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1st Conference on Sustainability – COS '23
12-14 October 2023, Győr, Hungary

COS'23

Editors
PETAR S. VARBANOV, BOHONG WANG,
PETRO KAPUSTENKO

Composition
HON HUIN CHIN

9026 Győr, Egyetem tér 1.

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Scientific Program

The conference aims to gather leading experts and researchers from various scientific fields to exchange knowledge, discuss challenges, and explore innovative solutions for sustainability. It provides a platform for professionals across different disciplines to present their sustainability-related work and promotes collaboration to advance sustainable practices, policies, and technologies. The scope of the conference encompasses contributions from diverse areas such as engineering, IT, design, health, economics, sport, arts, teaching, social sciences, political sciences, agriculture, food engineering, architecture, transportation, and law.

Themes: sustainability in: engineering; IT; design; health; economics; sport; arts; teaching; social sciences; political sciences; agriculture; food engineering; architecture; transportation; law

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Plenary 2: Sustainable Process Systems Engineering for a chemical sector within planetary boundaries (Prof G Guillén-Gosálbez), Switzerland

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Plenary 5: Sustainable manufacturing of novel biologics: Design and scale-up issues (Prof S S Mansouri), Denmark

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EXAMINATION OF SPOTLIGHT ON ENVIRONMENT AND HEALTH EDUCATION IN HUNGARIAN PRIMARY SCHOOLS

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Health education and promotion, as important elements of education for sustainability, prepare students to respect health as a value and be able to contribute to the creation of a sustainable society and economy in an active and constructive way. The purpose of this study is to present the link between the environment and health, as well as the theoretical background and pedagogical practice of health education. Such a link was evaluated by examining three tools that shed light on Hungary's educational system: the content of national curricula, the school programs, and a survey performed with elementary school educators. Environment and health education can be supported by project work highlighting sustainability and the importance of environment protection, as it is represented in this paper. The novelty of this environmental education project is the module focusing on environmental hazards, as this is an extracurricular topic. The survey carried out among learners after the project implementation proved that they understood - among other things – the importance of waste management and the effects of environmental pollution on the food chain.

1. Introduction

"Sustainability is defined through three interconnected domains or pillars (environment, economic, and social), and it is the process of maintaining change in a balanced environment, in which the resource exploitation and the orientation of technological development are all in harmony and enhance the potential to meet human needs and aspirations" (Kiss, 2019). According to the World Health Organization (WHO), the evidence of a link between human health and the environment is mounting. It includes the direct effects of chemicals, radiation, and certain biological factors as well as the indirect effects of housing conditions, urban development, land use, and transport on health and well-being. The Seventh Ministerial Conference defined the future environment and health priorities and commitments with a focus on climate change, biodiversity loss, and environmental pollution (WHO, 2023). In Geneva (2004), the 57th World Health Assembly emphasized in its decision for health promotion, health education, and a healthy lifestyle that unhealthy nutrition, smoking, alcohol consumption, and a sedentary lifestyle are serious challenges. (WHO, 2004). The growing technological and anthropogenic impact on the environment and the need for sustainable development of human society require the development of education and putting a greater emphasis on environmental issues, preparing students to perceive the rapidly changing everyday reality (Aleksandrov et al., 2016). The basic task of health education in Hungarian schools is to prepare the rising generations by developing their health behavior so that they can take an active and responsible role in the realization of a healthy lifestyle as adults (Meleg, 2002). The effectiveness of health education requires a process-based, interactive, skill-building activity system (Bazsika, 2011). According to the Comprehensive School Health Promotion Program (2015), schools should focus on four areas: healthy nutrition, daily physical exercise for all students, promoting the development of children's mature personalities with person-centered pedagogical methods, and facilitating the skill-level acquisition of a wide range of health knowledge. Járomi (2016) examined the implementation of the Comprehensive School Health Promotion Program in 288 primary schools among 3rd, 5th, and 7th grade

students. The research aimed to detect health knowledge and attitudes and explore movement patterns and the characteristics of health culture. The results show not extremely determining but positive changes in children's health behavior. The examination of Health Education Programs was carried out by the Hungarian School Health Society at the national level, involving 10 % of the institutions of public education, in 2006. The research proved that the schools cannot be characterized by a cross-curricular approach. The examined schools do not check and evaluate the efficiency of the health education program, and it would be essential to establish a team that is responsible for the implementation of the planned health education activities (Kaposvári, 2007). The Health Behavior of School-Age Children research has been carried out in cooperation with the World Health Organization. According to the conclusion of the Hungarian national report based on this research "poor eating behaviors, physical inactivity and the rise in adolescent overweight and obesity indicate that insufficient progress has been made in the implementation of policies and actions." (Inchley et al., 2020). Measurements in Hungary at the national level, or any research results on the health status of the 6-10-year-old age group are not available, which means a serious research gap. Moreover, Czrappán (2022) summarized that the experiences of the last decade show that there is hardly any research-based data and systematic monitoring that would serve as a basis for central decisions regarding Hungarian National Core Curricula. A content analysis of the specific educational goals of the Hungarian National Core Curricula has not been prepared before. These facts underpin the necessity of the content analysis and questionnaire surveys that provide insight into the Hungarian educational system. This paper analyzes the goals of health education and promotion in Hungary as important parts of sustainability. For this, a review of the main documents concerning children's education in Hungary was carried out, and surveys were conducted among educators to generate data concerning the educational conditions and the attitude of the system towards sustainability. Moreover, this paper presents the results of a pilot test for a project on environmental education with children, which was formulated considering the information generated by the previous document analysis and surveys. The environmental education project focuses on sustainability and the link between the environment and health, as well as draws the children's attention to the need for any little steps to protect the environment. For this reason, the knowledge of the causes and health effects of environmental hazards are revealed, and some actions to protect the environment and health are also mapped. These data show learners' knowledge about sustainability, their attitudes to the environment, and their environmental culture and behavior. The project can contribute to the development of Green competencies that embody sustainability values, embracing complexity in sustainability, envisioning sustainable futures and acting for sustainability (Bianchi et al., 2022).

2. Methods and materials

The research related to this paper involves document analysis, questionnaires, and statistical analysis as research tools (Boncz, 2015). The basic assumption of the research is that, despite the central regulations, the cross-curricular approach, learner-centered methods, and project-based teaching are not integrated into the everyday pedagogical work of the institutions examined in order to achieve sustainability and health education as priority educational goals.

2.1. Document analysis 1 – Content analysis of Hungarian National Core Curricula 1995-2020

In Hungary, the National Core Curriculum regulates the content of educational work in public education institutions. Since 1995, the National Curricula have identified physical and mental health education as a priority development goal for schools. As the first step of the content analysis, common elements appearing in each curriculum were selected. After that, the focus was on the examination of different, new elements. Current and relevant expectations must be incorporated into school documents (Government decree, 2020).

2.2. Document analysis 2 – Content analysis of Health Education programs (2019)

Since 2003, for Hungarian schools, it has been compulsory to prepare a health education program. These programs should be built on the expectations and elements of the Hungarian National Core Curricula. That was the reason for the analysis carried out in 45 primary schools maintained by the state institution mainte-

nance centers in Győr-Moson-Sopron county. The programs were examined according to given criteria, such as whether the given institution has a Health Education program, whether it is based on a situation analysis, and whether any goals, tasks, activities, or methods have been defined. Another important question was whether there are people responsible for coordinating, controlling, and evaluating the implementation of the activities.

2.3. A questionnaire among headteachers (2019)

In addition to the content analyses of the health education programs, the head teachers of the above-mentioned schools were interviewed using a written questionnaire with 31 questions. The survey contained mainly closed questions based on the results of the Health Education program analysis, and its aim was to reveal the relevance between the plans and reality. The questions concerned some general data about the schools, as well as the goals, tasks, activities, and methods they use in education for sustainability. The survey was filled in by 40 headteachers. This study highlights only two questions concerning the methods used in lessons and the extracurricular activities to reveal the forms of sustainability education and to prove the need for the health education project that was prepared.

2.4. A questionnaire among English language teachers of primary schools (2019)

As the project was prepared for English lessons, it was also important to get some information from the English teachers of the schools. Only 32 teachers gave answers for the online survey that contained 10 closed questions concerning the methods and tools they use in their lessons and whether they implement any material concerning sustainability or health education and development process.

2.5. A survey among language learners – case study (2019)

A written questioning of the students was carried out before introducing the project involving 63 fourth-grade students, studying English in one voluntary participating school. The purpose of the survey was to reveal the students' prior knowledge. After presenting the project in 10 lessons, there was another written questioning to check the short-term effect of the project on the children's knowledge, attitudes, behavior. The questions concerned the causes and health effects of environmental pollution and activities carried out for environmental protection and health preservation. In the first questionnaire, there were open questions. The answers in the first 3 places from the lists were highlighted. In the second questionnaire, the Likert scale was used.

3. Results and discussion

Hungarian National Curricula emphasize that schools have a great responsibility in the field of physical, mental, and social development of students and establish the joy of health and the value of harmonious living. Another key concept is the development of positive attitudes, behavior, and habits toward the environment and health. The documents include tolerance and assistance for injured and disabled people, as well as preparation for adulthood and responsible relationships. Another common feature is that they highlight the importance of preventing domestic and traffic accidents and diseases, as well as the development of a system of activities aimed at preventing harmful addictions. The project, carried out among the students, emphasizing the importance of environmental protection in order to preserve health, is in line with these goals. Considering the results of analyzing health education programs, they contain very similar general issues; no unique goals, tasks, or activities can be found, and they are not built on a situation analysis. The organization of daily physical exercise, movement or any physical activities like folk dance is a legal requirement (according to the Comprehensive School Health Promotion Program) that all institutions comply with. In order to ensure students' mental health protection, schools focus on reducing bullying and conflicts and offer extracurricular activities after lessons. In the range of extracurricular activities (84.44 %), school competitions and quizzes are at the first place. In the case of 30 schools (66.66 %), the organization of Health Days is an important element of the health education activity system. There are schools (64.44 %) that highlighted the presentations/lectures given by the school doctors or nurses. In order to ensure sports

and physical exercise, some schools (53.33 %) organize sports circles, walking and cycling tours (48.88 %), excursions (28.88 %), and sports days (26.66 %). Only 7 schools (15.55 %) have ever prepared projects related to health education. (Figure 1a)

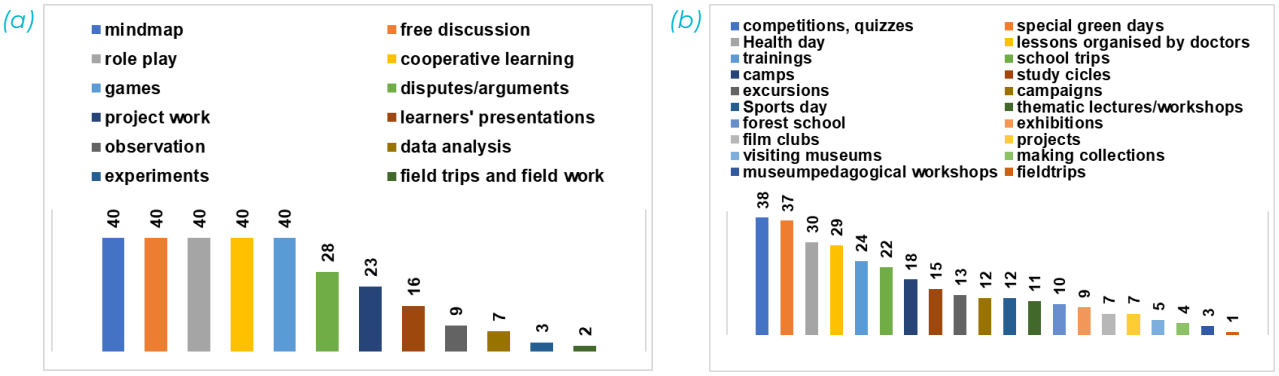

Figure1: Results of curricula and national program examination (a) Methods used in lessons (b)

Analyzing the results of the headteachers' questionnaires, it can be stated that games, discussions, mind maps, cooperative learning, and role-plays are parts of everyday pedagogical practice, according to each interviewed headteacher. Project work (57.5 %) and more presentations of students (40 %) could be included in the methodological palette. (Figure 1b) The headteachers' answers - considering the extracurricular activities - show that the celebration of special green days can be easily incorporated into daily practice. On Health Days and thematic days, schools organize contests, sports programs, and excursions, and there are lectures held by school health experts and external speakers. Considering the answers of English teachers, among the methods they used, explanations, discussions, and role plays are in the first three places. Only 9 teachers mentioned projects. They deal with healthy eating, family and relations, and daily routine as these are among the topics of 4th grade teaching-learning material, but they do not use any extracurricular material on environment and health because there is no time for it, it is not so important than the general topics, and children even in Hungarian do not have enough knowledge, so it is pointless to deal with it in English lessons. Table 1 presents the results.

Table 1: Teachers' methods and attitude towards sustainability

What methods do you use most often?	Do you cover any topics of sustainability in your lessons? If yes which ones?	If you do not deal with sustainability, why not? Give reasons
explanation – 80 %	healthy eating – 80 %	lack of time – 72.50 %
discussion – 80 %	family and relations – 67.50 %	it is less important than any other topics – 45 %
role plays – 42.50 %	daily routine – 67.50 %	it is pointless to deal with this topic because of the low level of English – 42.50 %

The main aim of the project is to focus on sustainability and the link between the environment and health as well as draw the children's attention to the need of any little steps - made by them - to protect environment. The Healthy English project consists of three modules. (Figure 2(a)) Two of them contain the topics of the curriculum. The novelty of the project is the module that focuses on environmental hazards because this is an extracurricular topic. Each module has its own goals. (Figure 2(b))

Figure 2: The modules of the project (a) and the main aims of the modules (b)

The process of the project creation was divided into four phases, which were the preparatory, planning, implementation and feedback stages (Pinter, 2017). In the preparatory phase, the topic, aim and title of the project were defined, and a written questioning was carried out aiming to reveal the students' prior knowledge. During the planning phase, for each module, the environmental challenges to which solutions must be found together with the children during the processing of the module were formulated. For each module, a goal to be achieved, classroom activities helping to achieve the goal, and methods for processing the course material were assigned. The methods based on the activity and cooperation of the children were used so project work and cooperative learning were preferred. Lesson plans were also prepared for processing the teaching–learning material of the module. In the implementation phase, the Environmental hazards module was worked on, applying the previously prepared lesson plans. The lessons focused on vocabulary expansion and integrated skill development. The teaching–learning procedure was supported by videos and interactive materials. The feedback phase contained the post-questioning of the children. In the first question of the pre-questioning survey, the children had to write down the three words that came to their mind in connection with the word "environment". Students wrote 49 different words. The most popular words were plant/plants. In the second place was the word nature, and in the third place was the word animals. Considering the results of the pre-and post-questioning of children, a small progress can be seen in the children's knowledge and behavior. Based on the given answers, there are common elements in the questionnaires. It can be seen that there are some changes in the order of the words, and new elements also appeared after the lessons of the module. It means that their vocabulary was widened and deepened. Table 2 shows the causes of environmental hazards as well as health damage and diseases caused by these environmental hazards, comparing the results of the children's pre- and post-questionnaires. Among the activities of protecting the environment, in the 1st questionnaire, children mentioned that they don't litter, collect the waste in a selective way, and save the environment. In order to preserve their health, they move or do sports, sleep enough, and eat fruit and vegetables. These things are taught to them in the lessons of Environmental Studies, and everybody can hear about these typical activities. This means that children pay attention to the basic rules and expectations.

Table 2: The results of the children's questionnaire – causes and effects of environmental hazards

Environmental hazards	Causes of environmental hazards 1st	Causes of environmental hazards 2nd	Health damage/illness 1st	Health damage/illness 2nd
air pollution	cars factories garbage	factories exhaust fumes cars/vehicles	lung disease cough lung cancer	poisoning lung disease/ lung cancer asthma
water pollution	garbage oil plastic	waste sewage chemicals	death dermatologic problems infection	infection epidemic diarrhea
soil pollution	chemicals garbage oil	plastic bottles plastic foil garbage	poisoning unhealthy plants food shortage	drinking water pollution poisoning food poisoning
stress	tests work lack of time/ deadlines	meeting deadlines test continuous noise	depression nervousness insomnia	irritability/ nervousness depression anxiety, fear
virtual hazards	computer hackers phone	social media reality shows phone	addiction eye damage sleeping disorders	addiction detachment from reality eye damage

In the 2nd questionnaire a list of activities was offered for children and in a 1-5 Likert scale, they had to decide how important they feel the given activities. The list of statements contained the results of the 1st questionnaire and some elements of the module. According to the answers it can be seen that the privilege of waste management was not broken but some other elements of environment appeared, for example water, electricity and air. These areas were mentioned in the module. The evaluation average of the statements is between 4.86 and 4.37 (standard deviation 1.14 and 0.43) and there is only a difference of 0.49 between the average values, which means that their attention was successfully focused on a wider range of activities. Figure 3(a) shows the results of the 2nd questionnaires concerning the activities to protect environment. Figure 3(b) introduces the results of the 2nd questionnaires concerning the activities to protect health.

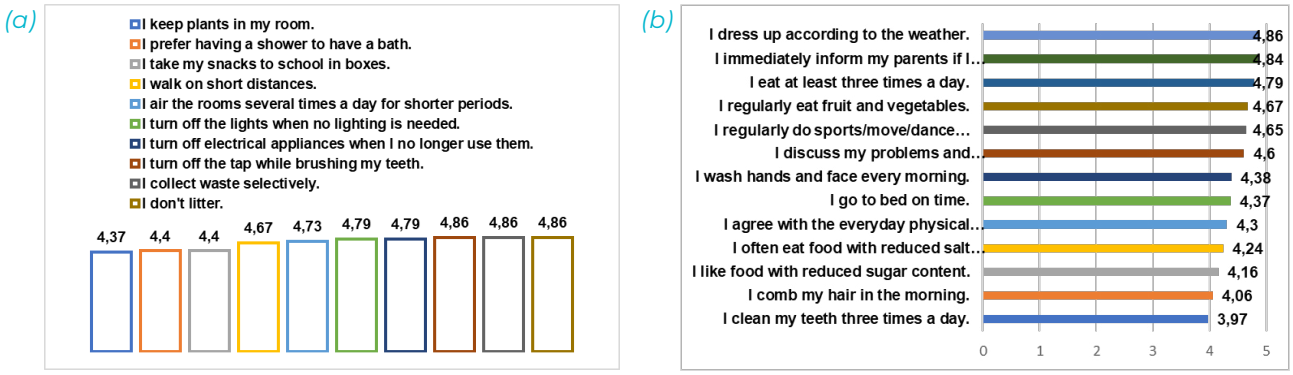

Figure 3: Activities to protect environment (a) and activities to protect health (b)

Analyzing the activities that protect children's health, fruit and vegetable consumption, moving, sports and sufficient sleep retained their importance for a healthy lifestyle. The most important for them is wearing clothes according to weather that is a new element. On the second place, cyberbullying can be found. All this coincides with the fact that children consider fear and anxiety due to bullying to be the most significant of the health effects of the virtual environment (4.34; standard deviation 1.16). Social media is considered the most dangerous in the virtual world (4.34; standard deviation: 1.11). The statement in the 6th place can be

linked to this topic, based on which, children discuss their problems and difficulties with their parents (4.60; standard deviation 0.83). If students trust their parents and can turn to them with confidence, they can also get help in overcoming the causes (deadlines, school assignments) and consequences (irritation, depression, anxiety, fear) of stress. In addition to these, children also take care of everyday hygiene and dressing. More diverse answers were given regarding the causes and consequences of environmental pollution and also in the field of environmental protection and health protection. The order of the previously named causes and consequences has changed the range of activities has expanded. The project demonstrates - even though at a case study level - that it is worth to enrich the teaching learning material of any subject with elements on sustainability to draw the learners' attention on environmental hazards and global problems.

4. Conclusions

The main aim of this paper was to present the current situation of health education as a part of sustainability education in Hungary with the help of a case study. The results of the research prove that there is a great need to emphasize the role of sustainability education however some efforts are being made to develop students' environmental awareness and their positive attitudes towards environment. According to the results of document analysis and questionnaires, it can be concluded, that the institutional documents mention a wider range of activities concerning sustainability education and health developing processes than in the everyday pedagogical practice is realized. The institutions do not check or evaluate the implementation of health education activities. Moreover, there is a lack of examination of the health education activity system not only at institutional but at county and national level as well. Considering the methodological richness, among the methods used by the teachers, project work, is neglected. The cross curricular approach and topics of sustainability do not appear in the everyday pedagogical practice, which was proved by the asked teachers. The implementation of the project has shown that to achieve the goals of sustainability education, it is important to transfer knowledge by using learner-centered methods, like projects. As a result of the project, children's knowledge about environmental hazards increased, their attitudes to their environment changed, and all this was realized in their actions. The project can serve as a model, but it must be further developed and made accessible to different age groups. It should also be used in university education and teacher training to value sustainability and promote nature.

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EXAMINATION OF THE MÉNFŐCSANAK DISTRICT IN TERMS OF SUSTAINABILITY

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In this paper, we aim to examine a specific local society in Győr, in the spirit of sustainability. More precisely, we focus on the awareness of the population regarding the Győr-Ménfőcsanak district. We cover the infrastructural provision of the district (built-up institutional system, public transport, bicycle paths, civil organizations, etc.). We primarily use previous research results commissioned by the local government as a basis. We undertake a second analysis of these statistical data, and in the framework of empirical research, we map the awareness and information of the population of the district regarding the topic. The online questionnaire, published on an online platform covering that specific part of the city, is prepared for the purpose of collecting data from the population, and also provides information from the point of view of environmental awareness. Topics to be explored include food waste and distribution, selective waste collection; delivery and rental of household goods, transport habits (car, public transport, cycling, walking), the importance of keeping green areas close to nature. During the research, the population reflects on existing problems, and this can lead to the enhancement and strengthening of communication and collaboration between the local residents, civil organizations, and the local government. As a result, the local government can take concrete steps to address what is perceived as urgent tasks.

1. Introduction

Sustainability is an unavoidable issue nowadays. Numerous scientific articles emphasize the importance of intervention, whether on a national or global scale. Within the subject matter consistently related to the content of this article, the widespread flow of information is essential. In the case of Győr, it is exceptionally important to address issues such as shortcomings in selective waste collection, decreasing green areas, the distribution of local producers' goods, and gaps in public transportation. Due to its industrial development and proximity to the Slovak and Austrian borders, as well as the presence of Széchenyi István University, it is one of the main destinations for internal migration. Sustainable Development Goals (SDGs) are a set of global objectives aimed at addressing various challenges, including poverty, inequality, climate change, and environmental degradation, at the local, national, and international levels. (un.org/sustainabledevelopment/development-agenda). This article focuses on community-based sustainability initiatives. Researchers often examine community-led sustainability projects and initiatives worldwide.

The primary objective of our study is to identify and present the district's best practices within defined areas of sustainability. We are also interested in the environmental awareness of the local society, the inhabitants of the district, and how satisfied they are with the already existing and available green initiatives. Finally, our goals include getting to know and collecting the ideas and suggestions of residents related to the studied topic areas.

2. Theoritical framework

Sustainability in local communities (such as Ménfőcsanak) is a significant area of research and interest, as it focuses on developing environmentally, socially, and economically responsible practices at the community level. Celata and Sanna (2019) categorized community-based sustainability initiatives into six typologies: community gardens, solidarity purchasing groups, food cooperatives, community energy, recycling, and mobility initiatives. These encompass environmental, social, and economic dimensions involving the social capital as a resource, mentioned in terms of trust for this study. The empirical investigation examines each of these elements while interconnecting the three dimensions.

Community-Based Sustainability even contains community participation, strenthening local economy, preserving culture, solving local environmental issues, social inclusion and collaboration, and long-term commitment that we have to take care of. Sustainability efforts should consider social equity and inclusion to ensure that the benefits and burdens of sustainable practices are shared fairly within a community.

Resilience and adaptation are even more important. With the increasing frequency of natural disasters and the impacts of climate change, studies look into ways local communities can build resilience and adapt to changing environmental conditions (Rasul and Cheng, 2023). Morseletto (2020) investigates strategies for local communities to adopt circular economy principles, such as recycling, upcycling, and sustainable resource management, to reduce waste and promote sustainable consumption patterns.

Examining the role of local governance and policies in promoting sustainability is crucial. Studies often focus on identifying effective policies and strategies for sustainable development and the barriers to implementation (Salvador and Sancho, 2021). Environmental conservation and environmental management require democratic decision-making. The local government's environmental policy approach, the involvement of experts, the activation of the population, and increasing environmental awareness are crucial in sustainability-related measures. However, this requires the presence of genuine communities and trust among their members, which promotes cooperation instead of competition, and cooperation also entails the strengthening of identity (Fodor, 2019). This study emphasizes the importance of collaboration between the local government and local communities. Information flow serves not only to provide information but also to facilitate a dialogue during which civil organizations are mediating in the examined district.

3. Research methodology

Among our research methods, document analysis played an important role, during which we processed the relevant strategic documents of the municipality of Győr. In addition, the collection and use of articles published in print and online media were also of great help. In our empirical research, we used online and paper-based questionnaires to interview members of the examined local community on selective waste collection, the Green Ménfőcsanak Program, community garden, local products, local market, protection of swallows, and transport. An interview was also conducted with the local councilor of the district, on the basis of which we can collect and identify good local practices.

The population of the studied district (Ménfőcsanak) is approximately 12,000 people. According to official sources, there are 10,138 individuals with a permanent address. This number is associated with those who have a temporary residence (628 people) as well as those who do not appear in the registry but live in the district on a regular basis (Mayor's Office, 2023).

The motivation for our research is twofold. On the one hand, we aim to assess the population's engagement with various sustainability topics, and on the other hand, we want to inform the residents about existing infrastructural and other opportunities. In addition to this, we provide an opportunity for the formation of independent opinions. These results can enable the local government to create a specific development plan for the district along these lines, filling any gaps.

We are conducting quantitative research both online and through paper-based surveys. We strive to ensure that residents who are not active in the digital sphere have the opportunity to express their opinions. To achieve this, we involve associations, educational institutions, senior clubs, and sports clubs operating in the

district. We see the need to involve a wide spectrum of respondents, including those who are not active on online platforms.

The foundation of our empirical research began in the summer of 2023. The questionnaire was made available online two days before the manuscript submission, so in this article, we rely only on preliminary results. The survey could be filled in starting September 6th and is also now available and open in order to get the opinions of as many residents as possible. Therefore, the final analysis of the final data will take place thereafter.

In addition to mandatory questions in the online survey, we included questions related to each subfield that allowed for free-text responses. Respondents' answers to open-ended questions are exceptionally high in volume and contain lengthy descriptions. Therefore, when presenting the various areas, we highlight the main points. Due to the small sample size currently available (112 people), we do not attempt to provide demographic data.

3.1. Identification of good practices in Ménfőcsanak district

In both green matters and sustainability initiatives and programs, the Muszáj Nature Conservation Coordination Association is a key association in the district. The organization (as its name indicates, "must") deals with pressing problems such as environmental protection. Their creed is to help the population develop a nature-friendly lifestyle. To this end, they organize sessions, lectures, and camps for all ages. As a result of the close cooperation of the above-mentioned civil association, the Local Government, and the local government representative, the Green Menfőcsanak Program was launched in 2021, within the framework of which a number of green and sustainability initiatives, events, and ideas have already been implemented by involving the population. The Program also has a social media page called Zöld Ménfőcsanak (Green Ménfőcsanak), in order to reach as wide a range of people as possible and involve them in local initiatives.

