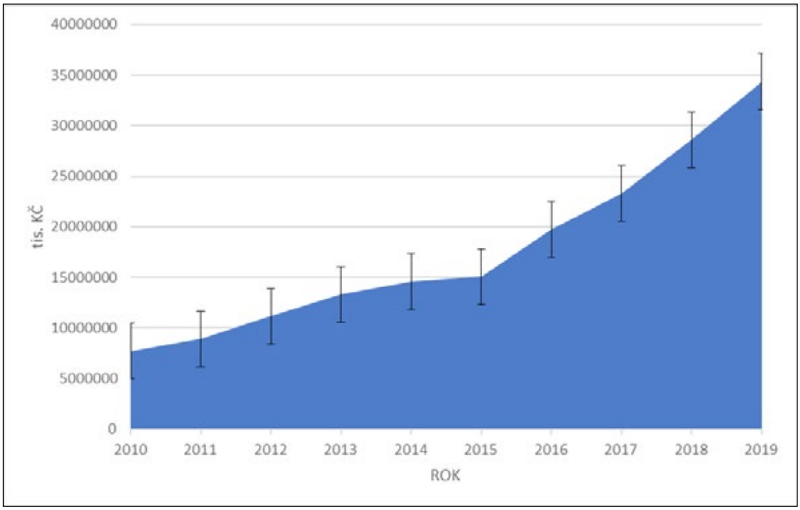
7 SPIR: Internetová inzerce loni přesáhla 13 miliard, za posledních pět let vzrostla dvojnásobně. [online]. 2014 [25.2.2021]. Available at: http://www.inzertnivykony.cz/download/TZ_inzertni_odhady_SPIR_2013.pdf

8 SPIR: TZ V internetové reklamě je přes 11 miliard korun a její objem dále roste. [online]. 2013 [25.2.2021]. Available at: http://www.spir.cz/tz-v-internetove-reklame-je-pres-11-miliard-korun-a-jeji-objem-dale-roste

9 SPIR: Internetová reklama nadále poroste i v roce 2012. [online]. 2012 [25.2.2021]. Available at: http://www.spir.cz/internetova-reklama-nadale-poroste-i-v-roce-2012

(pay-per-click, performance advertising), advertisers spent almost CZK 2.2 billion in real (so-called net net) prices[10]. More graph no. 1.

Graph 1:
Analysis of the development of the total volume of Internet advertising in the Czech Republic (in CZK) in the years (2010–2019)



Source: Own processing based on SPIR data

10 SPIR. TZ Internetová reklama hlásí 7,7 mld. korun za loňský rok [online]. 2011 [25.2.2021]. Available at: http://www.spir.cz/tz-internetova-reklama-hlasi-7-7-mld-korun-za-lonsky-rok

4.1.2. Analysis of the development of Internet media traffic in the Czech Republic

The Czech Internet traffic in January 2010 reached 5,521,813 real users from all over the Czech Republic. This follows from the project of measuring the traffic of the Czech Internet carried out by the company MEDIARESEARCH for the Association for Internet Advertising[11].

In January 2011, 5,873,635 million users from the Czech Republic visited the Internet servers involved in the NetMonitor project, and they viewed 7.93 billion pages[12].

The research of Internet traffic in the Czech Republic SPIR-NetMonitor shows that in January 2012, 6,214,328 real users were registered with the size of the Internet population of the Czech Republic (6,360,623)[13].

In January 2013, almost 6.5 million users (6,425,762) from the Czech Republic visited the website involved in the NetMonitor research. Czech users generated more than 9 billion-page views on the measured pages[14].

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11 MEDIARESEARCH: *Návštěvnost českého internetu v únoru 2010*. [online]. 25.3.2010. [25.2.2021]. Available at: https://www.nielsen-admosphere.cz/wp-content/uploads/2016/03/tz-navstevnost-ceskeho-internetu-v-unoru-2010.pdf

12 NetMonitor: *TZ Návštěvnost českého internetu v únoru 2011*, – SPIR – MEDIARESEARCH & Gemius, leden 2011, únor 2011 [online]. 28.3.2011. [25.2.2021]. Available at: http://www.netmonitor.cz/tz-navstevnost-ceskeho-internetu-v-unoru-2011

13 NetMonitor – SPIR – Mediaresearch & Gemius: V*ýzkum sociodemografie návšt ěvník ˚u internetu v České Republice*. [online]. Leden 2012. [25.2.2021]. Available at: https://www.netmonitor.cz/sites/default/files/verejne-vystupy/2012_01_total.pdf

14 NetMonitor. NetMonitor: *Od ledna narostl počet mobilních uživatelů internetu o 40 tisíc*. [online]. 1.4.2013. [26.9.2020]. Available at: https://channelworld.cz/zpravy-cr/netmonitor-od-ledna-narostl-pocet-mobilnich-uzivatelu-internetu-o-40-tisic-8461

In 2014, NetMonitor registered 6,993,770 real computer users, 4,256,162 real mobile phone users and 1,691,339 real tablet users[15].

The research of Internet traffic in the Czech Republic by SPIR-NetMonitor shows that in January 2015, 8,894,797 real users (of which 6,908,452 from the Czech Republic) and 4,012,580 real mobile Internet users were registered[16].

The research of sociodemography of Internet visitors in the Czech Republic by SPIR NetMonitor showed that in January 2016, with the size of the Internet population in the Czech Republic (6,921,144 citizens), there were a total of 6,761,957 real users[17].

According to the socio-demographic survey of Internet visitors in the Czech Republic SPIR NetMonitor, in January 2017 there were a total of 6,915,341 real users with the size of the Internet population of the Czech Republic 7,078,139 users[18].

In 2018 (December), NetMonitor registered 7,005,006 real computer users, 4,280,463 real mobile phone users and 1,658,401 real tablet users[19].

15 NetMonitor – SPIR – Mediaresearch & Gemius: *Výzkum sociodemografie návšt ěvník ˚u internetu v České Republice*. [online]. Leden 2014. [25.2.2021]. Available at: https://www.netmonitor.cz/sites/default/files/verejne-vystupy/2014_01_total-streaming.pdf

16 NetMonitor – SPIR – Mediaresearch & Gemius: *Výzkum sociodemografie návšt ěvník ˚u internetu v České Republice*. [online]. Leden 2015. [25.2.2021]. Available at: https://www.netmonitor.cz/sites/default/files/verejne-vystupy/2015_01_netmonitor_offline_report.pdf

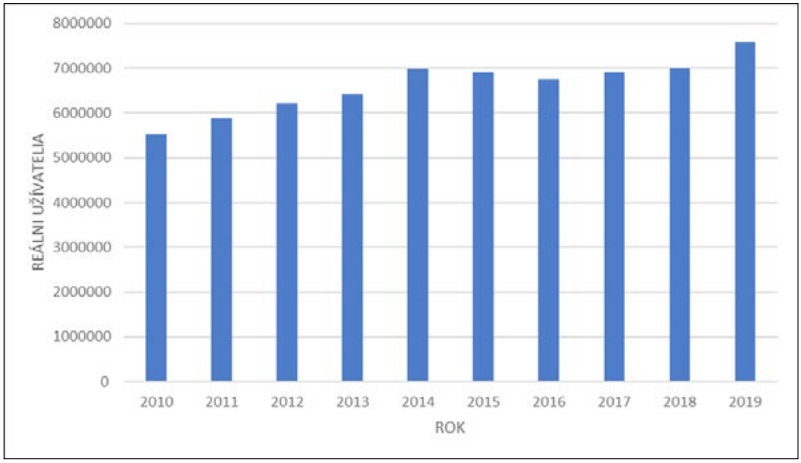
17 NetMonitor – SPIR – Mediaresearch & Gemius: *Výzkum sociodemografie návšt ěvník ˚u internetu v České Republice*. [online]. Leden 2016. [25.2.2021]. Available at: https://www.netmonitor.cz/sites/default/files/verejne-vystupy/2016_01_total-stream.pdf

18 NetMonitor – SPIR – Mediaresearch & Gemius: *Výzkum sociodemografie návšt ěvník ˚u internetu v České Republice*. [online]. Leden 2017. [25.2.2021]. Available at: https://www.netmonitor.cz/sites/default/files/verejne-vystupy/2016_01_total-stream.pdf

19 NetMonitor – SPIR – Mediaresearch & Gemius: *Půl milionu nových uživatelů použilo v roce 2018 mobil pro připojení k internetu*. [online]. 7.1.2019. [25.2.2021].

January 2019 brought many important events that could increase traffic to individual categories of websites. In January, the Internet population of the Czech Republic older than ten years reached 7,581,039 real users from computers, 5,568,927 real users from mobile phones and 1,726,649 real users from tablets[20].

Graph 2:
Analysis of the development of estimated real Internet users (January) in the years (2010–2019)



Source: Own processing based on NetMonitor.cz data Graph 2: Analysis of the development of estimated real internet users (January) in the years (2010–2019)
* Explanations: These are data for computers. Since 2014, data on Internet users from mobile phones and tablets have also been available on an irregular basis, so the actual range of Internet users may be greater.

Available at: https://www.netmonitor.cz/pul-milionu-novych-uzivatelu-pouzilo-v-roce-2018-mobil-pro-pripojeni-k-internetu

20 NetMonitor – SPIR – Mediaresearch & Gemius: *Brexit a koronavirus ovlivnily návštěvnost internetu*. [online]. 5.2.2020. [25.2.2021]. Available at: https://www.netmonitor.cz/brexit-a-koronavirus-ovlivnily-navstevnost-internetu

4.2. Analysis of development trends of the Internet media market in the Slovak Republic

Analysis of the development of the volume of Internet advertising in the Slovak Republic

Internet advertising spending increased by 7% in 2019. In 2019, the Slovak online received in the amount of 136.8 mil. Euros, which represents an increase of 7% compared to 2018[21].

In 2018, expenditures on Internet advertising on the Slovak market amounted to 128 mil. Eur. In terms of ad formats, display advertising has the largest share of expenses (42%), followed by search (23%) and the top three are closed by video (17%). Of the formats, the largest year-on-year increase of 38% was recorded by native advertising and line advertising, the so-called classifieds[22].

In Slovakia, expenditures on Internet advertising in 2017 amounted to almost 118 million euros. Within member expenditures in individual formats, native advertising grew the most, reaching four times the amount of expenditures in 2016[23].

In 2016, spending on Internet advertising exceeded € 112 million. According to the declared income of the members of the association for Internet advertising IAB Slovakia and the classified estimate of the

21 IAB: Slovakia: *Dáta IABmonitor.* [online]. 2020 [25.2.2021]. Available at: https://monitor.iabslovakia.sk/ IAB. 2020. Výdavky do internetovej reklamy 2019 (SK) [25.2.2021]. Available at: https://www.iabslovakia.sk/vydavky-do-reklamy/vydavky-internetovej-reklamy-2019-sk/

22 Celkové výdavky do online v roku 2018 rástli o 9%, avšak výdavky do slovenských médií až o 18% [25.2.2021]. Available at: https://www.iabslovakia.sk/tlacove-centrum/celkove-vydavky-online-v-roku-2018-rastli-o-9-avsak-vydavky-slovenskych-medii-az-o-18/

23 PZ: Výdavky do internetovej reklamy v roku 2017 narástli. Najviac zadávatelia investovali do nativnej reklamy. [online]. 2018 [25.2.2021]. Available at: https://strategie.hnonline.sk/marketing/1721790-vydavky-do-internetovej-reklamy-v-roku-2017-narastli-najviac-zadavatelia-investovali-do-nativnej-reklamy

AdEx commission, the expenses for Internet advertising increased by 23.2% year-on-year[24].

Revenues from Internet advertising on the Slovak online market in 2015 jumped by 20.5%. In 2015, Slovak clients spent more than € 91 million on Slovak and multinational internet media. Compared to 2014, this is an increase of 20.5%[25].

Internet advertising increased by 14.7% in 2014 According to the IAB Slovakia member volume declarations and estimated revenues of international and Slovak non-member media, Internet advertising revenues increased by 14.7% compared to 2013. In absolute terms, advertising volume in 2014 reached more than 75.5 mil. €[26].

Expenditures on online advertising in Slovakia increased by 17.3 percent in 2013, according to an estimate by the Internet media association IAB, which was the third highest year-on-year jump among other European countries[27].

In 2012, total expenditures on Internet advertising in Slovakia amounted to € 56.022.793 million, of which display (21,330,188), classifieds and Directories (12,446,982), paid-for search (20,231,973), and the rest[28].

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24 IAB: *V roku 2016 výdavky do internetovej reklamy presiahli hranicu 112 miliónov eur.* [online]. 2017 [25.2.2021]. Available at: https://www.iabslovakia.sk/tlacove-centrum/v-roku-2016-vydavky-internetovej-reklamy-presiahli-hranicu-112-milionov-eur/

25 IAB: *Príjmy z internetovej reklamy na slovenskom online trhu poskočili o 20,5 %.* [online]. 2016 [25.2.2021]. Available at: https://www.iabslovakia.sk/tlacove-centrum/prijmy-z-internetovej-reklamy-na-slovenskom-online-trhu-poskocili-o-205/

26 IAB: *Objemy reklamy na Slovensku v roku 2014.* [online]. 2015 [25.2.2021]. Available at: https://www.iabslovakia.sk/tlacove-centrum/objemy-reklamy-slovensko-tlacova-sprava/

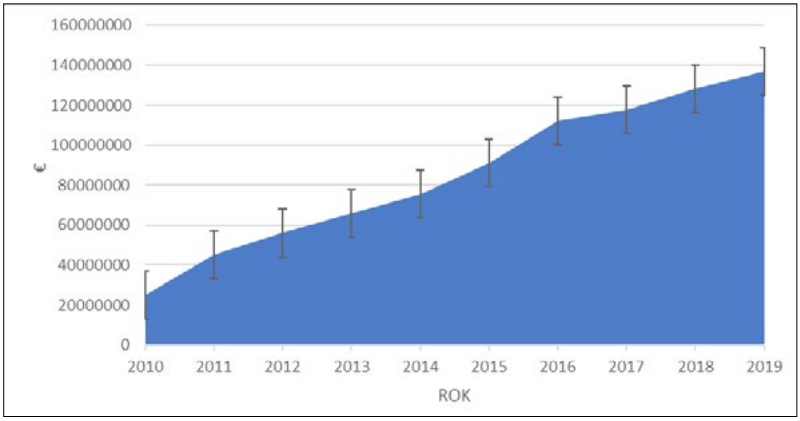
27 Cwitkovics, T.: *Rast výdavkov do online reklamy bol vlani na Slovensku tretí najvyšší v Európe.* [online]. 2014 [25.9.2020]. Available at: https://medialne.etrend.sk/internet/rast-vydavkov-do-online-reklamy-bol-vlani-na-slovensku-treti-najvyssi-v-europe.html

28 MEDIALNE.TREND: *Investície do internetovej reklamy vlani rekordne rástli* [online]. 2013 [25.2.2021]. Available at: https://medialne.trend.sk/marketing/investicie-internetovej-reklamy-vlani-rekordne-rastli

In 2011, total expenditure on Internet advertising in Slovakia amounted to € 45,175,847 million, of which display (20,793,003), classifieds and Directories (7,456,469), paid-for search (13,113,166), sponsorship (950,837), e-mail (514,967), slotting fees (168,368), rich media (1,406,264), lead generation (772,773). (RIDEA, 2012)

In 2010, total expenditure on Internet advertising in Slovakia amounted to € 25,086,605 million, of which display (13,105,787), classifieds and Directories (4,961,665), paid-for search (3,973,87), sponsorship (736,806), e-mail (751,963), slotting fees (114,992), rich media (1,119,134), lead generation (322,371)[29]. More graph no. 3.

Graph 3:
Analysis of the development of the total volume of Internet advertising (in euros) in the years (2010–2019)



Source: Own processing based on IAB Slovakia data

29 RIDEA: *Výdavky na online reklamu na Slovensku*. [online]. 2012 [25.2.2021]. Available at: http://www.pridea.sk/vydavky-na-online-reklamu-na-slovensku-za-i-polrok-2012-45-mil-eur/

4.2.1. Analysis of the development of Internet media traffic in the Slovak Republic

In 2019, 76% of people aged 12 to 79 from the Slovak Republic accessed the Internet.

In January 2018, the Internet population in Slovakia was 12 + with 3,457,621 users. Of which PC Internet population (3,621,263), telephone Internet population (2,598,501) and tablet Internet population (1,099,025).

In 2017, AIMmonitor estimated 3,773,378 real Internet users for all monitored advertising Internet media with a population of 12+ in Slovakia.

In January 2016, the Internet population in Slovakia was 12 + in the number of 3,599,551 users.

In January 2015, the Internet population in Slovakia was 3,457,621 users. According to AIMmonitor, users made a total of 1,694,952,787 impressions, of which approximately 460 million were from mobile devices.

In January 2014, the Internet population in Slovakia was 3,273,916 users. Users received a total of 2,103,021,245 views, of which approximately 638 million were from mobile devices.

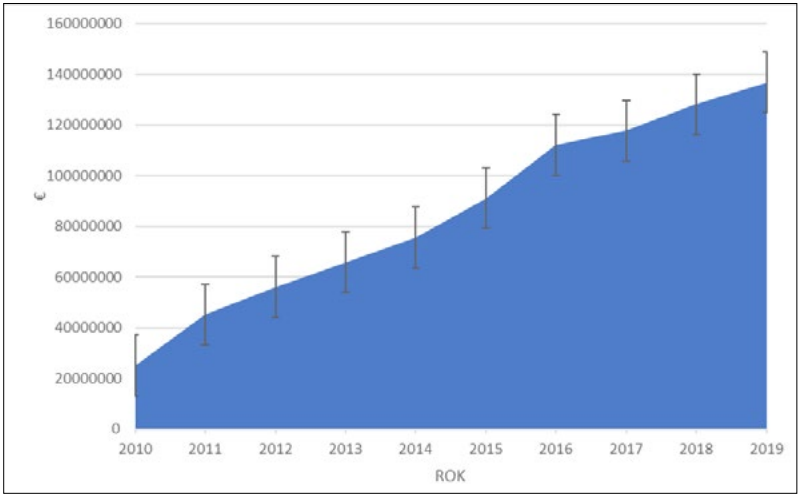
In January 2013, the Internet population in Slovakia was 3,053,086 users.

In January 2012, AIMmonitor registered 2,503,363 real users with a total Internet population of 2,721,047.

In January 2011, AIMmonitor registered 2,305,819 real users with a total Internet population of 2,506,325.

In January 2010, AIMmonitor registered 2,099,976 real users with a total Internet population of 2,282,584.

Graph 4:
Analysis of the development of estimated real Internet users (January) in the years (2010–2019)



Source: Custom processing based on AIMmonitor data

4.3. Analysis of similarities and differences in the development tendencies of the market of selected Internet media in the Czech Republic and the Slovak Republic for the observed period

Subsequently, we performed an analysis of time series of rating and volume of advertising in the Czech Republic and in the Slovak Republic in the period under review (2010–2019). The analysis showed that the total volume of advertising in Slovakia grew by an average of 20.74% year-on-year between 2010 and 2019, while in the Czech Republic we observe a slightly lower average year-on-year growth of 18.05%. Period (2010–2019) grew by an average of 5.75% year on year, but in the last two years we have observed a year-on-year decline of about 4%. The situation in the Czech Republic is similar, the average

year-on-year increase is 3.58%, but there was a decrease in 2015 and 2016, year-on-year in the range of approximately 1–2%. More table No. 1. Next, we subjected the data to Pearson's correlation coefficients. The realized correlation showed that there is a very strong positive dependence between the development of the volume of advertising in the Czech Republic and the Slovak Republic, as the detected dependence is statistically highly significant. Furthermore, we found that there is a very strong positive dependence between the development of advertising viewership in the Czech Republic and the Slovak Republic, as the detected dependence is statistically highly significant.

Test of hypotheses

	Bank Ownership Type	
	Chi-Square Value	P-Value
H1: We assume the development of the volume of Internet media traffic in the Czech Republic and in the Slovak Republic in the years 2010–2019 it is very similar.	16,919	0,0001
H2: We assume that the development of the volume of Internet advertising in the Czech Republic and Slovakia is very similar in the observed period.	16,919	0,0001
H3: We assume that there is a present relationship between volume evolution Internet advertising and the development of Internet media traffic in the Slovak Republic.	<-1,1>	0,009
H4: We assume that there is a present relationship between volume evolution Internet advertising and the development of Internet media traffic in the Czech Republic.	<-1,1>	0,002

Table 1:
Analysis of time series of viewership and volume of advertising in the Czech Republic and in the Slovak Republic in the observed period (2010–2019)

YEAR	ADVERTI-SING (SR)	GROWTH FACTOR	ADVERTISING (CZ)	GROWTH FACTOR	VIEWSHIP (SR)	GROWTH FACTOR	VIEWSHIP (CR)	GROWTH FACTOR
2010	25086605		7716453		2099976		5521813	
2011	45175847	1.800795564	8900469	1.153440447	2305819	1.098021596	5873635	1.063714943
2012	56022793	1.240104984	11151399	1.252900156	2503363	1.085671946	6214328	1.058003774
2013	65834244	1.1751332	13307435	1.193342199	3053086	1.219593802	6425762	1.034023631
2014	75522797	1.147165858	14584460	1.095963272	3273916	1.072330095	6993770	1.088395431
2015	91039838	1.205461683	15044122	1.031517245	3457621	1.056111702	6908452	0.987800857
2016	112184711	1.232259563	19727451	1.311306236	3483849	1.007585562	6761957	0.978794815
2017	117769884	1.04978551	23310883	1.181646985	3773378	1.08310607	6915341	1.022683374
2018	128215655	1.088696453	28585825	1.226286666	3621263	0.959687315	7005006	1.0129661
2019	136834096	1.067218321	34365080	1.202172056	3472328	0.958872084	7581039	1.082231621
		20.74%		18.05%		5.75%		3.58%

Source: Own processing based on available data

Table 2:
Development of advertising volume in the Czech Republic and the Slovak Republic from the point of view of Pearson's correlation coefficient

Correlation matrix (Pearson):		
Variables	ad_SR	ad_CR
ad_SR	**1**	**0.944**
ad_CR	**0.944**	**1**
p-values (Pearson):		
Variables	ad_SR	ad_CR
ad_SR	**0**	**< 0,0001**
ad_CR	**< 0,0001**	**0**

Source: Own processing based on available data

Table 3:
Development of advertising viewership in the Czech Republic and the Slovak Republic from the point of view of the Pearson correlation coefficient

Correlation matrix (Pearson):		
Variables	viewership_SR	viewership_CR
viewership_SR	**1**	**0.896**
viewership_CR	**0.896**	**1**
p-values (Pearson):		
Variables	viewership_SR	viewership_CR
viewership_SR	**0**	**0.000**
viewership_CR	**0.000**	**0**

Source: Own processing based on available data
XLSTAT 2014.5.03 – Tests on contingency tables (Chi-square…) – on 9.12.2020 at 8:05:32 Contingency table: Workbook = Zošit1 / Sheet = Hárok1 / Range = Hárok1!$A$1:$C$11 / 10 rows and 2 columns

Table 4:
Test of independence between the rows and the columns (Chi-square):

Chi-square (Observed value)	271433.970
Chi-square (Critical value)	16.919
DF	9
p-value	< 0,0001
alpha	0.05

Source: Own processing based on available data

Test interpretation: H0: The rows and the columns of the table are independent. Ha: There is a link between the rows and the columns of the table. As the computed p-value is lower than the significance level alpha=0,05, one should reject the null hypothesis H0, and accept the alternative hypothesis Ha. The risk to reject the null hypothesis H0 while it is true is lower than 0,01%.

Table 5:
Association coefficients (1):

Coefficient	Value
Pearson's Phi	0.053
Contingency coefficient	0.053
Cramer's V	0.053
Tschuprow's T	0.031
Goodman and Kruskal tau (R/C)	0.000
Goodman and Kruskal tau (C/R)	0.003

Source: Own processing based on available data1

Table 6:
Association coefficients (2):

Coefficient	Value	Standard deviation	Lower bound 95%	Upper bound 95%
Goodman and Kruskal Gamma	0.053	0.000	0.053	0.053
Kendall's tau	0.033	0.000	0.033	0.033
Stuart's tau	0.041	0.000	0.041	0.042
Somers' D (R/C)	0.048	0.000	0.047	0.048
Somers' D (C/R)	0.023	0.000	0.023	0.023
Theil's U (R/C)	0.001	0.000	0.001	0.001
Theil's U (C/R)	0.002	0.000	0.002	0.002
Theil's U (Symmetric)	0.001	0.000	0.001	0.001

Source: Own processing based on available data

XLSTAT 2014.5.03 – Tests on contingency tables (Chi-square…) – on 9.12.2020 at 8:13:04 Contingency table: Workbook = Zošit1 / Sheet = Hárok1 / Range = Hárok1!$A$16:$C$26 / 10 rows and 2 columns

Table 7:
Test of independence between the rows and the columns (Chi-square):

Chi-square (Observed value)	3338467.757
Chi-square (Critical value)	16.919
DF	9
p-value	< 0,0001
alpha	0.05

Source: Own processing based on available data

Test interpretation: H0: The rows and the columns of the table are independent. Ha: There is a link between the rows and the columns of the table. As the computed p-value is lower than the significance level alpha=0,05, one should reject the null hypothesis H0, and accept the alternative hypothesis Ha. The risk to reject the null hypothesis H0 while it is true is lower than 0,01%.