3.1.1 Selective waste collection islands

In Győr, the first selective waste collection containers appeared in public areas in 2004, and since then, the system has expanded significantly. Nowadays, the Győr Hulladékgazdálkodási Nonprofit Kft. operates about 179 selective islands in the city. Plastic, paper, glass, and metal waste can be deposited free of charge on the selective waste collection islands. Selective islands are located in busy places - at road intersections, next to shops and schools. There are currently 11 selective waste collection islands in Ménfőcsanak, 1 of which was transported due to the opening of a new street but will be returned as soon as its new location is ready. Several locations operate with double containers for certain types of waste, one location operates a double island (each container has a double), and one location has a sunken island.

Otherwise, since 2015, a designated waste depot for the disposal of accumulated household waste has been organized in Ménfőcsanak. This service, known as the waste depot, is provided at least once a year, but sometimes, it occurs twice a year. The waste depot practically 'comes to the doorstep' of the district during these occasions.

The collection of used cooking oil is closely related to waste collection. In Győr, oil collectors were installed next to the selective waste collection points in 2021. In Ménfőcsanak, two were installed in 2022. Unfortunately, as of July 1, 2023, these oil collectors were removed, and this form of residential collection ceased for a while. As a consequence, the most dedicated individuals transport it there. Used cooking oil can still be delivered free of charge to waste depots operated by GYHG Nonprofit Kft. Thanks to lengthy negotiations, oil cans were again deployed throughout the city in August, including one in the Ménfőcsanaki district.

3.1.2 Community garden

The Muszáj Association's Raspberry Garden project (community garden) also encourages household farming. The purpose of the garden is to offer the joy of greenery to those whose homes do not provide such an opportunity. The essence of the community garden is that everyone can receive a plot for free, which they

have to cultivate, weed, and water. The Muszáj Nature Conservation and Coordination Association provides the seeds, tools, and gardening equipment needed for gardening.(gyorplusz.hu) Currently, the residents can cultivate 23 plots voluntarily, and the produce from these plots can be taken home by the growers.

3.1.3 Consumption of local products

In November 2021, the "Egy kosár hazai" (One Basket of Domestic Goods) Ménfőcsanak Handicraft and Producers' Market was launched, and since then, the 12th edition was organized in May this year. The aim of the market is to provide a space for local and nearby producers to sell their seasonal produce and handicraft products locally, thereby supporting local small-scale farmers and entrepreneurs. For visitors, it offers the opportunity to purchase seasonal, fresh, and healthy fruits and vegetables directly from the source. During the intervals between markets, the Ménfőcsanak Market Point operates in the center of the district, providing another opportunity for the sale of produce.

Among these are dairy products, eggs, and seasonal vegetables. As residents of a family house neighborhood, people make use of the opportunities provided by their gardens and yards.

3.1.4 Closer to the nature

There are several efforts in the district that draw attention to living in harmony with nature. The district won the "Bird-friendly Community" competition, and as part of this, the community is trying to assist swallows as well by installing two swallow hotels. Swallows, in turn, will help us control the mosquito population. Also, thanks to the grant, we were able to establish a birdwatching trail in the park in front of Bezerédj Castle. With this trail, visitors can learn about various-sized nest boxes. Information boards provide details about the barn owl nest box, the sparrow colony, and the bird feeders. The protection of swallows is a priority for the whole city, a unique project started three years ago.

3.1.5 Transportation

The establishment of new bus stops is aimed at reducing traffic. Additionally, among the short-term plans is the creation of separate bike lanes on two more sections of the district to ensure safe cycling, as mentioned earlier. Based on data from a project completed in 2010, which surveyed the transportation habits of the district's residents, it was revealed that the most popular means of transportation was cars. Respondents were least satisfied with the quality and frequency of public transportation. (Sustainable Urban Mobility Plan Győr, 2023)

3.1.6 Results

Based on the preliminary results, 99 % of respondents engage in ***selective waste collection***. In addition to PET bottles, glass waste, metal waste, and cardboard, compostable waste appears in a high proportion. However, despite this, nearly 60 % of respondents are dissatisfied with the frequency of emptying the selective waste collection points and the surrounding environment (Figure 1). Among the suggestions made by residents, the most common ones include increasing the frequency of emptying and placing selective collection points in more locations throughout the district. Among the responses, changing people's attitudes and installing a camera system were mentioned in at least 40 cases as potential ways to improve the current situation.

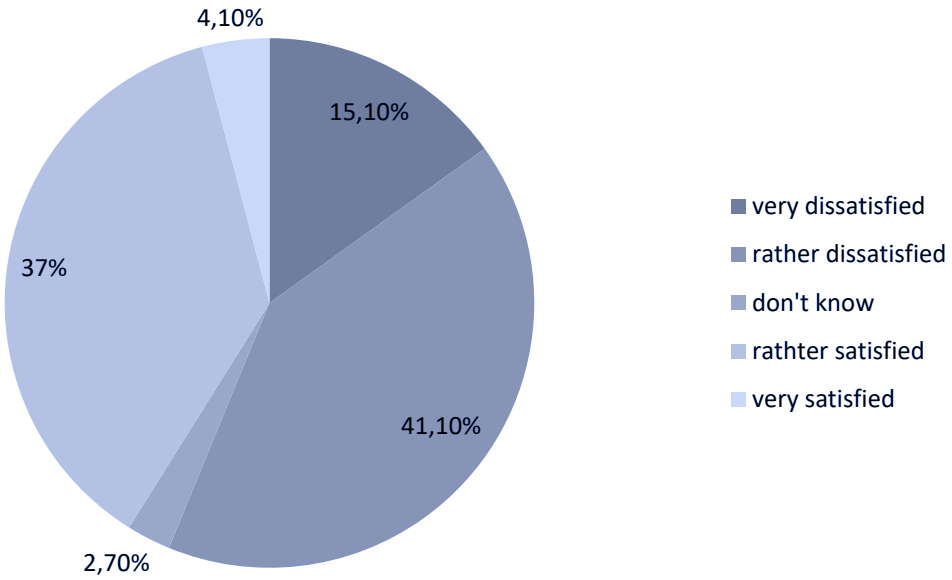

Figure 1: The satisfaction of respondents with the selective waste collection points (%)

Moving on community garden, 90 % of the respondents consider the establishment of a community garden useful for those who do not have a plot. The service is beneficial for those living in the district's condominium zone. 80 % of respondents cultivate vegetables and fruits within their own gardens, with the majority having plots ranging from 5 to 20 m^2 (Figure 2). Survey participants strongly assert that the local government should assist those striving for self-sufficiency. Based on the pre-filled questionnaires, the most suggested ways to support this are by providing seedlings and seeds, as well as offering plant-specific, public lectures.

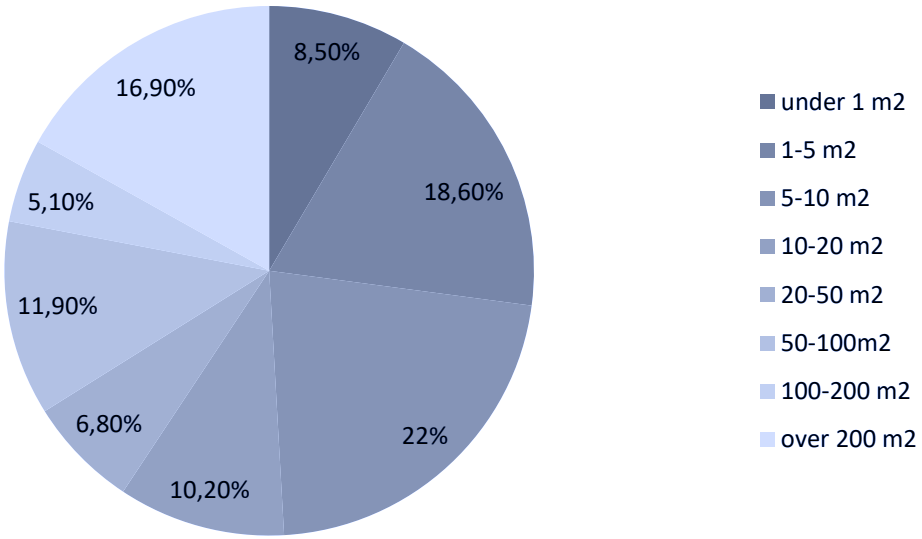

Figure 2: The size of respondents' own garden used for growing vegetables (%)

In terms of consumption of local products, the vast majority of respondents (78.1 %) expressed their willingness to purchase essential food items such as eggs, milk, meat, cheese, and honey from local producers (Figure 3). However, only 30 % of respondents regularly visit the local market (Figure 4).

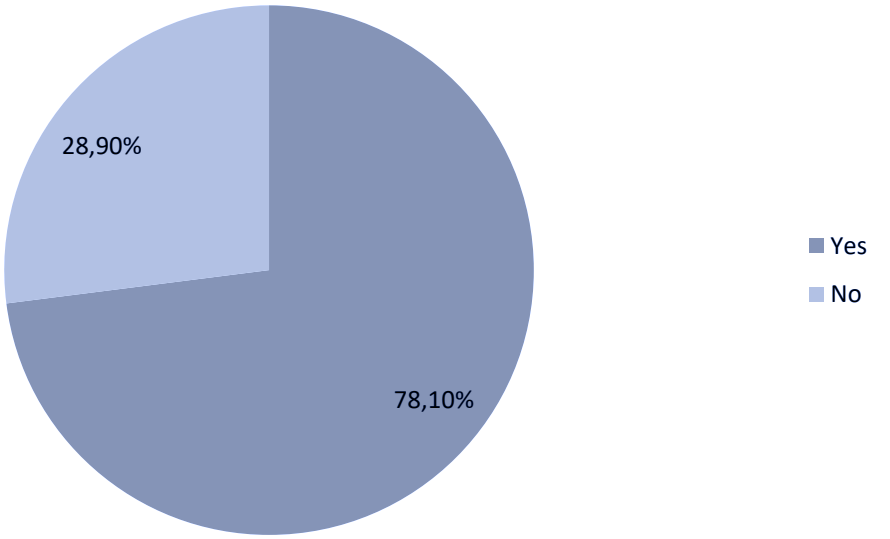

Figure 3: Preference among respondents to purchase vegetables, fruits, handicrafts produced locally and in neighboring settlements (%)

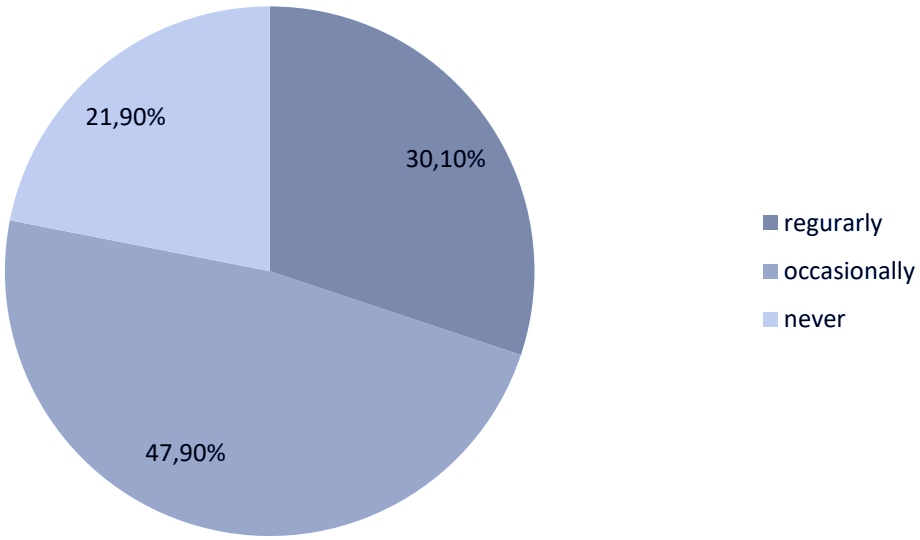

Figure 4: Frequency of respondents' visits to the local market in Ménfőcsanak (%)

In relation to swallows, 69 % of respondents have noticed a decrease in the swallow population this year. According to their claims, swallows did not build nests on their own property or neighboring properties. In order to initiate the growth of the swallow population, they have formulated suggestions and causal relationships, such as permitting and promoting backyard animal husbandry. Barns and stables attract abundant insects that can serve as natural food sources for the birds, acting as natural pest controllers. Swallows, in turn, will help us control the mosquito population. As a result of this argument, the frequency of chemical insecticides can be reduced if the undisturbed functioning of the food chain is restored. It is worth considering a permaculture approach to addressing the mosquito issue.

According to our preliminary research on traveling habits, car travel remained overrepresented among the residents, but 38 % of them regularly use bicycles for transportation. The city administration has also introduced a community bike-sharing system in the Ménfőcsanak neighborhood, but none of the interviewed respondents make use of this service. The most pressing needs identified include the establishment of dedicated bike lanes and the marking of cycling routes, with the latter being done in parallel with road main-

tenance. The development of public transportation has been mentioned several times, and the residents who filled out the survey consider it necessary to improve pre-rail transportation, utilize existing stops, and create associated P+R parking facilities.

4. Conclusions

Overall, it can be said that sustainability is a two-way process in which both the local government and members of the local community, as well as the civil organizations they create, must play equal roles. Assessing the needs of the population is essential in democratically organized (local) societies, and together with responses to these needs, progress can be promoted. Using the results of the public survey, we will present the issues perceived by the community and make recommendations to the local governments regarding the future direction of developments.

Based on the preliminary results of our ongoing research, it can be stated that each of the surveyed sub-areas requires further intervention, both in terms of selective waste collection and efforts to promote local products and assist local producers. Increasing the swallow population is a complex, multi-faceted process with interconnected elements, each of which can contribute to promoting sustainability. A critical issue is the prompt development of transportation and public transit, road improvement, and the alleviation of traffic on major routes within the district. Ensuring safe cycling opportunities for the population through the creation of new bike lanes and marking cycling routes is crucial. Our goal is to maintain and deepen cooperation for the sake of a livable, sustainable community.

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DIGITAL CHILD PROTECTION IN THE LIGHT OF SUSTAINABILITY

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In the 21st century, child protection and the enforcement of children's rights must be ensured and advocated not only in the traditional space but also in the digital environment. This transnational space offers young users a whole range of opportunities, but it also creates potential risks. Protecting children in relation to the digital environment is addressed in international law, both in soft and hard law documents. It is a global issue that requires broad cooperation and response, and international legal instruments on this subject can provide a common basis as a starting point. These documents refer to the UN Sustainable Development Goals (SDGs) as part of a common international framework. Given the relevance of the digital environment in the everyday life of 21st-century children, the child rights-based approach to the SDGs should include a digital child protection perspective. International organisations and business operators play an important role in achieving these goals alongside states. However, the importance of the individuals cannot be overlooked, as it is vital to ensure that children and their caretakers are aware of their rights and are able to manage risks in the digital environment, as well as that they take advantage of the opportunities offered by technology.

1. Introduction

The United Nations General Assembly resolution on Transforming our World: the 2030 Agenda for Sustainable Development envisages, already in the Declaration, a world based on respect for human rights, investing in children and promoting a free childhood without exploitation (UNGA, 2015). Children, as a group deserving special attention, are mentioned several times in the 2030 Agenda, which refers to human rights conventions as a foundation, including the Convention on the Rights of the Child (UNCRC) adopted under the aegis of the United Nations in 1989 (UN, 1989).

The international recognition of the need to protect children and children's rights began in the 20th century, with more vigorous action to promote international cooperation starting after the First World War, under the auspices of the League of Nations and continuing within the UN, culminating in the UNCRC, which is the most rapidly ratified international treaty by most states. At the end of the 20th century, there was no longer any doubt about the legitimacy of recognising children's rights and taking measures to enforce them, but with the new century new concerns arose, including how to ensure sustainability and how to link children's rights approach to this (Grindheim et al., 2020).

The digital environment is a new space for realising children's rights in the 21st century, where children – defined in the UNCRC as persons under the age of 18 – spend more time from a fairly young age. Digital transformation is an ongoing process; results can support the achievement of the SDGs in all three pillars (economic, environmental, and social), and innovation can contribute to solving the problems of the present and future generations (Dias and Rosario, 2022). Information technology and global interconnectivity have the potential for human progress. For children, new technologies also offer a multitude of opportunities to develop and exercise their rights, but they also carry several risks. The challenge for child protection in the digital space in the 21st century is twofold: to guarantee children's rights and to empower future generations

while providing adequate protection. This paper aims to analyse the relationship between digital child protection and sustainable development framework in the light of international legal instruments.

2. Methodology

The study uses the methods of social science, in particular jurisprudence, to examine the rights of children in the digital environment in the context of sustainable development. International legal instruments (hard law and soft law) are examined at the universal and regional levels in terms of their response to the relationship between digital child protection and sustainable development. The paper seeks to demonstrate, through a descriptive and analytical approach, how the relationship between digital child protection and sustainable development can be understood from a children's rights perspective, drawing on the available literature and relevant international legal instruments. Digital child protection and a child-centred approach to sustainable development are receiving increasing attention from the scientific community. However, the connection between these two areas has been marginalised, although international documents show a correlation, so this paper seeks to provide a novelty in terms of the presentation of this issue.

3. How the international framework for digital child protection relates to the Sustainable Development Goals

As the digital environment is a global space, protecting children online is also a cross-border issue that requires global cooperation and response (Muhammad et al., 2021). Supranational protection is implemented through international organisations. Within the regulatory framework, there are conventions that are binding on States Parties and many soft law instruments that are not binding but are recommended for States to follow. The study focuses on the universal level of digital child protection and the European framework at the regional level without mentioning regulations applicable only to specific categories of risks.

The events of traditional space and cyberspace have an impact on each other, and what happens in cyberspace can have consequences on one's life in traditional space (Kelemen and Németh, 2019). In its General Comments, the UN Committee on the Rights of the Child broadens the UNCRC Article 5 principle of evolving capacities. In one interpretation, it is referred to as the enabling principle (Varadan, 2019). This perception is reflected in General Comment No. 25, claiming that both children's opportunities and their risks are part of the digital environment. Age-appropriate measures are needed, but children must be allowed to exercise their rights. To achieve this, states, economic stakeholders, and those who bring up and look after children and the children themselves need to be aware of both the rights of children and the potential risks in the digital environment.

The challenge in designing sustainable development policies is posed by the fact that as life circumstances change rapidly, new problems arise, and the models used to solve them often reflect the perceptions and values of the designers (Abony et al., 2018). This difficulty can also be observed in the context of digital child protection, where the transnational nature of digitalisation and the international nature of problem-solving make it important for policymakers to adopt certain common ground. Given the number and characteristics of the risks to children in the digital space, it is encouraging that the 4Cs classification of risks, which will be presented below, has been adopted by several international organisations. The 4Cs model is based on the EU Kids Online's 3Cs classification of online risks to children, which originally distinguished three categories – content, contact and conduct – of risks according to four dimensions: aggressive, sexual, values, and commercial. Given the significant changes that have taken place in the almost 12 y since the model was created, a fourth element has been added to the 3Cs risk model: the contract – or consumer, commercial – field, which covers the risks that may arise from children's interaction with digital service providers. In addition, the OECD has added a so-called cross-cutting risk category to the original typology, with privacy risks, advanced technology risks, and health and wellbeing risks being considered in all four risk categories (OECD, 2021). The risk model is a good example of how a framework at the regional level can have an influence on the international arena of policymakers.

3.1. Universal level of protection

The fundamental document of international child protection at the universal level, the UNCRC, provides full protection of children's rights, including both positive and negative rights, and sets out obligations for States Parties to ensure these rights, and it is a hard law (Leib, 2011). The implementation of the UNCRC by States Parties is examined by the Committee on the Rights of the Child, which is composed of 18 independent experts. In addition to monitoring, the Committee drafts and publishes General Comments to assist in the interpretation of the articles of the UNCRC, which are more in the realm of soft law in terms of their legally binding force (Szeibert, 2018).

General Comment No. 25, published in March 2021, addresses children's rights in the digital environment. It highlights that the digital environment is becoming increasingly important in most aspects of children's lives. The digital environment becomes even more valued in times of crisis, creating a whole new opportunity for children to realise their rights, but it also brings a multitude of threats. It is important to distinguish risks from harms; risk implies the possibility of harm, but its realisation depends on several factors, such as societal and individual vulnerability (Livingstone and Stoilova, 2021). The four principles of child protection also play a crucial role in the digital environment. Non-discrimination requires states to ensure equal and effective access to digital tools for children, reducing digital exclusion. The principle of the best interests of the child demands States Parties to reckon it as a primary consideration in their actions in establishing rules that affect the digital environment. The role of the opportunities offered by the digital environment in crisis situations is enhanced, but ensuring children's right to life, survival, and development requires that states take the necessary steps to address the risks they face. Regarding the right to life, survival and development, special attention should be given to the early years of children's lives, when their interpersonal relationships with parents and caregivers are crucial for their cognitive development, so certain precautions are recommended regarding digital technology. The digital environment offers children new ways to express their views on issues that affect them, as well as participation at local, national, and international levels. In light of the general principle of respect for the views of the child, states are expected to anticipate children's needs and views when developing regulations and policies related to children's rights in the digital environment (UN Committee on the Rights of the Child, 2021).

The 2030 Agenda mentions children as a distinct group several times but does not specifically address them in relation to technology (Rothe et al., 2023). The sustainable development framework is also based on human rights conventions, including the UNCRC, to which 7 General Comments have been drafted since the adoption of the sustainable development framework to guide States Parties in the implementation of the convention. Of these, only 2 mention the 2030 Agenda. General Comment No. 19 mentions sustainability among the principles of public budgeting for children's rights (Committee on the Rights of the Child, 2019a). General Comment No. 20 addresses the importance of realising children's rights in adolescence, in line with the sustainable development framework (Committee on the Rights of the Child, 2019b). The General Comment No. 25 on Children's Rights in the Digital Environment does not refer to Agenda 2030. The current draft version of General Comment No. 26 deals in detail with sustainable development, which is not surprising given the theme of the document, which approaches children's rights from the perspective of climate change and the environment so that environmental sustainability is emphasised (Committee on the Rights of the Child, 2023).

3.2. European regional level of protection

At the regional level of human rights protection in Europe, the Council of Europe (CoE) and the European Union (EU) have taken steps in the field of digital child protection, in the following, the study will focus on the relevant, but in terms of legal nature, soft law documents.

The Council of Europe's Strategy on the Rights of the Child (2016-2021) includes children's rights in the digital environment as its 5th priority. The ICT sector is evolving much faster than the CoE can respond to, and a good partnership with market operators is needed. The CoE will also monitor compliance with the binding conventions listed in the Strategy, such as the Convention on Child Pornography and the Convention on Cybercrime. The CoE seeks to contribute to the implementation of the goals set out in the 2030 Agenda through the objectives outlined in the strategy (Council of Europe, 2016). In its strategy for the period 2022-

2027, the CoE has linked four sustainable development goals related to digital child protection. Integrating the objectives of the Strategy with the Sustainable Development Goals in the context of access to and safe use of technologies for all children covers the following goals: quality education; gender equality; industry, innovation, and infrastructure; peace, justice, and strong institutions (Council of Europe, 2022).

The EU's commitment to sustainability dates back to the 1997 Treaty of Amsterdam, and the European Union's objectives include the implementation of the SDGs within its policies (Scavarda et al., 2015). In the EU, the European Strategy for a Child-Friendly Internet already addressed the cross-policy issue of creating a safe Internet in 2012 (EU, 2012). It handled a broad spectrum of issues to make the Internet a safer place for children through the regulatory environment (O'Neill et al., 2020). The European Union Strategy on the Rights of the Child proposes action in six thematic areas, setting out priorities for action at the EU level, including the creation of a safe digital environment. Exposure to harmful effects or too much screen time is one of the key issues addressed in the strategy. The strategy also refers to the SDGs. In the annex, it assigns the corresponding goals to the objectives of the strategy in the international framework (European Commission,2021). The renewed Better Internet for Kids Strategy also refers to the sustainable development framework in the context of international cooperation (European Commission, 2022.

4. Digital child protection in relation to specific sustainable development goals

Child rights-based approaches to sustainable development is an emerging discipline at the intersection of law and development studies, an inherently normative field, lacking the basic principles of development law - the intergenerational principle, the precautionary principle, and the principle of common but differentiated responsibility (Vandenhole, 2019.). However, there has been a slight shift in terms of the precautionary principle. The essence of the principle adopted from environmental law is briefly the 'better safe than sorry' approach (Lievens, 2011). According to this principle, in the case of serious or irreversible threats to human health or the environment, scientific uncertainty should not justify postponing action to prevent a potentially harmful effect (Martuzzi and Tickner, 2004). The principle already appears in the draft of General Comment No. 26 of the Committee on the Rights of the Child in its approach to the environment from a child's rights perspective (Committee on the Rights of the Child, 2023). In their joint report on the health and well-being of children, the World Health Organization (WHO), UNICEF and The Lancet argue that the precautionary principle could form the basis for an optional protocol to the UNCRC, which would address commercial harms and create an obligation under international law for states parties to implement its provisions (Clark et a.,2020). Risks that lead to commercial harm are also included in the 4C categorisation as described earlier, so the concern is not negligible in the digital environment.

The commercial category, however, only covers a part of the risks that children's well-being in the digital environment is exposed to. The range of potential threats is much wider. While well-being is also a priority in the SDGs, little is known about the impact that technology has on children's lives and their development in the long term. At the same time, a growing body of literature on harmful effects is trying to raise awareness among decision-makers and society about the importance of conscious usage of ICT tools (Kelemen, 2021). Hence, there is a rationale for a wider use of the Precautionary Principle to protect children in the digital environment (Lievens, 2021). This could promote the well-being of the growing generations in the long term, supporting the achievement of SDG3.

In recent years, the child rights-based approach to child protection has become increasingly important and the participation of children in policymaking has also become more prominent (Kaseb and Milovidov, 2021). One of the most important measures taken by the state towards children is the involvement of them in decisions that affect their lives, whether in the form of legislation or policy. The digital environment gives children the opportunity to exercise their rights more extensively. The right of the child to be heard is becoming a key element in the process of drafting international soft law documents. The digital environment and ICT tools help to channel children's views and opinions. The United Nations Committee on the Rights of the Child, in preparing its forthcoming General Comment No. 26 on environmental issues mentioned above, has involved many children, including by online questionnaires (Committee on the Rights of the Child, 2023). General Comment No. 25 also engaged with the participation of children in the underlying research

(Committee on the Rights of the Child, 2021). Involving children in decisions that affect them, including at the policy level, supports the achievement of SDG16. At the regional protection level of Europe, several platforms have been launched to support the expression of children's perspectives. The EU and the CoE launched the Child Participation for Europe Platform (CP4E, 2023) on 1 July 2023, which provides information primarily to professionals and organisations working with children to strengthen children's participation. The launching of the child participation platform by the EU addresses children who can connect and express their views through member organisations.

A precondition for channelling children's voices through the digital environment is to develop digital literacy among children, and the education system must do its part. School closures caused by the pandemic and digital education have made even more evident the need for a dual approach to the digital environment from a child protection perspective: on the one hand, the digital environment can contribute to the fulfilment of children's rights, but on the other hand, it must also address the presence of risks to children that are constantly changing and evolving with the development of technology. Quality education, as set out in the SDG framework (SDG4), now includes the acquisition of digital skills. Digital literacy and resilience are competencies that are necessary to thrive in everyday life in the age of the 4th industrial revolution (Trung et al., 2020). Resilience and vulnerability are two extremes on a continuum, resilience itself being understood as a complex phenomenon consisting of psychological variables and coping skills (Livingstone, 2015). A major challenge for children is to develop digital literacy from an early age, given the use of ICT devices in early life and the growing popularity of smart, internet-connected toys (Kaseb and Milovidov, 2021). As part of social sustainability, states should actively engage in programmes to prevent the growth of e-exclusion among children in need, ensuring the fulfilment of SDG1 (Soňa and Kowaliková, 2020). The ability to cope in the digital environment is nowadays almost indispensable to succeed, and the lack of access discriminates individuals. Access tends to be seen by children as a necessity and by some as a right, with a particular emphasis on the need for information in children's mother languages and the provision of barrier-free access for children with disabilities (Third and Moody, 2021).