Table 8:
Association coefficients (1):

Coefficient	Value
Pearson's Phi	0.057
Contingency coefficient	0.057
Cramer's V	0.057
Tschuprow's T	0.033

Goodman and Kruskal tau (R/C)	0.000
Goodman and Kruskal tau (C/R)	0.003

Source: Own processing based on available data

Table 9:
Association coefficients (2):

Coefficient	Value	Standard deviation	Lower bound 95%	Upper bound 95%
Goodman and Kruskal Gamma	-0.038	0.000	-0.039	-0.038
Kendall's tau	-0.019	0.000	-0.019	-0.019
Stuart's tau	-0.019	0.000	-0.019	-0.019
Somers' D (R/C)	-0.034	0.000	-0.034	-0.034
Somers' D (C/R)	-0.011	0.000	-0.011	-0.011
Theil's U (R/C)	0.001	0.000	0.001	0.001
Theil's U (C/R)	0.003	0.000	0.003	0.003
Theil's U (Symmetric)	0.001	0.000	0.001	0.001

Source: Own processing based on available data

5. Result and Discussion

In examining the first specific research question, we came to the following findings: The analysis of Internet media traffic in the Czech Republic showed an irregular increase in real Internet users from 2010 (January: 5,521,813) to 2019 (January: 7,581,039). The highest increase in Internet users compared to the previous year was recorded in the period under review in 2019 (an increase of 576,033) and, conversely, the largest decrease in real users compared to the previous year was registered in 2016 (-146,495). The analysis of Internet media traffic in the Slovak Republic showed a gradual increase in real Internet users

from 2010 (January: 2,099,976) to 2017 (January: 3,773,378) and a subsequent slight decrease until 2019 (January: 3,472,328). The highest increase in Internet users compared to the previous year was recorded in the observed period in 2013 (increase in 549,723) and, conversely, the largest decrease in real users compared to the previous year was recorded in 2019 (-148,935). When recalculating the share of real Internet users, it can be stated that this market of Internet media has been stable in recent years, as in the years 2010–2018 the first three places were azet.sk, zoznam.sk, sme.sk. In 2019, sme.sk reached the second place and zoznam.sk moves to the third place. In examining the second specific research question, we came to the following findings: The total volume of Internet advertising in the Czech Republic from 2010 (CZK 7,716,453,000) more than quadrupled by 2019 (CZK 34,365,080,000). The highest increase in the volume of advertising compared to the previous year was observed in 2019 (5,779,255,000 CZK) and subsequently in 2018 (5,274,942,000). It is very interesting that the increase in the volume of advertising compared to the previous year in the period from 2010 to 2019 was so strong that it did not fall even once, but still grew. We can observe a slight stagnation of the growth trend in 2015, when it increased by CZK 459,662,000. The total volume of Internet advertising in the Slovak Republic from 2010 (€ 25,086,605) increased more than fivefold by 2019 (€ 136,834,096). The highest increase in the volume of advertising compared to the previous year was recorded in 2016 (€ 21,144,873), and then in 2011 (€ 20,089,242). It is very interesting that the increase in the volume of advertising compared to the previous year in the period from 2010 to 2019 was so strong that it never fell below 5 million euros, but still grew. The lowest increase can be observed in 2017, when the volume of advertising increased by 5.5 million euros compared to the previous year. After examining the third specific research question, the following conclusions were drawn: The development of advertising volume as well as the development of advertising in the Czech Republic and

the Slovak Republic for 2010 and 2019 is very similar, which is confirmed by a statistically significant dependence on Pearson correlation.

6. Conclusion

Based on the analysis of the development tendencies of the market of selected Internet media in the Czech Republic and in the Slovak Republic for the observed period in the years 2010–2019, the following conclusions can be stated:

In the monitored period (2010–2019), we recorded a gradual increase in Internet media traffic in the Czech Republic as well as in the Slovak Republic. The increase in real users on the Internet was higher in the Slovak Republic (65%) than in the Czech Republic (37%). We registered an increase mainly in the first monitored decade (2010–2014), while since 2015 it is possible to observe a gradual slowdown in the increase in Internet media traffic in both countries, which can be explained by the saturation of the population aged 10+.

In the analysed period, it is also possible to observe a clear trend of growth of Internet advertising in both monitored countries. This increase was again higher in the Slovak Republic, where we recorded a more than fivefold increase in the volume of Internet advertising in 2019 compared to 2010. The increase was also high in the Czech Republic, as we recorded more than a fourfold increase in Internet advertising over the last 10 years.

From the above, it can be stated that in the Czech Republic and the Slovak Republic in the last ten years there are similar developments in the Internet media market.

As for the forecast, in the next two years (2020–2021) a short-term increase in Internet media traffic can be expected in both countries, given the global coronavirus economy and citizens' interest in news and websites, especially on health. It is also possible to anticipate an increase in real Internet media users from mobile phones and tablets

at the expense of computers. A rapid increase in Internet media traffic cannot be expected given the saturation of this market. On the other hand, we expect a gradual shift of investments in Internet advertising at the expense of advertising in other mass media in the Czech Republic and the Slovak Republic.

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Communication strategy with customers in introducing a new multifunctional application in waste management in the Czech Republic

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Abstract: The aim of the paper is to draft an effective communication strategy aimed on introduction of the new digital waste management application SOWA for B2B customers. The analytical/research and draft of new communication strategy is based, as the first step, on the literature review which characterizes the state of knowledge of the issue of modern waste management, as well as the necessary theoretical base in the specific field of B2B communication. The analytical and research part of paper provides the necessary data and information that forms the starting point for the draft of communication strategy of one of the fundamental innovations in the field of waste management, which is the introduction and roll out of the new multifunctional application in the Czech Republic. The bearer of this plan will be the company Recovera Využití zdroje, a. s. Further spread of this innovation on other central European countries is subject of serious reflections and comes seriously into account.
Keywords: waste management, digital technologies, B2B marketing communication, personal sales, relationship marketing, social media, influencer, print media, communication campaign

The issue of the application of new technologies in marketing communications has a double dimension in this paper. On the one hand, it is the use of new communication technologies to support modern solutions and efficient processes within waste management, respecting the principles of environmental protection, and on the other hand, marketing communications supporting the implementation of these

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new technologies and approaches to a specific market – B2B market. Thus, companies and organizations that are on the one hand waste producers, but at the same time are and can be those who can, thanks to modern waste management and the use of modern technologies and communication technologies, be recipients of benefits, both financial (cost reduction, profitability growth) and non-financial (corporate social responsibility, image of companies and organizations, etc.).

1. Bases of waste management solutions in the Czech Republic

Waste is a thing that its owner wants to get rid of (Gálik, 2020). Unfortunately, recently we have witnessed an exponential increase in waste, and until last year, waste in the Czech Republic was unfortunately treated according to 30-year-old legislation. In the second half of 2021 the Czech Republic approved new legislation in waste management in the Czech Republic, by Implementing Decree No. 273/2021 Coll. on the details of waste management, which followed the approved Act No. 541/2020 Coll., on waste. The most important part of the new law is waste recycling and understanding waste as a potential in the form of other industrial resources. Today, this assumption is based on the results of a number of researches, especially in the United States. E.g. by using one million tons of recycled PET and HDPE US households will save 1.4 million m^3 (9 million barrels) of oil. (Winkler, 2009).

Major changes are taking place in the field of waste management, thanks to the unprecedented development of technical and digital technologies based on Industry 4.0 and 5.0 approaches in the field of waste. There is a gradual interconnection of information systems in connection with the Internet of Things (IoT), or special digital technologies supporting the so-called „smart" waste management.

Thanks to the new legislation, there is also more intensive communication with customers. Therefore, the company "Recovera Využití zdrojů, a. s." solve the question which marketing communication tools should be used and which target groups should be effectively targeted in order to the project success. Due to the fact that Recovera is a multinational company, the question of the possibility of comparing digital systems in Europe and in the world arises here as well. So far, none of the large companies in the Czech Republic has implemented a comprehensive system using digital technologies in the field of waste management and they still use traditional tools and technologies for waste registration during collection and disposal. For the above mentioned reasons it was decided to find out and verify, using the research, the interest of customers in the above-mentioned innovations, as well as which customer groups should be targeted and how the communication should be targeted. The company is determined to invest into the introduction of these technologies as early as in 2023 in the case of positive results from this research.

Another very important key factor is the introduction of so-called „smart" waste management, which is a combination of advanced technologies, and innovative strategies that support efficient sorting, recycling or disposal of waste. The aim is to ensure cost-effective and efficient management of the entire waste life cycle, with a view to improving public health and the environment.

The global smart waste management market expects an increase to $ 4.66 billion by 2026. With the continued growth of smart city initiatives around the world, there is an urgent demand for new smart technologies in the field of waste management. Tighter environmental regulations and technology development support the growth of these innovations. On the contrary, the insufficient infrastructure and technological security of developing economies still present new challenges for the development of the waste management market.

The growing demand for technologies for cost-effective waste management uses a number of modern technologies such as: radio frequency identification (RFID), Internet of Things (IoT) or GPS systems. This trend is particularly significant in urban areas, where the protection of the environment and human health appears to be highly topical. Such systems may include, but are not limited to, so-called „smartbins". They are equipped with sensors; the most commonly used are ultrasonic or infrared. They may be sensitive to moisture, gases, noise, fill level, weight (Pardini, 2020). In the Czech Republic, industrial customers are still unaware of the fact that if they do not start working systematically with their waste, they will not have anything to produce from in the future, nor will they have space for their own production and their priority areas of business. Moreover, under the rules of the new green policy, this area may become very expensive for them in the near future.

Last but not least, the issue of waste management is part of corporate social responsibility (CSR). According to the authors in the results of their research conducted in Slovakia, the concept of CSR should be part of the daily activities of company management. Thus, the care of waste management should be part of the daily activities of responsible managers in companies (Supekova, 2014).

2. Waste management concepts for the 21st century

The European Commission published an action plan for the circular economy (EC 2015) and in 2018 it included it in the long-term strategy (EC 2018). The concept of circular economy is based on the effort to change from a unilateral to a closed cycle (from raw materials through products to waste), which, unfortunately, still prevails in the current economic system. In a circular economy, the value of products and materials is maintained for as long as possible, resources and waste are minimized, all resources remain in the economic system

when products reach the end of their life, and are reused. It is clear that this is a challenging and comprehensive strategy, which depends to a large extent on the definitions and rules laid down in the legislation. (Moldan, 2020)

Based on the European Union's decision from 2018 on the Environmental Perspective under the so-called Recovery Funds, the financial framework for the environment was also set in 2021, and EUR 401 billion are allocated for the years 2021–2027 (Plán na podporu oživení Evropy, 2022)

And waste management is one of the key areas of the environment. Therefore it will be very important to decide about the form of investment in order to improve waste management. Related to this it is clear that one of the major international problems is the contamination of water resources, soil and subsequently the products of plant and animal production with heavy metals. One piece of evidence is a newly conducted study: „Spatial distribution of heavy metals in soil, water and vegetables from farms in Sanadaj, Kurdistan and Iran", where researchers studied the load of heavy metals and the content of products (Bonn, 2017).

2.1. Digitization of waste management – waste management 5.0

All companies operating in the international waste management market are trying to address 3 key issues: 1) How to accelerate all activities so that they are able to implement the exponential growth of waste. 2) How to automate activities, due to labour shortages in this field. 3) How to communicate properly with customers in order to improve waste management and its subsequent use. The target solution should be a comprehensive application that will be available to customers in the municipal and industrial areas and the data will be usable both for the internal system (preparation of individual trips and invoices) and for a comprehensive IT system that will process data for

CRM. Customers will have just-in-time data and control all information about their waste in the same time.

A transparent framework tool for providing information to a large number of people who can then use it should be the Internet of Things (IoT). The complex structure of such a tool consists of a number of devices, technologies, link layers and applications in the field of application. (Murugesan, Ramalingam, & Kanimozhi, 2021) The Internet of Things is a concept where the synergy of information, communication and technological devices implemented in, for example, „smart cities" solutions and implementations are achieved. The interconnection and communication of individual facilities in the concept of the Internet of Things represents a possible solution in the field of urban services, infrastructure and supervision, not only in the field of waste management (Marques, 2019).

The interconnection of the installations forming the IoT model for waste management should meet the requirements for variability, interoperability, reliability and quality of service. There are many reference models in IoT and each research and testing group has its own specific one, which often means a conflict of views and disagreement in the process of standardization and complexity (Pardini, 2020).

In general, four layers of IoT are usable in waste management: perception layer, network layer, middleware layer and application layer. The perception layer represents the physical interconnection at the hardware level in open system models, and is responsible for data collection, processing and transmission to higher layers. The essence is the detection of physical data using sensors (weight, humidity, temperature). In addition, it ensures the collection of data about a specific object, e.g. using a QR code or RFID. The network layer of the IoT model ensures the transfer of data measured in the perception layer to the higher layers, where the data processing and evaluation units are located. Analog data from the perception layer are digitized in the network. It uses for example ZigBee, Z-wire, GSM, UMTS, Wi-Fi,

Infrared, 6LoWPAN. Data management takes place in this layer and the „cloud computing" platform works here. The middleware layer is the software layer between operating programs and applications. The application layer guarantees confidentiality, integrity and authenticity (CIA – confidence, integrity, and availability). The layer itself creates a connection directly with the users and is a place that mediates the interpretation and availability of data (Pardini, 2020).

One of the smart waste management schemes is a combination of a wireless sensor network (WSN) and the IoT. Waste containers are equipped with sensors that form a wireless network and collect data at any time interval. The sensors convert the raw data into digital signals and transmit them to the control centre. Once the contents of the waste container reach the filling level, the waste collection agent receives the request and the collection vehicle is informed based on the IoT system (Murugesan, 2021), (Arpitha, 2018). One of the ways to ensure effective waste management is the use of RFID, as one of the technologies for classifying the properties of processed waste. Part of waste classification is the creation of databases and storage of data related to waste properties. The processing of information on individual types of waste takes place in a cloud environment, which for the development of such technology means an improvement in the quality of the service that ensures communication and exchange with the cloud. The use of „smart" technologies (data collection, evaluation and transmission) using IoT helps to optimize the infrastructure for collecting, collecting and locating waste bins (Marques, 2019).

Automation and optimization of the entire product life cycle could greatly simplify and favour the waste management cycle. This happens at the beginning of the process, when technical information about the product is recorded during its production, such as information about materials or recycling methods. This would help waste collection and collection authorities to focus directly on their content and subsequent time and route planning (Hackernoon, 2021).

2.2. IoT models in practice

There are a number of IoT-based models in the world. Some have already been introduced, some not yet.

The team of Bharadway et al., proposed a method of monitoring collection containers, which was able to calculate and design the optimization of the collection route. In this model, the LoRa network of wireless sensors was used, which are used for communication purposes as standard. The use of interconnection technologies using the LoRa system was evaluated in the study as the most reliable compared to Zigbee, Bluetooth or GSM. LoRa technology does not require the use of, for example, a SIM card or an Internet connection. Implementation in the concept of „smart city", it is already used, for example, in the Netherlands. In the study, they used the Google maps matrix together with the API to determine the most advantageous route of the collection vehicle from the starting point of the route to its end point. When the waste container displayed in the collection vehicle application is checked in, the container icon changes to green. After completing the route, the vehicle is shown the closest and most efficient way to the final waste treatment site, specifically in the study it was a landfill. Special vehicles were designed to collect biodegradable waste, which was collected in biogas plants. This model was submitted for Bengaluru, India, according to the 2020 studies on waste management in Bengaluru, the system described above was not implemented (Bharadwaj, 2016), (Naveen, 2020).

Another model of introducing „smart" waste management using the IoT principle was described in a study by Guerrero et al. The models here were designed based on the use of infrared sensors and GSM systems. The filling level of the collecting vessel is recorded by a sensor, from which the signal is transmitted via the GSM system to the control unit. In the study, an Arduino microcontroller was used to connect the sensor and the GSM unit. The detector itself consisted of

IR sensors that transmit the recorded data to the microcontroller. In the above study, four sensors were used to compare the level of vessel filling over time. The moment the amount of waste reaches the level of maximum filling, the fourth sensor is activated. The information from the microcontroller is sent via the GSM module to the control centre, where all operations are managed (Guerrero, 2012).

A similar study with the implementation of „smart" waste management in two areas in Malaysia was presented by Omar et al. The project used ultrasonic sensors mounted on existing collection containers (Omar, 2016).

Many of the research projects are summarized in a review by Saha et al., which provides insights into smart waste management using solar panels to supply energy. The energy of the solar panels is used by a system and a network of sensors that monitor the filling level of the collection containers. If necessary, the contents of the collection container are compressed; this reduces the volume of waste and can lead to more efficient collection and collection of waste. Filling data is sent via wireless communication to the server (cloud), where it is then stored and further processed. The „SmartBin" designed in this way works as a „hotspot" and is easily adaptable to any type of collection container (e.g. large-capacity underground containers). In this way, customers obtain clear information about collection containers by logging in to the application, thus gaining access to data analysis, container filling information, and can also alert the collection company to the need to empty the container. This notification optimizes the collection route that is designed by the system. The study showed savings in operating costs of up to 80% (reduction of fuel costs, time, and reduction of the number of used cars), (Saha, 2017).

A similar study by Mustafa et al., proposed monitoring of collection containers using ultrasonic sensors with notification of their filling directly to municipal services. The system consists of ultrasonic sen-

sors together with a RISC device (ARM – Advanced Risc Machine) controlling the management processes connected to the screen and the audio device. The above system distinguishes 4 categories of waste (municipal, paper, glass and plastic) using LCD and Thing Speak. The data are then stored and used for further analyses, such as prediction of the maximum filling point, etc. (Mustafa, 2017).

The use of „Smart" collection containers can also monitor the environment in which the container is located. In a study by Vasagade et al., Such monitoring was tested for the purpose of incorrect collection or collection of waste by citizens. Infrared lamps are used to detect discarded waste outside the collection container, and also record its filling level. Infrared signals that pick-up waste around the container trigger an alarm alerting the person who stored the waste incorrectly. In the case of waste disposal outside the collection container, a system was designed in which the container is equipped with rakes, motor, gear shaft and belt, and controlled by a special control unit that controls the collection of waste outside the container. In case of impossibility of waste disposal, a report on the need for emptying is automatically sent to the collection company (or to the municipal services of the given locality), (Vasagade, 2017).

The containers can be equipped with a second sensor that provides detection and communication with the cloud and are processed by a microcontroller (eg Arduino Yun or Latte Panda card). They capture, distribute and transport the modified data to the „cloud". A system of sensors to monitor the environment around the collection containers can be used to determine the accessibility of the collection container in connection with parking or can help monitor in the event of theft of waste. The choice of sensors depends on the required accuracy. The waste weight measuring unit works with the humidity detector and updates the microcontroller. Based on the data, the humidity sensor can determine when the container needs to be emptied, in the event of increased humidity in connection with, for example, leakage or in

the event of decreasing humidity, determine the time of the last use of the container. The lever sensor of the lid can be used for data on overfilling of the container. „Smartbins" are equipped with GPS, which completes the complexity of the solution. The mobile application used for this system helps to optimize the collection company route and collection schedule, and conversely provides the citizen with information about the collection, allowing him to control the collection schedule in the district. The application can be designed only for residents, which is secured by a QR code specific to each resident. Residents and drivers of the collection car can monitor its speed and location over time. The central CPU is a key element of the system. Based on the data it processes, it is possible to evaluate the route optimization, taking into account the weather, rush hour, traffic restrictions (sports, cultural, etc.), (Aleyadeh, 2018).

One of the established and tested „smart management" systems is Rycycle.io. The testing model consists of bins for sorted components of municipal waste (smart recycle bins) and bins for biodegradable waste (smart organic bins). Each basket is equipped with a camera module and an ultrasonic sensor. The data collected by the camera module and sensors are sent to the analysis unit, which together with the classification unit evaluates the captured image of discarded municipal waste and decides whether it belongs to the given bin or not. If not, the operation is evaluated as a violation. The result is displayed on the control panel of the basket management and monitoring unit, the so-called „dashboard". The classification unit works on the principle of the so-called determination model, which is set on cartons, CFL bulbs, eggshells, plastic bags and polystyrene. In order to classify these sorted waste components, Microsoft Custom Vision has been integrated as an artificial intelligence tool that can mark a captured image and identify the waste component based on comparison and compliance with a set of images with which it was „trained". The Azure IoT Hub platform is used to control and maintain the bins, which helps to up-

date and add new modules to peripheral devices. The whole process works by interacting with peripheral devices without using the „cloud" mentioned in previous studies. The benefits associated with skipping the „cloud" include: improving real-time data analysed at the local device level, improving the performance of the entire Recycle.io model, reducing operating costs for IoT technology. Specifically, this model works, for example, in the USA, more precisely in the city of Seattle (Al-Masri, 2018).

Pardini et al. described the user application My Waste app. Based on the user's needs; the application can be adapted to the citizen's preferences (specific collection container according to separable components of municipal waste, distance, filling time and collection). In this way, the application automatically displays the status of the collection container and, based on the notification, passes the information to the user. If the selected collection container is full, the closest possible one with the same user preferences is automatically marked. The application also works operatively on the basis of a one-time need to get rid of waste, without introducing preferences, based on the current location of the user, according to which it will offer him current options. This resource-open platform was used to test and validate the model for reasons of its free, easy and clear user access. The aim of the application is user comfort, when proper sorting and storage of waste is expected. The baskets were equipped with photovoltaic panels, which increased energy efficiency. At the end of the study, the prototype of „smart" containers and the introduction of mobile and web applications were evaluated as a tool that improves the method of waste collection and optimizes economic and material costs. The use of solar panels in terms of energy was also advantageous for the operation of data transmission in this model. This IoT model in the field of waste management can be extended not only across areas, but also through facilities (bins) and their specifications (sorted components of municipal waste), (Pardini, 2020).

The team of Kang et al. designed a „smart" e-waste management system in Sunway, Malaysia, with a population of 500,000. The project focused on testing the „smart" e-waste collection system model. The reason was to propose a solution to achieve the United Nations' goals in the field of sustainable urban development, production and communications. The model was based on the IoT principle. The mobile application uses GPS to display the nearest location of the collection containers, which are equipped with a microcontroller, ultrasonic sensors and a wireless connection to the central cloud-database server. The administration server reads the data on the basis of which the filling level of the container is evaluated. If the set level of filling the company for waste collection is reached, an e-mail will automatically be sent about the need to empty the given waste container. Communication between the user and the administration server takes place via a mobile application, which is started by registering and logging in the user. After logging in to the user account, it is possible to observe the user's activity, the list and the history of electronic devices that the user has got rid of. The application provides a map view of the nearest collection bins where electrical waste can be stored. Using Google Maps, API and user GPS signal, the application suggests a route to the nearest collection container. The method of verification is secured by a QR code, which the user reads using the application, so the pairing with a specific container takes place. The user is prompted in the application to upload an image of the specific electrical waste that he is disposing of. The photo is then processed and the correct disposal of the waste is verified. Motivationally, the user is rated stars. The application provides options to select a specific device (e.g. mobile phone, laptop, and tablet) and the number of stored devices. In order for the waste to be properly stored and in accordance with the application (i.e. for the waste to be displayed in the user account history), all the above steps must be completed. A larger study and integration of „smart" waste management was carried out by the team of Hong et al. The

study deployed 136 smart garbage bin (SGB) containers in six areas of Seoul's Gangnam district. The containers were intended for the collection of kitchen waste and their placement was specifically in residential residences in places where municipal waste was also collected. The energy source was solar panels as part of the container. Part of this system was to provide an ID and password to each user so that it was possible to connect the entire system, i.e. to connect the RFID card of the user and the website. The users were divided into three categories: administrators, collection company and residents. The administrator monitored the amount of kitchen waste over time in each container and its overall status. Thus, the administrator could distribute data on the basis of region, residents and containers and also registered new users (residents) on the basis of an RFID card. For this reason, the administrator had the highest authority in the entire system. Residents only had the opportunity to monitor the status of the container, their activity (time and place of waste disposal) and information on payments and fees for the waste produced. Collection companies, in turn, had access to collection data and were also notified when a container was over 90% of its capacity. The collection company requested data from the server for the given collection route, and the location of the containers that need to be emptied was displayed in the mobile application for a specific collection vehicle. Based on the quantity and location of the application, it then optimizes the fixed route. The purpose of the model is to reduce the amount of kitchen waste and thus minimize operating costs of both processing equipment and collection companies (e.g. by optimizing collection). Residents have a financial incentive in this system. The cost of the amount of kitchen waste per kg will be reduced if the amount of such waste in a given month is reduced compared to the amount of waste generated in the previous month. The specific method of fulfilling the fee obligation was not mentioned in the study (Kang, 2020).