In addition to the role of states, including global cooperation between them through international organisations, the responsibility of market operators to ensure safe digital environments for children is also important. In relation to market operators, the UN Committee on the Rights of the Child's General Comment No. 16 specifically addresses the obligations of the state to ensure that market operators respect children's rights. The International Telecommunication Union has produced a guide dedicated to the online medium, which, in addition to general guidance, provides a checklist for market operators (ITU, 2020). The rapid innovation, technological development, and their global impact mean that states must now necessarily cooperate with market players. In the market sphere, the protection of children's rights has become important in recent years as part of corporate social responsibility (CSR) (Ságvári and Máder, 2013). In addition, there is an effort to bring the SDGs and CSRs convergence, in this relation the SDGs can serve as a framework for CSRs (Fallah Shayan et al., 2022).

At both the universal and regional protection levels, there is legislation to promote children's rights in the digital space. At the same time, the link between digital child protection and the sustainable development framework is not made at universal level in the examined documents. It would be beneficial if the SDG targets were given more prominence in drafting general comments, enhancing the child rights approach to the implementation of the 2030 Agenda. In Europe, there is a tendency at regional level to incorporate sustainability goals in relation to children's rights in the digital environment and to align different strategies within the sustainable development framework.

5. Conclusions

As the literature on the SDGs from a child rights perspective has grown in recent years, so has the academic research focusing on the legal aspects of digital child protection, but there are still relatively few resources available at the intersection of the two approaches. Several international legal documents address digital child protection, and quite a few of these refer to the 2030 Agenda.

Today, the factors that influence well-being and health depend heavily on the digital environment alongside the traditional space. Children's well-being (both physical and mental) is essential for future generations

and for achieving the SDGs. The realisation of children's rights in traditional and digital environments and the legal, technical, and other solutions that support this can contribute towards achieving the SDGs. From a regulatory perspective, the fact that comprehensive strategies for digital child protection are also building on the SDG framework is positive progress. The child rights dimension of sustainable development can no longer be neglected in relation to the digital environment. The Sustainable Development Goals imply partnership: not only are the Goals included, but the document is also a sign of cooperation. In the digital space, children's voices can be included in decision-making on topics that affect them, including SDG-related issues, realising the 2030 Agenda's purpose of including children as active participants in achieving a sustainable future.

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SUSTAINABILITY OF ELECTION SECURITY FROM A MULTIDISCIPLINARY APPROACH

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The study discusses the importance of election security in modern information age and its impact on democracy. It emphasizes that elections are crucial for democratic functioning, and any threats to their integrity undermine public confidence in the political system. With the increasing digitisation of the electoral process and the reliance on social media for election campaigns, the risks of interference and misinformation have escalated. The paper explores the relationship between national security and sustainability in today's security environment, highlighting the complexity and totality of security challenges. It argues that sustainability is essential to safeguard security interests in the long term, encompassing not only material aspects but also cognitive and societal resilience. The study delves into the cyber vulnerabilities of electoral systems, such as attacks on e-voting systems and attempts to manipulate related information. It underlines the importance of network and internet security in protecting election-related systems and data and also addresses the role of social media in spreading misinformation and disinformation during elections, as well as the need to enhance security awareness and resilience among the public and election officials. It presents EU and national legislation and practices in this area and then identifies areas where progress is needed in both regulation and best practice to achieve sustainability, based on these and on the experience of recent years.

1. Introduction

The election of members of the legislature is a cornerstone of democracy, a crucial opportunity for voters to participate, at least indirectly, in the political process and in shaping the laws that affect their lives and their everyday lives. The processes leading up to elections, the organisation and conduct of elections and the declaration and publication of results are, therefore, extremely sensitive points in the democratic functioning of a state. Maintaining a high level of public confidence in these systems is essential to ensure that the legitimacy of the branch of power, and ultimately of the entire attribute of state power, is beyond reproach in society. However, in the current geopolitical context of the information age, the threat to elections and attempts to influence them have been greatly enhanced.

In many countries today, the electoral process, or its certain elements, is being implemented digitally. In addition, the success of election campaigns is strongly linked to cyberspace, especially social media (Kwak et al., 2022). This has led to a renewed focus in recent years on interference by one party in the democratic processes of the other and, on the other hand, on more effective defences against attempts at influence and delegitimisation. Ensuring the sustainability of electoral legitimacy is an aspect that has a major impact on voters' faith and trust in democracy – a fact that is also highly vulnerable to misinformation, disinformation and fake news from cyberspace.

Election security can be approached from both a network security and a cognitive security perspective. Electronic voting systems are a part of critical government infrastructure. In recent years, many countries have

experienced cyber-attacks on electoral information systems, with the perpetrators gaining access to large amounts of personal data. In addition to network security, the increasing number of foreign information operations over the past decade has posed a particular threat to the integrity of elections.

In this paper, we use the tools and scientific methods of military and legal science to investigate the links between sustainable security and electoral security. In doing so, it will examine how the transformed and totalising security environment of today's military science experience and the high level of digitalisation of states and societies affect the security of elections. How election security can be segmented. It will also examine the regulatory and practical responses of individual states and the European Union to this issue. The lessons learned will be summarised and conclusions drawn on the areas where progress is needed to enable democratic states to achieve sustainability in the area of election security.

2. The relationship between national security and sustainability and election security in today's security environment

The complexity of security is now a fundamental principle (Dannreuther, 2013) in thinking about the functioning of national and international communities. Security in its essence, can be interpreted in all areas of life, with its individual sectors. Beyond traditional military security and public security, if we take food security, economic security, transport security, energy security or information security as examples, it goes without saying that security permeates the functioning of our societies in both horizontal and vertical senses. From this perspective, security is not only complex but also totality in the 21st century, as are the dynamically changing challenges, as they can affect all aspects of life, are truly global and real-time, and can partly break away from spatial boundaries through technological development, especially cyberspace. The security medium is, if you like, 'total' because it has both horizontal – i.e. according to the multiplicity of types of challenges and threats – and vertical – i.e. according to the scope of each specific challenge/threat – extreme and partly unpredictable variability.

It also follows that sustainability has fundamental security linkages, as environmental change, consumer society's exposure to different supply systems, economic stability and resources (Khanna, 2016) all bring with them the recognition that sustainability is a long-term strategic interest in safeguarding security. This insight is supported by work on the relationship between climate change and security (Moran, 2011) or resource-driven conflicts (Isaszegi, 2015), both in a specific military and broader geopolitical context (Dalby, 2020).

However, when it comes to security, we have a tendency to focus all our attention on the material links: the infrastructure, the services, and the resources. However, the problem of information warfare, disinformation and post-truth phenomena, as well as hybrid threats (Giannopoulos et al., 2021), have highlighted the need to strive for sustainability not only in material terms but also in cognitive, individual and societal psychological terms, in order to make our security sustainable. The human factor, and within it cognitive and mental resilience, is fundamental to the functioning of our societies and indeed to the safe operation of many of our technological systems, without which misinformation can create uncertainty that can have a significant impact on material security.

In the age of total security, therefore, sustainability is also understood in a complex way, and in this complexity, the reliability of information, our ability to process and control information, and our individual and societal cognitive resilience play a prominent role. Sustainability, if you like, is also a key issue for the functioning and culture of the information society and, therefore, for information security in a broader sense. The absence or dysfunction of these can result in security exposures that can lead to political-legitimacy disruptions and, in serious cases, to the erosion of physical security, for example, in the case of disinformation-based riots. In the age of total security, a political dimension must, therefore, be properly considered.

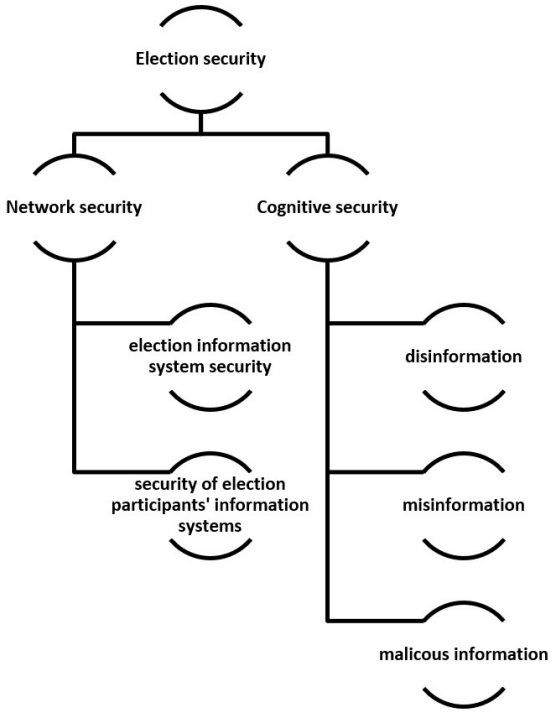
In 2015, the UN adopted the Framework for Sustainable Development, which states that "Sustainable development cannot be realised without peace and security" and thus includes peace among the sustainable development goals. To this end, the document argues that it is essential to reduce all forms of violence,

support the rule of law and strengthen appropriate national institutions (Squillace et al., 2023). One such national institution is democratic elections, a pillar of the rule of law. In recent decades, however, with the proliferation of cyberspace and related technologies, this institution has come under attack from many sides. On the one hand, these attacks have targeted electronic systems associated with electoral processes, and on the other hand, they have attacked the integrity of democratic elections themselves.

The relationship between sustainable security and election security is rooted in the broader concept of ensuring the stability and well-being of a nation or community. Sustainable security focuses on long-term, comprehensive strategies that go beyond traditional military measures to safeguard a nation's interests. Election security, on the other hand, pertains to the protection of electoral processes and the integrity of democratic institutions during elections.

These two concepts intersect in several ways: (1) Democratic stability: Sustainable security relies on stable political systems. Secure and transparent elections are crucial for establishing and maintaining political stability, as legitimate leadership transitions reduce the risk of internal conflicts and violence. (2) Public trust: Sustainable security efforts benefit from a population that has trust in its government and political institutions. Ensuring election security by preventing fraud and interference fosters this trust, which is vital for national cohesion and resilience. (3) Foreign influence: Foreign interference in elections can undermine both election security and a nation's sustainable security. Hostile actors may seek to manipulate election outcomes to weaken a nation's stability, making it imperative to safeguard elections from external manipulation. (4) Rule of law: Sustainable security is closely tied to the rule of law, which includes the fair and equitable enforcement of electoral rules. Secure elections uphold the rule of law, bolstering a nation's legal and political systems. (5) Conflict Prevention: Secure elections reduce the risk of political disputes turning into violence. In this way, election security contributes to conflict prevention, a key aspect of sustainable security. (6) Resilience and adaptability: Sustainable security strategies must adapt to evolving threats and challenges. Election security also demands adaptability to address emerging threats like cyberattacks or disinformation campaigns, reflecting the shared need for resilience.

In summary, the relationship between sustainable security and election security is symbiotic. Secure and transparent elections support long-term national stability and well-being, while sustainable security strategies aim to create a conducive environment for such elections to take place. Both concepts are integral to maintaining a robust and resilient society.



Figire 1: Diagrammatic representation of electoral security

3. European Union and national practices and regulations on election security

In recent years, there have been a number of incidents involving electronic systems related to elections. For example, in autumn 2020, Iranian hackers attacked US election databases and gained access to large amounts of voter registration data, and actors close to the Chinese, Russian and Iranian governments significantly affected the security of US political organisations (JUSTICE.GOV, 2023). In Israel, the personal data of 6.5 million Israeli voters, virtually the entire eligible population, will have been exposed ahead of the 2021 general elections.

The security of election-related electronic systems is a priority for national security authorities in each country, as well as for the European Union. According to an annual cybersecurity report published by the security and counter-terrorism agency under the Ministry of Justice and Defence of the Netherlands, one of the main targets of cyber-attacks by states for geopolitical gain is attacks on systems that ensure the democratic process (NCTV, 2021).

The Cybersecurity & Infrastructure Security Agency (CISA), the main body responsible for election cybersecurity in the United States, classifies cyber threats relevant to elections into three groups: phishing, ransomware and distributed denial of service. To avoid these threats in the US, officials seeking to secure election infrastructure should carefully review each section to identify the tools and services that can address the primary risks. The services and tools used should all be consistent with the Protect and Detect functions of the NIST Cybersecurity Framework. Within this scope, Protect defines the precautions to ensure the provision of critical services and Detect defines the activities to identify when a cyber security event has occurred. (CISA, 2023a) In addition, election officials should have extensive oversight of technological, physical and procedural systems to reduce the likelihood of malicious cyber activity that could affect the integrity of the election, such as altering votes or otherwise disrupting or preventing voting. To this end, measures such as the use of provisional ballot papers and reserve ballot books are possible (CISA, 2023b).

In addition to the direct attack on electoral systems, a particular problem is the hacking of information systems of organisations or individuals involved in the election campaign and the extraction and leakage of data from these systems in order to influence the election results. Two of the most notorious of these are the cases of the presidential elections of Hillary Clinton and Emmanuel Macron. In these cases, the source of the threat was mainly inappropriate employee behaviour or inadequately designed data management rules and systems. Such cases make clear the need to develop the appropriate infrastructure and internal controls for such actors, in addition to awareness-raising activities tailored to their own organisations. (Tenove et al., 2018) Our surveys conducted during the COVID-19 pandemic showed that, in the case of Hungarian businesses, this type of preparedness was most prevalent among multinationals but that the cybersecurity awareness of employees was already highly contested among these actors. In the case of SMEs, however, it is clear that neither the business organisation nor the majority of employees had an adequate level of preparedness in these areas. What is also reflected in the 2022 Hungarian elections is that there were several data breaches of the organisations and their employees during the campaign period. (Németh, 2022)

The European Union's Regulation on restrictive measures against cyber-attacks that threaten the Union or its Member States includes attacks on public elections and the electoral process among those that threaten Member States. Accordingly, persons, entities and bodies to whom such attacks may be directed are subject to restrictive measures, including the freezing of their funds and economic resources (EU, 2019).

The network security of elections is based on a properly built, operated, monitored and improved information system and its well-functioning funding, as well as the training and preparation of election officials, but at least as important is the improvement of social resilience on the part of those involved in the election campaign, for whom it is necessary to develop and enhance security awareness, as all of these are essential to ensure the integrity of elections in the future.

Another interesting case of electoral security is cognitive security in elections, which also seeks to undermine the legitimacy of electoral institutions. Russia's actions against Ukraine have led the European Union to recognise the potential for the exposure of trust in the democratic functioning of Member States and EU institu-

tions, mainly through Russian and Chinese disinformation scenarios. Therefore, in 2015, the East StratCom Task Force was set up to improve the EU's capabilities to anticipate, detect and respond to disinformation. In 2018, an action plan against misinformation was adopted. It provided for a split action between Member States and EU institutions. The coordinated response is based on four pillars: improving the capacity of EU institutions to detect, analyse and expose cases of misinformation; strengthening coordinated and joint responses to misinformation; mobilising the private sector to combat misinformation; raising awareness; and improving the resilience of society (EUROPA, 2018).

Some Member States have not been idle in this area. France has adopted a law to combat the spread of disinformation during election campaigns. The law allows the authorities to remove or block false information that could influence the electoral process and provides for transparency in the financing of online political advertising (Guillaume, 2019; Craufurd Smith, 2019). Spain adopted a law in 2018 aimed at protecting the electoral process from disinformation and interference. The law establishes measures to monitor and combat disinformation during electoral campaigns, focusing, among other things, on social media and online platforms. (Campos-Freire et. al., 2021) The Irish Elections (Amendment) Act 2021 focuses on political advertising and transparency. It requires online political advertisements to include information on who is responsible for the advertisement and whether it is a paid advertisement. (Kirk and Teeling, 2021; Lynch, 2020) Latvia introduced amendments to its Law on Electronic Mass Media in 2019 to address disinformation and the use of mass media for electoral interference. The aim is to regulate the publication of political advertising and funding sources (WIPO, 2023).

In December 2020, the European Commission presented an Action Plan for Democracy in Europe (EUROPA, 2020). The fourth point of the Action Plan is the fight against disinformation. It advocates closer cooperation with the private sector, civil society, academia and the EU's international partners, but still only to better understand hybridity. In other words, it is still just a promise to implement the code of conduct and develop a common methodological framework. In the case of the platforms, he criticised the opacity of the algorithms they use and their news practices, problems that were only identified during the evaluation of the Code of Conduct. The Commission believes that a stronger and clearer commitment from platform providers and an approach based on an appropriate monitoring mechanism are key to an effective fight against disinformation. The Commission remains of the view that one of the most important areas in the fight against disinformation is media literacy.

The Helsinki-based Hybrid Centre of Excellence has made recommendations to ensure smooth elections in 2020. It divided the pre-election period into three periods: beyond one year, within one year and within six months. One of the key tasks of the one-year period is to establish mechanisms for cooperation with other Member States, allowing best practices to be collected and integrated into the process. To this end, the European Union set up the Rapid Alert System in 2019 to facilitate the exchange of information and coordinate the action of Member States and EU institutions against disinformation. To this end, a network of twenty-seven national contact points has been set up to coordinate and share best practice. This division of responsibilities makes it difficult to solve problems, and the national toolbox remains (Makela, 2019). From a disinformation perspective, the last six months are still relevant, as it is here that issues that divide voters need to be mapped and targeted actions on these issues need to be monitored. These should then be communicated to policymakers, journalists and candidates, and the potential for escalation should be raised (Rosenstedt, 2021). Also central to this recommendation is the ability of individual public bodies to engage appropriately with platform providers. However, experience shows that no progress has been made. The Avaaz team's report points out exactly that. In 2019, there were 158 million views of political falsehoods about the upcoming presidential election monitored by Avaaz. That number is horrific in itself, but when you add in the 153 million voters registered for the 2018 mid-term elections, you can jump straight to the conclusion that at least one piece of fake news has reached every single voter (AVAAZ, 2020).

Following Russia's attack on 24 February 2022, the European Parliament reaffirmed its opposition to foreign interference in democratic processes in a resolution of 9 March 2022 (European Parliament, 2022). In this area, protests against interference in elections could not be ignored. The reason given for this was that the external aggressor was using the fundamental values of the Unison, namely openness and pluralism, the dangers of which and the weakening effect on social resilience are only increased by the use of new, modern technologies, which create doubt and uncertainty and delegitimise the entire electoral process. However, whether the EU and the Member States will have a real response and whether progress will be made in this

area by the 2024 elections is still very much in question, as it is now quite clear that unless social media platforms are genuinely involved in this process, share their screening mechanisms and cooperate with public authorities, there is no real chance of effective action.

4. Conclusions

Given the complete transformation of the security environment in recent years, and the security challenges that are becoming total, a sustainable security environment can only be achieved in a resilient society. Election security is one of the components of this area, where, based on the above regulatory and practical experience, progress is needed in the following areas to enable the European Union and its Member States to respond adequately to the threats to election security from cyberspace in the coming years:

Increase international cooperation. In order to develop the necessary resilience, Member States and regions should increasingly rely on information sharing, exchange of best practices and coordinated responses to election-related threats. NATO and the European Union are of particular importance in this process in the Euro-Atlantic region.

The codification of appropriate cybersecurity legislation is a priority. The European Union has made significant progress in 2022-23 with the regulation of NIS2, DSA, and DORA, among others, but the rules on critical infrastructure in the Member States are far from uniform. For example, the Hungarian regulation and cybersecurity strategy is already ten years old, so law enforcement faces extreme difficulties in responding to today's security challenges.

NATO's overall approach to resilience must include educating and preparing voters against specific cyber threats, and thus, there is a need to raise voter awareness in the areas of network security and cognitive security. The need to do so was highlighted by the infodemic during the COVID-19 pandemic. The most vulnerable are those who do not speak foreign languages, have a low level of education and live in small communities. We have seen many examples of this during this period, both in the Central and Eastern European regions. Thus, the importance of cognitive awareness has been highlighted in several EU documents, but no progress has been made to date in the field of individual education. It would be necessary to channel the development of these skills into public education and also to develop awareness-raising programmes for older generations at the local community level.

Transparency and verifiability are also key issues for states. Transparency and verifiability are key elements in ensuring the integrity of elections in an increasingly digital and interconnected world. Transparency refers to the openness and accessibility of the electoral process, allowing stakeholders, including voters, to observe and understand each stage of the election. This transparency is essential for building trust in the electoral system by allowing for independent verification and validation. In the context of electoral security, transparency means making the process of casting, counting and tabulating votes as clear and understandable as possible. This may include measures such as publicly accessible electoral databases, clear guidelines on electoral procedures and open-source software for electronic voting systems. Confidence in these systems can be undermined by, among other things, over-regulation and excessive reliance on traditional solutions that are difficult to understand in a digital environment (e.g. the Hungarian postal voting system, which has suffered from a number of setbacks in recent years), over-control of the digital space or political ambitions to do so. Verification complements transparency by ensuring systematic and rigorous scrutiny of election results and processes. Audits are essential to verify that the results declared correspond to the votes actually cast, thus preventing fraud and ensuring the accuracy of results. Various forms of auditing can be used, including post-election paper ballot audits and risk-constrained audits. In these procedures, a statistically significant sample of paper ballots is examined to confirm the integrity of the results of the electronic voting system. The combination of transparency and verification enhances the credibility of the election process, assuring the public that their votes have been accurately recorded and counted, and providing a robust defence against potential cyber threats and manipulation.

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STRENGTHENING HEALTH VISITOR EDUCATION BY INCORPORATING INTERDISCIPLINARY KNOWLEDGE OF SUSTAINABILITY

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Knowledge of sustainability is essential for activities aimed at improving the health and well-being of individuals and communities. The dissemination of such knowledge in the training of all professionals is therefore crucial. A research team made up of university teachers has decided to develop and complement the training of health visitors with basic sustainability knowledge by launching an optional course. The goal is to develop a course that will provide students with sufficient theoretical and practical preparation, based on the professional experience gathered through a review of relevant international literature. During the 14 weeks of the course, interactive lectures on different sustainability topics will be organized occasionally, with the involvement of experts from other disciplines, following an interdisciplinary approach. Input and output questionnaires to assess the effectiveness of the session will be developed. In the autumn semester of the academic year 2023-2024, the professional preparation of the course is to be launched (elaboration of the theme, recruitment of lecturers, etc.). The launch of the course and the input and output data collection will take place in the spring semester of the academic year 2023-2024, and the revision and finalization of the curriculum and teaching methodology based on the training experience will be planned for the next academic year. The course proposal will be presented in this paper and previously at a conference.

1. Introduction

The humanistic concept of health seems to be far away from the technical concept of sustainability. Yet the UN Sustainable Development Goal 3 is to "Ensure healthy lives and promote well-being for all at all ages" (Tsalis et al., 2020). The link between these two concepts is not self-evident. Health is linked to the idea of environmental sustainability and makes clear the idea that humans and other living things on Earth are interdependent. If human affairs are managed in a way that keeps the ecosystems that support life in a stable state of equilibrium, then humans will survive and thrive. However, if a local, regional, or global ecosystem is degraded beyond the limits of sustainability, then the health and survival of the people in that ecosystem cannot be sustained. Emphasizing the multi-faceted relationship between human health and the Earth's living and non-living environment, "One Health" is an integrated, holistic approach to balancing and optimizing the health of people, animals, and the environment (Eckert and Kovalevska, 2021).

Nature ensures the good health and well-being of the world's population. Clean air, water, and food are essential for sustaining life; the natural environment provides space for recreation, relaxation, and social interaction; and raw materials are put into our production systems to ensure the comforts of modern life. However, pollution is inevitable. We are exposed to pollution in our homes, at work, in the outdoor environment, and when we eat, play, sleep, drive, walk, swim, or run. An indication of the impact of the environment

on human health is that 23 % of global deaths could be prevented by a healthier environment (World Health Organization, 2019), and 250,000 additional deaths are expected to be caused by climate change every year between 2030 and 2050 (World Health Organization, 2021).

At the same time, human impact on the environment is increasing. Many of the resulting risks cause ongoing illness and injury, affect the quality of life, reduce productivity, and strain health systems. As a single example, 5-10 % of greenhouse gas and other air pollutant emissions are caused by health systems (Cummings, 2019).

The vital role of the living environment in human health has only begun to be more widely recognized in the last decade. Biodiversity, ecosystems, and the essential services they provide are central pillars for all living things on the planet, including human life (Arora et al., 2019). They are sources of food and essential nutrients, medicines and medicinal compounds, fuel, energy, livelihoods, and cultural and spiritual enrichment. They also contribute to the provision of clean water and air and perform critical functions ranging from pest and disease control to climate change and natural disaster regulation. Each of these functions has direct and indirect consequences for our health and well-being, and each is an important piece of the epidemiological jigsaw that confronts our efforts to control communicable and non-communicable diseases (Alamoush et al., 2021).

The links between biodiversity and health are manifested at different spatial and temporal scales. At planetary scales, ecosystems, and biodiversity play a critical role in determining the state of the Earth system, regulating its material and energy flows and its responses to sudden and gradual changes. On a more intimate level, the human microbiota – the symbiotic microbial communities present in our gut, skin, respiratory, urinary, and genital tracts –contribute to our nutrition, help regulate our immune systems and prevent infections (Romanelli et al., 2015).

Health professionals are some of the most trusted and respected members of society and are in the perfect position to inspire and demand the changes that the United Nations needs for a healthier planet and healthier people. There are several ways that healthcare professionals can support sustainability or advocate for action at the intersection of people and planet health (Maibach et al., 2021).

Most health professionals are aware that climate change is happening and affecting the health of the people they care for; however, many still feel that they do not have sufficient knowledge on the subject and the majority of health professionals working in clinical practice today are unlikely to have received specific training or education in this area. An important first step to harnessing the potential of health professionals' voices is to ensure that they understand the principles of sustainable health care and the relationship between health and the environment (Kotcher et al., 2021).

At the most basic level, change must start at home and in the local community. Health professionals can increase their influence and advocacy credibility by leading by example through positive climate and environmental behaviors, such as active transport (e.g. walking or cycling to work), reducing carbon emissions, and sustainable eating. Leading by example has been shown to further increase the motivation of health professionals to take further action, which can help to foster a virtuous cycle of positive action (Economist Impact, 2022).

Health professionals are skilled communicators, especially when it comes to simplifying complex messages in a way that promotes behavior change. The trusted voice of health professionals can be persuasive not only to patients but also to colleagues, family members, and communities. The sight of a bicycle in a clinic office sends an important message to patients and colleagues, and the impact of positive action can be multiplied by explaining to others why they are taking action. Health professionals can often advise on healthy behaviors such as walking or reducing meat consumption in our diets, and where appropriate, explain how these choices can benefit the wider community and the health of the planet.

In addition to making changes in their personal lives, health professionals can also reduce the environmental impact of the care they provide in their institution or organization. Individually or collectively, health professionals can make policy or practice changes to increase energy efficiency, reduce emissions, minimize waste, and purchase low-carbon materials or sustainable equipment. They can also influence the design

and implementation of existing care models and delivery models in their organizations. And they can identify innovative options, products, or services that reduce the environmental footprint of care without compromising clinical outcomes. Examples include supporting teleconsultations or care closer to home, reducing unnecessary use of healthcare resources such as plastic gloves and other single-use devices, and exploring digital solutions as an alternative to traditional care methods.