2.3. Digital platforms in the world

The platforms shortly described below operate on the principle of sensory monitoring of collection containers using a system of chips and software. Some also provide a pick-up service, but in principle they operate using „full-service" management, i.e. they provide the sensors themselves in containers or directly „smart" containers and a program monitoring their filling capacity. The basis is IoT technology – connecting things with software and based on their interactions, evaluation and analysis of data. The user package for waste management solutions for a specific customer includes the most common services and programs for: collection vehicle management, processing and analysis of data from container sensors, optimization and planning, collection container condition forecasting, collection vehicle navigation, alerting and statistical evaluation. Based on the overview of platforms below, it is usually necessary to provide a system for any components of separate waste collection, where most companies offer sensors that can be flexibly applied to any collection container. The user application provides a real map overview of these containers and the user has the opportunity to orient himself on his user „dashboard". They work contractually with both waste producers and collection companies. Companies providing the „smart" technology program have their own applications. Many have a network in several countries across continents. Of course, evaluating the efficiency of collection routes reduces transport costs and reduces emissions in cities.

Waste Hero (Denmark): provides products such as „smart" bin sensors for collection containers, a program for monitoring container capacity, a navigation system with collection route planning. It provides a platform for waste monitoring. This platform provides optimization, monitoring and control of waste management for the collection company (overview of collection containers, container location, waste flow

analysis, mobile reports and e-mail notifications, reports for a given period of time, etc.). Rather, the application is a program for collection companies and does not connect waste producers with processors. It offers the product itself, but not the service. They operate on the principle of strategic partnership; they also have their own blogs and provide professional advice (Waste Hero, 2022).

NORDSENSE (Denmark / USA): Basically a very similar platform with the same products as the above WasteHero (e.g. Smart bins), (NORDSENSE, 2022).

AMCS Group (Europe, Australia, USA): A similar platform that offers software and technology for the overall management of waste management (digitization of services, management and data registration). Company works on a wider scale than Nordsense or WasteHero, in addition provides services in the field of construction and demolition waste, municipal waste, recycling technologies, waste treatment centres and mobile toilets (AMCS, 2022).

E-CUBE Labs (USA/South Korea): Another platform providing products such as Smart bins (sensors for current, but also e-bins themselves). The data is collected by the CleanCityNetwork software, which then evaluates the collection routes. Provides analysis, evaluation and prediction of container filling based on already collected data. It is again a larger platform and part of the „SmartCity" concept (ECUBE LABS, 2022).

There are a number of other identical or similar systems provided by companies not only in the US or Western Europe, but also in Asian or Central European countries. These are, for example, the systems provided by the following companies: ENEVO (USA/UK/Finland), SENSONEO (Slovakia), BIGBELLY (USA), BRIGHTBIN (Belgium), RUBICON (Atlanta, USA), BIN-E (Poland), FARSITE net (UK), ASHBEE (India).

The situation is similar for digital applications, which are responsible for communication support of waste management. An example

is MyWasteApp, a „web-based" application that connects waste producers with waste processors. Helps waste producers locate recycling, disposal or waste treatment sites. It primarily serves applications for hazardous waste, waste from the chemical industry, but also provides the possibility of municipal waste management (e.g. kitchen, office or construction waste). The application was developed by GreenEdge application LTD and plans to operate in Scotland and Northern Ireland in the future (Green Edge Applications, 2022).

Another example is the iRecycle Mobile Application (USA), which works without the need for user identification and uses the GPS or type of waste to find the nearest recycling or disposal centres. It identifies more than 110,000 recycling projects at approximately 250,000 locations across the United States. It can be downloaded for free on the App Store (Earth911, 2022).

The so-called „location-based" application, i.e. without user identification is Recycle Nation (USA). It works on the basis of postal code and type of waste (according to the name) and finds the nearest collection centres. It is purely an information application. It provides information on individual operations for the collection, purchase or processing of a specific type of waste, such as: opening hours, address, web link (RECYCLE NATION, 2022).

In contrast, the YOWASTE application (Uganda) works with the request to create a user account. It is a combination of waste producers and processing companies. It provides registration to the user, who then chooses the type of waste from the options provided by the application (medical, municipal…), determines the collection company, marks the address where the waste is to be collected and pays through the application. The application is currently on Google Play and can be used to create one-time irregular orders for waste collection. It provides a service, but it is not about reducing environmental costs. Collection is solved based on the needs of the person disposing of the waste (YOWASTE, 2022).

Thus, most applications provide citizens with a pick-up schedule. After entering the address, they will receive information about the collection of a specific type of waste, most often municipal, garden waste, or waste according to the colour of the container (e.g. SmartRicicla (IT), RecycleNation (USA), iREcycle (USA), 1800Recycling.com). Other applications serve as a combination of two functions – information on a fixed schedule for a specific address and a specific type of waste and the search itself for the delivery method of collection to the collection or foundation site (e.g. TOwaste App, Toronto), (Toronto, 2022).

3. Marketing communications in B2B markets and their specifics

Although many experts or authors of relevant publications on B2B markets, B2B marketing and B2B marketing communications demonstrate, based on research and/or in-house experience, elements of convergence between buyers' behaviour in B2B and B2C markets (Taylor, 2018), B2B marketing and marketing communications retain some specifics. These are specifics of both a general nature, applicable to more or less all markets of companies and/or organizations, but also specifics related to individual sectors (industry, agriculture, construction, services), characteristics of buyers (small, medium and large companies and/or organizations), product characteristics (material and semi-finished products, auxiliary material and services, capital items).

Marketing communications are understood as all communications related to marketing processes. Its task is to support the company's marketing strategy. It is a discipline that uses knowledge from economics, business, psychology and sociology. The company uses marketing communications tools to inform, persuade or influence the target group. It is precisely influencing the further actions of the recipient

of the communication message that is its main goal (Karlíček & Král, 2011).

Marketing communication in the B2B environment is not only static, one-way, but there is mutual participation and interaction of both participating parties. That is, both the communicator and the recipient of the message. Communication is more complex, based on the formation of longer-term business relationships, mutual understanding, and understanding of needs and the functioning of the organization. Understanding the division of roles between the individual members of the shopping centre is essential for the communicator. They have different positions and hold different roles in the organization. The principles of communication leading to the formation of long-term relationships, to the creation of affection and loyalty are based on three key parameters:

- emphasizing partnership, trust, cooperation and mutual understanding;
- quality communication behaviour and information sharing;
- The use of appropriate conflict resolution techniques (Fill & McKee, 2012).

The basis of the successful operation of B2B markets is, above all, mutual trust, in the building of which marketing communication plays an important role. According to Mohr and Spekman, a partnership based on mutual trust is conditioned by three key parameters. They are the parameter of partnership (mutual connection and loyalty, coordination of activities, degree of interdependence and trust), communication behaviour (quality, information sharing and participation in communication) and finally the way of resolving conflict situations (solving common problems, persuasion, conflict resolution, dominance, the use of crude words and the method of arbitration) (Mohr, 2015). One of the important ways of building mutual trust is the strategic building of networks and alliances based on mutual trust and the needs of companies. The existence of these networks

becomes not only a matter of rational decision-making but also of emotions, on the basis of which a strong and solid network of business relations is built. Networking is based on so-called relationship management, which is based on customer care after sales, increasing their satisfaction and building loyalty. One of the strategic approaches is the so-called key account management. It is true that companies that systematically manage relationships and communication with their clients, especially the most important ones, are more successful in the long run than those that do not implement this strategy. It consists mainly in gaining information and understanding of the client, analysing relationships and setting goals based on them, managing cooperation, identifying new business opportunities, creating value for the customer, all based on effective communication with him. It is interesting that not so long ago, progressive companies began to use this approach in the field of customer care management in B2C markets, while in the B2B environment this approach has been common for decades. Communication plays a crucial role in relational marketing and key account management.

The right choice of media has always been and is one of the key decisions of experts in the field of marketing communications, influencing the resulting effectiveness of communication activities. Small businesses often choose one or only two media (internet, print in the form of leaflets) as media channels, which, however, increases the risk of communication failure. On the contrary, strong business entities also in the B2B area use more media ways to transmit the message to the target recipient.

Fraccastoro et al., divides the use of media in B2B in terms of the degree of digitization in sales communication into three categories:

- Traditional personal selling tools, including face-to-face personal communications, telephone calls and the use of traditional postal services.

- „Digital" sales communication tools which include emails, websites, search engine optimization, online meetings and chat platforms (Skype, WhatsApp, etc.).
- Social media as sales media based on user-generated content in the form of social networking sites such as Facebook, LinkedIn, Twitter, Instagram, as well as online blogs and content communities in the form of e.g. YouTube (FRACCASTORO, 2021).

4. Outputs of marketing research and communication context analysis

Among the main activities of SUEZ CZ, a. s. (today Recovera Využití zdrojů, a. s.) includes waste and water management. For the purposes of the diploma thesis, it was agreed with the company's management that it will be used and worked only with the SBU of waste management and B2B customers.

The analytical part used the principle of triangulation, i.e. a combination of quantitative and qualitative research and secondary sources obtained from a literature search describing the current state of the solution.

The Focus groups method was chosen as a tool for qualitative research due to the researched problem, in the form of laboratory interaction of 7–10 erudite employees from different levels of management and the test focused on their views and opinions on the questions and how to address respondents in the questionnaire solution. The aim was to verify the wording and correctness of the questions for the questionnaire survey. Based on it, the questions in the prepared questionnaire were adjusted so that it best described the researched intention. Based on the group FG, the information that must be communicated to the customer before completing the questionnaire was evaluated.

The company's target group for quantitative data collection was in B2B markets. A total of 1,067 respondents were addressed, either directly in writing or without the intervention of the interviewer (CAWI) or orally through the interviewer (CAPI, CATI). 343 questionnaires were completed. Since all results using Pearson's contingency coefficient and Crammer's contingency coefficient did not show a correlation, the so-called cluster analysis was used to select the focus segment.

Based on the answers from individual respondents, five segments were created using cluster analysis using the K-means algorithm.

A) The first segment is represented by a man who has a university degree and holds the position of ecologist. He works for a company of up to 500 employees in the field of industry. He solves waste once a week. Attitudes towards mobile applications are positive, they do not subscribe to printed matter. The most interesting form of advertising here is internet advertising. He is interested in a webinar in the form of an application on a mobile phone or tablet.

B) A typical representative of the second segment is a man with a higher professional education; he holds the position of ecologist in a company with up to 100 employees. He is from the Public Administration branch. They deal with waste several times a week. He has a positive attitude towards mobile applications and would be interested in a webinar. The preferred form of advertising is Internet.

C) The most common representative of the third segment is the environmental manager from a company with up to 100 employees, but from the Trade sector. They deal with waste several times a week, but they do not receive printed matter and are not interested in a webinar.

D) The representative of the fourth segment is from the Public Administration, this time from a smaller company – up to 50 employees. They deal with waste several times a week; the relationship to applications is neutral. He prefers newspaper advertising, subscribes to publications and is not interested in a webinar.

E) The fifth segment is the smallest cluster, making up only 5% of all respondents. He is an ecologist from a company of up to 500 employees in the field of industry. He is neutral about the applications, but he is not interested in the webinar and prefers flyer advertising.

The results of the cluster analysis gave the possibility of reliable segmentation of the company's customers and subsequent definition of suitable persons. The outputs document how the structure of employees in companies dealing with waste management is formed and who can co-decide and influence negotiations on the use of the company's new application. The division into age groups also creates additional data, especially on the relationship of employees not only to the use of digital applications in the field of waste management, but also about the appropriate addressing of this group by digital media, especially social media. Based on all the above characteristics, documents and personal experience of the authors with the management and communication of companies in B2B markets, it was also possible to perform a context analysis as a basic basis for choosing a communication strategy.

Before designing a suitable communication strategy for the introduction of a new innovation in the field of waste management, it is necessary to perform an analysis of the communication context (situation analysis). Světlík defines this term as: „Context analysis includes an analysis of individual parts and conditions of the environment in which communication takes place". (Světlík, 2017, 552). Before designing a suitable communication strategy for the introduction of a new innovation in the field of waste management, it is necessary to perform an analysis of the communication context (situation analysis). Světlík defines this term as: „Context analysis includes an analysis of individual parts and conditions of the environment in which communication takes place". Accordingly, the context analysis is divided into 4 main parts, which are the corporate context (company strategy and plan, brand analysis, organization, communication), customers

(target segments, awareness, perceptions and attitudes to the brand / company, engagement, perceived risks , purchasing decisions), external context (stakeholders and their communication needs, social, political, economic and technological opportunities and constraints) and finally internal context (financial constraints, corporate identity, corporate culture, values and opinions), (Světlík, 2017).

Based on the above marketing research and performed analyses, the segments were identified and their typical representatives were described, the so-called persons:

Segment 1: Mgr. Pavel Novotný, works in the position of Facility manager with associated activities of ecologist, company Myonic s.r.o., supplier of bearings for medical equipment, armaments industry, etc., solves waste occasionally as needed about once a week, prefers electronic communication and tries to go so uses the internet and finds out information about implemented webinars, prefers personal meetings about 1–2 times a year. It is a family type, hobbies gardening + sports activities at a recreational level. He is very interested in the commodity exchange.

Segment 2: Mgr. David Linhart, mayor/ecologist in Lhota u Lipníka – The village has 10 employees. Mr. David has a positive attitude towards new applications, the online world through the Internet. A very innovative approach to OH solutions. He is a versatile athlete. He has 2 children, he likes to discover new places with them. He is interested in what is happening in the world and, as far as possible, he likes to be educated in the form of an online environment.

Segment 3: Michal Havran, env. manager, Vodovody a kanalizace Vsetín a. s., approx. 100 employees, handles waste several times a week, it is waste from sewer cleaning, separated waste, hazardous waste and sewage sludge from WWTP. He takes an uncompromising stance on mobile applications, often uses the Internet, does not prefer printed matter and is not very interested in webinars. The hobby is sport shooting, house, family and garden.

Segment 4: Mgr. Aleš Kordulík, operations technician Domov na Jarošce, 45 employees, solves waste several times a week, infectious waste and gastro-waste, takes a neutral position on mobile applications – transferring information through them, etc., prefers to meet in person and prefers traditional methods of communication, such as newspapers, leaflets, etc., their collection is not prevented, however, it does not prefer other forms of education in the form of webinars, etc., hobbies are mainly cycling and staying in nature.

Segment 5: Bc. Karel Moravčík, Company: Lear Corporation Czech s. r. o., hobbies: hiking, cycling. Characteristics: This is a man of high moral qualities with a sense of responsibility, he is careful. He approaches the tasks in the solved areas in detail. Mr. Moravčík is cheerful with a sense of humour.

It can also be stated that customers of all five segments are above average in the field of waste management. In terms of motivation and ability to apply new digital technologies representing innovation in waste management, there is a significant difference between segments 1 to 3 in the willingness to get acquainted and possibly use new digital technologies in comparison with the other two segments. These segments also use social media, read professional blogs, respectively. Podcasts, which receive new information from the field of waste management from the Internet, are among the segments open to change in this area. On the other hand, segments 4 and 5 represent a rather conservative market in terms of the implementation of the above-mentioned digital innovations and feel some concern about the introduction of innovations that are not entirely close to them. The addressing of these companies should also be based on traditional tools, whether personal contact or delivery of materials in traditional printed form. The content should also focus on explaining the simplicity of the application, which can be described as user-friendly. The form, content and communication tools leading to innovation will have to be adapted to this, using the SMART waste management application.

5. Communication campaign design

The main goal of the communication campaign is to support the introduction of the new SOWA (Smart Online Waste Application) digital application to SUEZ customers (now Recovera Využití zdroje, a. s.) enabling and supporting waste management from a smartphone.

Partial communication goals of the campaign:

1. In the first stage of the campaign, 90% of the company's existing customers are aware of the offer of innovation in the form of a digital application for a smartphone.

2. In the second stage of the campaign, 80% success rate of the application implementation for company customers.

3. Acquisition of new customers from existing competition (increase by 8%).

4. Promoting the loyalty and satisfaction of existing company customers by introducing innovation as an expression of a proactive retention strategy.

5. Strengthening the reputation and image of the company brand.

The campaign will be divided into two stages. The first one is a presentation of the new digital application SOWA through traditional personal meetings with representatives of companies responsible for waste management with information about the new application and its use, its benefits and savings, as well as the use of social media and the creation of a special target website offering more detailed information about the SOWA application, including a video.

The second one, which will follow the first stage, will be the use of influencers in the field of B2B, namely their participation in the conference of waste management innovations, an article in the professional magazine Waste, and a blog post, respectively. create a podcast. All these communication tools will be available on the target page of the project. Appropriate persuasive tools will also be used (popularity (companies that have already acquired the SOWA application will

be listed on the target pages with their consent), authority (influencer article – renowned independent waste management expert in the magazine, introductory conference lecture) and social approval (emphasizing current environmental requirements and corporate social responsibility, the reputation of the company or organization associated with the progressive introduction of new digital technologies, etc.). The exact timing and coverage of the campaign will be determined by the final decision of the company and the implementation of the campaign.

From the point of view of the use of individual communication tools, it can be stated that segments 1 to 3 (with a certain limitation for segment 3) are ready to communicate in digital form as well. Both the use of communication tools Zoom, WhatsApp, Teams, Skype, etc. for direct communication, as well as the use of social media, whether LinkedIn, Instagram or Facebook.

In the case of segments 4 and 5, emphasis should be placed on personal communication and the submission of written promotional materials. In all segments, it seems to be a problem-free target page of the project and, of course, personal communication, as the most powerful tool for providing information and creating desirable emotions in B2B.

It is difficult to generalize the distribution of customers according to their value for the company from the point of view of using Pareto's 80/20 rule within the performed segmentation. However, SUEZ/Recovera knows its VIP customers and expects the use of personal communication with these customers, including the use of appropriate initiatives compatible with the company's code of ethics, to acquire these customers for active participation in the project (meetings, active participation in the conference, etc.) and for subsequent communication. their involvement both in the professional journal and on the target pages of the project.

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The communication, which will be the connecting line of the entire campaign and at the same time the basis for appropriate appeals, will not only emphasize the benefit and cost dimension of the value of using the application for companies, but especially seek to evoke positive emotions by emphasizing social responsibility, using advanced technologies in one from areas of social priority. This emotional side of the message's content will also be reflected in the campaign's slogan.

The communication will be consistent across all platforms. The design also includes suitable gift items with a selected slogan, which will be handed over to company representatives (T-shirts, notebooks, notebooks and possibly other gift items).

Multiple platforms need to be used in the campaign design to ensure complexity and increase the communication pressure of the cam-

paign. The use of personal communication, project website, social media, the use of an expert – influencer, as well as traditional printed materials, will be used.

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From knowledge management to relationship marketing in B2B segment – Impact Academy case study

Aleksandra Brzozowska[1]

Abstract: Relationship-oriented service companies can generate a higher return on investment than transaction-oriented companies. Therefore, finding an appropriate approach to building relationships with customers, as well as using appropriate tools seems crucial for the development of a modern company. The presentation of the educational project entitled the Impact Academy, implemented by Ringier Axel Springer Polska and addressed to Polish marketers, is the first publication of this type in the Polish market. It attempts to present a strategy for building knowledge-based relationships by use of offline and online events in the B2B area.

The article discusses in detail the Impact Academy project, the main objective of which was to share knowledge on digital marketing in order to become a tool for building long-term relationships based on mutual understanding and trust. Two stages of the project are discussed chronologically. The first stage related to building the expert's image and knowledge sharing and the second one focused on strengthening the relationships and creating a space for commercial transactions.

The descriptions and conclusions presented herein focus on the Polish advertising industry from the publisher's perspective, including, in particular, the emphasis on how to conduct a marketing campaign as part of the B2B strategy. The project is assessed in terms of the achievement of project objectives and compliance with the trend of marketing relationships.

Keywords: B2B marketing, media, knowledge sharing, events, customer service
Additional: Ringier Axel Springer Polska, Impact Academy

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1. Introduction

The definition of marketing proposed in 2004 by the American Marketing Association (AMA) stipulates that it is an organisational function and a set of processes for creating, communicating and delivering value to customers and managing customer relationships in a way that benefits the organisation and stakeholders. The management is often directly associated and discussed in the context of CRM (customer relationship management) technologies and systems[1]. At the same time, there is more and more discussion on relationships with customers in the area of sales and marketing, where these relationships are established, and only then on CRM solutions, which are one of tools to maintain the relationship[2]. This differentiation is important because relationship-oriented service companies can generate a return on investment greater than transaction-oriented companies[3]. Therefore, finding an appropriate approach to building relationships with customers, as well as using appropriate tools seems crucial for the development of a modern company.

The presentation of the educational project entitled the Impact Academy, implemented by Ringier Axel Springer Polska and addressed to Polish marketers, is the first publication of this type in the Polish market. It attempts to present a strategy for building knowl-

1 Hasan, T. (2018). *Customer Relationship Management in Business: A Study on Bangladesh*. IOSR Journal of Business and Management (IOSR-JBM). 20(12). pp. 16-20. From: https://www.iosrjournals.org/iosr-jbm/papers/Vol20-issue12/Version-4/C2012041620.pdf (accessed on: 3/6/2022).

2 https://smallbusiness.chron.com/difference-between-relationship-marketing-crm-57555.html (accessed on: 5/6/2022).

3 Kumar, P. (1999). *The Impact of Long-Term Client Relationships on the Performance of Business Service Firms*. Journal of Service Research. 2(1). pp. 4-18. doi: 10.1177/109467059921002. More about the difference between transactional and relationship marketing, for example, in: Harker, M. & Egan, J. (2006). *The Past, Present and Future of Relationship Marketing.* Journal of Marketing Management. 22. pp. 215-242. doi: 10.1362/026725706776022326.

edge-based relationships by use of offline and online events in the B2B area. As Ahmad Arslan points out, while there has already been a wide range of studies on B2B marketing communication, much less time has been spent on different forms of communication, including a distinction between face-to-face and virtual activities[4]. The following case study may therefore complement this knowledge and it shows the specificity of building and developing B2B relationships in the advertising market in Poland.

2. Basis of the project

Ringier Axel Springer Polska (RASP) is a publisher with „more than 300 brands in the area of press, media and Internet" in its portfolio[5], including, without limitation, Onet, Newsweek, Fakt, Przegląd Sportowy, Forbes, Business Insider. Apart from the publishing activities, it also sells advertisements, organises events, provides business advice, carries out e-commerce activities, and offers classifieds advertising[6]. As RASP reaches over 21 million Poles each month[7], it is perceived as a medium which should at least be considered while planning brand communication and developing a media plan. As a result, in B2B it maintains commercial relationships with several thousands of companies in Poland.

Before 2014 Ringier Axel Springer focused in the B2B area on organising events of various sizes aimed at establishing relationships

4 Arslan, A., Golgeci, I., Khan, Z., Ahokangas, P., Haapanen, L. (2021). *COVID-19 Driven Challenges in International B2B Customer Relationship Management: Empirical Insights from Finnish High-Tech Industrial Microenterprises*. International Journal of Organizational Analysis. https://doi.org/10.1108/IJOA-04-2021-2719.

5 From: https://www.ringieraxelspringer.pl/ (accessed on: 1/6/2022).

6 Cohen, W.A. (1996). *Building a Mail Order Business: A Complete Manual for Success* (4th ed.). New York: John Wiley & Sons. ISBN 9780471109464.

7 From: Mediapanel 4/2022 – https://media-panel.pl/pl/aktualnosci/wyniki-badania-mediapanel-za-kwiecien-2022/ (accessed on: 3/6/2022).

with business partners, as well as on sending product newsletters. At the same time, the company was perceived by customers mainly as a „place of advertising"[8]. This is important because at that time most direct customers benefited from the support of advertising agencies, media agencies and PR agencies[9], whose main task was to provide business advice on brand communication strategies, creative lines, media selection and planning, and to publish press releases. As a result, people in RASP often lacked a direct contact with customers and an opportunity to talk about business or marketing objectives of actions to be planned, and not only about media goals.

Another element influencing the way RASP is perceived was the growing activity of the advertising duopoly of Google and Facebook, which, with its attractive portfolio of solutions, international support and budget capacities, was skilfully establishing relationships with its business partners.

Therefore, the main challenge for Ringier Axel Springer Polska in 2014 was to change the perception of the publisher: from the place of advertising to a valuable business partner, which would also provide a communication strategy or a creative line. As a consequence, the customer was to become independent, at least partially, of agency entities and the awareness and perception of the company as an expert and partner in preparing a comprehensive marketing communication strategy was to be developed.

The second major challenge for the company, which the project presented below, was supposed to respond to, was to create interesting and valuable contents and establish the image of the company's

8 The author works with Ringier Axel Springer and, while writing this article, she talked to a dozen of persons from various parts of the organisation in order to collect data and insights on the situation of the company in 2014 and now.

9 Wider presentation of the market of entities operating in the Polish Internet: https://www.iab.org.pl/bez-kategorii/mapa-podmiotow-internetowych-iab-polska-2021-2022-juz-do-pobrania/ (accessed on: 30/5/2022).

employees as experts in their fields. Most B2B messages developed in 2014 were limited to product novelties and elements of offers. They did not contain educational and inspirational content which would constitute an added value for customers. At that time, in the environments dealing professionally with B2B marketing, suggestions were made that the customer did not want to be seen solely from the angle of the purchase of a given product, but that the customer should be involved at every stage of the purchasing process. Marketers were also encouraged to experiment and change the existing activities, which ceased to be effective[10].

3. Project assumptions

The strategy adopted by Ringier Axel Springer Polska in response to the above challenges was to establish knowledge-based relationships with its customers. That is the idea of the Impact Academy project. It is an annual educational programme where knowledge, inspirations and trends concerning digital marketing are shared. At the beginning, the academy organised two Impact Day conferences and held online seminars and webinars several times a year.

The Impact Day is a large two-day conference (for around 500 people) held in the spacious and modern place in Warsaw. The purpose is to support the company's reputation and create some space for building relationships with customers invited to the conference. It is to inspire and show market trends. Therefore, each event has its leading motive, e.g. growth, content marketing, leadership, video. To the Impact Day, the company invites both experts from Poland, including RASP representatives, and speakers from abroad, including, for example: Carsten Cramer (Borussia Dortmund), Joe van Brussel (Huffing-

10 Taylor, Nick. (2018). *B2B Marketing Strategy: Differentiate, Develop and Deliver Lasting Customer Engagement*. Kogan Page Limited. USA.

ton Post), Mark Adams (VICE), Jim Fanning (Amazon Web Services) and Eyal Reshef (Israel Mobile Association).

The Impact Seminar is held for around 100 people. It takes about 4–6 hours. During the meeting, one strategic issue is discussed from several perspectives. The subject is thoroughly analysed and product solutions of the Advertising Office are presented. The seminar is divided into a lecture and workshops.

The Impact Webinar is a 60–120-minute online meeting on one specific subject. It is attended by around 100–150 people, depending on the specificities of a given issue.

In addition, a certificate awarding ceremony is held once a year. It is called the End-of-Year Seminar and after the lecture on trends and events for the next year and the awarding of Digital Expert certificates[11], a short cocktail party for RASP marketers and account managers is held.

The target group of the Academy includes direct customers, mostly brand managers and marketing directors. If reasonable, people from media houses or marketing agencies are also invited to the events. However, this is not the rule.

The permanent Impact Academy team consists of three persons: Project Manager, Programme Director and Project Director. In addition, for specific events, the team cooperates with an event agency, graphic designers, RASP video department, as well as experts, who attend the events as speakers.

4. Project implementation (2014–2019)

The first part of the Impact Academy project was presented in 2014–2019. The main objective of this phase of the project was to:

11 The certificate is given to each participant of the Impact Academy when they achieve the required score corresponding to their active initiatives during the calendar year. The active initiative means participation in various events, which are scored at a different level.

- Create the image of a reliable business partner and expert in digital communications;
- Establish a customer relationship based on knowledge sharing;
- Develop a programme which would be attractive to potential business partners and constitute a strong image factor.

All of the above goals were met. The Impact Academy got 9/10 points in the NPS scale[12], and the Impact Day conference in the independent study conducted by a research agency was considered as one of the most recognisable conferences in the Polish advertising market. The programme involved 5400 customers from over 170 companies. 400 „Digital Expert" certificates were issued. More than 200 speakers were invited to the programme. The programme got the greatest number of points for the Impact Day during the certification of DIMAQ partner events[13] by IAB Polska[14]. The programme was also incorporated into the internal project aimed at the development of speakers who represent the company at external conferences and lectures.

It is also important that in 2019 a new unit called the Knowledge Network was established in the company and the main purpose of that unit is to manage knowledge in the organisation. The Knowledge Network was established because, as a result of the Impact Academy, it is more and more necessary to exchange knowledge between company departments. Each employee of Ringier Axel Springer Polska has

12 *What makes customers willing to recommend a retailer – the study on roots of positive Net Promoter Score index*, Instytut Naukowo-Wydawniczy SPATIUM, Journal Central European Review of Economics & Finance Year 2014, Issue Vol. 5, No 2, pp. 61–74.

13 DIMAQ is an international standard for digital marketing qualification, which has existed since 2015. It defines, and enables the comparison and evaluation of, the necessary level of knowledge and qualifications of digital marketing specialists. From: www.dimaq.pl (accessed on: 1/6/2022).

14 Związek Pracodawców Branży Internetowej (Association of Employers of the Internet Industry), IAB Poland, https://www.iab.org.pl/o-nas/ (accessed on: 1/6/2022).

access to materials in the programme and event repository. Knowledge management became an important element in the development of involvement and employer branding strategies[15].

Another success of the project is the fact that no closed and complete educational system for customers of the media industry was developed in the Polish market yet.

At the same time, from the point of view of marketing relationships[16], it is clear that the project was only implemented partially. A large group of customers only participated in selected events, which means that RASP had a contact with them 2–4 times a year, which cannot be considered permanent communication for sure. Linking data from offline events with CRM data also faced some difficulties. On the other hand, long-term activities were taken, NPS index was applied in the monitoring processes, and many company departments, and not solely a project team or the Knowledge Network department, were involved in quality development.

5. Impact Academy 2.0 (2020–)

In the 2015 report published by the US Content Marketing Institute, in-person events were considered the most effective business-to-business tool in the area of content in the USA for the 6th time in a row[17]. In 2021, they were ranked 7th in the same report. Virtual events, webinars and online courses were at the first place. This change was influenced by the development of the technology offered in this area (bet-

15 Koporcic, N., Ivanova-Gongne, M., Nyström, A.-G., Törnroos, J.-Å. (2018). *Developing Insights on Branding in the B2B Context: Case Studies from Business Practice*.

16 For more, see: Otto, J. (2004). *Marketing relacji. Koncepcja i stosowanie*. Wydawnictwo C.H. Beck, Warsaw. ISBN 8373874429.

17 https://contentmarketinginstitute.com/wp-content/uploads/2015/09/2016_B2B_Report_Final.pdf (accessed on: 4/6/2022).

ter interaction with participants or tools linked with CRM systems), general growth of the pace of life as a result of which the whole day was often devoted to participation in a B2B event held by a business partner, and in particular the COVID-19 pandemic[18].

The fear of leaving home and contacting other persons also significantly influenced the Impact Academy project and the manner in which knowledge-based marketing relationships were implemented.

Just before the outbreak of the pandemic, the company's current image projects, including the Impact Academy, were revised. The company decided to move from the project whose major objective had been to develop the company's image and establish relationships with business partners towards a project that would support business goals and provide new sales contexts in a more direct way. That is how the new strategy – Impact Academy 2.0 – supporting the growth of the value of the existing customers and helping to acquire customers for digital products in new market segments was developed.

The main strategic goals of the programme include:

- support the implementation of sales goals;
- increase customer loyalty and value;
- educate on digital offers;
- acquire information about customer needs and expectations;
- support the education of salesmen on offers and products.

It was also noted that the present potential of the project increased the chances of its monetisation so that the project could finance its activities on its own in the future or even become one of the company's income centres. This could be achieved, among others, by acquiring commercial partners as a result of sponsoring or by selling tickets to the company's own events.

18 Coronavirus disease (COVID-19) is an infectious disease caused by the SARS-CoV-2 virus, https://www.who.int/health-topics/coronavirus#tab=tab_1 (accessed on: 30/05/2022).

Five areas of activities were specified while implementing the new strategy:

- Impact Academy 2.0 as a sales support tool
- Impact Academy 2.0 as an education tool
- Insight Tool – customer knowledge management
- Platform for communication with customers – cooperation on creating and testing new concepts of the sand box for new products
- New source of financing the development of Impact Academy 2.0.

It is clear that the project's objectives and implementation areas in 2020 were much more specific and related to the activities of the Advertising Office than in Version 1.0. At the same time, that gave rise to some kind of concern that relationships with project participants would be transformed into transactions.

However, as part of the above activities, a strong focus was placed on interaction and dialogue with customers on their needs. The customers were also directly involved as academy speakers, which meant that they were able to talk about their projects and develop their position within the valuable „knowledge" content. Some of the customers were also directly interested in co-financing events.

The most noticeable change related to the transfer of all activities to the virtual environment was an increase in the frequency and coverage of activities. In the years 2020–2021, over 30 online events were held, including 4 large Impact Days conferences for over 1000 people each and webinars for 500 people each on average. The company also launched Impact Voice podcasts, which were listened to around 800 times per episode. In the above period, 200 certificates were issued.

As part of the new business area, Impact Academy events have generated more than 4000 new potential business leads. Leads were not one-off but developed over multiple occasions, proving they were long-lasting and relationship-based. There were over 150 corporate

client representatives who attended 10 or more of the 23 Impact Academy events held between 2021 and mid-2022. Another over 400 potential B2B partners participated in at least 5 events in the same period. Repeated occasions for experts' presenting new market insights paid off financially. Out of 348 companies that had not reported any turnover with Ringier Axel Springer Polska in 2018–2019, 84 attended Impact Academy meetings and re-activated their activities, generating profits for Ringier Axel Springer Polska in 2020–2021.

Moreover, over 600 employees of Ringier Axel Springer Polska participated regularly in Impact Academy events and achieved the required score for DIMAQ recertification in 2020–2021.

Finally, it is worth noting that the programme is actively promoted outside of Poland. English presentations are also available to employees of parent companies, Axel Springer and Ringier. The case study on consecutive project stages is regularly presented at joint events within the holding company.

6. Summary

Although the theoretical dimension of relationship marketing is still being discussed[19], this issue is more and more known among marketers from the practical point of view because it implements the attractive vision of healthy and sustainable relationships based on care, trust, commitment and proper service[20].

The Impact Academy project implemented by Ringier Axel Springer Polska is an interesting example of knowledge-based activities, which were supposed to support sound relationships between a marketer and

19 Al-Noorachi, M. (2014). *Współczesne wyzwania marketingowe: wybrane zagadnienia*. Studia i Monografie – Społeczna Akademia Nauk, No 54. http://piz.san.edu.pl/docs/sim-54.pdf (accessed on: 5/6/2022).

20 Buttle, F. (Ed.) (1996). *Relationship marketing: Theory and practice*. SAGE Publications Ltd, https://dx.doi.org/10.4135/9781446252062.

a publisher. Initially, a series of offline events enabling quite a rare, but physical, contact with the marketer turned into a platform for remote, however regular, communication.

Materials in the form of videos, podcasts and presentations were made available to the participants of events via a dedicated repository platform. To access the library, the participant has to log in or give their e-mail address. This is an additional form of collecting leads from programme stakeholders who have not had any prior contact with the advertising office of Ringier Axel Springer Polska.

At the same time, certain limitations to the Impact Academy, such as the individualisation of communication methods, can be observed. In turn, referring to the definition proposed by M. Rydel and C. Ronkowski, which provided for a need to maintain ties not only with customers, but with other cooperating entities as well[21], it should be pointed out that this aspect could also be further developed in Ringier Axel Springer Polska.

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Natural language processing in chatbot and virtual assistant technology development

Paulina Piekarczyk[1]

Abstract: The development of artificial intelligence is closely related to the work on technologies that facilitate communication between humans and machines. The most popular and frequently used are chatbots and virtual assistants. At the core of these mechanisms is the NLP system, which means natural language processing. A detailed description of this process is presented in the following article. This review presents research achievements in the area of chatbot and virtual assistant technologies using natural language processing technology.
Keywords: chatbot, virtual assistant, natural language processing

1. Introduction

The main idea of the work on the development of artificial intelligence is to improve and facilitate the lives of mankind, who will use it. The emergence of machines that will technologically surpass human capabilities has always been the focus of researchers. Scientists who undertake such activities face great technological and ethical challenges. Already today, the development of robots affects the extension of human life and significantly improves its comfort. The term "artificial intelligence" in the context of natural language understanding was first introduced by John McCarthy in 1955. Additionally, the work of developing super intelligent machines is supported by the fact that the field of computer science itself is a constantly evolving science. Since artificial intelligence is a discovery that leads

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to a significant development of civilization, we find its application in more and more areas of life. Gigantic application of intelligent machines we observe in medicine, economics or fighting crime.

However, is science considering the development of artificial intelligence that will surpass the human mind? Certainly, such intensive development of technology and research on artificial intelligence has risks and leads to many threats. The rapid growth of technological potential is very important. It cannot be ruled out that the latest technological inventions will be used for purposes other than those for which they were intended, as is the case with atomic energy. Is it therefore worth stopping work on this field of science? Certainly not.

Today, new inventions, technological solutions are produced at a very fast pace. The way in which human biological development measures up to technological development can already be observed today. Nervous system hypersensitivity is one of many aspects that accompany us as witnesses of this huge technological revolution. (Brown, 2011)

It is likely that most of the inventions that will be used by humans in 5 years had already been developed or exist as prototypes in laboratories.

Currently, one of the most research-intensive areas of artificial intelligence is communication technologies. There are three main components of this area: machine learning, deep learning, and natural language processing.

In recent years, one of the fastest growing areas of artificial intelligence is that of natural language processing (NLP). This technology is based on analysing the meaning of words through complex algorithms. Studies representing NLP research confirm the ability of a machine to recognize and decode human language (James H. Martin, 2008)

Scientific areas related to linguistics, computer science and mathematics are at the core of this field. Programs are designed in such a way that they can recognize both written text and human speech. This

communication is called H2M which means "human to machine". A detailed description of natural language processing can be found later in this article.

2. The origins of Human to Machine

One of the more spectacular experiments on the comparison of artificial intelligence with human intellect was the attempt to compete supercomputer created by the American company "International Business Machines Cooperation" in 2011. The machine was distinguished by much higher computing capabilities than the average computers at the time. Colloquially, this computer was named "Watson" after the founder of IBM (Ferrucci, 2009). The innovation of the supercomputer consisted, among other things, of introducing into its interface the ability to recognize and process natural language. The experiment consisted of playing a quiz between two previously invincible players and a supercomputer. The results turned out to be unequivocal and announced the superiority of technology over a man. Interestingly, the machine made mistakes during the game. They concerned the reaction time to the question asked and resulted from the inability to listen to the answers given by the rivals, which resulted in repeating their wrong answers.

Tab1. Analysis of the performance of artificial intelligence used in computer games. Comparison with human performance. Compiled from "Superintelligence: Paths, Dangers, Strategies" by Nick Bostrom

Chess	Exceeds human intelligence	In 1997, a computer beat a human in a chess match for the first time.
Scrabble	Exceeds human intelligence	The 2002 experiment

Crosswords	Significantly exceeds human intelligence	The 1999 experiment
Checkers	Exceeds human intelligence	A 1952 computer program outperformed the chess game of the program's author.

The above table discusses the superiority of artificial intelligence over human intelligence when it comes to games, which requires many features directly related to digital skills. The human brain, due to its limited size and a certain number of neural connections, causes the human potential to fall short during the incremental potential of artificial intelligence.

Below is a comparison of selected human intellectual skills compared to modern technology. This information is probably obvious to the reader, but I decided to recall it to clearly illustrate the advantage of digital technology:

- The first difference is the speed of information processing. Human nerve cells have biological limitations for transferring information. Human brain is not able to perform several calculations at the same time. Machines in this area have no limitations.
- Next, as a result of neural limitations, human memory is not able to store large amounts of data. Both working memory and long-term memory are significantly limited.
- Additionally, it is worth mentioning the ability of machines to copy data, edit it or easily exchange data between devices.

3. Natural Language Processing

The field of artificial intelligence that underlies the design of chatbots and personal assistants is natural language processing. The main principles of NLP are the automated decoding, analysis, translation

and interpretation of natural language. We can distinguish two main perspectives of this field:

1. Processing information in the form of text,
2. Decoding and generating speech

The speech generation that leads to a conversation between a human and a computer is much more complicated. This process requires the machine to understand the context of the conversation, to have knowledge in the domain of conversation, to follow the conversation.

The presented features are therefore difficult to implement in a computer because they are typically human. For humans, these kinds of actions are completely intuitive. Between natural language and natural language processing there is also a formal language. It is a kind of intermediate stage, through which a man with the help of symbols and their sequences creates communication between him and the computer. This type of language includes those used by programmers e.g. Java, Phyton, and description languages such as HTML.

The mechanism of NLP consists of the following steps (Kibble 2013):

1. Directing a natural language message to a machine
2. Recording the sound of the message
3. Converting the sound into written text
4. Decoding the text
5. Creating a response
6. Creating an audio response
7. Playing back the reply to the initial message

The mechanism of NLP is made possible by algorithms that take data and transform it into much more complex forms enabling the computer to understand the message.

The two main algorithms involved in this process are:

- syntactic analysis, which focuses its action on the linguistic and grammatical correctness of the message

- semantic analysis, which is responsible for the context of the information and its logic.

To present this process in a more accessible way, we can say that the basic step in this process is to extract a sentence. The machine then breaks it down into smaller elements: words, syllables, letters, and symbols. English is considered to be one of the easiest languages to work with this mechanism. Languages with difficult grammatical structures, such as Polish, are much more challenging.

In addition to being used in the creation of chatbots, natural language processing is used in programs for the blind, interactive toys for children, or in programs used to learn a foreign language, among others.

A simple example of the use of artificial intelligence is the use of text programs such as Microsoft Word that use NLP when editing text. When the program recognizes a spelling error in the text being created, it will communicate it to the user by creating a visible underline of that area.

4. Personal assistants

Research on the use of artificial intelligence in mobile devices has been conducted by major technology companies. The main idea of the personal assistant function is to control the device with the help of given voice commands. This tool has been developed mainly thanks to the work on natural language processing. We can distinguish personal assistants installed in mobile devices, which start working the moment they are activated by the user.

This type of solution includes a device from Apple called "Siri". Devices that are completely independent and designed only to carry out user commands are becoming more and more popular. This means that they can only be used by voice. These devices constantly function listening to commands. This type of a device includes a product developed by Amazon – the "Amazon Echo".

The first company to complete work on a voice assistant was Apple, introducing a downloadable feature called "Siri" to the online App Store in 2011. Research on this device began back in 2003 completely outside of Apple. As the originators of this project is considered the American agency DARPA. Steve Jobs' company bought the license to the device in 2010 and, interestingly enough, significantly narrowed the functioning of the personal assistant.

Since the device was supposed to recognize multiple languages, its originators gave up several capabilities, including limiting some kind of mischief in the device's responses.

On Apple devices, Siri was built in as an interface feature in 2011. It combined voice technology with applications that recognized weather forecast, incoming messages, email inbox, calendar, music application and notepad.

The competing device for Siri is an intelligent assistant created by Google. Unlike the Siri app, Google Assistant recognizes Polish language. It was first used in this language in 2016.

Microsoft has created an assistant called "Cortana". The device was presented in 2014. Cortana supports both Microsoft devices and those with Android and iOS software. Commands can be given in voice and in a written form.

Recent developments in personal assistants provide information on how these machines accumulate data and use it in subsequent conversations. Voice assistants accumulate previously generated responses and thus personalize their actions. This makes it possible to predict the user's next choices or questions.

A revolutionary solution in the field of virtual assistants is to be the "Duplex" assistant presented by Google. In 2018, there was a presentation of a chatbot that would independently arrange an appointment or book a table in a restaurant. During the conference, a chatbot that made an appointment with a hairdresser was presented. The robot applied commonly used words, and sounded just like a human. The

goal of Google Duplex is to be able to perform a conversation in a colloquial language and answer questions in a rational way. During the presentation, the audience was convinced that the person who spoke to the robot did not notice the difference. What the researchers point out is the danger that comes from having to share most of your personal information with the program. Currently, the program is being refined.

5. Chatbots

The definition of the term chatbot has not been officially constructed. Researchers of this phenomenon talk about chatbots as advanced computer programs which task is to conduct a conversation using natural language. In scientific texts there are also names: machine conversation system, virtual agent, chatterbot or dialogue system [Shawar, Atwell 2007]. The main purpose of this invention is to imitate human communication in the form of a dialogue. In 2006, the principles that, according to the authors of the article "Intelligent Virtual Agents Lecture Notes in Computer Science", should be fulfilled by chatbots, were defined.

The first principle describes the ability to understand speech, both written and spoken. The algorithms that chatbots are equipped with enable them to analyse text and create a response.

Next, the chatbots must be equipped with an access to an external database in which they will search for answers to questions posed to them.

These databases are divided into two categories:

- those having information about the company it supports, regarding its activities, products,
- having information about the rules of conversation building, using words such as "hello", "I don't know the answer to your question".

The third condition is to preserve the context of the conversation and store data about the user, including the user's name. The last element is to get as close as possible to a human figure by using an avatar or a chatbot's own name. Most chatbots take the form of a so-called "pop-up" window placed in the corner of a web page.

Classification of chatbots (Vogel, 2017):

- Conversation-oriented chatbots: their algorithms are mainly adapted to carry on a conversation naturally. Scientifically, their task is to pass the Turing test.
- Goal-oriented chatbots: their algorithms lead a conversation that has a specific goal and you can determine if and when it has been achieved. This type of chatbot does not require a focus on natural language or maintaining the context of the conversation.

The manual of the chatbot:

- The user using natural language enters the content of the question in the text field. It is also possible to use a speech recognition mechanism.
- The chatbot mechanism starts searching databases by using NLP algorithms. If the robot does not find the answer, the question content is saved and added to the pool that needs to be checked by a human. The latest technologies that improve the work of chatbots guide the conversation according to rules whose priority is to end the conversation by exhausting the topic and giving the user a comprehensive answer. The dialogue system is supposed to ask the user additional questions to help find a solution to the problem.
- In case of further difficulties, the chatbot will suggest contacting a consultant who is human and will provide answers if necessary.

Turing Test:
One of the first and certainly more important experiments to use the idea of combining a chat machine with a robot was Alan Turing's experiment conducted in 1950. The test was conducted between a man, who conversed using a natural language, and a machine. The conversation was listened to by a so-called "judge" whose task was to determine which of the parties was a machine and which was a human. If the judge was unable to determine with certainty who a robot and who a human was, the machine would have been considered to have passed the Turing Test.

In summary, this test was to answer the question of whether a machine could communicate with a human in such a way that they would not notice the difference.

Chatbot Eliza:
Fifteen years later in 1966, a chatbot was created and used as an online therapist. The conversations with the chatbot, named Eliza, were meant to imitate a therapy session which forced its creators to pay more attention to the robot's eloquence (Weizenbaum Joseph, 1966). It is interesting to note that the conversation was conducted in the so-called current of Rogerian psychology, which consists of asking questions to the patient and paraphrasing them.

Naturally, Eliza had no psychiatric knowledge, she only responded to the users but this alone allowed some of them to form an emotional bond with the robot.

As a result of this experiment, a certain psychological phenomenon called "The Eliza Effect" was born. It consists of attributing meaning to certain signs, words or gestures which by definition have no meaning (Colby, 1999).

Based on the model of the Eliza chatbot, a completely new mechanism called *the Alice chatbot* was created. It was first used in 1995 and won the Loebner Prize.

The idea for the Hugh Loebner Award goes back to 1991. Nine judges evaluate, in a subjective way, whether a human or robot is talking by assigning points from 1 to 5. The fewer points a chatbot receives the more it resembles a robot.

A recent story describing the achievements of chatbots discusses a 2014 experiment when the robot Eugene Goostman, who was programmed as the character of a 13-year-old boy originally from Ukraine, convinced 30% of those who interviewed him that he was a human [BBC 2014].

In 2020, a report of an extensive study on the use of chatbots in Poland among users of banking, media, telecommunication and tourism websites was released. The survey was conducted on a representative group of 256 people (Symetria Ux 2020).

The study shows that more than half of the respondents (53%) prefer chatbots are operated via written text. They cited a sense of greater anonymity as the main reason for this choice. Respondents also identified speed of response as the main reason for using this form of communication with companies.

Advantages and disadvantages of chatbots based on the report (Symetria UX 2020):

Advantages	Disadvantages
Can be used at any time of the day or night	They don't understand the questions
Provide an immediate response	They are redirected to FAQs
They are helpful	Do not remember previous conversations
Good for shy people	Answers incorrectly or inadequately
Are intuitive to use	Answers are limited, poor in information
Use clear language	Answers are too elaborate

As the chatbots are, by design, programmed to function without constant human supervision, unforeseen difficulties appear. Some robots are created to relieve humans of activities with which they would not want to be associated. Such practices include the so-called zombie bots, which are capable of spreading themselves to other computers and using their software to create threatening, false messages. Most commonly, such practices are used on social media platforms such as Facebook or Twitter. An example of one of the first chatbots to spread negative messages was a robot named Tay, created by Microsoft in 2016. Its launch took place on the social network – Twitter.

It was programmed to respond to other users' questions, even those that contained political content. The robot imitated other users who asked racist questions or used vulgar words and started spreading similar content in response. As a result, Microsoft suspended the chatbot.

6. Conclusions

A 2020 report, Industrialized Disinformation Global Inventory of Organized Social Media Manipulation, outlined three types of organizations that can create chatbots for their own unspecified purposes.

As the first type of organization, the authors of the report list government agencies whose primary goal is to create public opinion. In a similar way, robots are used by political parties and private companies that try to harm their competitors by publishing false information via chatbots.

The predictions of experts on the development of robots are not unequivocal. We cannot predict clearly when or what form the future virtual assistants will take and how much human behaviour they will assume. Taking into account the pace and momentum of artificial intelligence researchers, we can assume that super-intelligent machines will appear much faster than we expect and their beneficial impact will be as important as the awareness of the threats they pose.

Certainly, a large part of the work on intelligent machines will be an attempt to humanize this technology. Since consumer expectations are for robots to be as similar as possible to humans, we can expect the development of machines that will not only perform the same tasks as humans, but will also resemble them visually.

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Multiuser virtual environments in virtual reality and augmented reality: influencing factors in serious applications and the use of advertising

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Abstract: In this work, we focus on the possibilities of using multi-user environments within various types of applications in virtual and augmented reality. As part of the division of applications into fun and serious, we try to define individual factories that affect the user experience, usability and immersion of users in the virtual environment. The paper also includes a description of four basic types of advertising carriers in multi-user virtual environments, while these are identified for use, for example, within social networks in virtual and augmented reality or within free-to-play games. For serious applications used for education, in the medical field or in industrial environment simulations, the use of such advertisements in individual forms is excluded.