Among the health professionals, members of the research team are training students to become health visitors. Health visitors are registered nurses with additional training in community public health nursing. They provide a professional public health service based on the best evidence of what works for individuals, families, groups, and communities; improving health and reducing health inequalities through a proactive, universal service for all children 0-5 y and for vulnerable populations targeted according to need. (Cowley et al., 2015) After childbirth, the health visitor teaches the mother how to breastfeed and her responsibilities to the child. They monitor the health and development of newborns, provide community health care for children (ages 3-18), help prevent behavioral disorders and bad habits, solve problems of adolescents, and refer them to the appropriate professional. Health visitors help families with mental hygiene and organize vaccinations. They participate in the planning, organization, and implementation of health development and promotion programs for individuals and communities. Health visiting is a proactive, universal service that provides a platform from which to reach individuals and vulnerable groups, taking into account their different dynamics and needs, and reducing health inequalities. Health visitors work with parents who have new babies, providing support and expert advice from the antenatal period until the child starts school. They may work in teams or have sole responsibility for a caseload derived from the local area or a general practice list; they are usually based in children's centers, surgeries, community, or health centers. Health visitors visit parents through a minimum of 5 universal home visits from late pregnancy to a developmental assessment at 2 y of age.

In preparation for the project to develop a course for health visitor students, the authors undertook a selective literature search, supplemented by a thematic internet search.

Based on the results of the search, it can be concluded that in the health sector, publications on sustainability in higher education relate partly to medical education and partly to nursing education. There is a significant increase from 2017 to 2021 regarding nurses as agents for achieving environmentally sustainable health systems. The most relevant countries in this area are the United States, the United Kingdom, and Sweden (Luque-Alcaraz et al., 2022). Maxwell and Blashki (2016) stated: "Given the dire implications for human health, climate change is of fundamental relevance to future doctors. Integrating climate change into medical education provides an opportunity for future physicians to develop skills and insights essential for clinical practice and public health roles in a climate-changing world." Experts generally agree that medical education should prepare future physicians for climate-associated hazards and corresponding professional challenges. (Boekels et al., 2023) Evaluation of an optional course that focused on the concept of planetary health, with an emphasis on the health consequences of climate change and options for action and adaptation in clinical and practice settings, shows that it had a significant impact on student's knowledge, attitudes, and behaviors (Lemke et al., 2023).

Climate change and limited natural resources will impact the sustainable supply and disposal of materials used in health care. Nursing students need opportunities to reflect on the environmental footprint of healthcare to mitigate negative impacts on service delivery. Evidence-based educational tools that are relevant and meaningful to nursing practice are needed to raise awareness of these issues (Richardson et al., 2014). One way to make this topic real for students is through the use of clinically relevant scenarios in skills sessions (Grose and Richardson, 2016). Using a scenario-based learning approach with nursing and midwifery students can change attitudes and knowledge about sustainability and climate change. Embedding this approach in the context of clinical skills provides a novel and engaging approach that is both pedagogically sound and clinically relevant (Richardson et al., 2017). An international survey has shown that nursing students have increasingly positive attitudes toward incorporating sustainability and climate change into their nursing curricula. They also recognize the importance of education about sustainability and the impact of climate change on health, which supports formal preparation for environmental literacy (Álvarez-Nieto et al., 2022). Medina (2022) noted that the impact of education is long-lasting: "Attitudes and environmental awareness about climate change and sustainability increased significantly as students received the learning sessions over the three years."

Recognizing the responsibility of academics to reconcile human health and sustainability, and driven by research curiosity, the research team formulated the following scientific question: "What can university faculty do to disseminate sustainability knowledge to the general public? How can they contribute to a positive change in public attitudes and behavior towards sustainability? The authors, a research team of university teachers, decided to develop a sustainability training course for their health visitor students.

In this paper, the research group aims to present the procedure for developing and complementing the training of health visitors with basic sustainability knowledge by launching an optional course. For the design of our research, we studied a very similar survey conducted with British and Chinese students (Guo et al., 2022), which suggests that the attitudes of students at Széchenyi István University towards sustainability will shift in a fundamentally positive direction after completing the course.

2. Objective

The goal is to develop and supplement health visitor training with basic sustainability knowledge by launching an elective course. The educational effectiveness of this newly launched course will be assessed with the help of questionnaires. With the new course, the goal is that the students participating in the nursing education at Széchenyi István University will gain a better insight into sustainability and be able to integrate it into their other studies. In addition to making their diploma even more marketable with the knowledge acquired in the course, they will be able to effectively spread the view of sustainability during their work. In the future, it is planned to launch additional courses related to the topic of sustainability for a wider range of students, even at the university level.

3. Implementation

3.1. Starting a new optional course

With the information gathered during the study of the relevant international literature, the research group envisages launching an optional course that will provide students with theoretical and practical knowledge about sustainability. They develop the course primarily for students studying nursing, but they also want to ensure that the course can be taken by all students of Széchenyi István University.

For this purpose, during the 14 weeks of the course, interactive presentations on various sustainability topics are organized - following the approach of interdisciplinarity and involving experts from other disciplines.

It is planned to implement the curriculum for 14 weeks; the order of the topics is summarized in the first table.

Table 1: Course of the planned subject

The course of the semester (weeks of diligence period)	Sessions of the current week's classes	Discipline field of study
1.	Introduction, basic concepts	General foundation
2.	Sustainability in healthcare	Health Science
3.	Sustainability and waste management	Chemistry
4.	Sustainable healthcare	Applied sustainability
5.	The sustainability of the health visitor district	Health Science
6.	Energy management and healthcare	Physics

7.	Sustainable development	Economics
8.	The legal relationship between sustainability and healthcare, sustainability and law	Jurisprudence
9.	Project work: foreign examples of sustainability efforts in the healthcare sector (making a poster and competition work)	General knowledge
10.	Cooperation with the bodies of the European Union from the point of view of sustainability	International relations
11.	Project work: planning a sustainable health visitor district (making a poster and competition work)	General knowledge
12.	Sustainable education, sustainable health pedagogy	Educational science, health science
13.	Project work: Surveying the sustainability of health visitor work in Hungary	General knowledge
14.	Summary, repetition, practice for the exam, clarification of emerging questions	General repetition

In the first week of the course, the technical terms and definitions used in the field of sustainability will be introduced to the students. After that, from the second week onwards, specific topics are explored with the involvement and cooperation of experts from various scientific fields. In the second half of the semester, starting from the ninth week, the students prepare individual work (a poster on the topic of sustainability and a competition work modeled after the Science and Art Student Circle at the Széchenyi István University) as part of the project work every other week. Prepared applications are mandatory to obtain a signature certifying the successful completion of the course. The best works can also be submitted to the "Science and Art Student Conference" competition. In the last week of the hard work period of the semester, a summary of what has been learned so far takes place, as well as a discussion of the professional and technical questions that arise during the semester. The exam is then either written or oral, depending on the number of students, where knowledge is evaluated on a five-point scale (insufficient-adequate-medium-good-excellent). The required and recommended literature for the course will be given in the class note(s) and the special literature will be indicated by the instructors. For each of the specialized areas of the fourteen weeks, experts from the Faculties of Széchenyi István University will be invited, as well as recognized professionals working outside the University, to be speakers. The course will be prepared in the autumn semester of the 2023-2024 academic year (obtaining approval from the department, faculty, and then the University Education Committee, entering the final subject matter into the electronic lesson book (Neptune system), integrating the course into the Széchenyi István University courses, officially inviting instructors, etc.). The course itself will be started in the spring semester of the 2023-2024 academic year. Based on training experiences, the curriculum and teaching methodology will be reviewed for the next academic year and, if necessary, amended.

3.2. Survey

The plan is to develop a questionnaire to assess the efficiency of the four-month course. The questionnaire assesses what kind of knowledge and attitude the students have about sustainability and its various aspects at the time of entry and exit. The results will be used to revise the course. In addition, it is foreseen to publish the results, as the research group is confident that the results can contribute to the achievement of wider sustainability. The survey will be repeated every school year, thereby it will be created a larger database for later analysis and evaluation of trends.

As the first step in the development of the questionnaire, are view will be performed on the available relevant questionnaires, to formulate the questions taking into account the university's environmental specialty, and compile the questionnaire. The questionnaire developed in this way will be tested first in pairs and then in groups. The data collected in the survey are analyzed and interpreted in the framework of "before and after" design.

4. Conclusion

A few publications in the literature analyze the role of health professionals in contributing to sustainability goals. Other studies focus on the education of health professionals in sustainability. These papers mainly focus on the opportunities for environmental and energy conservation in the provision of health care. Health visitors can also act as role models and advise on sustainability to the parents they come into contact with in the course of their work. Therefore, the planned educational program will answer the question of what university teachers can do to spread sustainability knowledge among the population.

Sustainability is fundamental to Széchenyi István University and it is also an important topic for the authors' department. Familiarizing students with the possible tasks related to sustainability in their future fields is an important part of this. The students receive such new and relevant knowledge that they become more competitive in the labor market, not only in Hungary but also in the European Union. In line with international efforts, the training of health visitors concerning sustainability – similar to the training for other health professionals – can significantly promote the social diffusion of the view of sustainability through more intensive client relationships. Professionals of health visitors trained with this approach will naturally shape their area with sustainability in mind. In addition, they also play a major role in the transmission of attitudes among both adults and children. In this way, the civil sphere can connect more deeply with the scientific fields. In some way, the health visitor is also an educator who passes on the knowledge she has learned through young people and families, ultimately contributing to the sustainability of the health visitor practices and their wider environment. The development of effective sustainability training aimed at health visitors can significantly contribute to the fulfillment of sustainability goals. As a result, after the achievement of the set Sustainable Development Goals, further, larger-scale advances can be expected.

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GLOBAL MINIMUM TAX FOR SUSTAINABLE DEVELOPMENT IN HUNGARY

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This paper seeks to offer a comprehensive background on global minimum tax rules as a critical element of sustainable tax policy and explore their impact on Hungarian tax law. A sustainable tax policy that considers variations in wealth and development among countries, as well as solidarity, is a crucial source of funding for sustainable development. In December 2022, EU Member States reached a consensus to implement the global minimum tax rules, referred to as Pillar 2 in the OECD's international tax reform. In this context, every EU Member State has pledged to incorporate the global minimum tax rules from the EU Directive into their national legislation by the end of 2023, with full implementation of its core components set to begin in 2024. Considering the aforementioned, the study focuses on the sustainability of the Hungarian tax system. Developing new tax legislation in this domain necessitates thorough evaluation and analysis to safeguard the country's tax revenue. It is equally important to identify an optimal solution that avoids imposing a substantial tax burden on the majority of businesses. As a result of this study, considering the specific conditions and challenges in Hungary, introducing a domestic minimum top-up tax emerges as a judicious and well-suited option. The implementation of global minimum tax rules could also serve as a long-awaited and effective tool in the fight against international tax evasion.

1. Introduction

Sustainable development essentially aims to achieve human development objectives without jeopardizing resources for future generations. A comprehensive review of this concept, its historical roots, and guiding principles can be found, for example, in Mensah (2019). The evolution of sustainable tax policy has been influenced by various entities, shaped through international dialogues, academic research, policy initiatives, and a growing acknowledgment of the need to harmonize economic, social, and environmental considerations in taxation. For more insights, we refer to the United Nations 2030 Agenda for Sustainable Development (UN, 2015), Johannesen (2022) on global minimum tax, and Khamphilavanh and Masui (2021) on the carbon tax.

While the well-being of offshore areas and low-tax countries relies on their favourable tax policies, it is essential to consider that this dependence can potentially undermine the tax base of other states. Sustainable tax policy, in this context, strives to address these complex dynamics by taking into account solidarity between generations, intra-generations, and among countries. This study examines tax policy changes in the past and the present years, focusing on the solidarity among countries. The global minimum tax, as an element of economic sustainability, has the potential to address tax avoidance, promote tax fairness, and generate revenue that can be invested in sustainable initiatives. This, in turn, contributes to the advancement of environmental and social justice, integral to the broader goals of environmental and social sustainability. Therefore, the study focuses on the global minimum tax as an innovative instrument of international tax cooperation, recognizing that sustainable tax policy encompasses a multitude of facets.

In recent years, global cooperation has intensified to counter tax evasion and tax avoidance by multinational corporations. As a result of the economic shocks caused by the coronavirus pandemic and the Russian-Ukrainian war, budget deficits and public debt have increased in many countries. The competition for tax bases has intensified even more in the world.

The extent of international companies' success in tax evasion and tax avoidance becomes evident through the striking statistic: an estimated loss of 427×10^9 USD/y for countries worldwide, as reported by the Tax Justice Network (Mansour, 2020). Moreover, the 2023 data (OECD, 2023a) from the Organization for Economic Cooperation and Development (OECD) reveals that base erosion and profit-shifting practices (BEPS) result in a loss of 240×10^9 USD/y for all countries worldwide, amounting to 10 % of global corporate income tax revenues.

In July 2013, the OECD introduced its 15-point Action Plan to combat international tax evasion (OECD, 2017). This plan against base erosion and profit shifting aimed to bring about significant changes in various areas. Within this context, the main subject of this paper, namely "Statement on a Two-Pillar Solution to Address the Tax Challenges Arising from the Digitalisation of the Economy" agreement, was adopted by the majority of OECD member states on July 1, 2021 (OECD/G20, 2021a). A total of 138 countries have shown their readiness to participate in an agreement (OECD/G20, 2021b) aimed at reshaping the global tax system. This agreement seeks to address the issue of corporate tax rate competition by implementing a global minimum tax rate across two pillars. Drawing from the OECD agreement and the corresponding European Union (EU) Directive, this research aims to elucidate the global minimum tax framework, with a specific focus on its implications for the Hungarian tax system. It is worth noting that the legislation for a global minimum tax in Hungary has not yet been fully determined. Consequently, the primary emphasis in this study is placed on exploring the potential regulations that may be applicable in Hungary.

2. Methodology

To demonstrate the applicability of global minimum tax rules in Hungary, this work primarily employs document and content analysis, historical analysis, and statistical source analysis as the methodology. In the first step, a comparison of corporate income tax rates across various countries is conducted, utilizing relevant databases for tax rate comparisons, such as those provided by the Tax Foundation. Hungary's current position in the global corporate tax competition is determined by the historical analysis and statistical source analysis of foreign direct investment. Secondly, the relevant background of the global minimum tax will be provided and discussed based on the OECD documents and EU law on this subject, using the method of literature searching and analyzing non-numerical data. This will be followed by a discussion of the fiscal effects of the global minimum tax with an analysis of estimated data. Interpretation of secondary data from the domestic and international tax consultancy firms (e.g., Niveus Consulting Group, PricewaterhouseCoopers Hungary) is performed in order to gain insights into the expected exposure of companies operating in Hungary. Finally, the forthcoming domestic global minimum tax rule will need to be integrated into the corporate income tax law. This requires understanding the existing legal framework and provisions. Therefore, the document analysis on global minimum tax and the current Hungarian tax law will be conducted.

3. Results and discussion

A concise historical overview, the main elements of the OECD Model Rules and the EU Directive, the fiscal effects of the global minimum tax, and finally, the case of Hungary are presented in the following subsections.

3.1. Historical overview

Tax competitiveness is defined as a country's tax competition ability, an ability to compete in international tax competition. The reduction in corporate tax rates is only one - perhaps the most typical - manifestation of the tax competition in the world. While in the 1980s, the average corporate income tax rate in the world was 40.11 %, and the corporate tax burden per GDP was 46.52 %, by 2022, the average tax rate had fallen to 23.37 %, and the tax burden per GDP to 25.43 % (Enache, 2022).

In Hungary, the corporate tax rate is 9 % from 2017. In the case of corporate tax, the calculated tax is not always the same as the amount of corporate income tax that is actually payable since there are several tax incentives available to businesses that can be used to reduce the amount of their calculated tax. Under the Corporate Tax Act (see Act on Corporate Tax and Dividend Tax), such tax reliefs include, for example, development tax relief, tax relief linked to support for spectacular team sports, to support for film production, and to investment or renovation for energy efficiency purposes. This is partly the reason for the steady increase in foreign direct investment since 2017. Their value increased from around 24×10^{12} HUF in 2017 to more than 34×10^{12} HUF in 2021 (HCSO, 2023).

An international survey conducted by Ernst & Young (2023) in the spring of 2023 asked 1,600 CFOs about the impact of the international tax changes of the OECD BEPS reform. 90 % of the decision-makers thought that the measures to prevent tax evasion by multinational companies would affect the operation of their company. However, only 30 % of them prepared an impact assessment.

3.2. OECD Model Rules and the European Union Directive

The EU strongly backs the OECD's global tax reform proposals and is dedicated to swiftly enacting them through EU legislation. The OECD "Statement on a Two-Pillar Solution to Address the Tax Challenges Arising from the Digitalisation of the Economy" is, as its name suggests, based on two "pillars". The OECD agreement applies to corporate income taxation and does not affect the burden on employees.

3.2.1 Pillar One

According to the first pillar, multinational companies should be taxed not only where they are headquartered but also in the countries where they actually operate. If a group of companies has a sales revenue of more than 20×10^{9} EUR according to its consolidated report compiled on the basis of international accounting standards and the proportional profit of the sales revenue exceeds 10 %, then the companies would have to pay a tax of 25 % on the excess (OECD/G20, 2021b). The proportion of taxable income in the affected countries would be calculated using a formula, and the tax would be redistributed among the participating countries. The revenue and profitability thresholds are very high. About 100 of the world's largest and most profitable international companies could be covered. Based on OECD calculations (OECD, 2022), "taxing rights on more than 125×10^{9} USD of profit is expected to be reallocated to market jurisdictions each y". International detailed rules for practical application are being developed.

3.2.2 Pillar Two

The global minimum tax rules are included in the second pillar published by the OECD in 2021. At the end of 2021, the European Commission proposed a related directive, and the December 2022 version was adopted by the EU Member States (EU Council, 2022). The EU Directive must be implemented into national law by the end of 2023. The personal scope of the global minimum tax directive extends to international companies operating in several states, whose annual consolidated sales exceed 750×10^{6} EUR, and whose ultimate parent company or one of its members operates in the territory of the European Union (Pkf.hu, 2022). Public administrations, international and non-profit organizations, and investment and pension funds do not fall within its scope.

However, the amount limit significantly narrows the scope of companies concerned in Hungary, for example, excluding the domestic small and medium-sized enterprise sector. According to the calculations of the tax consulting company, Békés Partners, the second pillar could potentially affect 2-3 thousand companies in Hungary, but this number is constantly changing (Békés et al., 2023).

The tax rate is determined by looking at the effective tax rate in each country. This is subject to the Global Anti-Base Erosion (GloBE) rules if the effective tax rate is below 15 %, see Pillar 2 (EU Council, 2021). These rules are mainly described therein, including the **Income Inclusion Rule** (IIR) and the **Under Taxed Payments Rule** (UTPR) to be introduced in the national tax legislation and the **Subject to Tax Rule** (STTR) in the treaty-based rule. For completeness, a short description of these rules will be provided in the following.

Income Inclusion Rule and Under Taxed Payments Rule

The GloBE model rules are formed by the Income Inclusion Rule and the Under Taxed Payments Rule. These rules are used to collect additional tax whenever the effective corporate income tax rate of an international company in a jurisdiction is below 15 %.

Under the Income Inclusion Rule, if the effective tax burden of an EU subsidiary is less than 15 %, the difference is first collected by the country of the parent company resident in an EU Member State. The IIR applies on a top-down basis, whereby it is applied by the entity, usually the ultimate parent company at or near the top of the ownership chain of the multinational enterprise group (EU Council, 2021). In this case, the country with the lower tax burden loses tax revenue.

An option is a domestic top-up tax: If the tax burden in one country is below the minimum required, the country with the lower tax can introduce new rules for the concerned taxpayers to pay the difference. In this way, the country applying the lower tax rate collects the resulting difference (Gombkötő and Szimler, 2022).

The country of the subsidiary may also decide to increase its own corporate tax rate uniformly to 15 %. This solution avoids extensive tax legislation revision. Thus, the tax no longer flows into the jurisdiction of the parent company, but the affiliate country itself benefits from the higher tax revenue generated by the higher tax rate.

The other national tax rule is the Under Taxed Payments Rule. It applies in situations where the ultimate parent company is located in a low-tax third-country jurisdiction, and there is no recognized Income Inclusion Rule in the jurisdiction. The UTPR assigns the additional tax to the jurisdictions of the EU Member States based on a two-factor formula: the book value of tangible assets registered in the given jurisdiction and the number of employees in the jurisdiction (EU Council, 2021). Therefore, the EU Member States have accepted that the individual EU subsidiaries collect the unpaid tax difference from the members operating in their territory as an additional tax.

As a relief, a regulation has been incorporated to take into account the substance-based carve-out of activities that are actually asset-intensive and labor-intensive. Based on the rule, the tax base will be reduced by 5 % of tangible assets and wage costs after a 10 y transitional, more advantageous period. The more assets and the more staff a subsidiary has, the less it will be affected by the global minimum tax (Bagdi, 2023).

There are also exemption rules from paying the global minimum tax: According to the EU Directive (EU Council, 2022), the company groups do not have to pay such a tax if they have an average revenue of less than 10^7 EUR and an average income or loss less than 10^6 EUR in a jurisdiction.

Subject to Tax Rule

The STTR is a treaty-based rule that allows a limited withholding tax to be levied. This measure will be enacted bilaterally and is not affected by the EU proposal (EU Council, 2021).

3.3. Fiscal effects

Taxation is one of the resources for financing sustainable development. Based on a World Bank analysis (Keen et al., 2023), the global minimum tax does not reduce foreign affiliate investments; rather, an increase is expected (nearly 30 %). Casella and Souillard (2022) examined the effect of Pillar Two on the taxes paid by multinational enterprises on foreign direct investment income. They calculate an increase in the corporate income tax liability for multinational enterprises between 14 and 20 %. According to OECD data published in January 2023, the proposed global minimum tax is estimated to raise approximately 220×10^9 USD in annual global revenue, equivalent to 9 % of global corporate tax revenue (OECD, 2023b). The International Monetary Fund also prepared an impact study (IMF, 2023). On the basis of their simulation, 18.5 % of the global profits of international companies are taxed below 15 %. They assume that the second pillar would increase global corporate tax revenues by nearly 6 %. Baraké et al. (2022) examined the fiscal revenue effects of the global minimum tax. According to their calculations, the EU can expect a total tax revenue of 55×10^9 EUR/y. In Hungary, in 2022, the amount of corporate income tax paid to the state budget was $746{,}59\times10^9$ HUF (Cdn.

kormany.hu, 2022). For 2023, the government expects revenues of approximately 10^{12} HUF (Government of Hungary, 2023). By 2024, corporate tax revenues of $1{,}153 \times 10^{12}$ HUF are already foreseen (Prime Minister's Office Hungary, 2023). It is likely that the global minimum tax was also expected to increase budget revenue.

3.4. Introduction of GloBE in Hungary

As a small and developing country, Hungary is trying to attract investment by lower costs. The tax system and tax rates are adapted to the level of economic development and the size of the economy. The tax competition has pushed the country to reduce some of its tax rates. For a long time, Hungary's tax policy has relied on consumption taxes instead of taxes on labor income. The value-added tax, with its standard tax rate of 27 %, is exceptionally high worldwide (Global VAT Compliance, 2023). However, the current corporate income tax rate of 9 % is internationally competitive and is considered the lowest in the European Union. The effective corporate income tax burden of the largest German companies (Audi, BMW, Mercedes, Siemens, Bosch, Knorr-Bremse, etc.) operating in Hungary was analyzed by the research of the Niveus Consulting Group (Bagdi, 2023). The average effective corporate income tax rate of the examined companies barely reached 3 % as a result of various legal tax benefits.

The introduction of the global minimum tax would not necessarily imply a general increase in the corporate tax rate in Hungary up to 15 %, but the country can use the option of introducing a domestic top-up tax. This would ensure that only multinational companies subject to international regulation would fall within the scope of the 15 % effective tax rate.

In this context, the system of corporate tax benefits needs to be reconsidered as it reduces the tax payable, lowering the effective tax rate. Miavecz (2023) concludes that the development tax credit will have to be paid in the form of a top-up tax, similar to other tax credits under the Corporate Tax and Dividend Tax Act.

It is also conceivable that in order to support investments, there will be a shift from fiscal to financial incentives.

A fundamental issue in the GloBE calculation is the range of taxes that can be included in the effective tax burden. For example, municipal taxes play an important role in the Hungarian tax system. According to the European Union agreement, the local business tax is taken into account in Hungary, so it will be included in the covered taxes. Under the Act on Local Taxes, its maximum tax rate is 2 %, and the tax base is different from the corporate income tax base. Based on the analysis of the Niveus Consulting Group, in many cases, the tax liability of companies is pushed above the 15 % tax rate in the effective tax burden (Bagdi, 2023). According to the calculations of the State Secretariat for Tax Affairs (Infostart.hu, 2021), the agreement will not lead to an increase in the tax burden for the majority of companies. This is because the minimum effective tax rate applies to corporate tax and local business tax together, and the substance-based carve-out brings relief for many businesses. 15-20 % of businesses subject to the global minimum tax could face additional tax liabilities. However, both the concerned companies and the tax authority will add more reporting obligations under the new rules.

PricewaterhouseCoopers Hungary conducts an annual survey of Hungarian business leaders on the trends shaping business (PwC, 2022). This survey of nearly 300 executives in Hungary for the year 2022 revealed that the introduction of the global minimum tax is not a concern for many CEOs. Almost half of the company managers did not take any measures to prepare for the changes, while only 19 % believed that the new rules would not affect their company. It can be assumed that changes in these thought-provoking data will be boosted by the introduction of specific tax legislation.

4. Conclusions

Taxation has become a determining topic of the world economy nowadays. Fight against tax avoidance is an important policy goal, and the global minimum tax regulation as an element of the sustainable tax policy can be one of the tools for this. Governments are currently drawing up implementation plans, and the OECD agreement will be enacted into law. However, we consider it a future problem that uniform tax legislation must be applied in countries with different resources and opportunities and with different economic and

social development. In addition, currently, different tax systems operate in each country, with various tax benefits, and the tax base is defined differently. Based on this study, it is concluded that countries with a low corporate income tax rate may lose a part of their investment attractiveness by the introduction of the global minimum tax. Therefore, they need to rethink their rules. Hungary is one of these countries. On the one hand, it must take into account the protection of its tax revenues. On the other hand, it is necessary to have the development of solutions that does not result in a significant increase in the tax burden and administrative burden for the majority of businesses operating in its territory. What can be a rational solution? In this study, the possible solutions were investigated with the help of the existing legal background. Via the proposed methodology and the following thorough discussion, it is concluded that in the Hungarian corporate tax regulation - especially for small and medium-sized enterprises - it is advisable to maintain the 9 % tax rate. Further, for taxing the businesses affected by the GloBE, the domestic top-up tax plays a role as well. The substance-based carve-out rule may even encourage the expansion of real economic activities. As it reduces the effective tax burden, the system of tax incentives to encourage investment needs to be reconsidered. The role of subsidies based on individual government decisions is expected to increase. Due to time constraints, a preparation strategy at the company level turns out to be necessary. Further, the involved complexity of the calculation (e.g. GloBE income, covered taxes) will result in increased administrative work and cost.

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DETECTING ANOMALIES IN THE FM FREQUENCY BAND USING STATISTICAL METHODS

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Based on Act C of 2003 on electronic communications, in Hungary, the National Media and Infocommunications Authority is responsible for ensuring harmful interference-free frequency usage and electromagnetic compatibility. Continuous measurements are conducted nationwide in order to reach this goal, but the evaluation and analysis of anomalies are time-consuming.