As part of the testing, we focused on evaluating the impact of a photorealistic multi-user environment in virtual reality on user immersion compared to a non-photorealistic environment. To verify the hypothesis, we verified the results through subjective testing on a sample of 37 participants. Based on the results, it has been shown that the photorealistic quality of scene display is expected by users when used in serious applications and has a significant impact on working in virtual reality.

To test the impact of advertising on user immersion, we evaluated the results of a focus group that had 24 participants. As part of the results, we evaluated which methods of displaying advertising are suitable in multi-user virtual environments, while it became clear that it is necessary to use such methods that naturally integrate advertising into the scene through 3D models of objects or displaying advertising for products and services in the form of interactive or non-interactive banners in the scene.

Keywords: virtual reality, augmented reality, multi-user, virtual environment, virtual advertisement

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1. Introduction

For the development of the use of virtual and augmented reality, it is important to have suitable virtual environments available that provide users with space for their activities. With the development of technologies and their accessibility to the general public due to the accessibility of technology due to the penetration of devices in the population, an important factor that will create the added value of such devices is the creation of multi-user virtual environments. These are suitable for implementing the development of user cooperation when used in various fields of industry, education, research, entertainment, culture, travel or leisure. An important space for meeting users in virtual or augmented reality is social networks transformed for the needs of these technologies (O'Brolcháin et al. 2016). These do not only have an entertainment function, but can represent a platform for securing the individual areas mentioned in the previous text.

Within virtual and augmented reality, social networks build on previous attempts by creators to create graphic virtual environments for meeting users, which were implemented without the use of virtual or augmented reality (e.g. Second life (Rymaszewski et al., 2007)…). To identify a multi-user virtual environment for the needs of virtual reality, the term Metaverse is often used (Dionisio et al., 2013). This designation is not only a trademark of the company Meta and its built virtual environment, which should follow the social network Facebook, but the designation metaverse is used as a buzz word for various virtual environments with the possibility of multi-user interaction. Several companies are building their multi-user virtual environment system, e.g. NVidia presented its version of the omniverse (Li et al., 2022), and Epic Games is building its space within the game Fortnite… In general, the metaverse is a parallel, virtual world where users can have different identities, possessions and characters. An entire digital economy, it exists both digital and physical realm. The Metaverse can be

characterized through a structure of seven layers, which are gradually built up from the lowest level. This is represented by the infrastructure layer and includes the physical resources needed to build devices for interfaces (e.g. 5G and 6G networks, Cloud, GPUs…). The next layer is the layer representing the Human interface containing wearables, interfaces for sound capture, haptic response, gestures, etc. The third layer is the Decentralization layer, which represents the metaverse as a technology that is not owned by anyone and exists decentralized within the Internet with the possibility of using Blockchain, Microservices or AI agents. From the point of view of making the digital form of the metaverse available, a Spatial computing layer is needed, within which graphic 3D engines, VR/AR/XR technologies are used for displaying virtual environments. Above these layers are three more layers Creator economy, Discovery and Experience, which make available to users the functions and usability of the metaverse itself for various types of applications in the fields of education, culture, eSports, but also within applications for industry or healthcare.

The virtual environment is an important part of virtual reality and augmented reality within single and multi-user environments, as it has the greatest impact on the level of user immersion. Virtual environments that are used in different virtual reality setups provide different levels of user interaction in the virtual environment due to the possibility of movement and interaction with objects in the virtual space. Virtual environments can be created through the acquisition of real environment data using photogrammetry methods (Chen et al., 2020), 360° photographs (panoramas, or video panoramas) (Škola et al., 2020) or manual modelling, or they are created artificially for the needs of various types applications based on the author's requirements and do not copy the reality of the world in real space. Due to different types of virtual environments, it is possible to use 3 or 6 degrees of freedom for movement in the given space. When moving in virtual space, it is possible to use various tools that increase the real

area created by the user for movement (e.g. Teleportation). When creating virtual environments, it is important to define what types of devices they are created for, or whether they can be shared, e.g. for a headset in virtual reality and for display on a monitor, or for virtual reality and augmented reality (for AR, only some objects that complement the scene need to be selected from the scene, not the scene as a whole).

From the point of view of cooperation in the virtual space, it is necessary to realize what needs the virtual environment is created for (e.g. Education (Christou, 2010), medicine (Šramka et al., 2020), employee training (Lacko, 2020), sport, culture, tourism (Shaikh et al., 2018), social cooperation or computer game). Based on the input requirements for different types of applications, different levels of interaction between multiple users are provided by digital content creators (Gong et al., 2020). In connection with cooperation, the use of input devices available to the user (e.g. Eye tracker, facial tracker, sensors for different joints of human body…) is also a decisive aspect. The degree of cooperation and cooperation tools in a multi-user virtual environment also defines the degree of immersion (similarity to the real world, or overcoming it when using, for example, the possibility of anti-gravity, flying in space, moving in space using teleportation, etc.).

From the point of view of utilizing the potential of multi-user environments in applications that use advertising (e.g. free-to-play games, social networks, media), it is possible to insert the promotion of products and services with varying degrees of influence on the existing environment, or the creation of partitioned virtual scenes with advertising). The field of digital marketing in virtual (Wedel et al., 2020) and augmented reality (Rauschnabel et al., 2022) includes various approaches to displaying advertising objects or advertising spots (from inserting advertising objects in the form of 3D models, to displaying advertisements in the form of billboards or virtual video

walls to the creation of complete 3D environments incorporated as partition scenes within VR or AR). Within the so-called in serious applications, any digital marketing should not be a part of the scene, because in such applications it is necessary for the user to focus on the interaction in the scene, following the required actions and the level of immersion should not be changed by external advertising influences. In other applications, advertising may be embedded directly in digital content or the digital content itself may be advertising in digital marketing (e.g. creating digital copies of cultural monuments and promoting them in order to encourage the user to visit them is directly digital marketing).

In this paper, we focus on the definition of factors that influence the immersion of users in serious applications in virtual and augmented reality, for example in the field of education, and various types of advertising that influence users in applications outside of serious applications.

2. Factors influencing the experience in virtual reality

When creating virtual environments, it is necessary to define the context of the application in which the virtual environment will exist, to define the possibilities of interaction with the given environment and the level of user immersion. When creating serious applications, the restrictions (requirements) placed on virtual environments are generally higher and for them the effort to copy the real (physical) world is more accurate, because they mostly serve to simulate phenomena in which we expect to get user experiences identical to those we get in the real world. With other applications, it is possible to create a virtual environment and define objects in it, including user avatars, also using non-photorealistic rendering. In the following sections, we will define the key factors affecting the experience and immersion in virtual reality.

2.1. Photorealism

When creating virtual environments, especially for applications in the field of simulations (when it is necessary to create an image of the real world), photorealistic rendering is a key factor affecting user immersion (Zibrek et al., 2019). When immersed in such environments, users of virtual reality expect that the virtual environment – the scene will be displayed in the same way as in the physical world. For this reason, it is necessary to take into account the ways of light propagation in the real world when calculating scene lighting, calculating shadows and shading. By creating suitable materials, texture maps and shaders, it is possible to simulate „photorealistic" quality of the scene even with devices that have lower computing power. When using devices (headsets) that contain a computing unit, the same quality of scene display cannot be expected as with devices that are connected to an external computer providing higher computing power. When rendering the scene, real-time computer graphics algorithms are used, which simulate the propagation of light in the scene with the use of empirical models or with the use of PBR (physically based rendering) methods.

The necessity of creating photorealistic virtual environments is shown when using e.g. for the purposes of environmental simulations (employee training, medical applications, education, etc.) or when presenting objects of the real world (objects of cultural and natural heritage, virtual museums displaying artifacts of the real world).

In the case of using virtual reality in the entertainment industry (computer games, e-sports,) it is not necessarily necessary to create photorealistic virtual environments. However, the user should know how the virtual environment will be created. When playing games in virtual reality, even without a photorealistic environment, users feel a sense of immersion. However, computer games together with art installations are a specific environment in which the user can expect

different approaches to rendering, including the use of non-photorealistic rendering methods.

2.2. Avatars and tracking

In multi-user virtual environments, great emphasis is placed on the use of avatars (Freeman et al., 2020), who represent other users in the environment, or represent the so-called NPC (non-player characters). When creating virtual environments for serious applications, it is necessary that avatars correspond to users in a real environment, or that their appearance corresponds to expected persons from a real environment (it is not appropriate to use unrealistic appearance as avatars in such environments). An avatar in a multi-user environment has several basic tasks. Crucial advantages and functions of avatars:

1. Perception
2. Localization
3. Identification
4. Visualization of others' interest focus
5. Visualization of other's actions
6. Social representation of self through decoration of the avatar.

When tracking the user's position, orientation in the scene and expressing his emotions, it is necessary to mirror the user's state in the real world as accurately as possible. In a standard virtual reality setup, the position and orientation of the user's head and possibly the position and orientation of the user's hands are fairly precisely tracked. For the needs of more accurate expression of the movement of other parts of the user, or for the needs of displaying his exact movement in the scene, it is necessary to add additional sensors to the basic setup, especially in the area of the joints, through which the movement of the user is transmitted from the physical world to the virtual scene. In order to express the user's emotions through facial expressions, it is necessary to scan the user's face (in the case of virtual reality, espe-

cially the position of the eyes through eye tracking and the expression of the lower part of the face). If we use the possibilities of virtual reality, e.g. in the field of training employees within Industry 4.0 for the operation of machines and equipment, a relatively precisely expressed state of the avatar is required when tracking the orientation and position of individual body parts, and at the same time, it is necessary to precisely define the height of the avatar corresponding to the height of the user in relation to the operated equipment.

2.3. Cooperation of users

In multi-user virtual environments, the possibility of communication and cooperation of two or more users is a must. A necessary condition is the implementation of such cooperation in real time. This set can be ensured through the transmission of data in the network, for example using the created client-server architecture, which, however, if we do not have a relatively fast network, can lead to lagging and delayed communication in the network when transferring information about the position and orientation of the avatar leads to the impossibility of cooperation in a virtual environment in real time. In addition to the transmission of information about the position and orientation of the user in space and its display through avatars, it is also necessary to carry out the transmission of an audio signal (user's voice). This problem can be eliminated when users share the same physical space (if the users are in the same room). In the case of remote access of users, when they do not share the same physical space, it is necessary to ensure audio transmission. An alternative to voice communication is the use of text links for communication between two users. However, we encounter two basic problems here. The first problem is the insertion of text messages by users in virtual reality. The problem of using virtual keyboards in VR has not yet been properly solved, because entering text inputs is time-inefficient and rather demanding,

and the second problem is the display of text messages, which can either be bound to a certain place within the global coordinate system of the scene or are bound when displayed to the image space of each user separately at a precisely set distance from the user's virtual camera in VR.

2.4. Physical constraints

The presence of the user in both single and multi-user virtual environments in virtual reality has its physical limitations of the real world in the virtual world. An important limitation is e.g. long-term user presence in VR. It is usually not possible to be present in the virtual world for more than 2 hours, because then the user begins to feel physical limitations such as fatigue, exhaustion, eye pain, etc. Based on this, it can be expected that the possible work of users in virtual reality will necessarily be limited to shorter time periods and will be interrupted by the absence of the user's avatar in virtual reality. For some virtual reality applications, a limiting factor is, for example, the lack of sharing the same physical space. For example, when rehabilitating patients remotely, we only have a limited amount of data available, which is transferred to the patient's avatar in VR, and thus the therapist cannot accurately control, for example, the precision of the exercises performed by the user, or he cannot control the position of the patient's entire body.

Another thing that needs to be focused on when designing virtual environments and user cooperation options is the problem of user location sharing and object sharing. IN a physical space, it is not possible for two people to be in one place at the same time, in a virtual space, as long as users are connected to it remotely, such a situation is possible, but it is not suitable from the point of view of interaction and the emotional feeling of personal space. Therefore, it is necessary to solve such a situation and not allow the movement of the user into

the space in which another user is located. However, this can lead to the creation of a disparity between the physical and the virtual environment, where in the physical environment we do not prevent the user from moving to another location, but in the virtual environment, for example, the movement stops. Consequently, we cannot copy the movement in the physical and virtual environment 1:1. If users share the same physical space, it is impossible for them to overlap at the same position in the virtual world (if their surface is well calibrated) because they will bump into each other in the physical world.

The following situation can occur with the problem of object sharing: Users capture the same object at the same time and try to manipulate it together. In the physical world, we have a haptic response tied to tactile sensors on the surface of the user's body, and we can manipulate one object at a time. Since we lack such a response in the virtual world, it may happen that one user in the virtual world moves the object to one side and the other user to the opposite side. In the physical world, this could not happen without a hapric response. In the virtual world, it is necessary to decide which of the users the object will follow based on the priority of the users. The solution may be to assign a higher priority to the „owner of the object", e.g. to the user who touched the object first.

2.5. Positive motivation

Positive motivation plays an important role in solving the problem of immersion in a virtual environment, which deepens this feeling in the user. The motivation to use the virtual environment in virtual reality can be defined in two directions. One of them is the use of the „WOW" effect, which is created by users who lack previous experience with virtual reality. This feeling is defined by a new experience and gradually disappears over time with more regular use of virtual reality. The second direction is the creation of positive motivation when ex-

ploring the changing virtual environment, or the possibility of modifying the appearance of your own avatar. The user is motivated to use and display new possibilities and functions of the world and thus acquires new stimuli. In terms of positive motivation to use virtual reality, limitation in spatial navigation also plays an important role. If the user has a relatively large space available in which he can be tracked in the physical world, it is possible to use standard methods of moving in the scene. Mostly, however, the user has a smaller space at his disposal, for example a room, where he has to use other possibilities of movement in the virtual scene, e.g. teleportation. In that case, it may be stressful for another user in the virtual environment if the avatar of another user appears near him, not by gradual approach, but by immediate movement, which may discourage the user from further using the multi-user virtual reality environment.

2.6. Privacy in virtual reality

A relatively strong factor influencing the use of virtual environments is the absence of privacy, as worlds are mostly created with the possibility of mass connection of users. In the case of using a multi-user virtual environment as a tool, e.g. in order to mediate teaching or solve the problem of rehabilitation between the patient and the therapist, it is necessary to ensure the possibility of conducting private sessions within the framework of the open world with an emphasis on privacy and confidentiality. However, such an approach can also be misused for planning and committing cyber or real crime, and therefore it is necessary to create such spaces very carefully within the framework of creating such environments.

2.7. VR and non-VR users in virtual environments

Within a multi-user virtual environment, user contact can occur not only through virtual reality, but also by a combination of users in and outside of virtual reality (non-VR users), who display their context through other display devices, e.g. using monitors. When cooperating in VR, such users use different input devices and different ways of displaying avatars. The non-VR user's avatar uses inverse kinematics methods for its movement, similar to the methods of controlling game characters in computer games, and does not directly mirror the user's movements from the real world. In addition, such an avatar does not have to be defined by a character, but e.g. through a camera that can operate in different camera modes.

3. Factors influencing the experience in augmented reality

In contrast to virtual reality, in augmented reality it is not necessary to create the entire virtual environment, but only individual objects, which, due to their location in a defined position within the set global coordinate system, mix with the real image of the world obtained by the camera of the display device for augmented reality. Nevertheless, there are decisive factors that affect the augmented reality experience in single user and multi-user settings.

3.1. Devices

When using augmented reality, the selected display device is an important factor. Devices containing an image sensor (camera) and a display part (monitor) are generally used for AR purposes. From this point of view, the cheapest devices for augmented reality are mobile phones or tablets, which, however, lack a more perfect experience because the user has to hold them in their hands. To improve the expe-

rience, it is possible to use wearable devices, such as magic leap or MS Hololens. With these devices, the biggest problem is the Field of view of the given device, which does not sufficiently cover the FOV of the user. For the needs of an ideal mixing of the real world and virtual elements in augmented reality, it would be necessary for the FOV of the devices to be at the level of approximately 110°. Currently, there are technical and technological limitations of the devices themselves in this area, which are also related to the computing power of the devices, which are mostly not connected to an external computing device with high computing power.

3.2. Data display quality in AR

Rendering objects in augmented reality is generally more complex than in virtual reality, as in virtual reality the appearance of the environment and the setting of the scene's lighting are defined for the entire scene, while the scene is rendered on the display with an opaque background. With augmented reality, it is necessary to take into account that the position, colour and intensity of light sources used in the rendering of virtual objects of the scene may not agree with these characteristics of light sources displayed in the real world. This is especially evident when using wearables. At the same time, with these devices, the content is displayed on a transparent surface, which affects the display of opaque objects, the display of black colour (by default, black colour is defined by turning off the pixel backlight), or problems arise with HDR rendering. This can be partially compensated for by obtaining the lighting model characteristics using the parameters of the inverse lighting model from the real-world camera footage.

3.3. Avatars in AR

In the case of a single user setup in augmented reality, there is no need to display the virtual avatar of another user in the captured scene (except for displaying non-player characters). In the case of a multi-user virtual environment in augmented reality, it is necessary to obtain information about the position and orientation of the user. However, the user's location is defined only locally with respect to the real environment in which the user is located. From the point of view of augmented reality, it is debatable whether it makes sense to render another user's avatar in such an environment, even with the display of his movement in the scene, since we only add virtual content in the local space around the user.

4. Advertisement and marketing in virtual and augmented reality

When using virtual environments for serious applications, advertising should not be a part of them, because it can cause a decrease in the level of immersion and the user's interest in performing activities in such a space. However, there are still large numbers of applications for both single and multi-user virtual environments in virtual and augmented reality where the possibilities of digital virtual marketing and advertising can be used. Such services usually reduce the price for users for using the virtual environment for various activities or activate the user in order to increase the profit of the operator of the virtual environment. In the following section, we will define how it is possible to display advertising in a virtual environment for single user and multiuser setup in virtual reality and how it is possible to display such advertising in augmented reality.

4.1. Methods of displaying advertising in single user VE in VR

Displaying advertisements in a virtual environment with a single setup can have different levels of user immersion. Advertising related to products or services can be displayed in four basic types:

1. Advertising objects

It only applies to products that can be inserted into the scene in the form of 3D objects to complement the scene. The influence of such a method of advertising can be realized through subliminal shifting of information for the user.

2. Advertising in the form of a static or video billboard

In this case, the advertisement is inserted as a banner or billboard into the scene and can be implemented as interactive if the user can interact with it using the tools available in virtual reality or non-interactive, when it is displayed in the form of a static image or video. The most common form of interactive element in this type of display is a button with the option to click through to the e-shop to purchase the product.

3. Advertisement displayed in the form of a partition static or dynamic image in the user's image space

Such advertising is most often displayed to the user within his image space and usually covers the user's entire field of vision, while when moving the head, the same movement is also transmitted to the displayed image, and thus the position of the displayed advertisement does not change with respect to the position of the user's head. When using this type of ad, a timer is used for the display, which automatically ends the display of the ad. When displaying this type of advertisement, it is necessary to inform the user that the advertisement will be displayed to him after a specified time, in order to avoid negative phenomena (user stress, induction of epilepsy, etc.).

4. Interactive 3D cut scene with advertising around the user

The last of the basic forms of advertising display is the display of advertising in the form of a partitioned 3D scene, within which the user

may or may not interact with the scene presenting the product. The same condition applies as for type 3, where the user must be aware of the upcoming ad display.

4.2. Methods of displaying advertising in multi user VE in VR

In a multi-user environment, it is possible to use all 4 ways of displaying advertisements as mentioned in chapter 4.1, but it is necessary to ensure that advertisements of type 3 and 4 are not displayed during mutual cooperation of users. In the case of types 1 and 2, these can be displayed independently of users and are tied to a position in space. For type 3 and 4, in the case of mutual cooperation of users, it is necessary to coordinate and coordinate the launch of advertising for all users at the same time, while in type 4, the avatars of individual users can be placed in the shared scene based on their position at the moment the scene is launched.

4.3. Methods of displaying advertising in AR

All 4 types can be used to display advertising in augmented reality. However, their use depends on the context and the way of using the augmented reality virtual environment. Individual devices are able to display all presented types, but it is advisable to exclude types 3 and 4 from such display, because they can be dangerous, e.g. When the user walks, the entire image space is covered, which can have fatal consequences. If the advertisement is interactive within augmented reality, it is possible to interact with the advertising object through natural gestures when using wearables. In the case of using a touch device (smartphone or tablet), it is possible to implement interaction by touching the screen or by using the so-called virtual buttons.

5. Methodology

Based on our previous experience, we focused on the photorealism of the scenes when measuring the impact of individual factors of virtual environments on user immersion. Since we have defined the need to create photorealistic virtual environments especially for the needs of serious applications, we measure their impact when used in the training of employees working in the industrial area.

For the needs of measuring the impact of advertising in virtual environments, we focused on the impact, or change of immersion when displaying ad types 1 to 3 according to the previous chapter. Based on these factors, we established two hypotheses:

H1: A photorealistic environment increases user immersion compared to a non-photorealistic environment.

H2: Advertising in virtual environments does not reduce the level of user immersion in the virtual environment.

Since the evaluation of individual hypotheses is subjective for each user, we created a series of tests through which we evaluated selected characteristics of individual scenes using a five-point Likert scale.

For measurement purposes, we focused on the evaluation of immersion for single users in a multi-user virtual environment, because the degree of immersion is independent of the number of users and only affects the user himself. With the help of testing on a larger sample of users, we tried to objectify the results for the established hypotheses.

Two test scenarios were designed for the methodology of testing individual hypotheses.

5.1. Testing the impact of a photorealistic scene in serious applications

To test photorealism for the perception of immersion in a virtual environment, we created a scene using photorealistic real-time rendering and at the same time a scene using non-photorealistic rendering. The goal was to measure the impact of the environment on immersion when performing activities in an industrial enterprise. Within the test scenario, the following tasks were defined for users:

1. Identify the position of individual items in the warehouse in the environment.
2. Move the item in the warehouse using the controllers.
3. Move to the specified position in the warehouse (the position was determined so that it was necessary to use teleportation).
4. Identify the avatar of another user in the scene.

The scenes created for testing purposes are shown in Figure 1. The goal was not to directly direct the user to the perception of the environment, but this environment was shown to him while solving the set tasks. The questionnaire of questions was focused on the effect of photorealism and was implemented after the completion of testing by each subject.

Fig. 1: On the left, the scene used in the Unreal engine for testing using photorealistic rendering. On the right, the scene used to test the stylized non-photorealistic rendering

5.2. Testing ad impressions and their impact on user immersion

For the purposes of testing the impact of advertising, we used a photorealistic scene in which individual advertising objects were inserted according to types 1 to 3. Within the scene, it was possible to test inserted advertising objects for several users at the same time using multi-user environments, because with this type of advertising, it is independent of position individual users in the space. The following tasks were defined for users in the scene:

1. Move freely in space and interact with other users.
2. Find the table in the area with the books.
3. Find the drink machine in the scene.

Advertising objects, advertising banners were placed near individual objects in the scene, and when approaching the beverage machine at a defined distance, the user was shown an advertising area in the image space of the virtual reality headset. The scene used in this test is shown in Figure 2. We tested the insertion of advertising objects into the scene – subconsciously receiving stimuli for the user, displaying the advertising area in the scene and displaying the advertising banner in the screen space.

Fig. 2: Scene with advertising banner for testing the impact of advertising

6. Results

As a part of the testing, two test groups were created. One test group (37 participants) was created to test the impact of a photorealistic virtual environment in serious applications on the level of immersion, and a second test group (24 participants) was created to test the impact of advertising on the level of user immersion. For the needs of testing, we arranged the individual groups based on the results of the pre-test questionnaire.

6.1. Pre-test

The goal of the pre-test questionnaire was to exclude users who have health indispositions related mainly to problems with vision, stability, motion sickness, spatial orientation, epilepsy tendencies…, because this could distort the result based on the negative health experience of users in the virtual environment of virtual reality. For pre-test purposes, we used the Virtual reality sickness questionnaire (VRSQ) (Kim et al., 2018), the primary goal of which is to determine the motion sickness index in a virtual reality environment, supplemented by questions related to other health indispositions of users.

6.2. The influence of photorealism

There were 37 users in the test group (15–62 years old, average [A]: 33.7 standard deviation [SD]: 12.9). As part of the questionnaire after the end of the testing, we monitored the following identifiers:

(Q1) It was easy to complete the required tasks
(Q2) I moved within the environment without any problems
(Q3) The created scene looked realistic
(Q4) I had a feeling of immersion in the virtual environment
(Q5) User avatar looked realistic

(Q6) The scene was similar to the real world

Within the indicators, we used a 5-point Likert scale, where value 1 means I do not agree with the statement at all and value 5 means I completely agree. Table 1 shows the average values and standard deviations within the focus group within the indicators Q1-Q6 for photorealistic scene and Table 2 shows the average values and standard deviations within the focus group within the indicators Q1-Q6 for non-photorealistic scene.

	Age	Q1	Q2	Q3	Q4	Q5	Q6
A	**33,7**	**4,05**	**4,21**	**4,54**	**4,67**	**4,02**	**4,62**
SD	**12,9**	**0,94**	**1.00**	**0,55**	**0,57**	**0,64**	**0,49**

Table 1. Average response and standard deviation for responses to questions in the photorealistic scene test

	Age	Q1	Q2	Q3	Q4	Q5	Q6
A	**33,7**	**3,43**	**3,75**	**1,75**	**3,32**	**1,48**	**1,35**
SD	**12,9**	**1,21**	**0,93**	**0,59**	**0,88**	**0,56**	**0,48**

Table 2. Average response and standard deviation for responses to questions in a test with a non-photorealistic scene

6.3. The impact of advertising

There were 24 users in the test group (15–74 years old, average [A]: 39.1 standard deviation [SD]: 17.2). As part of the questionnaire after the end of the testing, we monitored the following indicators:

- (Q1) It was easy to complete the required tasks
- (Q2) I moved within the environment without any problems
- (Q3) The created scene looked realistic
- (Q4) I perceived the displayed advertising objects in the scene
- (Q5) I perceived the displayed advertising banners in the scene

- (Q6) Advertising objects and surfaces were not distracting to me
- (Q7) The displayed advertisement in the image space did not bother me
- (Q8) I was activated and influenced by advertising in the space

Within the indicators, we used a 5-point Likert scale, where value 1 means I do not agree with the statement at all and value 5 means I completely agree. Table 3 shows the average values and standard deviations within the individual focus group within the indicators Q1-Q8.

	Age	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8
A	**39,1**	**4,54**	**4,37**	**4,66**	**4,29**	**4,33**	**4,33**	**2,21**	**3,29**
SD	**17,2**	**0,51**	**0,71**	**0,48**	**0,95**	**0,63**	**0,56**	**0,93**	**1,33**

Table 3. Average response and standard deviation for responses to questions in the test on the impact of advertising on user immersion

After the end of the testing, individual interviews were conducted with the selected participants within individual focus groups, which specified the individual results of the testing.

7. Discussion

Based on the responses of individual participants in the testing, it was shown that the photorealistic scene has a great impact on user immersion, especially when using serious applications where the user expects similarity to reality. The established hypothesis H1: A photorealistic environment increases user immersion compared to a non-photorealistic environment was confirmed based on the evaluation of the testing and on the basis of individual interviews with the test participants. However, any measurement of this type is only aimed at evaluating subjective feelings. For objectification, it is necessary to focus on collecting objective data. Real objective data can

only be obtained through sensors, analysis of the user's movement in space. When measuring the impact of immersion, it could also be useful to measure the user's emotions to objectify the results. Based on interviews with test participants, it became clear that for them, when using serious applications, e.g. For teaching or medical applications, guarantee privacy, trust, limit the duration of individual sessions for individual applications in multi-user environments, and have available hardware capable of generating scenes in photorealistic quality.

When evaluating the second questionnaire for the impact of advertising, it turns out that it is more acceptable for users if advertising is an organic part of the created scene of a multi-user virtual environment. The test participants had the biggest problem with displaying the ad in their image space, where the ad was displayed for 5 seconds and the user was not informed at which moment the ad would appear, which disrupted immersion, the context of the scene and the user's concentration when performing activities in the scene. The established hypothesis H2: Advertising in virtual environments does not reduce the degree of immersion of the user in the virtual environment was only partially confirmed. In order to fully confirm the hypothesis, it would be necessary to exclude type 3 advertising from display, when it is displayed as a banner in the user's image space.

8. Conclusion

As a part of the work, we focused on selected problems of user immersion in a multi-user virtual environment and defined individual factors that affect it in virtual and augmented reality. We tested and confirmed the established hypotheses. Based on our observations, the research potential of individual factors is shown.

As part of future work, it is advisable to focus on the objectification of the evaluation of individual outputs within the framework of quantitative and qualitative research by involving other measured quanti-

ties. When creating multi-user virtual environments, it is also necessary to focus on creating environments adapted to the individual tasks that such a system is supposed to fulfil for applications in various fields from entertainment to serious applications.

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Social media as a tool for educating employees about the employer's brand

Piotr Legutko[1]

Abstract: Due to social media, users have gained online power that they had never had before. The speed and range of information provided and the possibility of joint action mean that they can effectively influence the image of companies and sometimes even create it. Despite new and difficult challenges, managers in many companies are starting to notice that they are facing a unique opportunity. This opportunity is to reach engaged recipients who contribute to the image of the organization in the new media. Employer branding includes activities that are designed to build a positive and consistent image of the company as an employer among current employees, potential new employees and the business environment. Therefore, there is nothing to prevent the use of new social media as an element of employee education and strengthening its ties with the organization as part of building a positive image of the company's brand.
Methodology: The publication is based on qualitative research conducted as a part of individual in-depth interviews with representatives of Polish companies.
Keywords: education, internal communication, social media, employer branding, employer of choice, corporate branding.

1. Introduction

We are witnessing an exceptionally dynamic development in the area of social media and communication. However, claiming that social media play a large role in the sphere of communication as well as social and business education is like saying nothing. The times when social channels were only used to find and maintain interpersonal contacts gave way to the present-day era, where not only the mecha-

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nisms of social life, but also the complicated processes of the functioning of business and economies are transferred to the virtual sphere. The social channels are no longer perceived only as an area of entertainment or a place of communication and networking, but have also become a field of professional and constantly improved company life, education of professional groups and industries. This state of affairs thus created new opportunities for the companies, which, due to their natural feature of survival and building a competitive advantage, see their chance for success with the participation of social media. But how to define these media?

2. Social media

Generally, the definition of social media derives from an English term. The authors A. Kaplan and M. Haenlein define social media as a set of web applications that use web technologies and the foundations of the web 2.0 concept. They enable both the creation and exchange of the content they generate in interaction with other users[2].

One of the first definitions of social media was presented by H. Rheingold. According to his theory presented in one of his most important publications, social media are created by a certain set of people, gathered as a community, who, in the absence of the possibility of a personal meeting, communicate using a computer and the network[3].

J. Van Dijck presents a very interesting observation that should not be simply missed, as it treats the concept of social media not only in the technological category, but more broadly in the social category. The author is of the opinion that social media cannot be treated only as a virtual environment to which real communication process-

2 A. Kaplan, M. Haenlein (2010): *Users of the world, unite! The challenges and opportunities of Social Media.* Business Horizons 53 (1), pp. 59–68.

3 H. Rheingold, *The virtual community. Homestading on the electronic frontier*, MIT Press, Cambridge-London 2000, p. 23.

es will be implemented and mapped. According to her, the concept of social media should be treated as a specific change, which also includes the nature of human relationships, behaviour and interactions. Thus, these media place their users in relation to the previously known traditional media in a more symmetrical position functioning in the public space[4].

On the other hand, R. Hanna, A. Rohm, V.L. Crittenden, in their publication assign a particularly important role to users of social media. They allow ordinary users for self-realization and education through participation in social groups, interest circles, and, above all, to participate in the co-creation of media content published in social media[5] . The subtly created openness to the content presented in this way, and the increasingly common accessibility of social media began to gradually take the form of changes in larger social groups, discovering the freedom and space to present their views in social media, make decisions and plans based on them. Thus, the social changes caused by the freedom that social media started to allow, had a scale effect and entered everyday life for good. Thus, they resulted in a redefinition of relations such as recipient-sender, state-citizen, employer-employee, teacher-student. This type of relationship, which makes us look again at the processes of information exchange embedded in the media, opens up a number of previously unavailable opportunities also in the field of education.

3. Employer branding

Nowadays, the volatility of the business environment requires the continuous adaptation of enterprises to the current market-related sit-

4 J. Van Dijck, *Culture of Connectivity. A critical history of social media*, Oxford Scholarship, Oxford 2013, p. 21.

5 R. Hanna, A. Rohm, V.L. Crittenden, *We're all connected: The power of the social media ecosystem*, „Business Horizons" 2011, No. 54, p. 44.

uation, companies and other organizations are constantly looking for sustainable ways to achieve success[6]. This applies to changes in the social, marketing and demographic areas, including human resources, their competences or the broadly understood approach of people to work[7]. We are also witnessing changes taking place on the labour market in the area related to the approach to the very term of work perceived anew by new generations. Unfortunately, more and more often changes result in increasing difficulties of the organization in the processes of acquiring and retaining employees[8]. Nowadays, employees have also become more self-confident and more willing to change their place of work more often if they find that they have been treated badly by the employer[9]. All this means that organizations face significant challenges to meet growing expectations, ensure interest, educate, develop and, what is important, maintain the loyalty of valuable employees. One of the answers to such challenges seems to be employer branding, i.e. creating the image of the employer. This concept of deliberately creating the image of a good place to work has gained considerable participation and interest of specialists of personnel management in recent years. Employer branding is therefore understood as all the company's activities aimed at convincing employees and candidates that their organization is an attractive work environment and a place where they will develop and with whose values they can identify. Employer branding is also supposed to indirectly lead to the

6 Kozielski R., *Four-leaf clover. Business of New Opportunities*, Published by Wolters Kluwer Polska S.A., Warsaw 2012, p. 12.

7 Wojtaszczyk K., *Employer branding, i.e. managing the employer's brand. Conditions, processes, measurement*, Publishing House of the University of Łódź, Łódź 2012, p. 5.

8 Report „Businesses are increasingly short of hands to work", Grand Thornton, 2017, p. 2.

9 Barrow, S., & Mosley, R. (2011). *The employer brand: Bringing the best of brand management to people at work*. John Wiley & Sons, p. 13.

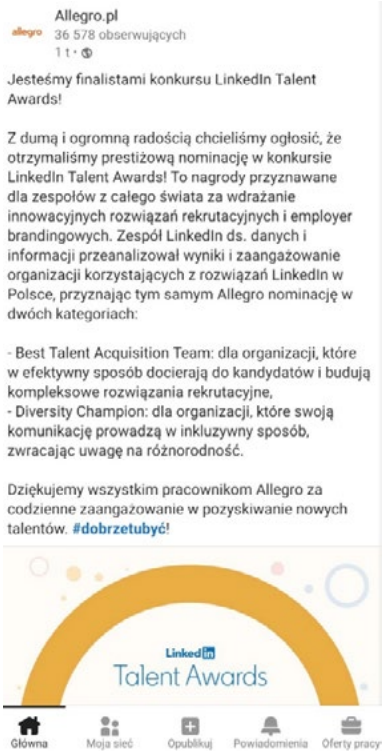
fact that in the eyes of employees and candidates the company will be perceived as the so-called "Employer of choice".

Organizations and employers do not forget about a very important fact, namely about the ongoing demographic changes. The labour market is slowly filling up with employees of younger generations who treat the virtual world of social media as their parallel reality of which they are active members. Bearing in mind, on the one hand, the above-mentioned communication possibilities of social channels, and on the other hand, the need to reach a wider audience with the values presented by the organization, companies are increasingly using their presence in social media to act in the field of building their image as a good work place. The activity of companies, apart from typical marketing procedures aimed at promoting their own brand, also focuses on the educational activities of their own and potential employees. Such opportunities are used, for example, on LinkedIn, which is a social channel dedicated to expert communication and the exchange of business contacts, which is a place to build employee relationships and develop professional careers[10]. The employer branding awards received by enterprises were an opportunity for such educational activities.

4. How it is done in Allegro?

Allegro S.A. and the several awards it received in the employer brand category is worth mentioning here. The first of the presented awards is the prestigious LinkedIn Talent Awards presented in Figure 1.

10 IAB-Guide-to-Social-Media-in-Poland-2019-2020-1, pp. 4–5.



Allegro.pl
Allegro 36 578 followers
1 week
We are the finalists of the LinkedIn Talent Awards competition!

We are proud and happy to announce that we have received a prestigious nomination in the LinkedIn Talent Awards competition! These are awards granted to teams from around the world for implementing innovative recruitment and employer branding solutions. The LinkedIn data and information team analysed the results and commitment of organizations using LinkedIn solutions in Poland, thus awarding Allegro nomination in two categories:
– Best Talent Acquisition Team: for organizations that effectively recruit candidates and build comprehensive recruitment solutions,
– Diversity Champion: for organizations that communicate in an inclusive manner, focusing on diversity.

We would like to thank all Allegro employees for their everyday commitment to acquiring new talents.
goodtobehere!

Figure 1 – LinkedIn Talent Awards for Allegro S.A.; Source: Allegro S.A. company profile on LinkedIn

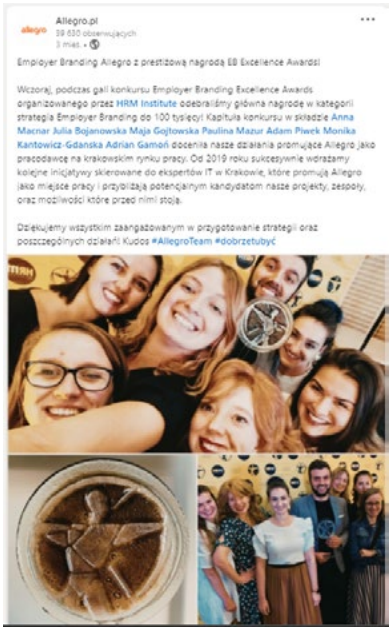
This is an award received in November 2021. The company announced this fact on the nominating portal, i.e. on LinkedIn. In the opinion of the company, it was received very warmly and with an almost 3 times higher percentage of reactions and positive feedback from followers compared to other company's posts. The fact of receiving this award was also an opportunity to thank Allegro employ-

ees, as quoted: "for everyday commitment to acquiring new talents". Undoubtedly, the presentation of the award received by the company in social media is educational and is a deliberate PR activity. Our assumption here is that if a company had been noticed and appreciated for its actions by an external entity granting the award, it should be perceived in the same categories by the environment and employees. The environment has not been deliberately distinguished here into an external or internal category, because due to the place of publication, i.e. the LinkedIn channel, the message reaches both of these groups. For an internal client who is his own employee[11] , thanks are sent for everyday involvement in the process of acquiring new talents. It is a well-known and well-thought-out formula for a joint celebration of the company's successes[12] additionally, according to the statements of the company's representatives, directly from the company's organizational culture.

Another award granted over the last few weeks is the award granted by the HRM Institute in the Employer Branding strategy up to 100,000 category. The screen of information on this subject is shown in Figure 2.

11 Balon, Urszula, and Joanna Dziadkowiec. *Internal and external customer in the quality management system*. Scientific Journals of UEK 815 (2010): 17–40.

12 https://employerbranding.pl/okazje-do-wspolnego-swietowania-w-firmie/, accessed on 2022-01-29.



Allegro.pl
Allegro 39 630 followers
3 months

Employer Branding Allegro with the prestigious EB Excellence Awards!

Yesterday, during the Employer Branding Excellence Awards gala organized by the HRM Institute, we received the main award in the Employer Branding strategy category up to 100,000! The competition jury composed of Anna Macnar Julia Bojanowska Maja Gojtowska Paulina Mazur Adam Piwek Monika Kantowicz-Gdanska Adrian Gamoń appreciated our activities promoting Allegro as an employer on the Krakow labour market. Since 2019, we have been gradually implementing new initiatives aimed at IT experts in Krakow, which promote Allegro as a workplace and introduce potential candidates to our projects, teams and opportunities.

We would like to thank everyone involved in the preparation of the strategy and individual activities! Kudos # AllegroTeam # goodtobehere

Figure 2 – HRM Institute award in the Employer Branding strategy category up to 100,000 for Allegro S.A.; Source: Allegro S.A. company profile on LinkedIn

This award was granted in September 2021, recognizing Allegro S.A. as an employer on the Krakow labour market. The information was published on the company's fan page in the LinkedIn channel. It was not without thanks from the company for everyone involved in the strategy and activities. This post was once again warmly wel-

comed by the followers, gathering a large dose of positive reactions. The fact of receiving the award was used in a similar way as in the case of ennoblement from the LinkedIn Talent Awards in the process of informing and educating own employees in the area of building the employer's brand. In this case also, the company decided to celebrate the fact of receiving the award with some of its employees. The recipient of the message is a group of company experts, to whom thanks are addressed for their commitment into developing the strategy and carrying out appropriate actions. In addition, the company, by publishing information in the LinkedIn channel, emphasizes the essence of the award received, i.e. for successive implemented initiatives addressed to IT specialists in Krakow, and promotes this area of the company's community among candidates and prospective employees.

The Allegro S.A. Group, using social media once again, presents a distinction awarded this time in the Retail Trade category according to the Forbes "Poland's Best Employers 2021" ranking on its corporate profile in the LinkedIn channel . This fact is shown in Figure 3.

Allegro.pl
Allegro 39 630 followers
8 months

Allegro is the best employer in the Retail Trade category according to the Forbes ranking „Poland's Best Employers 2021". Our company is a place conducive to development, full of interesting large-scale projects and a stable employer. Distinction in the ranking is another proof that it is really # goodtobehere :) Congratulations to the others awarded! You can find the full report here: https://lnkd.in/eh7-HqR
At the same time, we would like to remind you that our recruitment plans for 2021 are very ambitious – we plan to employ nearly 1,500 people. Information about who we are looking for and to which locations can be found at https://allegro.pl/praca

Figure 3 – Forbes Award "Poland's Best Employers 2021" for Allegro S.A.; Source: Allegro S.A. company profile on LinkedIn

The award was granted for development and work stability. The distinction has become, as in the previous two cases, an opportunity to educate the company's employees in relation to promoting the enterprise in the category of a place conducive to development, interesting projects and stable employment. When publishing information about the award, as in the previous cases, a mechanism for increasing the reach was used and the hashtag #dobrzetubyc (#goodtobehere) was included in the content of the post. The summary of the information

became an opportunity to present – to an external client: in this case a potential candidate for a job – information about ambitious recruitment plans for 2021. The company's representatives who are responsible for employee issues and employer branding emphasized several times[13] the importance of constant awareness of the size of the recruitment task as well as its current level of performance from the point of view of recruitment. Thus, implementing this assumption, using the celebration of the distinction, the company openly communicates the environment about specific and numerically defined employment plans, and skilfully educates its employees on issues related to building its brand of a reliable employer.

5. How it is done in Orange Polska?

In October 2021, the company Orange Polska S.A. won the main prize at the Employer Branding Excellence Awards 2021 Gala for the Best Online Communication, and, as the company informs, two awards:

1. For the best image video.
2. For employer branding innovations.

Information about this award was published, inter alia, on the company's profile on the LinkedIn portal. Picture nr 4.

13 https://www.youtube.com/watch?v=1LXrcQn-PSw

Orange Polska
22514 followers
3 months
We are celebrating! Yesterday, at the Employer Branding Excellence Awards gala we were granted the main prize in the Best Online Campaign category for the communication project of the Let's Orange summer internship programme and WłączOne, as well as two special awards:
*The best image and recruitment video – for Let's Orange
*EB innovation – for WłączOne
We would like to thank the jury for recognition and our team responsible for employer branding: Renata Szatecka Edyta Pawlik Lidia Pierścińska Helena Nadolska,
and Ewa Krupa and Jacek Kowalski for patronage and support.
We would also like to thank our Partner, the agency Job'n'Joy and the consultant Tomasz Duda, thanks to whom we were able to successfully carry out the above-mentioned campaigns and reach our target groups with communication.

Orange Polska is the laureate of Employer Branding Excellence Awards 2021

Figure 4 – Employer Branding Excellence Awards 2021 Award; Source: Orange Polska S.A. company profile on LinkedIn

The company, presenting this fact, would like to thank, among others, consultants and supporting agencies. However, the most important element of the analysed publication is the fragment in which the words of thanks are sent to the company's team responsible for employer branding. This is noticeably yet another example of how em-

ployees are skilfully involved in building the own brand of a good employer. It also has an educational and training dimension, where the company's employees become brand ambassadors.

6. Summary

It is worth emphasizing that companies willingly share the fact about the awards and distinctions awarded on social media, thus informing their employees about that. This is evidenced by a fairly large amount of pieces of information and publications on this subject. It is also easy to find relevant information on the Internet in this area. As E. Badzińska claims, the advantage of PR activities consisting in the publication of this type of information is undoubtedly the enhancement of the effects of the brand promotion campaigns carried out, and thus achieving the synergy effect of such activities[14]. The question then arises, "what is it like in the case of these companies"? Are we dealing with a coherent policy for the surveyed companies in terms of marketing, employee education, publication of awards and achievements, and the company's credibility and brand image?

In a way, the answers to such a question are partially provided by the subjects themselves with their approach to the subject. It is necessary to pay attention to the content of the message informing about the received award. In addition to the information on the subject and circumstances of receiving the award, practically every such message can contain references and thanks to the employees and teams responsible for the achieved success.

Enterprises publish information about the awards and distinctions achieved in such a way as not to forget about the people who made this success possible.

14 Badzińska, Ewa. *Interactive media as a condition for effective social communication*. Social Inequalities and Economic Growth 35 (2013): 24–41.

The scale of positive reactions to posts, the generated reach, and the educational dimension of such publications form a coherent unity, together with the activities undertaken by companies in the field of building the employer's brand. This way, a synergy effect is obtained, consisting of consistency between receiving the award, communicating about this fact in social media and confirming the legitimacy of the award by the users of social channels themselves. This is a specific key that makes the effectiveness of companies' activities in the area of employer branding more credible also thanks to training, education and integration of employees in matters related to the company's brand. As the companies themselves admit, the effect indirectly resulting from such efforts is the growing group of people responsible for company branding. The educational dimension of the publication thus translates directly into the purely promotional effects of the company as a brand, as an employer. It is impossible to remain indifferent to the phenomenon where the employees voluntarily become representatives (ambassadors) of their employers. From the educational and training point of view, it is a very positive phenomenon and unifies the entire organization. On the other hand, it is the essence of activities undertaken in the area of employer brand building.

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The potential of infographics – an overview of the literature and research on infographics

Gabriela Piechnik-Czyż[1]

Abstract: It is hard to provide information only by text. The average user often feels helpless in the face of the abundance of information that becomes quickly available in a few seconds. Modern civilization and the information society pose a new challenge to us – to convey information in a way that is easy to remember and, above all, to understand. The solution to the problems with the effective transmission of information to modern recipients may be an infographic. It is worth taking a look at the research of infographics so far and considering if information graphics can be effective. Selected research related to infographics, image and text perception, as well as memorization of information will be presented in this paper.
Keywords: information graphic, graphic design, infographic, research on infographics

Due to infographics, you can visually present information in one space and in an easy-to-process way by the recipient, but also about various, extensive processes. You can also show how to quickly assimilate large sets of numerical data. However, specialists do not agree how to define infographics. It is worth noting that in many definitions there is a common denominator: infographic is the message in the form of an image. Selected infographics definitions are presented below.

Both the concept of infographic and information design raises a lot of discussion, which may result from different approaches to un-

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derstanding the topic and the fact that these two areas are still developing and taking on new forms. Kim Baer writes that in the world of graphic design, information design is in the early stages of development. The term is relatively new, but it has already become a subject of debate in the design community. Baer draws attention to the problem of interdisciplinarity of information design, which is noticeable at the design stage. (Baer, 2010). If an infographic should be effective, then its creator should have knowledge not only about graphic design, but also about writing and editing text, colour theory, image perception, as well as at least general knowledge or contact with specialists in the subject that is being discussed.

Randy Krum describes the infographic as a creation more extensive than data visualization, containing texts, icons, illustrations and, above all, telling a story. Thus, it can be considered as a „visual article" that consists of three parts (introduction, development and detailing of the topic and an ending that helps the recipient draw conclusions). (Krum, 2013, p. 2–8, 27). It is not just a collection of charts.

Jason Lankow, Ross Crooks and Josh Ritchie use the terms infographic and information graphics interchangeably and indicate that a wide field of interpretation and meaning of these concepts should be preserved, due to the fact that an infographic can be both: a simple road sign and an extensive form depicting complex statistical analyses. An infographic does not have to contain a certain amount of data. There is no clear boundary that marks that a project becomes an infographic. It can also be considered as a unique genre that usually contains a certain amount of text, illustrations and is characterized by a long, vertical format and presents specific facts. Lankow, Crooks and Ritchie also note that the term has grown in popularity, thanks to the increased use of informational graphics in online marketing over the past few years. (Lankow, Ritchie, 2012, p. 20).

In turn, as Lech Mazurczyk writes – infographic can take various forms, sizes or degrees of complexity. However, readability is still very

important, so presented information must be simple and clear. The most important thing is the effectiveness of the infographic, which is to keep the recipient's attention only for the time needed to understand the message. (Mazurczyk, 2010). As L. Mazurczyk points out, an infographic can complement the text, but sometimes it is a separate entity and shows everything with an image. The criterion in this case is one: if the infographic exhausts the topic, the text becomes redundant. However, such cases, according to the author, are an exception. (Mazurczyk, 2010)

On the other hand, Michał Nowakowski cites one of the general definitions of infographics, which says that it is a graphical representation of data, information and knowledge. Its purpose is to show complex information in a quick and clear way. (Nowakowski, 2014). An extension of this definition may be the quoted claim of M. Burns and T. Bitner, who considered the infographic to be an „explanatory graphic", due to the fact that it emphasizes not only information, but also the graphical explanation of information and the transmission of various ideas through images (Nowakowski, 2014). M. Nowakowski also draws attention to the fact that infographic gives data and information a „graphic meaning". In this case, data visualization is an important factor that builds this process of transferring information. He emphasizes that information graphics cannot be identified only with the aesthetic appearance of the text. Text has an auxiliary role, and the main component is drawings, graphics or diagrams.