This research focuses on the detection of anomalies in the FM radio frequency spectrum. Within that, the study was concerned with the outages of radio transmission and the outages of modulation. The goal of this study is to automate the detection process, providing real-time alerts for potential anomalies and saving valuable time for spectrum monitoring engineers.

In order to solve the problem, statistical learning was used, including classification algorithms. Comparing the following algorithms: k nearest neighbor classification method, logistic regression, linear discriminant analysis, quadratic discriminant analysis, naive Bayes classification, support vector machines, and random forests. The most efficient method for this is Support Vector Machines, which can identify the phenomena with 93.28 % accuracy.

Statistical machine learning is highly efficient at identifying known phenomena in spectrum monitoring and generating real-time alerts. Alerts can be generated within a minute, effectively providing real-time information.

1. Introduction

In the field of infocommunication, establishing uninterrupted communication is of critical importance and falls under the jurisdiction of the National Media and Infocommunications Authority (NMHH). The NMHH is responsible for frequency allocation and regularly announces calls for frequency tenders. The winner of such a tender, who obtains the allocated frequency, is obligated to utilize it. It is essential to continuously monitor and maintain the assigned frequency, as NMHH is responsible for the harmful interference-free frequency.

The NMHH (National Media and Infocommunications Authority, 2015) provides rules for governing broadcasting. This decree specifies the distribution of national frequency bands and governs frequency usage. Radio broadcasting (FM) takes place between 87.5 MHz and 108 MHz in the VHF band, and in this thesis, FM broadcasting was exclusively discussed. The national frequency allocation and the guidelines for the use of frequency bands, as outlined in the 7/2015 (XI. 13.) NMHH decree (NFFF), are visualized and managed using the software named STIR.

Previous research has been conducted on the topic, where the spectrum is treated as time series (Yokkampon et al., 2020). Based on these studies, it can be concluded that treating the spectrum as time series leads to more efficient anomaly detection. There were times when the spectrum was monitored in time using a

sliding window solution, and then machine learning was applied (Peng et al., 2022). The radio spectrum is extensive and diverse, making it unclear what type of anomaly detection we would like to perform, as there are known phenomena that occur regularly, as well as isolated occurrences that may not be repeated. Therefore, it is crucial to precisely define the type of anomaly we want to detect to determine whether supervised or unsupervised learning should be employed.

Articles have been published regarding the application of unsupervised machine learning. Since labeling is exceptionally challenging, in most cases, it is easier to train on good samples and request alerts for deviations. An example is the article "Unsupervised Wireless Spectrum Anomaly Detection with Interpretable Features," which achieves 80 % accuracy in anomaly detection and provides only a 1 % false alarm rate in the system (Rajendran et al., 2019). AnoFSTSCNN approach has already been proposed in a published article. An alternative for radio monitoring and spectrum anomaly detection, the AnoFSTSCNN's performance was confirmed on a simulated data set, and it was demonstrated that the accuracy is significantly higher than that of the ST- and STFT-based techniques (Wang et al., 2022).

Nowadays, in the field of spectrum monitoring, there are measurements running all the time, which engineers evaluate days later. To simplify the workflow and to achieve real anomaly detection, it is advisable to improve the current unsupervised methods. Since some of the detected anomalies are recurrent, supervised machine-learning algorithms can be applied.

During the current research, the study focused on identifying two anomalies: radio transmission interruption and radio broadcast modulation shutdown. As these are well-distinguished phenomena, they cannot be considered classical anomaly detection cases. Therefore, supervised machine learning methods were employed in this study.

The **transmission outage** phenomenon occurs when a radio program abruptly terminates. This behavior is depicted in Figure 1, where the color change signifies a high electric field strength represented in the figure, which then rapidly diminishes beyond a certain point. The color intensity and electric field strength will increase again after a predefined period of time when the transmission resumes.

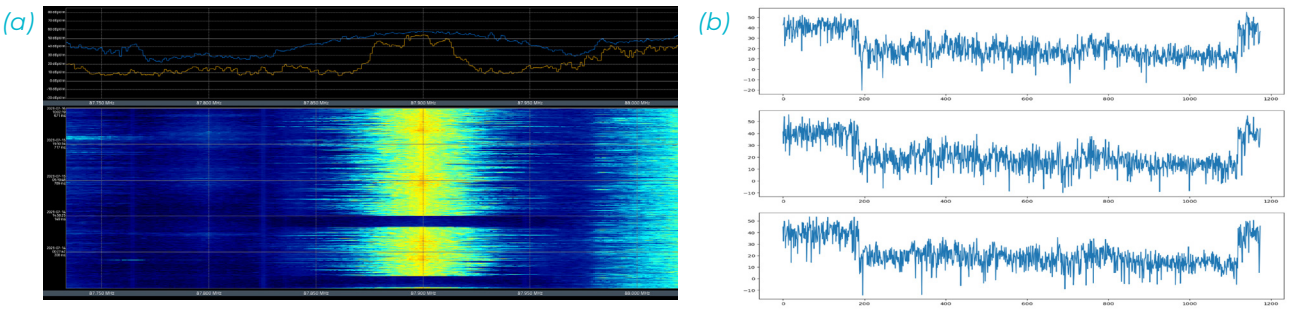

Figure 1: Radio transmission outages. a) Spectrogram about radio transmission outages. The x-axis is the frequency, y-axis is the time, and the color represents the magnitude of the electric field strength. b) A time series of outages. x-axis is the time, y-axis is the electric field strength value of the signal

Modulation outages is the other phenomenon under study, as depicted in Figure 3. A sinusoidal signal can carry information thanks to various modulation techniques. The three essential components of a sinusoidal signal—amplitude, phase, and frequency—can all be modulated. When modulation is stopped, the carrier frequency and the subcarriers are also discernible.

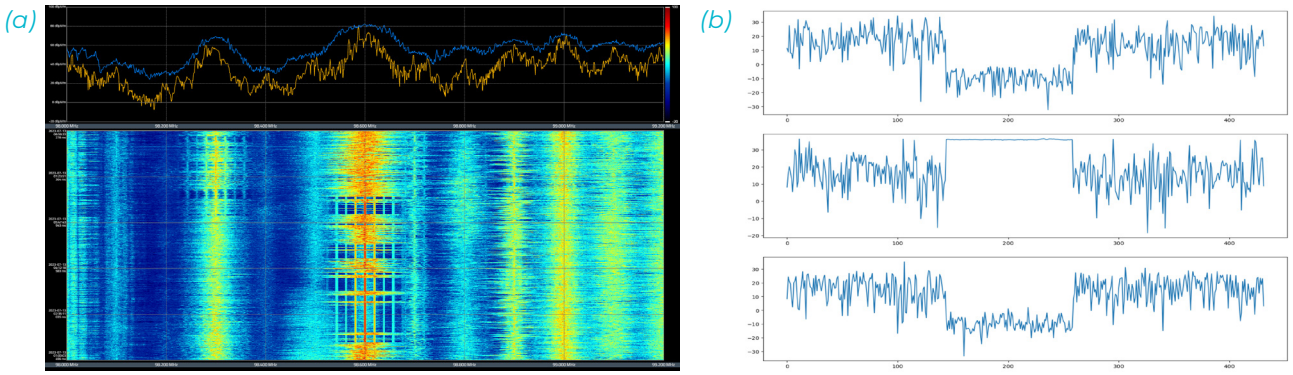

Figure 2: Modulation outages. a) Spectrogram about modulation outages. The x-axis is the frequency, the y-axis is the time, and the color represents the magnitude of the electric field strength. b) A time series of modulation outages; the x-axis is the time, and the y-axis is the electric field strength value of the signal.

The aim of the results is to develop a supervised machine learning-based signaling system compatible with the national spectral monitoring network used in Hungary. To implement the training, statistical machine learning will be used. Different algorithms will be applied and compared to determine which one yields the most accurate results.

2. Technology prospection and technology roadmap

Two hypotheses will be proven, which are:

- Supervised machine learning (only for known phenomena) can be used to develop much more efficient programs than unsupervised anomaly detection programs.
- The program can replace some of the engineering work, saving considerable time for the National Media and Communications Authority's staff.

In the following, several statistical-based classification methods have been used. Initially, a database was created, followed by a correlation-based analysis. After that, several algorithms were used to classify the phenomena. Finally, the accuracy of the algorithms was compared.

As presented in Table 1, the dataset was manually compiled, encompassing seven electric field intensity values and one label for each time event. The rows in the dataset represent various time periods with a precision of 25 seconds. The third column corresponds to the field strength measured at the intermediate frequency (IF), while the subsequent columns represent electric field intensity values measured at frequencies spaced 1 kHz apart from the IF. Each of these field strength values serves as a valid measure to characterize the particular transmission since it operates at a frequency of 150 kHz, which is typical for FM transmissions. The provided labels describe the specific activities that occurred during the respective radio transmission at a given time (Takács, 2023).

Table 1: Input data set, mixed (Takács, 2023)

0	1	2	3 (IF)	4	5	6	Class
-0.04	11.66	13.66	11.36	9.06	-1.03	9.77	switch-off
40.86	53.26	55.66	49.06	28.66	9.07	9.77	modulation switch-off
13.63	15.73	12.83	11.23	14.23	16.73	13.23	nothing
34.96	27.06	27.86	32.06	27.96	33.27	38.77	nothing
-13.67	-6.37	-10.67	-7.37	-12.97	-16.47	-14.77	switch-off

3. Application of supervised machine learning for anomaly detection

Data analysis was performed on the prepared dataset presented above. First, the correlation was examined. The purpose of correlation analysis is to find out which statistical learning algorithms can be applied. Then, statistical machine learning algorithms were trained with the dataset.

3.1. Correlation-based analysis

In the initial step, correlation analysis was conducted by examining the correlations between vectors constructed from the electric field intensities in each row. This analysis was performed within identical classes and across different classes. The average correlations are presented in Table 2. Based on these findings, it is evident that only the modulation switch-off exhibited strong correlations, rendering correlation-based discrimination inapplicable for the other two cases. The visual representation of this observation is shown in Figure 3, where the x-axis represents the correlation values and the y-axis denotes their corresponding frequencies. The figure exclusively focuses on correlations within the same group.

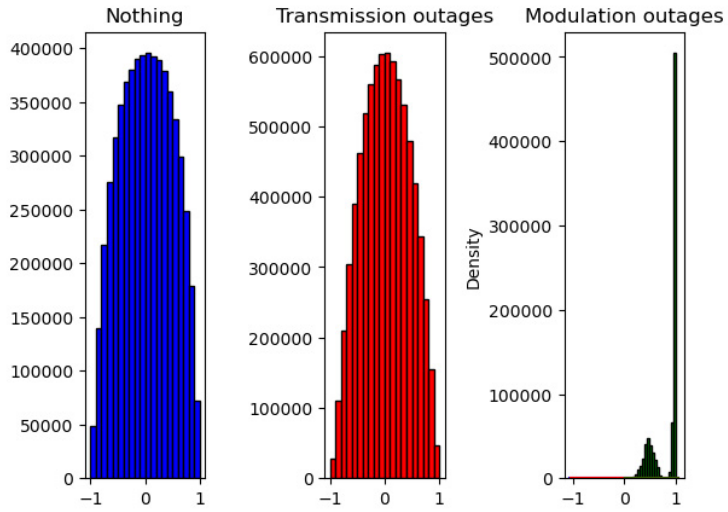

Figure 3: A visual representation of the variance of correlation between the same classes

Table 2: Size of correlation on average between classes

	Radio transmission outages	Modulation outages	Nothing
Radio transmission outages	0.01728	0.11547	0.01496
Modulation outages	0.11547	0.89382	0.12291
Nothing	0.01496	0.12291	0.03970

3.2. Statistical learning and application

k Nearest Neighbors classification method (kNN): The fundamental principle of k-nearest neighbors (kNN) is to compare vectors containing electric field intensities and determine, using the Euclidean distance, which class the newly arrived data belongs to (Hastie et al., 2009). For this purpose, the following equation is used:

$$\hat{Y}(x) = \frac{1}{k} \sum_{x_i \in N_k(x)} y_i \tag{1}$$

where $N_k(x)$ is the neighborhood of x defined by the k closest points x_i in the training sample. We locate the k observations in the input space with x_i closest to x and we average their results.

When using 9 nearest neighbors for cross-validation, the obtained values are as follows:

[0.641079 0.744813 0.565398 0.766089 0.844982 0.781314]

Based on the k-nearest neighbors (kNN) method and using 9 nearest neighbors for cross-validation, the best-achieved result is 84.5 %.

Logistic regression: The essence of logistic regression is to model the relationship between the dependent variable (output variable), and the independent variables using a linear association and then transform this linear relationship with a non-linear logistic function (Alpaydin, 2020).

$$P(y = 1|x) = \frac{1}{1 + e^{-(\beta_0+\beta_1 x_1+\beta_2 x_2+\cdots+\beta_n x_n)}} \quad (2)$$

where:

- $P(y = 1|x)$ is the probability of the dependent variable (output variable), y being 1 given the input variables x.
- $\beta_0, \beta_1, \beta_2, \cdots, \beta_n$ are the regression coefficients (model parameters).
- $x_1, x_2, \cdots, x_n$ are the values of the independent variables (input variables).

The following values were obtained for logistic regression:

[0.548409 0.679115 0.759169 0.610381 0.683737 0.912111]

Based on the logistic regression for cross-validation, the best-achieved result is 91.2 %.

Linear discriminant analysis (LDA): LDA is a statistical technique used to discern a linear combination of features that can effectively discriminate between two or more groups of entities or events. The resultant linear combination can be utilized as a linear classifier, or more commonly, to reduce the dimensionality of the data before applying a subsequent classification algorithm. LDA assumes that the distributions within each class possess equal covariance matrices, and adhere to multivariate normal distributions (Ghojogh and Crowley, 2019).

The following values were obtained for LDA:

[0.580221 0.674965 0.697578 0.633218 0.710035 0.901730]

Based on the linear discriminant analysis for cross-validation, the best-achieved result is 90.2 %.

Quadratic discriminant analysis (QDA): QDA is a discriminant method that differs from LDA in its assumption of unequal covariance matrices between classes. Unlike LDA, QDA allows for the consideration of more general covariance matrices for each class. This flexibility allows QDA to handle situations where the data within different classes exhibit varying levels of variability and correlation patterns, making it a powerful tool for classification tasks when the assumption of equal covariance matrices is not valid. By accounting for these distinct covariance structures, QDA can provide more accurate and precise discrimination between groups of entities or events (Ghojogh and Crowley, 2019). The following values were obtained for QDA:

[0.544260 0.706086 0.687197 0.729412 0.880277 0.914187]

Based on the quadratic discriminant analysis for cross-validation, the best-achieved result is 91.4 %.

Naive Bayes classification: In statistics, naive Bayes classifiers belong to a category of simple "probabilis-

tic classifiers" that utilize the Bayes theorem by making strong (naive) independence assumptions between the features. These classifiers merge the Bayes probability model with a decision rule (Kotsiantis, 2013). A common rule is to select the hypothesis that has the highest probability of minimizing the chances of misclassification; this is known as the maximum a posteriori or MAP decision rule (Russell and Norvig, 2005). The corresponding classifier, known as the Bayes classifier, is a function that assigns a class label $\hat{y} = C_k$ for some k, as follows: $\hat{y} = argmax \prod_{i=1} p(x_i \mid C_k)$ (Hart et al., 2000).

The following values were obtained for Naive Bayes classification:

[0.517981 0.673582 0.679585 0.606920 0.477509 0.845675]

Based on the Naive Bayes classification for cross-validation, the best-achieved result is 84.6 %.

Support Vector Machines (SVM): This method works by finding the optimal hyperplane that best separates different classes in the feature space, maximizing the margin between them. SVM's decision boundary is determined by a subset of the training data points, called support vectors, which play a crucial role in defining the optimal separation.

The following values were obtained for SVC:

[0.533195 0.706086 0.555709 0.768858 0.932872 0.773010]

Based on the support vector machines for cross-validation, the best-achieved result is 77.3 %.

Random forest: This method constructs multiple decision trees during training and aggregates their predictions through a voting or averaging mechanism to make final predictions. The key feature of Random Forest is its use of random sampling of both the training data and the features, which introduces diversity among the individual trees and helps to reduce overfitting. Due to its ability to handle high-dimensional data and its robustness against noise and outliers, Random Forest has gained popularity in various domains.

The following values were obtained for Random Forest:

[0.671508 0.769709 0.541176 0.755017 0.831834 0.802076]

Based on Random Forest for cross-validation, the best-achieved result is 83.1 %.

4. Comparison of methods

In statistical learning, cross-validation was employed, which provided six numerical values for each method. Based on these values, the average was examined, and the best achievable value with the method was also considered. Table 3. summarises the results.

Table 3: Spectrum-monitored radio transmitter outages and modulation outages using different statistical learning methods and their accuracy

Method	k Nearest Neighbours classification method	Logistic regression	Linear discriminant analysis	Quadratic discriminant analysis	Naive Bayes classification	Support vector machines	Random Forest
Mean Accuracy	0.72395	0.69882	0.69962	0.74357	0.63354	0.71162	0.72855
Max Accuracy	0.84498	0.91211	0.90173	0.91418	0.84567	0.93287	0.83183

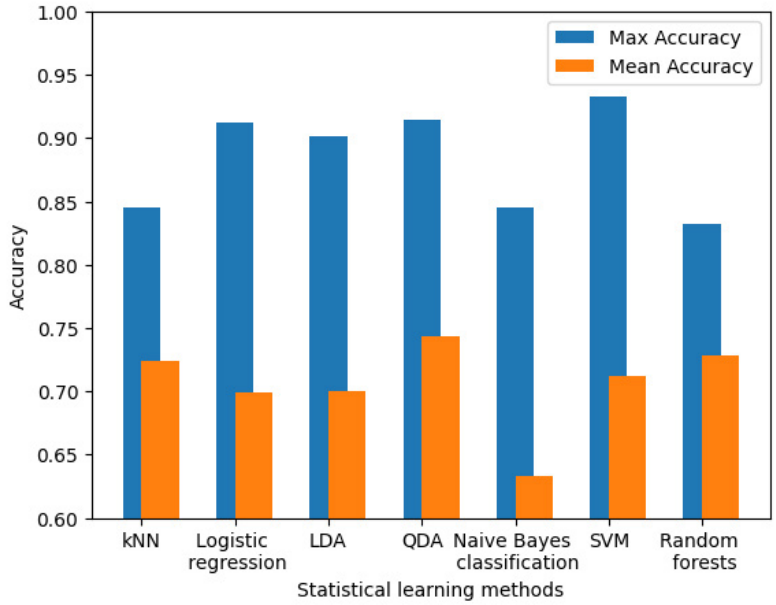

Figure 4: Comparison of statistical learning algorithms based on average and maximum accuracy

Based on these observations, it can be concluded that, on average, the Quadratic discriminant analysis method yields the best results, while the maximum achievement is attainable through the use of Support vector machines.

5. Conclusions

During the research, statistical learning was applied (supervised machine learning) to detect anomalies in the spectrum, specifically radio transmission outages and modulation outages. Supervised machine learning was chosen because these phenomena are distinguishable from each other. For each time point, electric field strength values were associated with the intermediate frequency of radio transmission. The average accuracy of the methods was above 60 %, with some cases achieving an average accuracy of over 70 %. For certain methods, the maximum accuracy after cross-validation has exceeded 90 %. As a result of the study, the best method for solving this problem is SVM, with an accuracy of 93.28 %. The detection can be further improved by treating incoming signals as time series instead of predicting individual time points.

In summary, statistical machine learning can be highly effective in identifying known phenomena in the field of spectrum monitoring, thus creating real-time alerts. The most efficient method for this is the Support Vector Machines, which can identify the phenomena with 93.28 % accuracy. As each phenomenon exhibits for a longer period of time, if the alarm is not triggered on the first anomaly detection, instead it triggers after a certain number of consecutive identical predictions, we achieve a reasonably accurate quasi-real-time signal, in which false alarms can be minimized.

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USE OF AI IN OPERATIONAL TECHNOLOGY NETWORKS AND PACKET-BASED ATTACKS DETECTION

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This research is focused on cybersecurity, including the detection of packet-based attacks. We collected a large amount of data by creating Honeypots and hosting them on virtualised private servers (VPS) with open IP addresses. The acquired data was analysed using different deep learning methods, such as Long Short-Term Memory (LSTM) and one-dimensional convolutional neural network techniques. These algorithms were used to compare the measurements with currently used packet analysis techniques, resulting in the identification and development of the most efficient packet analysis procedure. Additionally, we conducted regression tests in isolated and simulated environments using the attack mechanisms that had already been detected. Once the packet analysis concept was developed, our goal was to improve a classification algorithm. The construction of a penalty decision algorithm was crucial. We also conducted extensive regression testing of the concept from various perspectives. Upon completion of our investigation, it was discovered that natural and statistically-based language models can identify cyber-attacks. Statistical models that better fitted were SVC, Logistic, and Naive Bayes, with a 69 % accuracy for packet-based attack detection.

1. Introduction

The Operational Technology (OT) network connection is used for production devices such as robots, transfer bands, pumps, packaging machines, and other similar devices. The machines are usually controlled by PLCs, and they use this network to communicate with each other.

A packet-based attack involves altering data streams to trigger harmful actions. The primary motive behind this procedure is achieving economic gain. The cyberattack, from a process engineering perspective, has the potential to result in particularly intricate failures that could potentially impede the operations of production machines, produce defective products, or even result in the complete shutdown of production. Nowadays, it's not uncommon for these attacks to affect entire manufacturing establishments.

Our literature review, focusing on articles published between 2021 and 2023, revealed a significant increase in the amount of scientific research on cybersecurity topics in OT networks. For example, an article (Aljabri, 2021) points to the importance of cyber defence and its escalation. This trend has also increased in the world of IoT (Kuzlu, 2021). The previous two studies are confirmed by a third one (Saharkizan, 2020). All three authors analyse the potential of artificial intelligence for cyber security. However, our goal is to apply pre-trained artificial intelligence to microcontrollers in the near future. Therefore, we decided to implement a TCP/IP network structure with a minimal number of clients.

Consider a Modbus TCP/IP network topology as an example. A data packet is sent to each peripheral. When searching for a failure or anomaly, these packets must be analysed to find the root cause of the problem.

This analysis is usually done manually by humans (e.g., in Wireshark or Tshark software), which adds an additional source of error.

The identification of the source and destination of packets on OT networks is accomplished by labelling them with IP addresses. Since a large number of clients share a common OT network, data streams could be generated every nanosecond.

The increased number of peripherals in OT networks makes the analysis of packets in real-time difficult or impossible. The speed of communication has also increased. Packets are now arriving on a given bus in real-time at nanosecond intervals. For the reasons above, data packets are rarely analysed in real-time on OT networks.

Because of the packet-based attacks, real-time analysis is a necessity (in OT or industrial systems networks). It can help to detect cyber-attacks and other failures. Combined with artificial intelligence, it could even be predictive.

A non-standard data stream can be interpreted as an attack. This allows us to intervene almost immediately, even at the initial stage of the attack. This can prevent significant financial damage.

This research focuses on finding attacks in network data, specifically looking at data packets from network traffic.

The main question addressed in this study is the performance of different artificial intelligence subfields (statistical learning and deep learning models) in packet analysis tasks.

2. Methodology

The main protocol in industrial systems is Modbus TCP/P. Modbus is a communication channel in industrial systems, much like a wired network at home. TCP is a communication protocol that ensures communication stability between sender and receiver. The IP indicates that packets are addressed using Internet protocol.

In a Modbus TCP/IP communication, a request must be answered with a response. A practical example would be that a PLC sends a packet to a peripheral and waits for a response according to the protocol. If the request cannot be interpreted, the server sends an exception, which can be a cause for a system error. These exceptions can indicate attacks. Figure 1 shows a request and an exception. An exception has two codes (Function code and exception code).

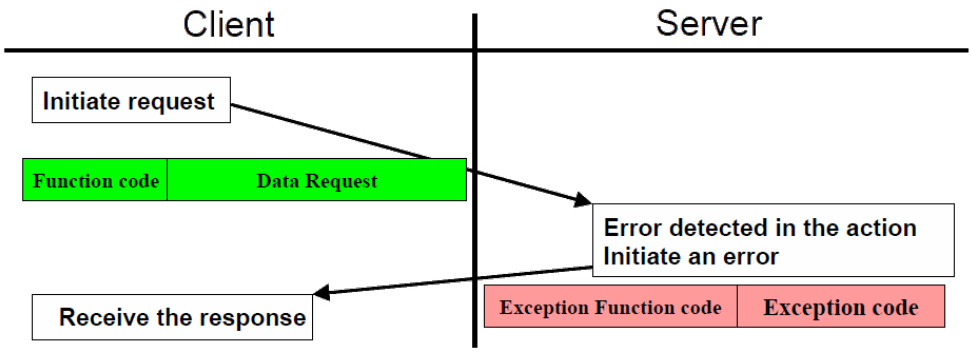

Figure 1: Modbus TCP protocol with an exception

For the simulated attack, a diverse real-world data set scenario had to be created together with a virtual environment. The structure of this environment is illustrated in Figure 2.

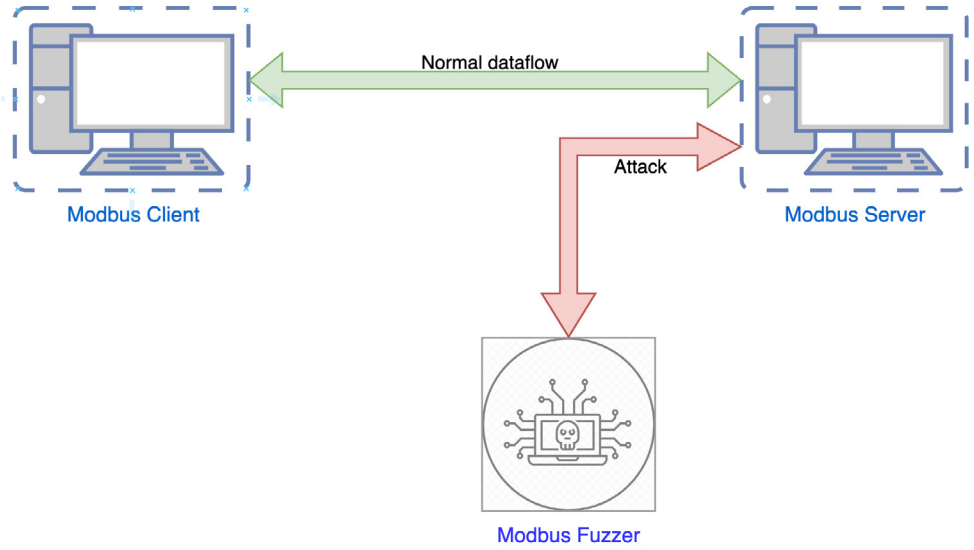

Figure 2: The theoretical construction of a simulated data acquisition environment

We used three virtual machines with standard Modbus Server/Client communication. A fuzzer was used in addition between the two devices. So, the third virtual machine was allocated to the fuzzer. Fuzzers are generally used for examining and testing applications/protocols. Fuzzers can be used to discover vulnerabilities and weaknesses in applications, making the implementation process easier. Therefore, signs of fuzzer usage should be monitored in an industrial network.