It can also be assumed that the purpose of using information graphics is to illustrate and explain difficult issues, so that readers can more easily and quickly understand complex structures, aspects, stages of the process and the effects and causes of action. Traditionally, infographic should be treated as a whole consisting of text and image elements that are attached or embedded in a text article with the same or similar content. Empirical research has shown that information graphics have a significant effect on reading behaviour because they

attract the attention of readers and prolong the reading of related text (J. Holsanova et al., 2008). Selected research will be presented below.

1. A literature review and research on infographics

Until a few years ago, infographics were not a popular topic for research. Some of the publications were like guides for designers, but there were not many scientific studies, especially in Polish. However, the increase in interest in infographics is visible in various industries, including science. After entering the term "infographic" in Google Scholar, 8,290 publications are visible in the titles and/or abstracts, while after entering the term "infographic" – 254,000 items[2]. In the databases of scientific publications, there is a greater difference in searches, e.g. in Scilit.net the term "infographic" generates 3888 publications, EBSCO 8943, and Web of Science 3011 items. There are only a few publications in Polish in these databases. In each database there is a significant disproportion in Polish-language and foreign-language publications. On the other hand, a wide range of research topics related to infographics is visible; hence the literature review should be treated interdisciplinarily.

Visual communication strategies are increasingly being used by healthcare professionals. Visual messages are becoming more and more common in the transmission of information. The potential of social media to rapidly disseminate knowledge through infographics has been recognized early in the coronavirus (COVID-19) pandemic by healthcare professionals. Scientific studies have emerged to describe the approach of healthcare professionals to developing infographics about COVID-19 vaccines. The reach and engagement with infographics shared on social media was also examined (Rotolo et al., 2021). Another publication on the subject of the COVID-19 pan-

2 Status on April 24, 2022.

demic aimed, among other things, to identify the directions and aspects of research on the use of infographics in the pandemic (Stępniak, 2022). In the field of medicine, it was also noted that infographics can be a useful tool for disseminating knowledge about multiple sclerosis and pregnancy. The prepared infographic informs about the inheritance and treatment of multiple sclerosis, as well as pregnancy and the evolution of multiple sclerosis, pregnancy planning and postpartum. The results showed that the infographic contributed to a better understanding of the topic (Martinez Moliner et al., 2022).

The infographic also provides information on securing firearms to avoid unintentional injuries to children due to improperly secured guns in the United States. Visual guidance for parents published by the American Academy of Pediatrics made it easier to access and understand important information (Johnson et al., 2021).

Information graphics are also of interest to researchers related to pedagogy. So far, the possibilities of infographics in engaging students in visual stories and the use of infographics in nursing education have been explored (Chicca, Chunta, 2020). It also explored the use of infographics for communication in academia (Sierak, 2021), as well as how to use them to engage students in learning and make them active and creative participants in the classes. Its important role in innovative education, especially in modern academic education, was also emphasized. Moreover, the authors see the use of infographics as a step forward in making online learning an interactive, stimulating, and rewarding experience (Ren-Kurc et al., 2018).

In the area of topics related to business, economics, science and culture, infographics are studied, among others, in terms of usefulness in presenting business data (Nowakowski, 2014). There are also studies related to the climate and its changes and the largest CO2 emitters in the world (Friedrich et al., 2015), as well as the use of infographics in cultural institutions (Dukalska-Hermut, 2021). The potential of infographics in promoting research was also noted (West, Lindsay, Hart,

2020), and a comparison of interest and citation rates on social media between infographics (visual abstracts) and original research articles was made (Kunze et al., 2021).

Polish and world literature is also increasingly interested in infographics in themselves, for example, what it is, how it is built, what features it has (Pulak, Wieczorek-Tomaszewska, 2011). Some studies are built on the principle of guides, some use their own research. Theories related to the design of engaging infographics are described (Scott, Fawkner, Oliver, 2017), as well as infographics are presented as a journalistic genre. The infographic in the press and the Internet was also analysed. For this purpose, three types of print media and the two largest Polish information portals were selected. A specialist internet portal dealing with data journalism was also taken into account. Both analyses lead to the conclusion that infographics in journalism are an important element of the multimodal narrative, increasing the attractiveness of newspapers and websites (Szews, 2020).

Many publications also include research on the image and operation of the human brain, processing and remembering information. Research shows the existence of the PSE phenomenon – the effect of image superiority. It means that if you want to recall a memory, most people will see an image of that thing or figure in their heads. John Medina in his book describes the effects of the test, which shows that people can remember more than 2500 images with an accuracy of at least 90% within a few days after seeing them, even if it took only 10 seconds. After a year, a person remembers these images in 63%. For other ways of communication, the results are much less spectacular. After 72 hours of hearing the spoken word, people remember about 10% of the presented content. However, this percentage increases when the oral transmission is accompanied by an image (Zimniak-Rucińska, 2019).

Cognitive experiments on keeping audience's attention on the front pages of newspapers show that infographics are more likely to grab

your audience's attention. Using various graphic messages on the front pages of newspapers, such as placing a very interesting photo or a corresponding infographic, the recipient kept his attention on the infographic for longer. The reader's eyes had to focus much longer on presented information (Leszkowicz, 2011). As Mateusz Leszkowicz writes – the explanation for this phenomenon should be seen in the fact that the infographic fulfils several functions that a photo or illustration is not able to (Leszkowicz, 2011). This is influenced by several factors related to the structure and function of the infographic.

S. Pasternack and S.H. Utt in 1989 explored how and why readers choose press infographics. In particular, they wanted to answer two basic questions. First, do newspaper readers watch the infographic before or after reading the headline/text? Second, when people decide to watch an infographic – do they do it for reasons related to appearance or content?

The results indicated that the recipient, when dealing with a large, text-dominant infographic (in this case, a graphic with a header and two bar charts and a pie chart) starts reading by analysing the infographic, and then reads the article. However, when the text was accompanied only by a chart or a small infographic, the reader traditionally began by reading the text. When it comes to visual considerations, they were not always the most important. The recipient expected that in large infographics there would be an accumulation of information that would help him understand the content better or even avoid further reading. In some cases, the infographic was also some kind of a reprieve or a break from reading the article (Pasternack, Utt, 1990).

In the same year, two other researchers, P. Stark and B. Hollander, also undertook to investigate how text and text with a visual message affect the audience and which of these possibilities will affect the best memorization of information (Griffin, Stevenson, 1996). Participants in this experiment received one of four versions of a sample newspa-

per's main page that told about a plane crash. In one version, only text was available, without visual elements; in another text, a photo from the crash site and an infographic summarizing the event; the third option contained text and a photo; the fourth text with an infographic. The answers to the questions about the disaster showed that participants with more visual elements were able to answer more questions and answer more precisely. Thus, the ability to respond was highest for the group where respondents saw text, an infographic, and a photo. The next place was taken by a group with an article and an infographic, followed by a group with text and a photo, and finally a group with only text (Griffin, Stevenson, 1996).

Although infographics affect the reception and reading of a text, they do not always have a positive effect. As J. Ramaprasad argues in a 1991 study, that infographics reduce the likelihood of remembering information that is contained in the text and was not referred to in the infographic. The participants of the experiment were divided into two groups. One of them received a text about earthquakes in the USA and an infographic showing geological cross-sections of the San Francisco and Los Angeles area. The second group received only a text on the same subject. The first group performed better when respondents had to answer questions related to the information contained in both: the text and the infographic. On the other hand, group number two fared much better in a situation where it was necessary to recall information contained only in the text, and not present in the infographic (Griffin, Stevenson, 1996).

Jefferey L. Griffin and Robert L. Stevenson also conducted a study to show the reception of journalistic texts in which a graphical presentation of data appears. The experiment showed that the graphical presentation of statistical information increases the memorization of material when the information is contained both: in the text and in the accompanying graphics. This is due to the repetition of the content. However, what was surprising, if the data was presented only in

the text or only in the graphics, the text article showed greater effectiveness (Griffin, Stevenson, 1996).

J. Holsanova, N. Holmberg and K. Holmqvist have shown that the influence of graphic structure is a key factor influencing the visual behaviour of the recipient. For their research, they used an eye tracking study, thanks to which they could track the reading path of the examined recipient. The assumption of the study was that the immediate vicinity of graphic elements depicting phenomena and textual descriptions will affect the perceptual behaviour of the recipient. Three factors were compared: reading order, reading time and integration of text with graphics. It was assumed that the order of reading individual parts of the graphics reflects the search for information, and the time spent on information graphics reflects interest in the material. It was believed that the proportion of saccades movements reflected the semantic integration of text and illustrations (J. Holsanova et al., 2008). Saccades are one of the elements that are studied using the eye tracking method and concern the rapid transfer of vision from one point of focus to another (Garczarek-Bąk, 2016). Study participants were assigned to two groups and had 20 minutes to review the newspapers presented to them. They could read anything they wanted freely in any order. Research has shown that when a graphic is separated from text, the reader chooses the infographic rather than the text immediately after the header. Graphics integrated into the main text are processed along with the text. In a separate format, recipients treated text and image as two separate parts. Conversely, in integrated formats with a smaller physical distance between text and graphics (J. Holsanova et al., 2008).

Most studies indicate the dominant role of graphics in memorization even if there are a few research results indicating the dominant role of text when the recipient deals only with the article or only with graphics. Proper combination is also a combination of an infographic and an article. Sometimes the audience also expects the infographic

to be a carrier of the most important information extracted from the text. However, the described research mostly took place in the 90s or early twenty-first century. It should be looked at whether the developing technology and visual communication have changed the perception of information graphics. There are already some studies, but they clearly indicate that preferences as to the way of transmitting information depend on the type of generation. The aim of the study conducted by A. Young and M. Hinesly was to check whether the information provided by infographics would provide better results than those given in the text version. Issues related to user preferences, understanding and performance of the reader were taken into account. An online survey of 895 respondents from three generational groups was conducted on an international sample of 895 respondents. Respondents were randomly assigned to read an article in the form of an infographic or its textual equivalent. Tests have shown that infographics can improve communication with certain age groups. Millennials were the group that were more likely to say they would read the article and recommend it to others if they received an infographic version than if they received a text version. However, Baby Boomers performed better in terms of understanding when they received a text version rather than an infographic version. The results indicate that infographics and traditional approaches to text are needed to reach a multi-generational workforce. Infographics are likely to grow in popularity over the next few years as more and more Millennials get started and Baby Boomers end their careers (Young, Hinesly, 2016).

2. Summary

Previous research indicates considerable possibilities for the use of infographics in the press, the Internet, but also in other fields such as education. They show the recipient's study of the text and image and what is important to him. It is also worth noting the dominant role of

visual perception in Western culture, which Martin Jay wrote about at the beginning of the 90s'. He introduced the term oculocentrism to describe this phenomenon (Jay, 1993). Almost two-thirds of the activity of the human brain relates to the process of seeing. Sight definitely dominates over other senses. The main method of perceiving the surrounding world is by visual stimuli. The predominance of this sense begins already in infancy. As John Berger writes almost at the beginning of his book *Ways of Seeing*: "*Seeing comes before words. The child looks and recognizes before it can speak"* (Berger, 1990). It is worth noting here that it is the infographic that allows the presented content to be shown in an attractive way – one that is understood quickly and easily, mainly by means of an image. In this way, large amounts of numerical data or complex processes can be shown. This is conditioned by several factors that are associated with the features of the information society and visual culture.

Infographics are still developing and taking on newer and newer forms, adapted to each of the medium in which they appear. The best creators of information graphics use knowledge related to, among others, computer graphics, colour psychology, as well as the reception of image and information by human and the processing of this information by the brain. Infographics use an image that reaches the human brain much faster, easier and stays in memory for longer. It is estimated that visual learners make up 65% of the general population (Smiciklas, 2013, p. 20). In the whole multitude of information that reaches the recipient every minute, the brain is not able to process everything. So it is looking for something that will be new, interesting, attractive, and noticeable is predominant. As Mark Smiciklas writes in his book – the brain inherently pays attention to what stands out or is somehow different (Smiciklas, 2013, p. 19). In addition, in the information society, information is the most important and valuable area. What counts, is the rapid collection, processing and dissemination of information, so if the recipient can easily assimilate the message

thanks to the infographic, then he/she can also share it further much faster. Therefore, broadcasters see the potential in the transmission of information using information graphics and the increasing popularity of infographics on the Internet.

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Art for art's sake, digital for god's sake

Aliaksandra Laurova[1], Jaroslav Světlík[2]

Abstract: This paper looks at the idea of programming as an artistic tool and a modern form of self-expression of an artist. It covers the topics of creative coding, generative algorithms, data visualizations, and development of this new form of fine art. The content of the paper combines programming, mathematics and fine art. The combination of these disciplines together brings new perspectives to the development of multimedia culture. The development of digital technologies brings a huge scope for research and creation of unique projects. Many programming languages and platforms, as well as hardware tools are available for use, but academic articles and paper of this very contemporary issue almost does not exist. One of the goals is to show that programming also can belong to the world of fine art. Some practical Alex Laurova's samples of applying creative coding methods in art are a part of the paper.
Keywords: creative coding, algorithmic art, computational art, programming, interactive installation, Processing, motion detection, data visualization.

1. Introduction

It is often referred to fine art and science as two diametrically different areas of our social reality. Areas that actually do not have any mutual relationship are not very related to each other. An artist is often presented as a person who is dependent most of all on emotions and intuition, without any place for sense, rational way of thinking and careful planning. A scientist is a person who represents cold world of

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logic, who is intellectual, reasonable, rational, where any imagination cannot be taken into account. The world is changing and old paradigms disappear and cease to be recognized. And in times of new discoveries in the field of influence of emotions on our decision making, importance of creative thinking and the existence of creative industries, etc., this abysmally different perception of art and science disappear. According to Isaac Asimov (1983, p. 116), writer and professor of biochemistry, this practice of splitting fine arts and science leads to false ideas. The real artist combines imagination and rationality, has a plan, steps he must go through, he knows what he is doing; If not, his art suffers. A real scientist cannot be only rational person, but also imaginative, the imagination and phantasy itself can sometimes lead to innovative, ground-breaking solutions, while reason and rational thinking usually can lead to similar output, but much slower and pass through longer way. Let´s cite Isaac Asimov: *There is an art to science, and a science in art; the two are not enemies, but different aspects of the whole*[3].

The advent of digital technologies and the Internet has changed our world. We live in new era of digital technologies, where, next to other aspects of these changes, numerous gadgets, computers and software programs are used to create new artistic directions, styles and techniques. Digital technologies have become new important tool of fine art. One of the practices that is constantly gaining popularity is creative coding – the way of using programming for self-expression. Instead of relying on existing traditional tools, new hardware and software technologies are used. And even instead of relying on existing, traditional software, such as Adobe Illustrator, Photoshop, 3DS Max, Blender, etc., which have a set of specific tools, commands and effects,

3 https://quotefancy.com/quote/832634/Isaac-Asimov-There-is-an-art-to-science-and-a-science-in-art-the-two – are-not-enemies-but

creative coders use special programs to create their artworks and do it without any predetermined restrictions.

Number of architects, designers and artists began to see enormous potential of the new approach. There are many new online platforms, portals and communities which both share artworks and learn from others. One of the utmost advantages of creative coding is the fact, that most of the programs can be stored online via open-source, which means that anyone can access code, download, copy, change, use as a basis for creating something else, better, different and next to it establish fruitful cooperation between coders from all over the world.

However, when people, who are not very familiar with this new technology, hear about creative coding, they can assume that only very skilled programmers can handle and make use of this technology. They think that creative coding could be something that belongs to the world of computer science rather than fine art. Yes, creative coding is still based on programming, but a set of different programming languages such as Processing has been created specifically for artistic purposes where commands and instructions are simplified and in fact, one can download numerous libraries that are able to replace large pieces of codes. The creative encoder, like a traditional artist, can start „sketching" the program without a specific plans, he/she can add various objects, colors and movements without knowing the shape itself. The results are often not what we would expect. By changing only one number in the code, we can change the entire appearance of the fine art project. This is also the reason why creative coding is so much exciting. Digital communication is constantly evolving and brings us more and more options to create new artworks every day. Technological advances lead to new logical systems, more powerful tools that can use and make use of a new generation of creative people. We can expect advents of new styles of fine arts, the limits are only in our heads, in our imagination and creativity.

The bond between technology, science and art is undoubtedly very strong. New tools allow designers and artists to create more freely and without limits. But the other side of this coin is also important. Art drives innovation and creates significant demand for technology. When working with various materials, artists often develop new techniques and shift the boundaries of imagination and creativity they open brand new directions of technological development etc. All broad artistic activities – from preservation and restoration of ancient artworks to the creation of complicated artworks of virtual reality within actual environment – that all also generate significant demand for innovations.

2. Defining the basic concepts

With every single day and the new steps in technological and scientific evolution, many new unusual art forms and tools are created. With the development of new tools of communication in the 1960s, various new tools became available to the public. Machines, originally invented for business purposes, had been used by artists as new fine-art tools. Shortly after the first copy machines were made, **xerox art** (xerography or braid art) appeared, which includes the use of a copier to create a new forms of art. The history began at the end of the 1960s, when several artists, Wallace Berman, Esta Nesbitt, Andy Warhol and some others began using copy machines to create distorted pictures of various objects, parts of your own body, drawings, photos, etc. (Xerox Art, 2015)

Another specific form of art – **fax art** (telecommunications art or telematics art) – appeared with the expansion of faxes. On January 12, 1985, Joseph Beuys, Andy Warhol and Japanese artist Kaii Higashiyama took part in the project "Global-art-Fusion". A fax was sent from one artist to another and each of them added his own drawing to the work. It took 32 minutes for the fax work to travel around the world –

from Düsseldorf (Germany) through New York (USA) to Tokyo (Japan), the final artwork can be seen in the Lichtenstein Museum of Modern Art in Vienna. This fax was actually a statement of peace during the so called Cold War in the 1980s'[4].

When computers have become accessible and spread over the public, they quickly turned into another artistic instrument, such as paint and brush for painters or clay for sculptors. Since the 1960s', artists have been equipped with a new fascinating tool, probably with an unmeasurable potential. Computers not only offer us more efficient ways of work, but have fundamentally changed our perception of society, art and the world in general. This was confirmed by social development in the last few decades, which have brought us many artistic styles and techniques. Some of them are: digital design, art of ASCII, telematics art, art of new media, systemic art, software art, artificial intelligence, algorithm art, fractal art, interactive art, data visualization, generative art, creative coding and many more.

Creative coding is becoming increasingly popular every day and more and more artists are looking for inspiration in this new media form. However, the discipline is still very new, there are not many studies that explore all the possibilities of creative coding in the world of visual media and promote it as another artistic tool that anyone could use. **Creative coding is a broad concept, which combines generative art, interactive design, information visualization, sound visualization, interactive installation and presentation**.

It would be useful to define basic terms before any analysis. What exactly creative coding is, generative art and generative algorithms? What do actually mentioned criteria mean? How do different artists and programmers understand this? Over the past 60 years, our world

4 WIEN 1985: Phänomen Fax-Art.Beuys, Warhol und Higashiama setzen dem kalten Krieg ein Zeichen. Chaahill Art Consulting [online]. October 13, 2015 [cit. 2021-10-20]. https://andrechahil.com/wien-1985-phaenomen-fax-art-beuys-warhol-und-higashiyama-setzen-dem-kalten-krieg-ein-zeichen/

has changed into digital one. No form of art has captured this transitional period – our present era – better than the generative art. **Generative art** fully utilizes everything that the computer can offer and produces elegant and impressive artworks that expand the same principles and goals that artists had been watching since the beginning of modern art.[5] What exactly is generative art? One simple but useful definition by Jason Bailey is that **generative art is art programmed using a computer that deliberately mentions randomness as part of its creation process. The task of the artist is to design or influence this process to some extent.**

The terms "generative art" and "computer art" are used in pillion. The constant development of digital tools brings a number of new techniques and procedures. Visual forms are created using computing logic, which is triggered by a specific set of rules depending on

the selection of code language and programming platform. It can be stated that generative art is a broader concept that has been divided over time and progress into various movements and practices that include:

- creative coding;
- code art;
- computing art;
- software art;
- Internet art,
- net art; interactive art;
- algorithmic art;
- procedural art;
- data visualization;
- fractal art.

5 https://www.artnome.com/news/2018/8/8/why-love-generative-art

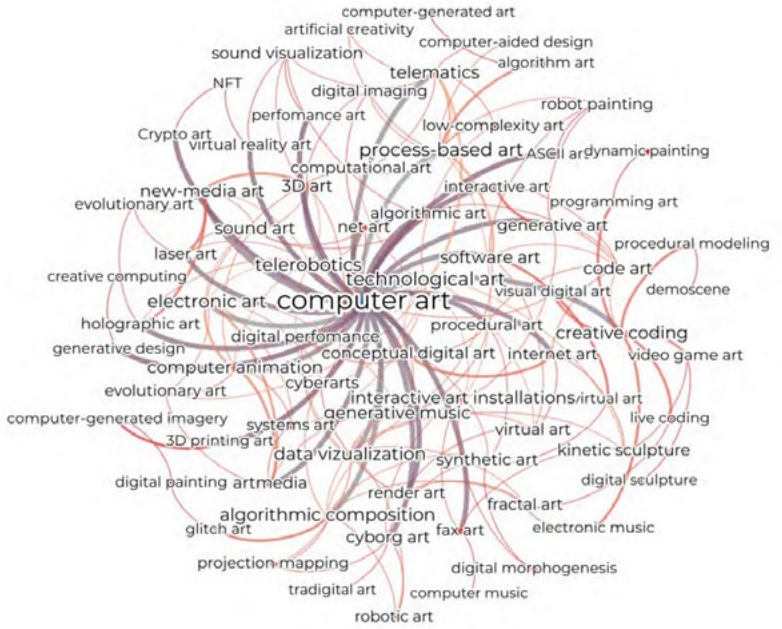

Figure 1. Categories of computer art. Source: Aliaksandra Laurova

Some of the terms mentioned above can be considered synonyms, others take significant differences, but all use computer execution and programming systems. Hundreds of artists prefer their own approach and vision of each component of a computer art family. Accurate definitions are difficult to find, below some of the most commonly used are discussed. One quite simple but mostly used definition claims that "creative coding" is a type of computer programming in which the goal is to create something expressive instead of something functional"[6] or

6 https://en.wikipedia.org/wiki/Creative_coding

even more simple: **Creative coding** "is simply the art of creating visualizations or expression"[7].

Another member of modern fine art family based on a computer is **algorithmic art**. Vlatko Ceric defined **algorithmic art** "as visual art created on the basis of algorithms that completely describe generation of images"[8]. This kind of art is closely related to the modern development of software technologies and especially computer programming. Another impact on algorithmic art is related to mathematics, which is used in image generation algorithms.

Fractal art is an example of algorithmic art. For a picture of a reasonably large size, even the simplest algorithms are too demanding on manual implementation, so it runs either on one computer or on cluster of computers. The result is a drawing, usually shown on a computer monitor as a projection or as printed graphics. Fractal art is a form of algorithmic art created by a calculation of fractal objects, the results are represented as digital images, animations, videos[9]. Fractals are infinitely complex patterns that are similar to different scales. They are created by repeating the simple process over and over in a constant feedback loop[10]. A similar definition applies to **code art**. As Michal Šimkovič states in his article, it is a computer – generated work of art that is defined by algorithms. It is located at the unique intersection of design, art and programming[11].

Software art can generally be defined as art which material is a formal instruction code and/or which deals with software cultural con-

7 Donovan Alexander https://interestingengineering.com/everything-you-need-to-know-about-the-artistic-world-of-creative-coding Nov 10, 2020.

8 Ceric, Vlatko. *Algorithmic Art: Technology, Mathematics and Art*. Trg J.F. Kennedyja 6, 10000 Zagreb, Croatia: Faculty of Economics and Business, 8. https://doi.org/10.1109/ITI.2008.4588386

9 Bovill, Carl (1996). *Fractal geometry in architecture and design*. Boston: Birkhauser. p. 153. ISBN 0-8176-3795-8. Retrieved October 28, 2011.

10 https://fractalfoundation.org/resources/what-are-fractals/

11 https://blog.hackerrank.com/creating-art-with-code/

cepts". (Florian Cramer, 2002)[12] In an effort to further expand this topic, Pete Schultz (2002) describes the software culture as a living programmer culture and users who take over the roles of active participants in the world of software. In its core, the software culture delimits the area of intensive intangible production, which arises as a reaction to the critical reflection of every aspect of human life, which is in some way controlled or guided by software[13].

Internet art (also known as **net art**) is a kind of art that uses the Internet as a way of spreading instead of a traditional gallery. Net art is often interactive, it can use a number of different media, such as sound, animation and videos. This method also allows small artists to share their work with a large audience[14]. The term Internet art usually does not refer to art that has been easily digitized and uploaded to be displayed over Internet, for example in the online gallery. Net art relies that the Internet exists as a whole and uses aspects such as interactive interfaces and connectivity with many social and economic cultures[15].

Procedural Art represents an artwork – defined by computing system (programming algorithms) and relationships and behavior that allow the artist to create flexible works that are adaptable and capable to systematic revisions. Activity description through code allows artists to manage complex structures and large data files, automatize processes and generalize and reuse operations[16].