Our attack technique employs the Fuzzer to essentially flood the Modbus server with large amounts of data, resulting in little to no communication resources left on the client side. The impact of this suboptimal execution on the environment is that the peripherals controlled by the Client slow down or stop altogether. 430,918 unique packets have been generated for the simulation, from which 133,995 packets were part of the attack. During the attack mechanism, we conducted a comprehensive monitoring of the system processes by utilising the network packet analyser software, Wireshark. Additionally, the data streams were archived for each peripheral. We have labelled the individual packets of the complete data array for artificial intelligence (AI). Afterwards, we split this dataset into two parts, using an approximate 75 % - 25 % ratio, where the larger portion was used for the training method and the smaller portion for validation.

Following the pre-processing of the data, we employed two approaches for machine learning. Initially, we used statistical-based learning, and subsequently, we utilised a neural network, specifically a language model. In the case of statistical learning, we also applied Cross-validation, which provided six values for each model. We took into consideration the maximum value and the average of these values.

Figure 3 shows the dataset created. The dataset contains six columns, which are:

- Source – the source of the package
- Destination – the destination of the package
- Protocol – the protocol used to send the packets.
- Length – length of the package
- Info – other information about the package.
- IsAttack? – It shows whether the packet is an attack or not. 0 indicates no attack, while 1 indicates an attack.

	Source	Destination	Protocol	Length	Info	IsAttack?
0	PcsCompu_22:46:4f	Broadcast	ARP	60	Who has 192.168.56.113? Tell 192.168.56.114	0
1	PcsCompu_75:69:b0	PcsCompu_22:46:4f	ARP	42	192.168.56.113 is at 08:00:27:75:69:b0	0
2	192.168.56.114	192.168.56.113	TCP	74	36610 > 502 [SYN] Seq=0 Win=64240 Len=0 MSS=...	0
3	192.168.56.113	192.168.56.114	TCP	74	502 > 36610 [SYN, ACK] Seq=0 Ack=1 Win=65160...	0
4	192.168.56.114	192.168.56.113	TCP	66	36610 > 502 [ACK] Seq=1 Ack=1 Win=64256 Len=...	0
...	...	...	...	...	...	...
430913	13.229.250.8	192.168.56.113	TCP	54	1234 > 502 [SYN] Seq=0 Win=8192 Len=0	1
430914	224.168.77.124	192.168.56.113	TCP	54	1234 > 502 [SYN] Seq=0 Win=8192 Len=0	1
430915	130.136.216.64	192.168.56.113	TCP	54	1234 > 502 [SYN] Seq=0 Win=8192 Len=0	1
430916	82.246.78.254	192.168.56.113	TCP	54	1234 > 502 [SYN] Seq=0 Win=8192 Len=0	1
430917	139.102.116.152	192.168.56.113	TCP	54	1234 > 502 [SYN] Seq=0 Win=8192 Len=0	1

430918 rows × 6 columns

Figure 3: The prepared dataset

2.1. Using statistical learning

The focus of the article is on statistical learning methods. During the investigation, various statistical algorithms were applied, such as linear regression (Alpaydin, 2020), logistic regression (Russell and Norvig, 2005), k Nearest Neighbors (kNN) (Hastie et al., 2009), linear discriminant analysis (LDA) (Ghojogh and Crowley, 2019), quadratic discriminant analysis (QDA) (Ghojogh and Crowley, 2019), support vector machines (SVC) (Siegelmann and Vapnik, 2001), naive Bayes (Duda , 2001), and random forest (Breiman, Cutler, 2001).

2.2. Natural Language Processing

After the statistical-based machine learning, we switched to a different approach, where we employed deep learning techniques. Among these techniques, we utilised a language model, which posed several challenges, one of which was that the artificially generated dataset was not always suitable for training such models. As a result, we decided to use the same data as during the statistical learning.

To achieve this, we applied two different language learning models: the Long Short-Term Memory (LSTM) model (Bayer, 2015) and the 1D Convolutional model. We prepared the dataset by combining the 'Source IP', 'Destination IP', 'Protocol', and 'Length' attributes into a single string and labelled the rows to indicate whether they were considered attacks or not. The newly created dataset consists of two columns: one containing the mentioned attributes ('data'), and the other indicating whether the corresponding row is an attack or not ('IsAttack?'). The structure of the finalised dataset is shown in Table 1.

Table 1: The new dataset

Data				IsAttack?
Source IP	Destination IP	Protocol	Length	(0 = No attack,1 = Attack)
210.11.140.185	192.168.56.113	TCP	54	1
14.221.153.215	192.168.56.113	TCP	54	1
176.137.215.247	192.168.56.113	TCP	54	1
88.64.227.9 192	192.168.56.113	TCP	60	0
3.156.6.135 192	192.168.56.113	TCP	60	0

3. Result and analysis

After pre-processing the dataset, we applied word-based tokenization on the 'data' column and created embeddings to construct the training dataset, which could be processed by the language models.

3.1. Using statistics learning

In statistics-based learning, running the learning, validation methods produced the results shown in Table 2.

Table 2: Accuracy of statistical learning algorithms

Models	Accuracy score
Linear regression	0.443869
Logistic regression	69.04627
kNN(k Nearest Neighbors)	31.23024
Linear Discriminant Analysis	68.80032
Quadratic Discriminant Analysis	68.75143
Support Vector Machine	69.04627
Naive Bayes	69.04627
Random Forest	46.13880

Figure 4 illustrates the results achieved by different algorithms. The kNN algorithm demonstrated the lowest performance, which could be due to the encoding process. After creating a mapping during the process, we formed a library that contained all IP addresses and protocols, which we used to establish the training database based on the encoded table. However, due to the occurrence order, the information was lost. In Figure 4b, we can observe the same comparison without the kNN and random forest algorithms. It becomes evident that the SVC, logistic regression, and naive Bayes algorithms yielded the best results.

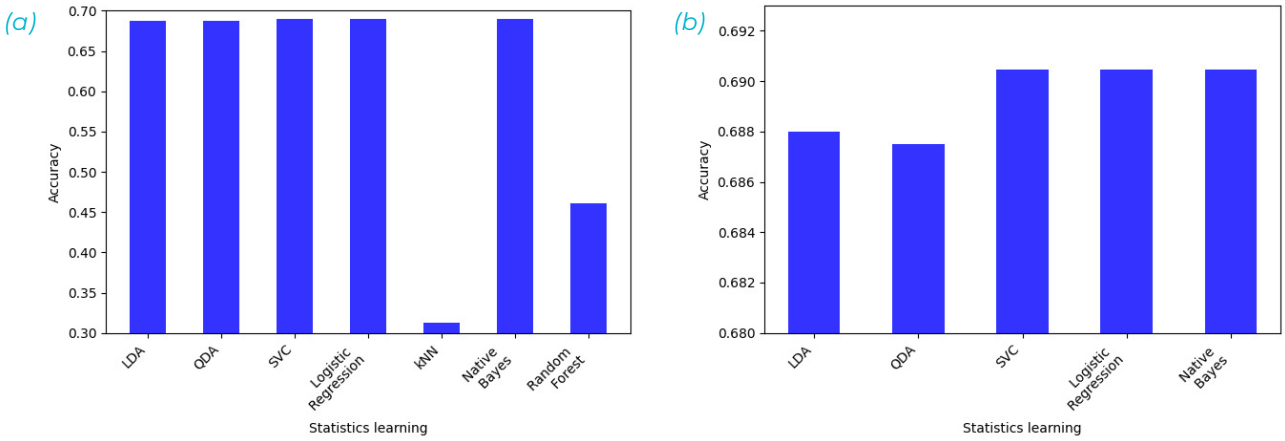

Figure 4: Results obtained with different statistics learning algorithms

3.2. Using natural learning

The LSTM model (Bayer, 2015) demonstrated higher efficiency compared to the 1D Convolutional model (Luo et al., 2016). Both LSTM and 1D Convolutional models achieved outstanding results in detection, with accuracy near the maximum threshold (approximately 99.9 %). The models were trained over 20 epochs.

Figure 5 shows a comparison of the LSTM model and 1D Convolution mesh. From the data set, we can observe that they are not appropriate for the model. Nevertheless, we observed that the dataset is not optimal for model training, as seen earlier, where statistical models also efficiently recognized the IP addresses. Two issues arise in this context:

- Limited or artificial data sample
- Overlay

These are discussed in the next two sub-chapters.

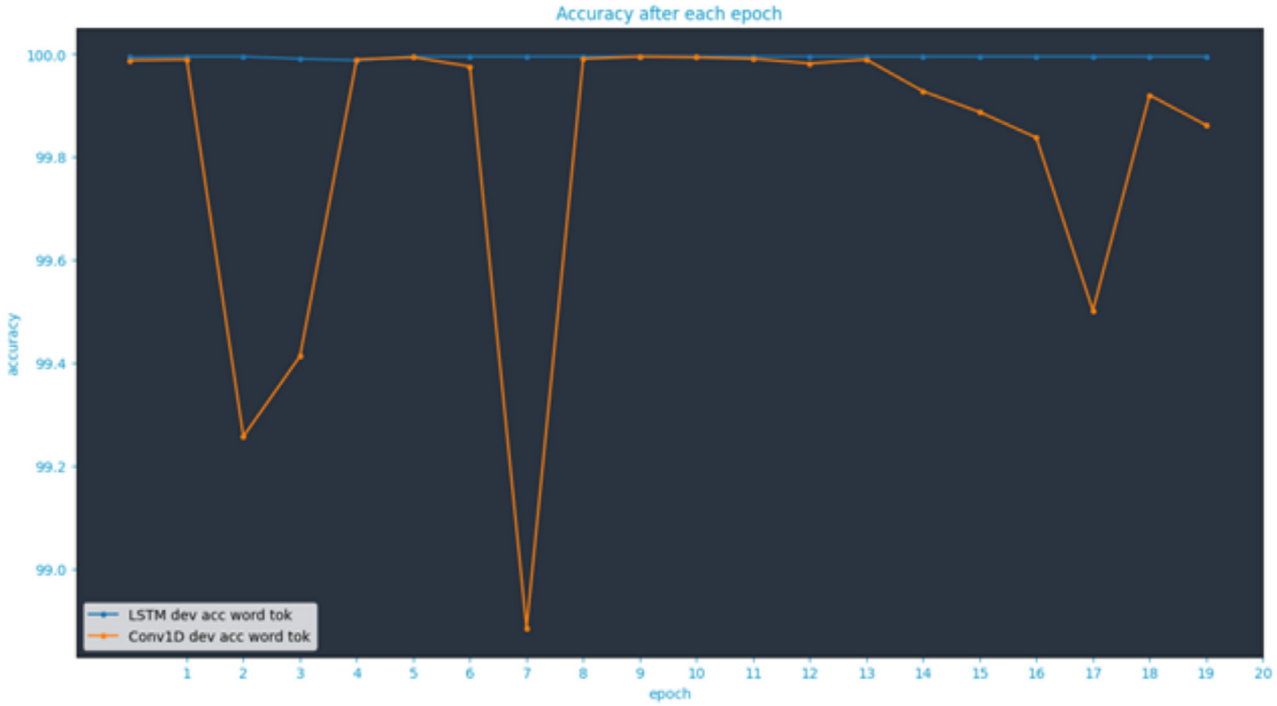

Figure 5: Comparison of LSRTM and 1D convolution model accuracy over 20 epochs

If the language model is trained and tested on a restricted or artificially generated dataset that does not adequately reflect the diversity and complexity of the real world, it is possible that the model may exhibit superior performance on this particular dataset; however, this may not be the case for other datasets. The dataset we have prepared simulated real data but is not fully adequate for teaching the language model. This is because in real attacks, our computer may receive a specific packet more than once. Attacks can be very diverse and independent. of each other.

There are several reasons why the model may be not suitable for the task. In the learning phase, it may learn features that only appear in the data set and cannot be generalised to other real-time data. This problem may arise if the model is not properly validated or if there is inadequate control against noise and redundancy in the data set.

It is likely that the models will start to learn the source IP addresses and ignore the other information. This is a problem because the 'protocol' and 'length' are relevant information. However, in this case, overfitting occurs. This presents a challenge as it is feasible to deceive an attack detection system based on IP addresses due to their potential for modification.

This raises the question of how other information should be considered in order to optimally train the model.

To prevent over-learning, further simulations and comparison measurements could be carried out by extending the simulation database. In this case, the IP address of the normal Modbus client-server data stream should also be changed.

4. Conclusions

The purpose of the research was to identify packet-based attacks. We applied and compared statistics-based learning and natural language learning models. In the first step, we utilised statistical learning algorithms on the generated dataset, achieving approximately 70% accuracy with support vector machines (SVC), naive Bayes, and logistic regression. The model considered the source IP address, destination IP address, used protocol, and packet length. The utilisation of statistical learning algorithms alone may not be sufficient for reliably detecting attacks; however, the combination of different models could enhance this accuracy.

Next, we applied natural language models, including Long Short-Term Memory and 1D convolutional models. In both cases, the data was assumed to be overfitted, as the models could have focused only on the source IP address and ignored other relevant data (destination IP, protocol, length, etc.).

This is also the reason for the over-adjusted results produced by the natural language models. In order to verify whether the neural network abandons this behaviour, it is imperative to conduct a test in a larger network where the attacker's IP address is randomly changed. Even though statistical and neural language models can identify data packets used for cyberattacks, they aren't ready to be used in practice yet. Further research and testing of the above-mentioned recommendations is required.

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SUSTAINABILITY ASSESSMENT OF HUNGARIAN CYCLING INFRASTRUCTURE INVESTMENTS

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The popularity of cycling and the development of cycling facilities has grown significantly in recent years all over the world. Numerous governmental funds and tenders help local authorities in Hungary to implement transport and tourism projects concerning the improvement of the bicycle infrastructure. In the 2014-2022 programming period, Hungary has made the development of cycling infrastructure in Hungary a top priority, with a twofold objective: to facilitate the movement of commuter cyclists and to improve the background and framework for recreational and tourist cycling. Every successful application and investment had to have some kind of sustainability element. The research will use the Hungarian tender database summarising the data of the cycling infrastructure tenders implemented during the 2014-2020 period to show the extent to which these investments meet the sustainability criteria described in the tender and the sustainability criteria of the National Cycling Plan for the period.

1. Introduction

The sustainability of transport is a global objective, particularly in view of the significant growth in urban populations and the transport sector's contribution to environmental pollution (Bencekri et al., 2021). In recent years, many countries have focused on solving the problems of urban traffic and the environment through the introduction of environmentally friendly means of transport (Ku et al., 2021). In the European Union and its Member States, public thinking on transport, transport systems, and infrastructure investment has undergone a major transformation over the last two decades (Oldenziel, 2016). As a result, the idea of sustainability has become a major factor in strategic thinking, which must guide developments from the planning stage through to construction and maintenance (Bruno, 2022). Among sustainable transport modes, cycling has been given the highest priority alongside public transport among the transport systems eligible for support in the European Union. Between 2014 and 2020, €2 billion has been allocated for cycling improvements in EU Member States. More than 7 % of this amount, 151.7 million Euro, was spent in Hungary. A large share of this funding was for road investments. In the case of Hungary, the amount of so-called explicit spending, also known as infrastructure investments, was 106.7 million EUR (Buczyński et al., 2022). With the right policy, planning and investments, demonstrable changes in vehicle use can be achieved (Ingeborgrud et al., 2023; Meng, 2022). The expected impact of investments is taken as a basis for ex-post impact assessments when assessing the use of grant funds. These can be explicit, measurable outputs, such as the percentage change in modal split, but they can also be complex and soft elements that are difficult to measure, such as changes in attitudes towards cycling (Abadi-Hurwitz, 2018).

In the following, narrowing down the focus of the research, a sustainability analysis of the official cycling investments is presented by analysing the main data and output indicators of the successfully completed TOP and VEKOP projects in the 2014-2020 programming period. To this end, it is necessary first to review

the conceptual framework and the professional context in which the success and sustainability criteria of the proposals can be defined. The EU legislation will be reviewed, and the main development cornerstones of cycling concepts and strategies in Hungary will be presented. After presenting and analysing the baseline data of 450 completed projects, the sustainability analysis of 20 projects in cities with county status will be presented, and finally, after summarising the experiences, sustainability recommendations for the next planning period will be formulated.

1.1. Strategic framework for transport development

According to the OECD definition, sustainable transport is transport that does not endanger public health or ecosystems and meets. mobility needs consistent with (a) use of renewable resources at below their rates of regeneration and (b) use of non-renewable resources at below the (OECD 1997). After the theoretical framework was established, the idea became part of the European Union's strategic planning and was applied as a horizontal principle in economic development. The European Commission launched the ten-year strategy, Europe 2020, on 3 March 2010. As stated in the strategy's subtitle, it aims at a "smart, sustainable, inclusive growth" with greater coordination of national and European policy:

- Smart growth: developing an economy based on knowledge and innovation.
- Sustainable growth: promoting a more resource-efficient, greener and more competitive economy.
- Inclusive growth: fostering a high-employment economy delivering social and territorial cohesion (European Commission 2010)

For each of the priority themes, the Commission has proposed a total of seven flagship initiatives to stimulate progress. In this case, the Flagship Initiative: "Resource efficient Europe", which sets out actions at both European and national levels to modernise the transport sector and promote energy efficiency, is relevant to the theme under consideration. In Hungary, the strategic background to the programme referred to in the introduction is summarised in the National Development and Spatial Development Concept, the fifth development priority of which is the implementation of local and regional development measures to promote economic growth. In addition, the link between transport development and the Europe 2020 strategy is established by the National Transport Infrastructure Development Strategy (3K-Nemzeti Fejlesztési Minisztérium, 2014), which aims, inter alia, at strengthening resource-efficient modes of transport, in particular by increasing the use of walking, cycling and, where the benefit-cost ratio is appropriate, rail and waterborne transport. The strategy is Hungary's transport policy strategy and, therefore, the defining document of Hungarian transport policy for the period 2014-2050. Cycling investments, if they contribute to the creation of a coherent European or national cycling network, are considered to be among the investments with high benefits but limited feasibility.

During the 2014-2020 programming period, Hungary has made cycling infrastructure development in Hungary a top priority, with a twofold objective: on the one hand, to facilitate the movement of professional cyclists (within and between settlements), and on the other hand, to improve the background and framework for recreational and tourist cycling (European and national networks). The two objectives are not necessarily always the same.

In the above-mentioned period, four sources of funding have been used to invest in cycling infrastructure in Hungary in the field of sustainable transport:

a. TOP-3: Transition to a low-carbon economy, especially in urban areas;
b. TOP-6: Sustainable urban development in cities with county rights;
c. VEKOP-5: Supporting energy efficiency, smart energy use and renewable energy use;
d. GINOP-7: Tourism.

The Operational Programme for Territorial and Urban Development (TOP) two types and the Competitive Central Hungary Operational Programme (VEKOP) mainly included investments important for professional

cyclists, where the main implementers were all municipalities, while the Operational Programme for Economic Development and Innovation (GINOP) supported cycling development for tourism, where the applicants and implementers were very diverse, both municipalities and municipalities. In the following, only investments in professional tourism will be evaluated, in which case the interventions can be compared.

1.2. Background on Cycling Developments

It is clear from the above that the conceptual and strategic background for cycling development, with a focus on sustainable transport investments, was well developed, both at the European and national levels. This was the spirit in which the calls for proposals were launched. However, a number of elements were still missing at that time to make the interventions understand and work in a systemic way.

Cycling investments have already been made in Hungary during the 2007-2013 programming period, but they were not accompanied by an approved cycling development document, so most of the investments were ad hoc. To overcome these shortcomings, several development documents were prepared during this period. First of all, the Cycling Roundtable, a group of cycling organisations in Hungary, wrote a concept paper in 2013 to draw the attention of the Hungarian government to the need to spend cycling resources as efficiently as possible in the next programming cycle (Kerékpáros Kerekasztal, 2013). Cycling-focused documents were prepared in connection with the National Transport Infrastructure Development Strategy. The most important of these is the National Cycling Concept and Network Plan, which emphasises the networked nature of cycling infrastructure and called for the development of missing network elements as its main objective. These included tourist and professional cycle routes. It also set out an important framework for future development. The horizontal positioning of cycling as a sustainable mode of transport in further developments and the definition of strategic targets were addressed in the 2014 Cycling Development Programme, entitled Cycling for pleasure, which included decision preparation and feasibility studies to prepare priority cycling investments and to examine the possibilities for maintaining the existing network. This included the elements of the cycle paths that could be integrated into the professional network evaluated in this study (3K, 2015).

The programme put forward six sets of measures, one of which was to develop and maintain infrastructure. In the field of infrastructure, the document set the following objectives for the period under review. 21 cycling-friendly town centres, created through the integrated and complex development of smaller towns and villages, where the new elements meet the needs of cyclists, including accessibility, safety and comfort. The creation of 500 kilometres of cycle-friendly facilities, including the development and improvement of regional cycle networks and cycle-friendly transport links. The rebuilding and renewal of existing but outdated network elements is also addressed here. A total of HUF 30 billion is planned to be spent on the two objectives, and a total of HUF 92 billion on the overall development programme.

In 2016, a government commissioner for cycling issues in Hungary was appointed to coordinate and oversee the development process.

In order to facilitate the applicants' planning work, the promoters were asked to prepare a local cycling network plan similar to the national and county cycling network plan methodology. The completed plans were then presented to a planning jury, where the good practices and key guidelines presented in the development materials were examined.

2. Cycling development projects 2014-2020

A total of 482 applications are included in the application summary document examined. Of these, 32 were terminated contracts, which, for some reason, were not implemented. The contracts for the 450 projects that entered into force were concluded between 2016 and 2021 between the managing authority and the applicant municipalities (although the period under review is the planning period 2014-2020, the first contracts were postponed by two years due to the tendering and evaluation of the calls for proposals, and the COVID situation hampered further work). A preliminary evaluation of sustainable proximity applications was already carried out in 2021, courtesy of the Főmterv (Főmterv, Collectivo, 2021). The evaluation discussed cycling programmes separately, but a large proportion of the investments were not yet completed, so a final evaluation and analysis of indicators was not possible.

2.1. Main features of the applications

In Hungary, cycling development projects have been paid for under three funding schemes (VEKOP, TOP, GINOP). The present study only looked at the tenders for cycling infrastructure for public transport (TOP, VEKOP), while the tenders for tourism, often involving complex improvements (GINOP), were not reviewed.

The word sustainability is only used in the title of the proposals implemented for smaller municipalities in 98 out of 450 proposals.

The total amount to be disbursed was HUF 156 billion, of which HUF 145.5 billion was actually paid for completed projects. This is almost one and a half times the amount projected in the programme mentioned earlier. 346 municipalities were awarded a grant during this period, the vast majority of which (297 winners) managed one project during the application period. Only the capital, the county capitals and larger cities deviated from this. Figure 1 shows the distribution of projects implemented, where the size of the circles increases with the number of projects implemented. One city with county status has the highest number of successful projects, with a total of 13 cycling proposals, ahead of the capital. The average amount paid per project was HUF 323 million.

When looking at the average investment, the highest value investments were made in the county capitals, where the integration of cycle paths into the existing urban access system required complex interventions. In nominal terms, the investments with the highest value, in addition to such internal investments in the cities of county status, were those where the applicants undertook to link two municipalities. Most projects were carried out in smaller towns and villages during the period under review. However, the value of the investments varied significantly, with smaller investments in villages, where 27 % of the total amount allocated was used, compared to 41 % in towns (Table 1).

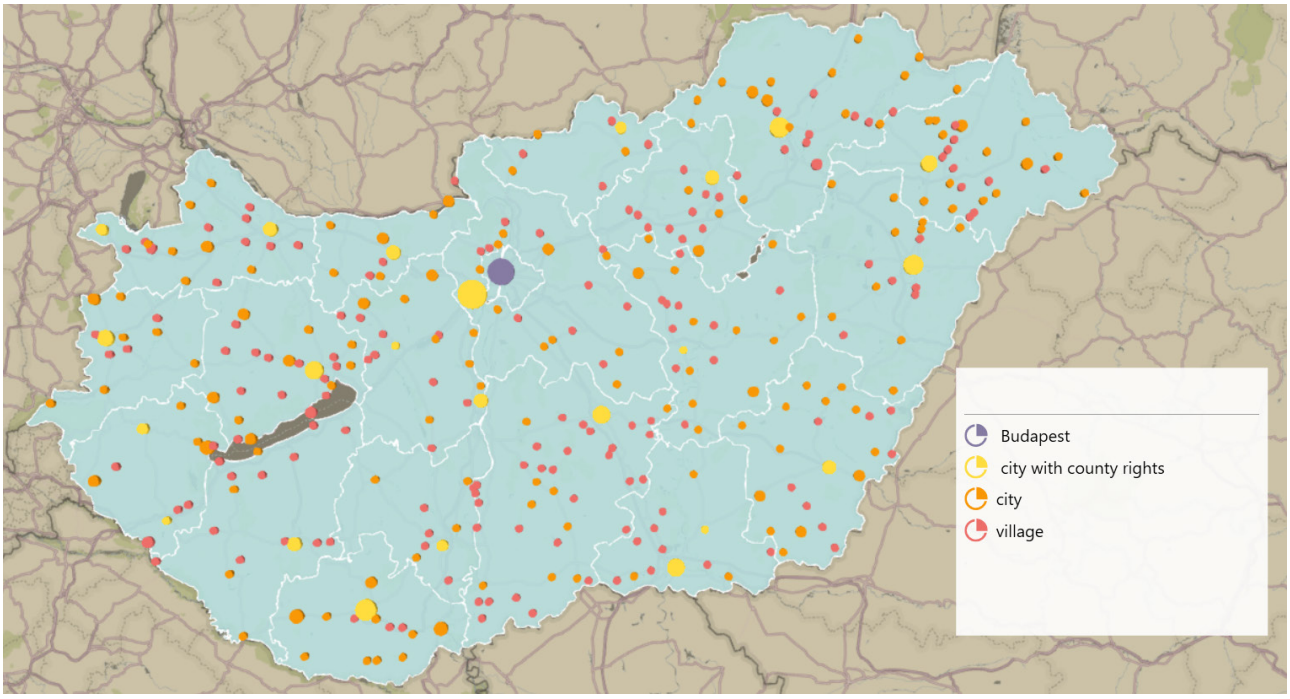

Figure 1: Successful cycling infrastructure-related TOP and VEKOP projects in Hungary in 2014-2020 programming period

Table 1: Distribution of projects between different type of settlements.

	Number of projects	Total amount of payment (bnHUF)	Variance (mHUF)	Mean (mHUF)	Min (mHUF)	Max (mHUF)
Budapest	11	2.2	223.7	215.1	2.3	671.1
cities with county rights	85	44.0	440.7	517.9	23.0	2,050.3
cities	180	59.9	306.9	332.7	10.3	2,260.4
villages	174	39.4	236.8	226.5	4.9	1,378.6
Total	450	145.5	328.3	324.0	2.3	2,260.4

The question arises: what is the relationship between sustainability commitments, the road sections built and reconstructed, and the cost of the projects?

2.2. Applications from a sustainability perspective

For accepted and implemented applications, the sustainable convergence elements were measured by the following output targets of the applicant company, where the target was meaningful for the investment:

1. Length of cycling facilities developed (km)
2. Number of developed cycle-friendly municipalities or parts of municipalities (number)
3. Number of municipalities with road safety improvements (number)
4. Number of new traffic calming zones created (units)

Of the 259 applications included in the research, none of the indicators presented above were met, i.e. the indicator value was either missing or zero. There were 47 applications where one indicator was met, which in most cases meant that the investment was built. More complex investments, with two or three or all four indicators met, accounted for one-third of all applications. Only 25 applications met all four indicators.

In the following, for each commitment, the number of projects that have committed to the indicator in the course of their development and the differences between the number of indicators committed and the number of indicators actually adopted are analysed. Smaller towns and villages are over-represented among the municipalities that have successfully adopted more than one indicator.

2.2.1 Length of cycling facilities indicator

This indicator shows the length of the road type suitable for cycling that has been built in the municipality or between municipalities during the project. The indicator statistics do not break down the facilities constructed into sub-types so that directional separated cycle paths, cycle lanes and cycle tracks are all included, which do not imply the same usability. This indicator was included in 87 % of the applications examined, i.e. 391 projects, the same number of municipalities where infrastructure was to be built or upgraded. The total length of the facilities to be built in the applications would have been 1603 km, with an average of 4 km per municipality. However, the reality is much more dismal, with only one-third of the committed figure, 488 km, representing only 1.2 km of cycle facilities delivered (realistic compared to the 500 km of cycle paths committed in the Cycling Programme).

Where no such commitment was made in the first place, or where targets were not met, there are also investments to promote cycling-friendly transport, often to promote safe walking and public transport.

2.2.2 Number of developed cycle-friendly municipalities or parts of municipalities Indicator

Before the investments started, the municipalities drew up a cycling network plan, which identified the areas of the municipalities that would be affected. If it could be demonstrated in the plan that the intervention had made the access routes to the designated municipality or part of a municipality cycle-friendly, the indicator was met. A settlement area is defined as any organic, functional unit within a settlement that includes both residential and traffic-attracting areas. In the case of smaller municipalities, the conversion of the entire section of the national road through the municipality or of the part of the road that could be considered a functional unit (the section between the centre of the municipality and the residential area on the edge of the municipality) was sufficient to meet the indicator. The vast majority of applications, 431, included such a commitment. On average, 1.39 urban areas were identified per application, with the highest value being 7 per application. The final result shows that only 36 % of the commitments were met, with a total of 157 functional municipalities or parts of municipalities that could be considered cycle-friendly being created during the application period.

2.2.3 Number of municipalities with road safety improvements

To meet the indicator, the applicant had to undertake a road safety audit in accordance with the government decree and implement the investment based on the recommendations and findings of the audit. Less than half of the applicants undertook to carry out a preliminary assessment in 215 cases, covering a total of 232 municipalities. Less than half of the numbers committed. 42.6 % were acceptable.

2.2.4 Number of new traffic calming zones created

Traffic counts before and after the works and speed limit signs were used to illustrate the traffic conditions before and after the intervention. If a reduction in the volume and speed of traffic in the zone could be demonstrated, the indicator was acceptable. This indicator was the least frequently undertaken element in the applications, as only 123 of the applications undertook to make a substantial reduction in vehicle traffic by introducing cycling. Although it was committed in a small number of applications, a comparison of the targets and the actual data shows that 55 % of the indicators committed were met, which is the highest of all.

3. Conclusions

From the above, an interesting picture emerges with regard to the sustainability of professional cycling-related investments funded in Hungary in the 2014-2020 programming cycle. Cycling infrastructure investments were also made in the previous programming period, but the period under review was the first seven-year planning period in Hungary, where there was a clear and understandable conceptual background behind the developments and a strategy underpinned programming at the national level for cycling development. The Managing Authority's objectives were clear, and the last three indicators included in the proposals included elements related to the long-term impact of the investments and sustainability. However, the situation was less clear for the municipalities responsible for implementation. In many cases, there is no local apparatus to fully integrate the objectives and recommendations of EU and national strategies at the local level and adapt them to local conditions. It can be seen from the distribution of indicators that in all cases, the primary objective was construction and reconstruction, while the related direct and indirect elements such as cyclist safety, changes in the livability of the settlement or modal split were less important and less achievable.

Furthermore, the applications do not show a transfer of a network approach, as most of the interventions are point interventions. Although methodological guidance was provided for the preparation of the compulsory cycle network plans, which are essential for the assessment of indicators, the quality and depth of the plans varied considerably. In the future, these documents should be standardised and, like other standardised planning materials, should be collected and made available to all for reasons of comparability.

Although increasing the share of cyclists in the metropolitan environment is the most urgent task, it is in relation to investments in these municipalities that the least focus has been placed on sustainability elements

and the demonstration of change in terms of indicators. Similarly, there is a great need to present best practices and exemplary investments.

The 2014-2020 period was a learning period for local-level developers. The strategic objectives of the new programming period have not changed much compared to the previous ones. There is a need to learn from both the experiences and mistakes of the past period.

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DOES A SUSTAINABLE BUDGET EXIST IN HUNGARY? – A PILOT STUDY OF MEASURING OVERSPENDING

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This research is a pre-step of revealing if Hungarian households have a sustainable budget. It is analysed through the overspending behaviour of families. According to the literature review, Reference Budget was defined as the methodology that approaches household budgets from quantitative and qualitative perspectives. The Reference Budget was used in Belgium to describe the poverty line by simulating the needs of different family types and comparing it to their income. The correlation between income and expenditure gives the basic frame of a sustainable budget and overspending. In this pilot study, the different steps of Reference Budget calculations for Hungary will be presented with one family type as the test of methodology. First, the output of the available data from the Central Statistical Office (KSH) in Hungary will be presented by SPSS statistical software. The demographical overview and the statistical analysis of the spending structure of the family types specified by KSH will offer a general picture of Hungarian society. Given that this paper is pilot research, only couples without children were interviewed as the chosen family type, about their needs regarding services and products essential to reaching subsistence levels. The results of this methodological test will be the base for measuring sustainable budgets and overspending in further research.

1. Introduction

The rate of household debts has risen significantly in the last few years. It might be explained by the development of financial institutes and their services; it never was so easy to get a debt like today. On the other hand, welfare is accompanied by more debt. In different life cycles, the families aim to purchase durable goods, like properties and cars. In times of recession, debt also means a safety net. Indebtedness is not sustainable; it causes several economic issues on the macro and micro levels (Dumitrescu et al., 2022).

US government debt was 134 % of the GDP at the end of 2020. It was more than the debt after World War II in 1946 (Reis,2022). Another study (Sun et al., 2022) examined how financial stress and financial shock correlate and how they reached different households in Australia. Financial stress means difficulty satisfying basic needs, leading to a financial shock. Low-income families and one-parent families with dependent children face both low financial shock; that is, they cannot afford 500 AUD in emergency cases and also face high financial shock, which means they cannot afford 2000 AUD in need. Growing financial stress is caused by the lack of financial literacy, like financial attitude, management and behaviour in Malaysian households (Munisamy et al., 2022).

Further research (Makarenko et al., 2022) on the micro level stated that loans and spent savings were considered disposable resources based on the analysis of The Russia Longitudinal Monitoring Survey-Higher School of Economics. Unfortunately, these savings month by month were not enough for Russian families to quickly purchase a car or other high-value durable goods. Hüttel and Balderjahn (2021) researched the post-pandemic effects on sustainable consumption and the willingness to spend sustainably in Germany.

Their results showed that COVID-19 had a doubled negative impact on sustainable spending habits. These results show that spending is unsustainable on the macro and the micro level.

The current paper is concerned with the pre-step of calculating the sustainable budget for Hungarian families. Measuring a sustainable budget requires getting to know the detailed expenditures of various household types. The identification of expenditure items is realized with the calculation of the Reference Budget. A two-level preliminary research (Vastag and Eisinger-Balassa, 2023) concluded that budgetary analysis is essential in studying families' overspending behaviour. Given the sensitive nature of the topic, calculating Reference Budget (Storms et al., 2014) provides the possibility to understand the different households' spending behaviour. The Reference Budget includes the essential goods and services to reach the subsistence level of living. It can be calculated for an individual or an entire household concerning the geographical area and demographical variables (Deeming, 2020). Many case studies exist in various geographical regions, like in the UK (Bradshaw and Veit-Wilson, 2020) , in Ireland (Mahon et al., 2020) and in Japan (Abe and Veit-Wilson, 2020) that aim to help and support the decisions of policymakers by providing the necessary minimal budget of families to decrease and avoid poverty. The references listed above, such as the benchmark paper of Penne et al. (2020), focus on the socio-political aspect of the Reference Budget. They focus on it on the macro level by calculating the Reference Budget and modelling different scenarios with the help of it. The novelty lies in studying sustainable budgets on the individual's level, how they perceive baskets of essential goods and how they plan their budget in Hungary in current economic circumstances. This paper deals with the adequate circumstances income level, which means the sum on the cash account after taxation and includes all affordable services and goods (Storms et al., 2023). The Classification of Individual Consumption According to Purpose (COICOP) is globally used to categorize the household's expenditures (Statistics Division, 2018). This classification and its main groups will be used as a guideline in this study to reveal the necessary items of baskets and facilitates to calculate Reference Budget. This study tests the methodology of calculating a Reference Budget for a selected household type and comparing it with the income from the simulation tool of HHoT (Gasior and Recchia, 2020). This will lead to the conclusion of the chosen household type overspend or not. Based on the results, the aim is to develop an improved method to analyse Hungarian households in an extended paper. This paper includes follows the following structure of introduction, methodology, results and conclusions. The method is based on two main sections; firstly, the available statistical data about households' spending will be analysed with SPSS software. The second part will present the preparation of the focus group discussion in the case of one chosen family type. The products and services from the conversations as essential items for a minimal standard of living will be the base of the Reference Budget for the chosen family type. The Hypothetical Household Tool (Gasior and Recchia, 2020) software will simulate the net income after taxation and social benefits to test and reveal the overspending in the selected family type. As a final step, evaluation comes where the Reference Budget and the net disposal income will be compared, and the results infer spending behaviour and the existence of the overspending phenomenon. The conclusion will phrase the pilot research's main consequences and limitations and state the extended study's expectations.

Figure 1 describes the different steps of the research.

Figure 1: Research's steps

2. Methodology

This part consists of two pillars. One is the statistical overview of the Hungarian Statistical Office's (KSH) data that were only available and processable in the research room of KSH. The spending of different family types on the COICOP's main groups was analyzed using SPSS software. Secondly, a pilot research was carried out by choosing a family type and involving them in a focus group discussion. The pilot study was prepared

based on the reference study of Penne et al. (2020). Focus group discussion provides the space for a casual conversation in a good atmosphere, where the talks led by the moderator can catch the voice of individuals. It also helps the researcher rephrase and rethink the research progress according to the responses (Leavy, 2014). Based on their answers, the basket of essential goods and services was defined as the Reference Budget of the household. The Hypothetical Household Tool software was run on this family type, so the average net income after taxation and with the available social benefits was calculated. In this study, it was not a purpose to analyze the family type's spending behaviours geographically detailed. It will be part of the extended analysis. This paper presents the main insights from the statistical analysis and describes the different steps of the pilot research that will be the base of the large-scale data gathering.

2.1. Statistical overview

KSH's research room provided data about the spending habits of Hungarian families. The latest Household Budget Survey database from 2021 was combined with the different family types of the latest Microcenzus from 2016. KSH defined the various family types as single, male under 65y of age; single woman under 65 y of age; single, male 65 and older; single woman 65 and older; single woman 65 and older; two under the age of 65, without children; double, one 65 and older, no children; three or more persons, without children; one adult with one or more children; two adults with one child; two adults with three or more children; three or more adults, with one or more children; other. These family types' spending were categorized in the different COICOP's main groups. In the research room, the cross-tables were created by SPPS to get an overview of spending habits. As a result of the cross-table analysis, the three or more persons without children spent the most summarized, considering all COICOP's groups.

2.2. Pilot research

The pilot research was conducted as focus group discussions with two persons under 65 without children. This type was chosen because they were in the middle range, neither extremely high nor extremely low value, concerning summarized spending in Figure 2.

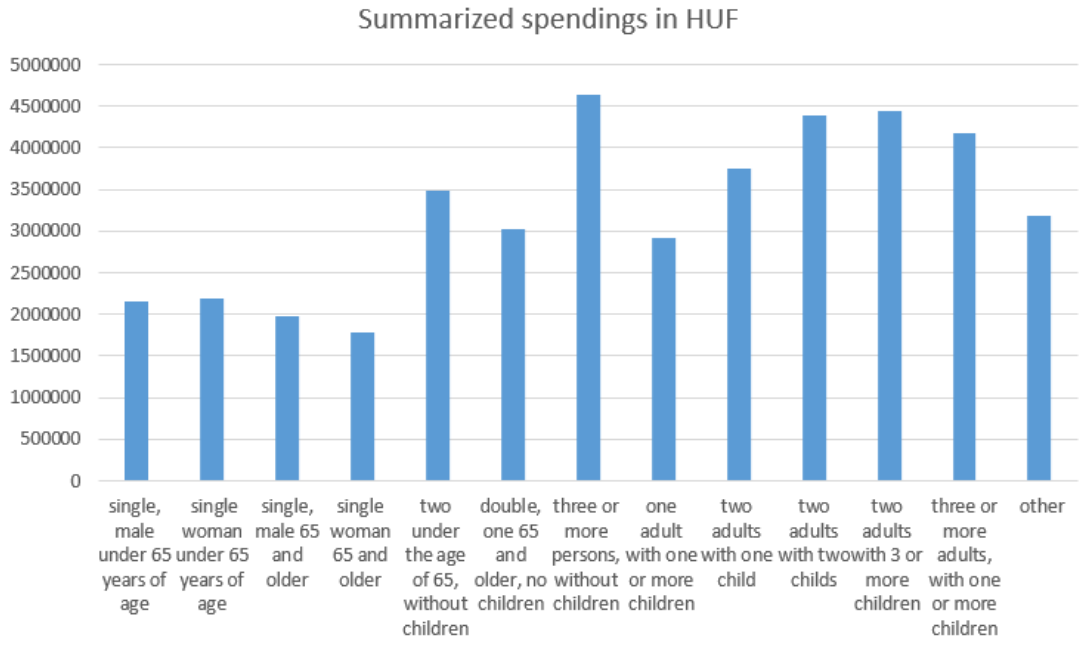

Figure 2: Summarized annual spending per family type in HUF

The couples were asked about their spending habits. First, they needed to place their household's total income on a scale (Hungarian Statistical Office, 2023) and declare how satisfied they are with their income on a Likert- scale from 1 to 10, where one was not at all, and 10 was satisfied. After it, they gave their associa-

tions hearing the expressions of overspending and family budget. They were asked what the essential products and services were based on the COICOP structure they could not live without. They were also asked if the brand is critical in choosing where they shop and why they chose those stores. Based on the answers, the products and services were selected for further analysis that appeared in every response. These items were priced with the help of the Hungarian government's price tracker site (arfigyelo.gvh.hu). The non-food product's prices were compared based on the stores the participants highlighted as the place of purchase. The lowest cost was calculated into the Reference Budget. With the help of the HHoT simulation tool, the net income was counted for two-earner adults above 25 y without children.

3. Discussion

The members of focus group discussions were all between 25-40 y with active employment status as white-collar workers. They placed their incomes between 500,001 – 1,000,000 HUF and 1,000,001 – 2,000,000 HUF. Their satisfaction rate was 6.8 on average. The results of association tasks are presented in Figures 3 and 4. The most common words were unnecessary things and impulse buying in case of overspending; while hearing the expression family budget, the participants referred to common budget and utilities.

Figure 3: Word cloud of overspending's associations

Figure 4. Word cloud of family budget s associations

Table 1 describes the monthly spent value in HUF for each classification of the COICOP structure. Food and non-alcoholic beverages; Housing services, water, electricity, gas and other fuel; Travel and transport; Communication and Other products and services were the categories where every participant spent money regularly. 351,389 HUF was calculated as the Reference Budget for two under 65 y without children households.

Table 1: Spent value monthly in the COICOP classification

Category	Spent value in HUF
Food and non-alcoholic beverages	95,640
Alcoholic beverages, tobacco products and drugs	none
Apparel and footwear	none
Housing services, water, electricity, gas and other fuel	130,000
Furnishing, household equipment, dwelling maintenance	none
Healthcare	none
Travel and transport	50,000
Communication	15,000
Recreation and culture	none
Education	none
Hospitality and accommodation services	none
Social care	none
Other products and services	30,749
TOTAL	351,389

After the calculation and the concerned social benefits, couples without children above 25 y are not allowed to receive tax allowances for young people under 25 y or any family allowances (Hegedűs and Szívós, 2023). Based on the Country Report (Hegedűs and Szívós, 2023), Hungary's minimum wage was 200,000 HUF in 2022. However, the simulation tool used the average income of 794,624 HUF for two persons. Personal income tax (16 %) and Employee Social Insurance Contributions (18.5 %) were deducted from the tax base during taxation. Employer Social Insurance Contributions were defined as 103,301 HUF. The net disposable income resulted in 520,478 HUF.

Table 2: Net disposable income after taxation in a household of two earners without children (based on the data of HHoT simulation)

Concept	Baseline
Income components in HUF Earnings	794,624
Taxes	-127,140
SIC employees	-147,005
Disposable income	520,478
SIC employers	103,301
Tax wedge in %	42.04
Marginal tax rates in % -earner 1 (100 % average salary)	
Taxes	16
SIC employees	18.5
Marginal tax rates in % -earner 2 (150 % average salary)	
Taxes	16
SIC employees	18.5

4. Conclusions

This paper aimed to describe the households' spending according to the available statistical data. Three or more persons without children spent the most, but the two adults with two or more children families were right after them concerning spending. For the pilot research, two persons under 65, without children, were chosen as a family type in the middle range of expenditures. The involved couples were asked about their baskets that contained the essential goods and services. Based on their answers, Reference Budget was defined as 351,389 HUF as the monthly budget to reach the minimal standard of living. HHoT calculated 520,475 HUF as disposable income for two –earners in one household without children. That might lead to the conclusion that a two-earner family with an average salary does not overspend. Nonetheless, after paying the rental fee or loan, purchasing groceries and maintaining one car, only 169,086 HUF is the budget for recreation, savings and vis significant situations. These results might suggest that the spending of couples without children do not overspend and their budget is sustainable, but it is not black or white. Ariely (2017) calls the attention to daily cognitive distortions that impact financial decision-making. Mental accounting categorizes the different expenses that would have been given out from various pockets. It gives the illusion of spending only a little on anything. The alternate costs and the value of different goods and services might help the customers get into the trap of overvaluing something, paying its price, and resigning other things at the end of the month. E-pockets, automated invoicing, and credit cards are the painkillers for paying. These methods ignore the physical contact with money and distort the value of goods and services.

Drawing a parallel between the statistical data and the calculated budget, the statistical data showed a discrepancy. The annual spending was 3,500,000 HUF divided by monthly; it is 291,666 HUF. The difference might come from the different economic circumstances (database of 2021) and the deviations of geographical regions This phenomenon begins at the micro level, but the analyzed literature shows that it can also cause enormous problems on higher levels. The budget serves as a map of income and expenditures. Making it sustainable for households might be a task and ethical issue for financial institutes and the government.

Are the different applications of commercial banks efficient, that aim to facilitate to be aware of spending and savings? How the government paper construction help the savings and decrease overspending behavior? To answer these questions, further research is suggested that helps to understand the spending behavior of Hungarians.

Several gaps should be filled in the extended paper. A more elaborate methodology can measure sustainability and overspending. Once the pilot research was limited to a few couples in one region, it should be extended to the entire country and measure the differences by region. Spending might show diversities by region. Other variables are the family types of KSH (Figure 2). All should be involved in focus group discussions in every region so their preferences might also be revealed. Using HHoT to define the average income will help to describe the overspending behaviour. Measuring a sustainable budget is planned in two steps. First, a summarized overview of the Hungarian population's greenhouse gas emissions will be calculated. This will be compared to other European countries' emissions. The second step requires a Reference Budget because it is estimated due to the cheapest products on the market. Still, as a second scenario, a sustainable budget will be calculated, where only the products will be considered that have an eco or sustainable label. Computing the different scenarios for various household types in other regions will show if the Hungarians can afford sustainable consumption or not. This paper shed light on the methodology's limitations and the topic's novelty. The reference Budget is approached mainly from regulations and taxation points of view. In further research, the measurement of sustainable budget and the existence of overspending will be in focus based on the experience of the focus group discussions. The more the individual's hidden motivations and reasons for overspending can be understood, the easier it will be to go against it.

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COMPARISON OF ESTIMATED YIELDING RATE AND PROBABILITY OF YIELDING RATE AT UNSIGNALIZED PEDESTRIAN CROSSINGS

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At present, the introduction of environmentally friendly modes of transport is the focus of several countries to solve urban traffic and environmental problems. The sustainability of transport is becoming a global objective, especially with the recent strong increase in urban population and travel activity. Transport is one of the main contributors to environmental pollution. Walking is one of the most sustainable modes of transport for short distances, but the increase in pedestrian casualties is a cause for concern. When approaching the uncontrolled crosswalk, drivers naturally slow down and drive carefully to avoid collisions. Therefore, the number of pedestrians at the crosswalk has a direct impact on the capacity of the roadway to delay vehicles on a given stretch of road. The aim of the present study is to investigate the interaction between drivers and pedestrians in order to know how much pedestrians influence the flow of vehicles, which can affect the capacity of the road. The Hungarian city of Sopron, a city with a population of approximately 62,000 (2023) close to Hungary's western border with Austria, was chosen as the study area. The study also aims to evaluate how pedestrians and drivers behave at the studied locations. To predict the yielding rate of drivers seeing pedestrians crossing the road, logistic regression was used. The results of the multiple linear regression calculation show that the independent and dependent variables have a correlation of 91 %. The p-value of each parameter is greater than 0.05, which means that it is not statistically significant. However, this does not mean that the results cannot be used, as there is still a probability that the return will be close to the initial return. The smallest p-value for the variable length equal to road width is the main factor that causes drivers to slow down and give priority to pedestrians. As a result, the p-value of each parameter is more significant than 0.05, which means that no effect was observed at the locations studied. It is necessary to observe more locations with different road environments, geometries, traffic volumes, and road categories. The impact of pedestrian crossing flows on road capacity in the presence of autonomous vehicles needs to be investigated in further research, as well as how pedestrians will react to automated vehicles and whether this would affect their behaviour.

1. Introduction

To solve urban traffic and environmental problems, several countries are currently focusing on the introduction of cleaner modes of transport (Ku et al., 2021). Transport sustainability is becoming a global objective, especially with the recent strong growth in urban population and travel activity. The transport sector is one of the main contributors to environmental pollution (Bencekri et al., 2021). Walking is one of the most sustainable ways to travel short distances, but pedestrians are fast becoming one of the largest groups of road casualties, which is a major concern. Despite this, road travel has become much safer for most road users over the decades, largely due to improvements made by car manufacturers to protect vehicle occupants.

In order to better understand pedestrian casualties, it is necessary to study the interaction between the driver and the pedestrian, which is influenced by the characteristics of the road layout.

The cross-sectional design is an essential characteristic of road categories and is a major factor affecting the capacity of road sections and influencing the effective speed of vehicles (Boroujerdian et al., 2016). Sufficient capacity is achieved by the number of lanes, while speed depends on the traffic volume itself, the road alignment and the lane widths (Montella et al., 2010). Clear information about the visibility of the pedestrian while crossing can positively influence the driver to reduce speed before entering the pedestrian crossing (Bella and Silvestri, 2016). Another factor for pedestrians to cross the road or the vehicle to brake for the pedestrian is vegetation and concrete barriers, which can hide the visibility of cars and pedestrians (Sisiopiku and Akin, 2003). In addition, some researchers have studied the safety of pedestrian crossings based on gender, age, education, purpose of travel and frequency of crossing, and it can be distinguished that female pedestrians crossing or crossing in a group feel safer than male pedestrians crossing individually (Parmar et al., 2019). Therefore, it is important to consider many aspects of traffic engineering.

The aim of this study is to investigate the interaction between drivers and pedestrians at the unsignalised crosswalks by conducting a field survey at the selected sites to analyse the yielding rate of drivers in the city of Sopron, Hungary. The estimated yielding rate of all eight pedestrian crossings was used to perform the probability (logistic regression) of drivers' yield or not to yield by calculating the yielding rate and other road and pedestrian factors. Among other things, a driver's travel time on a given road segment is a consequence of the delay due to stopping and waiting at pedestrian crossings. For this reason, the study of drivers' yielding behaviour was the focus of this research period.

Thus, this paper is organised as a general investigation of driver-pedestrian interaction at the uncontrolled crossing, then explores the methodology of site surveys to assess the outcome of driver yielding at each location. The probability of yielding is then compared with the initial yielding rate, which is calculated as the number of drivers yielding to pedestrians divided by the number of all interactions in the selected areas.

2. Vehicle and pedestrian at unsignalized pedestrian crossings

Driving behaviour is an important factor in traffic flow (Takahashi et al., 2005). The characteristics of pedestrians and vehicles are similar in terms of traffic flow, but the difference is the movement and speed, the pedestrian manoeuvre can move freely or change the desired direction of travel (Iryo-Asano et al., 2017).

Safe interaction between pedestrians and drivers should be promoted, as vehicle-pedestrian conflict can increase the likelihood of accidents due to the lack of proper crosswalks (Andre et al., 2019). The pedestrian crossing should be located and marked at the safest point for the pedestrian to cross (Antov et al., 2007). The safety of the pedestrian crossing without collision at any location is the high rate of vehicle yielding while approaching the pedestrian crossing. A driver is influenced before approaching the crosswalk within the decision zone at 50 m to 40 m (Varhelyi, 1998). In order to increase the yielding rate from the driver, some authors have developed a logit model to validate and analyse the vehicle yielding behaviour (Malenje et al., 2019). A logistic regression model was applied to impose the influential probability factors of driver deceleration from the recorded information at two unsignalized crosswalks, the existing one- and two-way streets, to implement the case studies of pedestrian-vehicle interaction (PVI) (Amado et al., 2020).

Furthermore, autonomous vehicles can reduce pedestrian fatalities (Combs et al., 2019). However, some studies have found that pedestrians' crossing experience is affected by distracted driver behaviour in conditionally autonomous vehicles, where pedestrians feel safer crossing the road when they have eye contact with the driver (Su, 2014). Pedestrians prefer to evaluate the available gap in all directions of the roadway in relation to the traffic volume in the lane to cross the road without any interaction with the driver (Dhamaniya et al., 2014). Moreover, different pedestrians react differently when encountering an automated vehicle due to the personal attitude of each pedestrian, which cannot guarantee the avoidance of accidents between pedestrians and autonomous vehicles (Razmi Rad et al., 2020). Therefore, the correlation between pedestrians and cars is imperative to be studied for the future of the upcoming autonomous vehicles.

3. Data Collection

Pedestrian crossings can be evaluated by two types of studies: a field study using video cameras and a survey of pedestrian preferences using questionnaires (Vissers et al., 2016). In this study, the field study method was used to analyse the yielding rate of drivers' influence on pedestrians while crossing. Eight unsignalised pedestrian crossings (two lanes and two directions) in the city of Sopron were selected (Table 1). At each location, a video recording is made, focusing on both directions of the road and the crosswalk during an average weather working day. The observation was carried out by video recording during the peak hours of the weekdays. The video recording tools were mobile phones (Nokia 5.3 and iPhone 6S) and selfie sticks mounted on a tripod.

The sites were selected based on the volume of pedestrian and vehicle traffic, the speed of the vehicles, and the proximity of schools, kindergartens, supermarkets, and university buildings. The recorded videos were replayed to see the relationship between pedestrian vehicles and other conditions in the study area. However, this paper focuses on the geometry of the road and the total number of pedestrians and drivers. The surrounding area of the two crossing locations is shown in Figure 1 as an example.