Data visualization is the interdisciplinary specialization. It splits facts and information and reformat it into digestible graphic presenta-

12 http://cramer.pleintekst.nl/all/concept_notations_software_art/concepts_notations_software_art.html

13 http://runme.org/faq.tt2

14 https://www.techopedia.com/definition/25603/internet-art

15 Ippolito, Jon (2002-10-01). „Ten Myths of Internet Art". Leonardo. 35 (5): 485–498. doi:10.1162/002409402320774312. ISSN 0024-094X. S2CID 57564573.

16 Jacobs, Jennifer. *Dynamic Drawing: Broadening Practice and Participation in Procedural Art*. 2017. Dissertation. Massachusetts Institute of Technology. Vedoucí práce Mitchel Resnick.

tions. Such visualizations help to communicate bulky data that are too complex, complicated or monotonous[17]. As Salah Uddin Ahmed[18] cites, **digital interactive art** concerns the particular genre of art, which is interactive and uses digital technology as an essential part of a creative or presentation process. Edmonds[19] states that interactive art is characterized by dynamic behavior in response to external stimulation, such as the sounds or movement of the audience. The audience behavior can cause a change in the artwork itself. When creating interactive art, the artist takes into account not only the aesthetics of the work of art, but also the way he interacts with the audience.

On-the-fly programming or **Live Coding** eventually is a programming style in which the programmer is a performer and composer at the same time, which expands and modifies the program in real time, without stopping or restarting to enforce significant, programmable driving on the run[20]. Live coding is most prompt as theater art, often used to create digital media based on sound and image, as well as light systems, improvised dance and poetry[21]. Some of the above definitions coincide with the description and represent the same or similar branch of computer art. The term used in this paper is **creative coding**, and in the summary of the deadlines studied, it can be confidently stated that creative coding is:

17 https://www.printmag.com/information-design/top-five-data-visualization-artists-to-follow-on-instagram/

18 Ahmed, Salah. (2018). *Interaction and Interactivity: In the Context of Digital Interactive Art Installation*. p 4 10.1007/978-3-319-91244-8_20.

19 Edmonds, E. (2011). *Interactive Art*. In L. Candy & E. Edmonds (Eds.), *Interacting: art, research and the creative practitioner.* (pp. 18–32). Faringdon: Libri Publishing Ltd.

20 Wang G. & Cook P. (2004) *On-the-fly Programming: Using Code as an Expressive Musical Instrument*, p. 1 In Proceedings of the 2004 International Conference on New Interfaces for Musical Expression (NIME) (New York: NIME, 2004).

21 Magnusson, T. (2013). *The Threnoscope. A Musical Work for Live Coding Performance. In Live 2013*. First International Workshop on Live Programming.

- The act of using computer programming software to create works of art, design, architecture, music, etc.
- method of using code to create art;
- procedural way of creating expressive media;
- cooperation of artist and computer;
- the intersection of the organic and mechanical world;
- The art of transforming sets of algorithms into graphics, visualization and animation.

Creative coding is closely linked to other forms of computer art, it can use the same mathematical procedures as algorithmic art, the same set of data as data visualization, the same interactive principles as artists working with interactive installations.

3. Coding versus programming

The terms "coding" and „programming" are used quite often in this paper, it is useful to define what these two terms actually mean. Coding and programming are often considered identical. Yadawan Shi defines **coding** as an act of translating human communication or commands into a machine language that computer can fully understand, e.g. language 0 and 1. The encoder uses different programming languages such as C, Java, C#, Python, JavaScript, etc. These languages help create and run programs by providing computer instructions. Coding includes writing instructions for software programs such as applications, websites, games, etc. On the other hand, **programming** is the „design and creation process of executable computer program to achieve a specific computing result or to perform a specific task"[22]. The task of the programmer is to plan and perform the entire process of creating specific software, from the initial idea to

22 https://content.techgig.com/techno-digest/difference-between-coding-and-programming/articleshow/81568031.cms

testing the finished product. Simply put, coders write commands in programming languages, programmers use these commands and other activities (document reviews, algorithms, problems modeling, data processing and project management) to complete the software product, application, or website. **Creative coding** includes both activities. Coding is used to write rows of commands that will be made by a computer. Coding uses command lines/algorithms to define each object, every color, movement, animation of art. Programming will include the conversion of the code into a complete program that can be transferred from one computer to another, connecting hardware tools, cameras, sensors, projectors if planned as part of a work of art.

4. Who is a creative coder?

When art and science are correctly connected in the creative process, it results in something, we can say brand and transformationally new. Unlike the functional focus of most ways of working with programming and code – such as programming series of mobile applications or coding web portals – creative coding uses programming languages exclusively for artistic purposes. Aesthetics always play a fundamental role here. In order to become a successful creative coding artist, the individual should include many disciplines: art, design, programming and mathematics. One without the others does not work. The knowledge of code itself without aesthetic understanding does not come in the work of art. On the other hand, even if some programming languages such as Processing are simplified for artistic purposes, they still require understanding of programming orders.

The project creation process often involves creating original algorithms. Jun Wu, a writer and technologist, has pushed ahead this problem in the article „Getting Started With Creative Coding". Creative coding requires not only mathematical foundations, but also ar-

tistic talent to use algorithms in creating works of art. "People who are really great in creative coding are polymaths. They seek meaning in both creative and logical universe".

It is true that creative coders often need to understand several programming languages to create works of art or any form of creative expression. The creative coder can organize interactive art installation, create generative art, animations, videos, design product prototypes, visualize data, perform stage performances with elements of visual effects, create interactive websites, or create sound art[23].

5. Programming languages and creative coding tools

When it comes to modern creative coding tools, artists and programmers have to choose from what is available. When artists become acquainted with a certain programming environment, they could proceed to the development of their own algorithms, commands and software programs, but the choice of initial programming language is crucial. What works best should be determined by what the artist wants to achieve if the goal is to create an interactive installation or a 3D scene for a virtual reality or a project visualization of data, etc., so it is necessary to thoroughly think about the goal before focusing on a particular set of the tools. Potentially, any technology or programming language can be used for creative purposes. Creative coding history proves it well, but certain libraries, software and programming environments have been specially created to help rapid creative artworks, especially when the artist has less experience in programming. Frequently used tool sets in this context include:

- Processing (Java nebo Python)
- p5.js (JavaScript)

23 https://interestingengineering.com/everything-you-need-to-know-about-the-artistic-world-of-creative-coding

- Three.js (JavaScript)
- D3.js (JavaScript)
- Shaders (WebGL)
- cables.gl (WebGL)
- openFrameworks (C++)
- Cinder (C++)
- OpenRNDR (Kotlin)
- Max MSP (Vizuální programovací jazyk)
- PureData (Vizuální programovací jazyk)
- Vvvv (Vizuální programovací jazyk)
- Babylon.js (TypeScript, JavaScript)

It is clear from the list above that different programming environments can be based on the same programming languages. It is clear from the theoretical analysis of literature, articles, practical examples of many modern creative encoders and their own programming experience, the most popular creative coding languages that will be studied in more detail, are: Processing, JavaScript, WebGL. Not only software components are decisive, but the practice of creative coding often includes hardware tools for inserting data from the environment, interaction with participants, and for screening the results of encoding into the environment. Examples of commonly used hardware include cameras (webcams of computers, deep cameras, and infrared cameras), microphones, motion detectors, MIDI drivers, projectors, LED strips, printers and plotters.

5.1. Javascript

JavaScript (JS) is a popular choice for art creation. JS is a programming language that is one of the basic World Wide Web technologies next to HTML and CSS. All main web browsers have a reserved ja-

vaScript engine to start code on users[24]. JavaScript is the most popular programming language in the world. JavaScript is already running in any browser on the user's computer, tablet and smartphone and is free to use for everyone. The ability to bring interaction and movement into any object on the website is what allows the use of JavaScript for creative coding – artists and programmers can encode animations, objects that respond to the mouse cursor or press a button or key. Many such projects are stored online with an open source code, for example, the CodePen web portal is a popular online community and gallery where such examples can be found. CodePen is a social development environment. Most of the code examples here are public with an open source code, so other people and community can communicate with them, from simple addressing to leaving comments to copying and changes for their own needs. It allows anyone to write the code in the browser and see its results immediately during writing. CodePen focuses primarily on languages such as HTML, CSS, JavaScript. The tool is useful and fast online code editor for creators with any programming skills, popular among people who learn to[25].

JavaScript was not originally created for the needs of creative coding, but as it has already been mentioned, it has numerous libraries and frameworks developed specifically for these purposes. These additional tools are used by coders and artists to create creative works of art. Framework is a structure on which software can be built, serves as a base, so the programmer does not have to start writing the program completely from scratch. Each framework has a set of preset commands and tools designed for a specific purpose. The programming library can be considered a collection of codes that is created for a specific purpose, so that the code needs to perform a task that relates to

24 Flanagan, David (18 April 2011). *JavaScript: the definitive guide. Beijing; Farnham: O'Reilly.* p. 1. ISBN 978-1-4493-9385-4. OCLC 686709345.

25 https://codepen.io/about/

this purpose at any time, it can use the library tool instead of creating this feature. Libraries are based on the basic abilities of the language and expand them. For JavaScript there are more than a hundred thousand libraries that allow you to perform a wide range of operations. Here are some names of frameworks and libraries created for artistic purposes: p5.js, three.js, d3.js, tensorflow.js, brain.js, convnet.js, synaptic.js, babylon.js, webgl frameworks, movement.js and many others[26].

5.2. Processing

It is likely that Processing is the most popular and most famous tool for creative coders. Processing is an open-source software, programming language and environment that can be started on Mac OS, Windows and Linux. Processing has been specially designed to be as simple as possible and was aimed on beginning programmers and artists, knowing that its simplicity will benefit even more experienced users. Over the years, it has actually developed into a sophisticated tool for professionals. Language of Processing was inspired by the immediacy of previous languages such as Basic and Logo. Processing is used by thousands of designers, artists, architects, musicians and encoders as an instrument for creation their artworks.

Processing can be implemented in every area of creativity and visual design: for scenic design of dance routines and live performances that are projected on the scene; for creating images, animation for music videos and movies; for creating game design and environment; for creating pictures for etiquette, logos, posters, magazines and books; for creating interactive websites and for creating interactive installations of various sizes both in galleries, museums and on the street.

Processing allows you to create programs and applications within the principles of interactivity, movement and visual. This system is

26 https://javascriptforartists.com/

a mixture of programming language, software environment and educational platform. The main purpose of the Processing programming language is to create and edit visual media. This software combines a simple graphical user interface and an advanced feature set. Even a person with zero experience in programming will be able to create the first program after reading simple instructions available on the official Processing website. Processing can depict almost any type of digital media: vector, raster images, 3D models, animations, network communication, and data visualization. It can support many input and output devices: mouse, keyboard, touchpad, cameras, sensors, audio devices, etc. There is no doubt that Processing indicates magnificent results, but probably the most important thing about this tool is how it has attracted a new generation of visual artists to consider programming as an integral part of their creative activities.

The program created using Processing is called "**the Sketch**". To experiment with Processing, the user has several options: he/she either downloads the software to his/her computer from the official website and will create sketches directly on the computer. Or he/she can make an account on the OpenProcessing online portal, where it is possible to create, edit and test sketches, as well as view, copy and edit sketches of hundreds of other users. Both options are completely free.

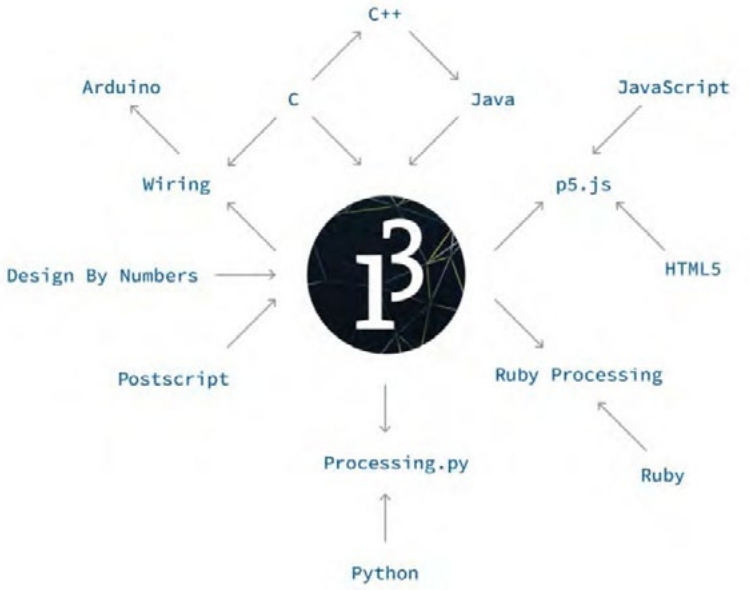

Figure 2: Processing was influenced by other coding systems and influenced others. Source: https://medium.com/processing-foundation/a-modern-prometheus-59aed94abe85

Sketches created in Processing can be exported as an EXE application for Windows, Linux and Mac OS X. Another way of exporting the project is to save it as a website. It has been mentioned several times, but it is extremely important that all programs created online and hundreds of other examples and libraries are available with an open source code, which means that anyone can view, copy and edit it, create something new, continue development someone else's work and thus create international and interdisciplinary cooperation. Thanks to this method, processing has become very popular. Web servers host thousands of projects with access to source code. "We learned to code largely by looking at the other code, and we wanted this openness to

be the central point of the project" – says its founders[27]. Processing is not a language created just from scratch, it is a hybrid between authentic elements and Java programming language. Since processing is created for creating visual art, the language contains elements specifically for working with form, shapes, colors, pictures, animations, etc. At the same time, any code can be used in processing. The main idea is to make it easier to create visual elements, but also to allow a more experienced programmer to do complicated things within the same platform.

5.3. p5.js

p5.js is one of the previously mentioned JavaScript libraries created specifically for creative purposes. It is based on Processing and is its interpretation for modern sites. p5.js, like the original Processing, focuses on the coding accessible and inclusive for everyone: artists, designers, architects, educators, beginners. It is free and with an open source code, because its creators believe that software and tools to learn it should be accessible to everyone (p5js). The advantage of using the JavaScript programming language is its wide availability, popularity and ubiquitous support: each web browser has a built-in JavaScript interpreter, which means that p5.js (also called "sketches") can be launched on any web browser. p5.js is an extension of JavaScript, a basic language that provides all tools for incorporating any features into the website. In addition, this library provides some features that make JavaScript users easier to draw and create artistic content online[28].

Using the JavaScript library p5.js is great in teaching and learning programming. p5.js allows you to create engaging interactive and

27 https://medium.com/processing-foundation/a-modern-prometheus-59aed94abe85

28 https://p5js.org/

visual pieces and also build a solid foundation for software development. The visual nature of this library allows you to see the results from scripts as graphics, and thus develop confidential understanding of program structures. p5.js, as well as processing, is based on the principle of sketching. Here comes comparability of coding and drawing: just as sketching can be considered a minimal access to drawing for sharing ideas and designs, so p5.js is based on the concept of code writing with minimal amount and complexity for the transmission of visual ideas to the computer screen or later on projection, installation etc. p5.js as an extension of JavaScript does not have limited possibilities. This library has an impressive number of functions, history and international community, making it a valuable investment in learning and a sophisticated tool for those who create or want to create visual art, design, websites or interactive works using code. The program created using p5.js can contain from several to thousands lines of code.

5.4. WebGL

WebGL (Web Graphics Library) is a javascript application programming interface for rendering interactive 2D and 3D graphics in any modern web browser without using additional scripts[29]. WebGL programs consist of a control code written in JavaScript and Shader code written in OpenGL ES Shading Language (GLSL ES) and run on the PC, so a better graphics card is needed for faster rendering. WebGL is developing and managing the non-profit group Khronos Group[30].

WebGL is a new standard for 3D graphics on the web. It is designed to portray 2D and 3D graphics and objects and make them interactive in compatible web browsers. With this tool, coders and artists can

29 https://www.html5rocks.com/en/tutorials/webgl/webgl_fundamentals/
30 https://jolicode.com/blog/webgl-the-wow-effect

create pictures of any complexity, from simple geometric to photorealistic, rotating objects, 3D scenes, each can be interactive – it will respond to a computer mouse or keyboard, sound, microphone. WebGL is also designed to speed up the features of web editors of images and their effects, as well as physical simulations. There is no need to install any additional plug-in modules to display the result or draw such an object/scene, allowing you to enjoy interactive content online without other complications.

WebGL has several significant advantages that include:

- Easy to set up. WebGL is integrated in HTML5, no further adjustment and installation is required
- WebGLl is stored with an open source code. It is easy to access the library source code and understand how it works, what it can and how it has been developed
- JavaScript programming – Webgl is part of the JavaScript family, programs are basically written in JavaScript. Such programs and applications can easily interact with the other elements of the website and its HTML code.
- Webgl is compatible with other numerous JavaScripts libraries and HTML technologies
- Mobile browsers – WebGL continues to work on mobile browsers, is accessible through browsers such as iOS Safari, Android Browser and Chrome for Android
- No compilation – there is no need to compile the file to start the script because it is a combination of JavaScript and HTML.

The disadvantages of WebGL include its complexity compared to the previously mentioned programming languages and libraries. It is also reported that it is responsible for the falls of browser caused by incompatibility of plugins.

5.5. GLSL Shaders

OpenGL Shading Language (GLSL) is a high-level language for creating shaders with syntax based on C-programming language. As explained by Hergaarden[31] on the graphics card, in order to handle the image before rendering it on the screen. Shaders allow different types of rendering effects such as adding light effects, all types of textures or adding drawn outlines to the graphical output. There are several different types of shaders, but two are commonly used to create graphics on the web: vertex shaders and fragment shaders. Vertex Shaders transform shape positions into 3D coordinates on the basis of which drawing is created. Shaders of fragments control colors and other attributes of the object. GLSL is not as intuitive as JavaScript, it includes a lot of mathematical algorithms to define vectors and matrices. The code can become very complicated to create more advanced graphics[32]. GLSL is part of other graphic APIs (such as WebGL), so to master this language, the encoder must learn it together with a relatively large graphics API, which is often necessary to set the GLSL code and the required graphical data for the graphics program. Shaders are widely used in video game design, post – processing movies, computer images, music videos to create a number of effects such as lighting modes, shade, satiety, brightness or image contrast, blur effects, volume effects, lighting, bokeh, posterization, distortion of image, glitch effect and many more.

6. How to start with creative coding?

Unlike the functional and practical focus of most code implementations – such as the programming orders of the smartphone applica-

31 https://www.cs.vu.nl/~eliens/download/literatuur-shaders.pdf

32 https://developer.mozilla.org/en-US/docs/Games/Techniques/3D_on_the_web/GLSL_Shaders

tions – creative encoding uses programming languages exclusively for artistic purposes. 2D, 3D objects, videos, music, interactive installations and visualization are generated by the application of algorithms using a programming language. Historically or in a broader sense, this is called **generative art**. Nowadays, a range of different styles, results, processes and thus names differ. It is a tradition or rather stereotype that artists generally consider programming for someone without technical education too complex, as engineers have stigma around the problems with creative expression. However, these disciplines may no longer be separate ways, because with modern tools and artistic styles are connected more closely than people expect.

For someone who wants to get into creative coding and already has experience in programming, the advice is simple: sticking to the programming language that he/she knows, because almost every language can be turned into an instrument for generating art. For those who have no previous experience with the programming language but want to enter this area, the general advice is as follows:

- Complete a creative coding course, many of them are available online, both paid and free of charge;
- get inspiration from creative coding artists;
- explore numerous online galleries where projects are stored with an open source code;
- create your own account on one of these galleries, copy projects of other encoders and start changing their code, number by number, line along a line for educational purposes;
- try different programming languages or libraries and frameworks available for creative works of art;
- start creating the first simple programs, share the results online, get feedback from the community and continue progress.

There may be too many options for a beginner when choosing a programming language. There are many different frameworks for creative coding, the most popular are based on JavaScript. Processing

and p5.js are great opportunities both for beginners and professionals. With these tools, one can create any impressive interactive and audio-visual work as well as a solid foundation for software development. All software is free, so the only investment is time. After mastering these languages, the individual can proceed further, engage in other frameworks such as sketch.js, D3, three.js. They are also powerful for beginners and are useful for creating everything from 3D objects and scenes to simple 2D drawings.

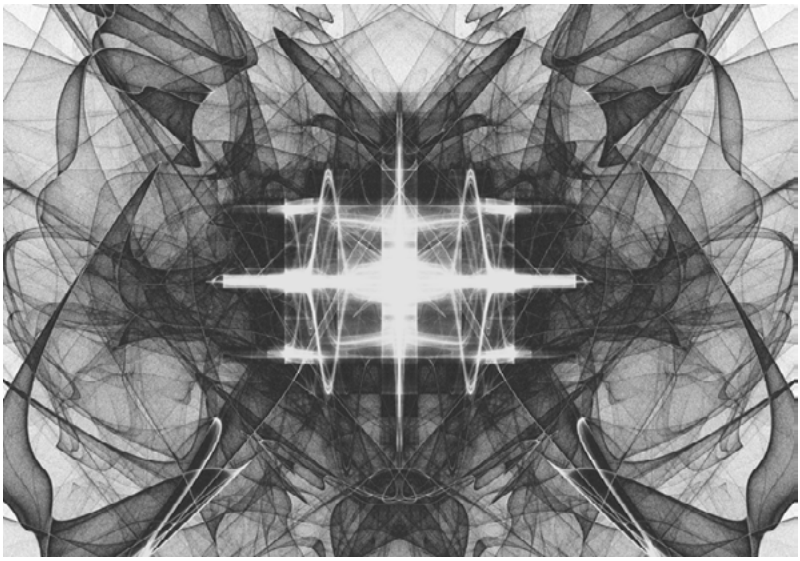

Figure 3. Object – Still. Source: Aliaksandra Laurova

As already mentioned, many newcomers or well-known artists now test their creative abilities with generated art, with different name creative coding. There are a number of web portals where anyone can create an online gallery, upload their finished programs or sketches. Other users can monitor programs, test, leave comments or suggestions, and, above all, save a copy of the program to their own gallery and change or improve the code, all code can be seen directly on this site. In rare cases

of licenses, it is forbidden to use these programs for commercial or other purposes that are not related to education, but in addition, the code is available for everyone. Online portals are a great opportunity to work together, learn from encoders from around the world, ask questions and take valuable advice from colleagues. Another advantage is that anyone can start encoding online in a web browser window. There is no need to download any special software, everything is already available on these portals. Built-in compilers run the code either directly during the writing process or when you press the "Start" button depending on the selected programming language. These online portals are divided according to the programming languages they work with.

Browsing these online portals is a great way to look for inspiration, find undiscovered talented artists and learn new tricks. Studying and testing the available code is an integral part of any creative process, involvement in modern tools, and communities will only benefit artists regardless of how experienced are. Each artist has a unique process of generating his work of art. Finding this process is as important as creating a work of art.

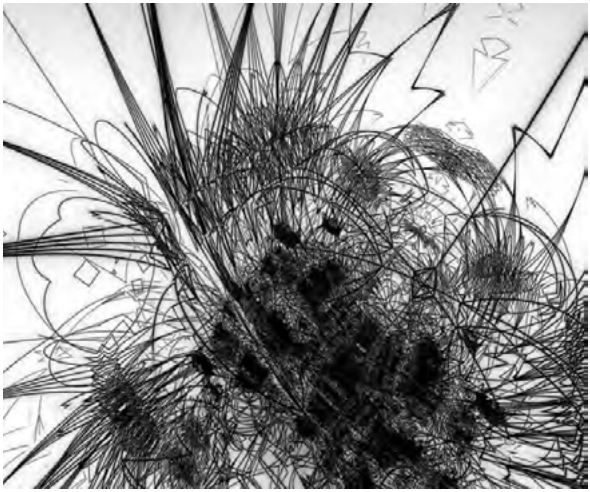

Figure 4. Object – Changing. Source: Aliaksandra Laurova

Here is an example of a creative coding process from Jan Vu (Getting Started With Creative Coding, 2020)[33]:

- First get inspired: word, picture, object, form, sound, etc.
- Create a sketch that will present what a future work of art will be.
- Visualize interactions – with the environment, with data, with mathematics, etc.
- Create an algorithm, create artwork with a programming language of your choice.
- Go through the iteration of modifications and research to get the final product.

When you manage the necessary knowledge and skills and add many of your own creativity, you and other people, you will be able to enjoy works of art, such as these: **Some examples of realized creative coding projects**

Another experience with generative art artworks including color, movement and sound can be found on these links:

1. Visualization of data as a aesthetics challenge: https://antrague.com/vizualizace-velkoobjemovych-dat/
2. See the wind: https://antrague.com/see-the-wind/
3. Everything flows, nothing remains: https://antrague.com/everything-flows-nothing-remains/

33 https://betterprogramming.pub/getting-started-with-creative-coding-16072ff7e778

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The monograph is a coherent, interesting and, above all, innovative study. The research results, opinions, evaluations and conclusions included in the various chapters are the result of different points of view on the subject of new technologies and their use in communication.

The different views of the researchers are harmonious, making them complementary. The monograph provides a sound basis for further research and scientific work in the area under study.

The articles included in the monography constitute not only an interesting compilation of different approaches to the main topic, but also they allow us to see a number of new aspects related to the issues of new technologies.

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