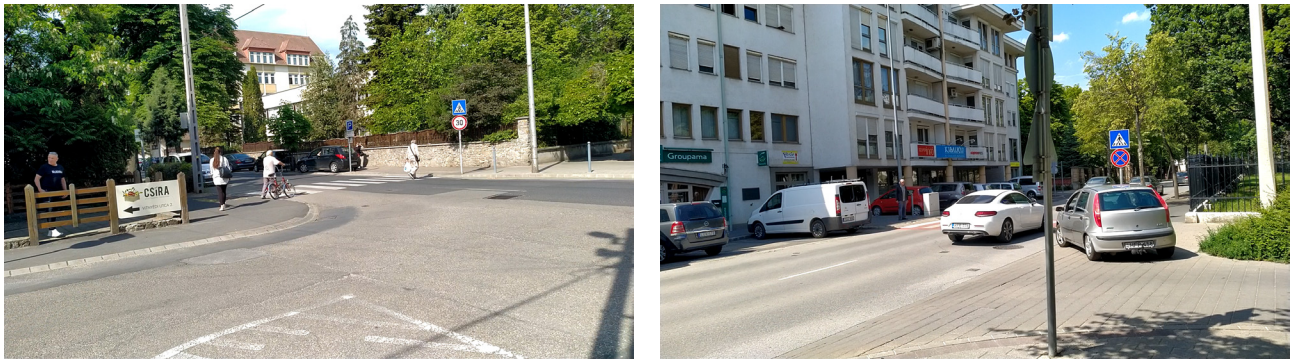

Figure 1: Pedestrian crossing conditions at two sample locations (with poor visibility), to the left Ferenczy Janos St - Vitnyedi, to the right Csatkai Endre St - Deak square

The road parameters observed at the selected locations are summarised in Table 1. All pedestrian crossings are two-way streets with two lanes.

Table 1: Road parameters of selected locations in the city of Sopron, Hungary

	Locations	Width (m)	Length (m)	traffic volume of vehicles (veh/h)	traffic volume of pedestrians (ped/h)	Speed of vehicles (km/h)	Visibility condition
1	Ferenczy Janos St - Vitnyedi St	3.25	7.5	585	165	23	not good
2	Martirok St.	3.25	7.5	519	129	34	good
3	Beke Way	4.5	8	876	108	31	good
4	Csengery St - Frankenburg St.	3.5	11	1095	63	50	good
5	Csatkai Endre St - Deak Sq.	3.25	8	771	87	42	not good
6	Banfalvi Way - Ojtozi St.	3.5	10	942	96	38	good
7	73 Varkerulet	3.5	9	525	99	25	good
8	49 Varkerulet	3.5	9	600	78	20	gogood

According to Table 1, the visibility of two locations, Ferenczy Janos Street - Vitnyedi Street and Csatkai Endre Street - Deak Square (Figure 1), cannot be classified as good because the parked cars obscure the drivers' view. Pedestrians have to look carefully for approaching vehicles, and the vehicles cannot see behind the parked cars.

There are many factors that can influence a driver's intention to yield or not to yield. In this study, five dependent variables are used to interpret the yielding rate as an independent variable.

- Width, W: This is the geometric parameter of the crosswalk. It is measured in metres.
- Length, L: This is another geometric parameter of the crosswalk. It is measured in metres.
- Vehicle traffic volume, VV: The number of vehicles that pass through the crosswalk in 1 h.
- Pedestrian volume, VP: The number of pedestrians successfully crossing the road in one hour.
- Speed of vehicles, SV: The average speed of vehicles passing through the crosswalk in free flow, with no pedestrian crossing action. It is measured in km/h.
- Yielding rate, YR: The proportion of drivers who stop and give way to pedestrians at crossings.

The ratio of the yield rate has been determined for all observed sites:

$$YR = \frac{DGP}{AI} \tag{1}$$

where YR is the yielding rate, DGP is the number of drivers who give priority, AI is the number of all interactions. The yielding rate of all locations has been calculated and is shown in Table 2.

Multiple linear regression (MLR) was used to estimate the effect of all influencing variables to develop a statistical model. Logistic regression models were used to predict the likelihood of the studied crosswalk and whether drivers gave priority to pedestrians crossing. Drivers yielding or not yielding is the outcome variable in this research. It is a binary variable where a value of 1 indicates that the driver did yield, and a value of 0 indicates that the driver did not yield.

Table 2: Calculated Yielding rate with all variables

Locations	yielding rate	Width (m)	Length (m)	traffic volume of vehicles	traffic volume of pedestrians	Speed of vehicles (km/h)	Visibility condition
1	0.7	3.25	7.5	585	165	23	poor
2	0.74	3.25	7.5	519	129	34	good
3	0.87	4.5	8	876	108	31	good
4	0.9	3.5	11	1095	63	50	good
5	0.58	3.25	8	771	87	42	poor
6	0.82	3.5	10	942	96	38	good
7	0.79	3.5	9	525	99	25	good
8	0.86	3.5	9	600	78	20	gogood

The multiple linear regression function can be expressed in terms of logistic regression as the following equation:

$$Y = \alpha + \beta_1 X_1 + \beta_2 X_2 + \cdots + \beta_n X_n \quad (2)$$

where: n is the number of independent variables, α: constant (y intercept); β is beta coefficients and Xn is the nth predictor (independent) variable.

Thus, the multiple linear regression model used in this study can be written as follows:

$$\mathrm{Y} = \alpha + \beta_1 \mathrm{W} + \beta_2 \mathrm{L} + \beta_3 \mathrm{V_V} + \beta_4 \mathrm{V_P} + \beta_5 \mathrm{S_V} \quad (3)$$

The probability of yielding p(y) or not yielding p(1-y) in this study can be expressed by the following equation:

$$P(y) = \frac{1}{1+e^{-(\alpha+\beta_1 W+\beta_2 L+\beta_3 V_V+\beta_4 V_P+\beta_5 S_V)}} \quad (4)$$

4. Results and discussion

The results obtained by calculating the multiple linear regression in Excel have shown that the independent and dependent variables have a correlation of 91 % (Table 3). The p-value of each parameter is greater than 0.05, which means that it is not statistically significant. However, this does not mean that the results cannot be used, as there is still the probability of yielding rate will be close to the initial rate. The smallest p-value of the variable length equal to road width is the main factor for drivers to slow down and give priority to pedestrians.

Table 3: Statistics Outcomes from Excel

Regression	Statistics		Coefficients	Standard Error	T Stat	P-value	Lower 95%	Upper 95%
Multiple R	0.913	Intercept	-0.7102	0.8163	-0.8701	0.4759	-4.2225	2.8020
R Square	0.835	Width	0.1968	0.1207	1.6301	0.2446	-0.3226	0.7162
Adjusted R Square	0.423	Length	0.1013	0.0528	1.9183	0.1950	-0.1259	0.3285
Standard Error	0.080	Vehicles	-0.0002	0.0004	-0.5974	0.6108	-0.0020	0.0015
Observations	8	Pedestrians	0.0010	0.0016	0.6383	0.5886	-0.0058	0.0078
		Speed of vehicles	-0.0002	0.0067	-0.0311	0.9779	-0.0291	0.0286

The results of the multiple linear regression derived from the calculation in Excel, which are the coefficients of each parameter, can be written as follows:

$$\boldsymbol{Y = -0.71 + 0.19W + 0.1L - 0.00025V_V + 0.001V_P - 0.0002S_V} \quad (5)$$

The actual equation for predicting the probability of the yielding rate in this study can be written as follows:

$$\boldsymbol{P(y) = \frac{1}{1+e^{-(-0.71+0.19W+0.1L-0.00025V_V+0.001V_P-0.0002S_V)}}} \quad (6)$$

Referring to Table 4, the values or probabilities of yielding rate for all sites are nearly to the yielding rate calculated by the number of drivers who give priority to pedestrians divided by all interactions, as shown in Figure 2, the comparison between initial yielding obtained by site survey, which calculates the rate of them and the probability of yielding rate predicted by logistic regression. It can be noted that this logistic model is suitable for this study by estimating two values (yield or no yield). Furthermore, it can be seen that the highest speed of vehicles, which is location 4 (Csengery St. - Frankenburg St.), does not significantly affect the yielding rate of drivers due to the fact that the length of the crosswalk is 11 m, which allows drivers to clearly see the pedestrian while crossing. On the other hand, the low speed of vehicles at site 1 (Ferenczy Janos St.- Vitnyedi St.) cannot increase the opportunity for drivers to yield because the visibility at this location was not good or it was not clear to see the pedestrian crossing behind the parked cars. The lowest yielding rate at location 5 (Csatkai Endre St. - Deak square) is 0.58, which is really close to 50 % not yielding, and the probability was also very low due to the poor condition. The widths of the pedestrian crossings in this study are not different and cannot be distinguished because they are mostly 3.5 m. Only the width of location 3 (Beke square), which is 4.5 m, has a yield rate of 0.87, and the probability of yielding is 0.7043, which might be the condition for many drivers to stop and give way to pedestrians.

Table 4: Calculations of Probability of Yielding Rate by Logistic Regression

Locations	yielding rate	Width (m)	Length (m)	traffic volume of vehicles	traffic volume of pedestrians	Speed of vehicles (km/h)	Visibility condition	Linear Scores	Probability of Yielding Rate
1	0.7	3.25	7.5	585	165	23	poor	0.7046	0.6692
2	0.74	3.25	7.5	519	129	34	good	0.6823	0.6643
3	0.87	4.5	8	876	108	31	good	0.8679	0.7043
4	0.9	3.5	11	1095	63	50	good	0.8698	0.7047
5	0.58	3.25	8	771	87	42	poor	0.6248	0.6513
6	0.82	3.5	10	942	96	38	good	0.8434	0.6992
7	0.79	3.5	9	525	99	25	good	0.8533	0.7013
8	0.86	3.5	9	600	78	20	gogood	0. 0.8139	0 0.6929

In addition, the calculations of yielding rate and probability of yielding rate in this study can support the interaction between Autonomous Vehicles and Pedestrians due to the average outcomes of yielding rates being over 0.5, which drivers preferably give priority to pedestrians as well as that autonomous vehicles will slowly stop when approaching the obstacles.

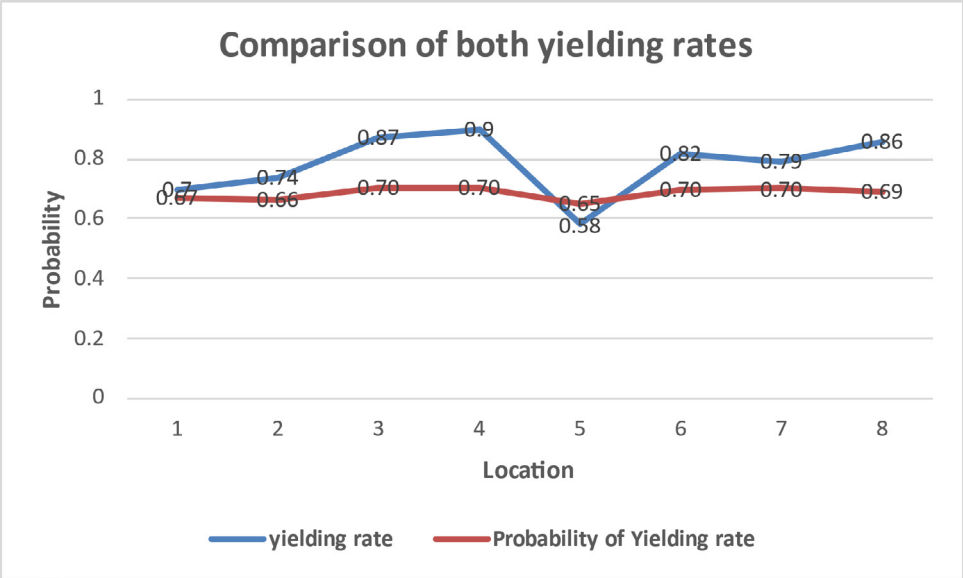

Figure 2: Comparison of estimated yielding rate and probability of yielding rate

5. Conclusions

Autonomous driving is expected to bring many benefits to individuals and society, including improved road safety, reduced congestion and a better environmental footprint. This paper has proposed a predictive model that can be used to predict the probability of drivers to yield or not to yield, which depends on the width and length of the crosswalk, the volume of vehicles and pedestrians, the speed of vehicles, which depends on the excellent visibility conditions. The interaction between pedestrians and vehicles in the selected locations is not significant because the population of the selected city is not high enough. The p-value is therefore greater than 0.05, which is not statistically significant.

The effect of pedestrian-conventional interaction at the uncontrolled pedestrian crossings studied in this research may be fundamental knowledge in the future when widespread acceptance of autonomous vehicles becomes a reality. Therefore, it is necessary to observe more locations with different road environments, geometries, traffic volumes and road categories. The impact of pedestrian crossing flows on road capacity in the presence of autonomous vehicles needs to be investigated in further steps of the research, as well as how pedestrians will react to automated vehicles and whether this would affect their behaviour.

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CULTURE OF NATIONALITIES IN A CREATIVE AND SUSTAINABLE CITY

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The concept of creative cities has a history of only two decades. According to Richard Florida, the most significant researcher of the topic, a settlement can only be successful if it is as tolerant as possible, and at the same time as diverse as possible. In addition, a creative settlement can only operate with a sustainable approach. In our study, we examine, partly from this prospective, the cultural activities of the nationalities of Szombathely, a medium-sized Hungarian city, and also because we believe that the cultural activities of the nationalities contribute to the performance of the local creative and cultural economy. The cultural activities of the nationalities are largely traditional, consequently it also reflects a close-to-nature, sustainable approach. There are four nationalities in Szombathely: Germans, Gypsies, Croats and Slovenes. They maintain civil organizations, educational institutions, community spaces, help the city's international relations, and contribute to the city's economic development with cultural programs. In our paper, we wish to present the importance of the culture of nationalities in general, as well as the specific activities of the four studied communities carry out in the city.

1. Introduction

Due to their much larger population, urban areas are generally more diverse than rural ones. Cities are melting pots of cultures, languages and traditions, the mixing of people from different cultural backgrounds can lead to a rich exchange of ideas, perspectives and traditions. Cross-cultural connections can foster creativity by exposing individuals to different mentalities and innovative approaches.

The urban environment shapes the collective identity of its residents. Nationalities in towns often develop specific cultural manifestations influenced by their environment, history and shared experiences. They serve as valuable repositories of creativity as they provide a means for urban populations to be able to express their identities and communicate their narratives to the wider world.

Persell et al. (2001) highlight two important dimensions of civil society, the institutional and the qualitative dimension. Persell et al. describe the institutional dimension of civil society as including all of the organizations and associations to which people belong and the qualitative dimension as the social attitudes such as loyalty and trust, social practices such as civility and cooperation, and the health and safety of its members.

In the definition of social capital, many have used the term ***social tolerance*** as a component of social capital. Social tolerance is generally considered attitudes of one social group towards members in a different social group. Persell et al. (2001) define pure or complete social tolerance as full recognition and acceptance of the identity and uniqueness of differences that are seen as not reducible to invisibility by their bearers. Florida (2010a) defines the level of tolerance in a country as consisting of two major dimensions; the degree to which a country values traditional beliefs over more modern or secular values and the degree to which a country values individual rights and self-expression. Past research suggests that tolerance is a part of social capital

and greater levels of social capital has been shown to promote economic growth and sound institutions. In our study, the latter aspect plays an important role in relation to the nationalities of the region under study.

Richard Florida, who created the concept of the creative class and also deals with creative cities, claims that individuals working in creative occupations strongly influence urban development and economic growth. One of the central elements of this theory is the tolerance index, which measures the level of acceptance and openness to diversity within the city's population. The purpose of the publication is to provide a comprehensive picture of the Index, its conceptual framework, and the promotion of social cohesion and the enhancement of urban well-being. Florida argues that diversity and tolerance are key components to the flow of talented individuals to cities and to encourage innovation and economic prosperity. The tolerance index can be calculated using various indicators. The results indicate the receptivity and receptive attitude of the cities. The most frequent metrics include racial and ethnic diversity, LGBTQ+ friendliness, religious acceptance, and the presence of creative communities. A high level of tolerance in cities can lead to increased social integration, reduced social tensions, and cultural revitalization, and cities with higher levels of tolerance and acceptance tend to attract diverse talents and skilled professionals from different fields. The inflow of creative individuals can contribute to economic growth, innovation, and the ignition of entrepreneurial activities. Tolerance therefore becomes a key factor in attracting the creative class and, as a result, positively influences the city's economic prospects, which is why the sustainability of tolerance is of high importance. Tolerance is not a static concept and may alter over time due to various factors such as economic and political changes and global events. Understanding the factors that maintain tolerance and prevent its erosion is essential to ensuring the long-term prosperity of diverse urban communities. (Florida, 2002) Florida also introduces the 3T model, talent, tolerance, and technology, which make cities attractive to the creative class. Talent refers to the availability of a highly skilled and trained workforce; technology refers to the availability of high-speed internet, state-of-the-art research facilities, and other technological infrastructure; tolerance on the other hand refers to the openness and diversity of a city's social and cultural environment. These components are essential for the new urban economy. (Florida, 2005) The strong correlation between tolerance and the creative economy has been confirmed by research outside of Europe and North America. (Brata et al., 2023) However, it should be noted that, according to some authors, the creativity indices (thus the tolerance index) make cities comparable, so the uniqueness disappears. (Kačerauskas, 2021)

After the economic crisis of 2008, Florida emphasized that an economic policy based on debt and consumption should be replaced by balance and sustainability, which requires more liveable and sustainable cities. New urban planning solutions are necessary, which require investment in urban infrastructure elements such as affordable housing, public transportation, or parks and green spaces (Florida, 2010b). Such sustainable cities are settlements that balance the social, economic, and environmental needs of their residents without compromising the prospects of future generations. The goal is to create healthy and liveable neighborhoods while reducing their impact on the environment. Sustainable cities ensure a high quality of life for their residents by promoting efficient transport, access to green areas, and social interaction. On the other hand, the sustainable settlement approach also induces significant economic benefits, as green investments create jobs, attract investors, and improve economic competitiveness. They also reduce the costs of infrastructure maintenance and operation (Nagy, 2008). Jeffrey D. Sachs said social inclusion is important to achieving sustainability goals. (Sachs, 2015). It is an important task to prevent and reduce the spreading out of settlements since the environmental burden strongly increases with the relocation of urban citizens to the agglomerations (Glaeser, 2011). Connecting the concepts of a creative city and an inclusive city can also help city branding. (Alsayel et al., 2022)

Based on the above, it can be concluded that creative cities are significantly influenced by cultural diversity, which is represented, among other things, by members of minority cultures. At the same time, the conditions of a creative urban milieu are urban sustainability and a liveable environment. We find that the traditional, native national minorities also like to represent their own traditional culture in the cities. These traditions can often be linked to the agrarian culture and their own sustainable community tradition, consequently, they point in the direction of not only the creative but also of the sustainable city. Based on the above, in order to create a creative, sustainable and culturally diverse settlement, it is necessary for the city decision-makers to embrace, support the urban nationalities by creating an accepting, partnering environment for them. Figure 1

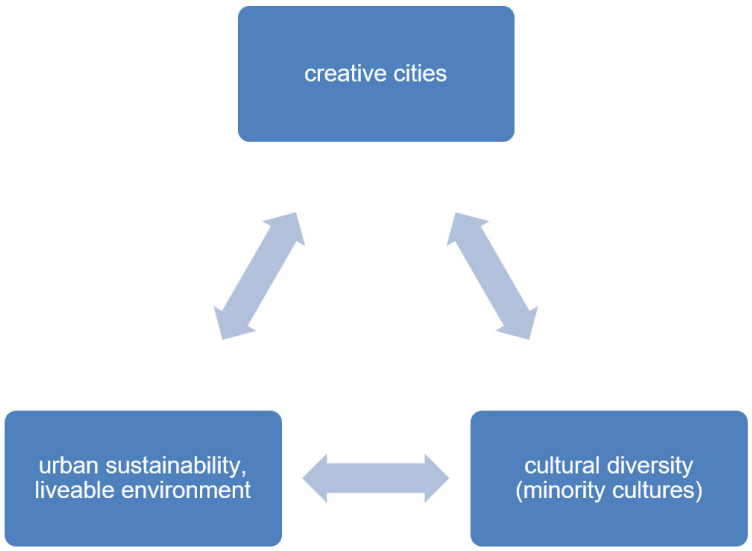

Figure 1: A model of the creative city, cultural diversity and urban sustainability (own editing)

In the following, we would like to present the functioning of ethnic communities in a Hungarian city, Szombathely, as a case study of the above theory.

2. Nationalities in Szombathely

Cultural arts and local traditions can create social closeness, maintaining a harmonious environment between humans and their surroundings. These local traditions have significant meanings and values that deal with religious and cultural differences in social interactions. The local practices are the expression of local knowledge or wisdom, often referred to as the local genius of a community in responding to their environmental situation. The values of local wisdom are viewed as an entity that significantly determines the human dignity in their communities. It contains the elements of intelligence, creativity, and local knowledge from social figures and their communities. Traditions and social norms in the community can functionally strengthen the cultural system as a life reference, essential in strengthening human social emotions. Therefore, local wisdom can be an element of social closeness in cross-cultural lives. (Rivadi, 2022)

Szombathely is a town in Western Hungary currently with approximately 75,000 inhabitants. It has been the country's longest continuously inhabited settlement for the past 2,000 years, significantly defined and shaped by different civilizations and cultures since the Roman era. The town is the center of Vas County - one of the areas with the most complex ethnic structure at the beginning of the 20th century in the Carpathian Basin. However, the assimilation at the beginning of the 1900s was already felt in Szombathely, as well. (Balizs and Bajmóczy, 2013)

From previous research on national minority communities, we highlight the example of Vas County. The questionnaire survey carried out in 2019 looked at the scope of activities of communities linked to the Slovenian nationality. It revealed that 58 % of the organizations are involved in cultural activities, 25-25 % are involved in child and youth protection, sports, health, and environment protection, 16-16 % in historical preservation and pensioners and elderly affairs, 8 % are involved in social and equal opportunities issues, and the other category includes national and historical preservation and fostering friendship between peoples and the preservation of traditions. (Vehrer–Papp, 2020)

The most recent census data is available from 2011 from Szombathely. At that time, the town's population was approximately 79,000. The number of Hungarians was 64,500. The largest ethnic community in the city was Germans (585 people). They were followed by Gypsies (579 people), Croats (412 people), and Slovenians (119 people). In the 2011 census, another 61 Romanians were recorded, as well as a small number of

Bulgarians, Greeks, Poles, Armenians, Ruthenians, Serbs, Slovakians and Ukrainians. The total population of traditional nationalities was 1,876.

Apart from them, a few declared themselves to belong to non-native nationalities (Russian, Arabic, Chinese, Vietnamese, and others): a total of less than 200 people. (During the census, several people did not want to answer the question about their nationality.) (Hungarian Central Statistical Office, 2011)

Table 1: Nationalities in Szombathely (Hungarian Central Statistical Office, 2011)

Nationality, language	Number of population
Hungarians	64,576
Bulgarian	14
Gypsies	579
Greeks	13
Croats	412
Poles	17
Germans	585
Armenians	15
Romanians	61
Ruthenians	7
Serbs	17
Slovakians	27
Slovenians	119
Ukrainians	10
Arabs	16
Chinese	11
Russians	29
Vietnamese	3
Other	115

We can see that the proportion of all non-Hungarian nationalities does not reach 3% in Szombathely, but their cultural and community presence is more significant than this proportion. There are four nationalities in the town that, thanks to Hungarian laws, can form a minority self-government with the support of the local government: Germans, Gypsies, Croatians and Slovenians.

The number of citizens of the four nationalities is also indicated by the number of citizens registered during the minority local government elections held in parallel with the municipal local government elections. In the case of the Gypsies, 258 people had the right to vote in 2010 (153 cast their vote); as for the Croats, 177 out of 237 eligible voters voted; among the Germans, 91 people were registered, of which 64 voted; while for the Slovenes there were 57 entitled to vote, but only 46 people cast their votes. (National Electoral Office, 2010) In 2014, the number of Croats eligible to vote decreased to 155 (of which 122 voted); 28 out of the 38 Germans voted; 34 out of the 40 Slovenians cast their votes. However, the number of voters of Gypsy origin increased to 315 (of which 157 people voted). (National Electoral Office, 2014) The number of voters increased in 2019 compared to the previous elections: 228 Croatians could vote, 196 Germans, 455 Gypsies, and 45 Slovenians. (National Electoral Office, 2019) Figure 2.

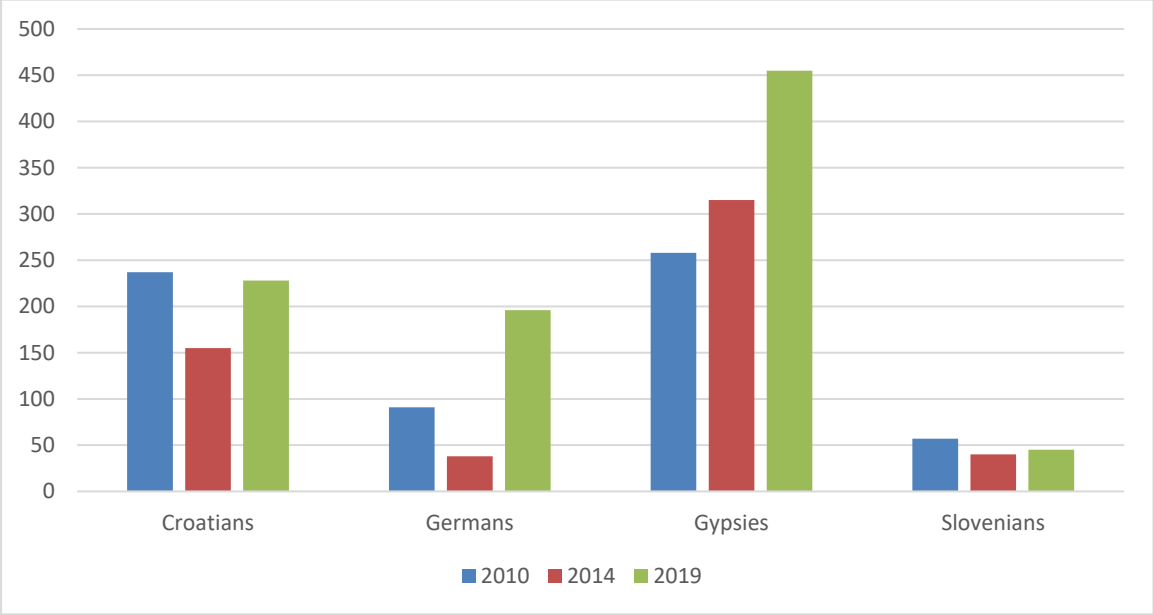

Figure 2: Number of citizens registered during the minority local government elections

Since whoever registers can vote, the recent numbers obviously do not authentically show how many people belong to the given nationality in the town, but they show the activity of the local ethnic communities, they are good indicators of community engagement. These local governments established after the elections are important because they will be the defining bodies of the local communities, primarily responsible for cultural, educational, community, or international (with the motherland) relations. The Szombathely municipality provides them with the official background and the resources necessary for operation. There is a separate sub-page on the town's website where the background materials, minutes of representative body meetings, decisions and reports of the four ethnic municipalities can be found. (szombathely.hu, 2023) In the following, we summarize their activities based on the documents found here.

The civil organization of the Slovenian nationality in Szombathely is the Slovene Cultural Association, named after the linguist, writer, and ethnographer Pável Ágoston, which holds a general assembly every spring according to their 2022 and 2023 program calendar. The association was founded in 1999 and organizes its programs jointly with the minority local government. During the year, they organize several trips to Slovenia or to the settlements of Slovenes in Hungary. They commemorate the local aspects of Slovenian culture, continuously cherishing the memory of Ágoston Pável. In 2022, they celebrated the 20th anniversary of the Slovene house of the Szombathely open-air museum, and in 2023, a book presentation by a local Slovenian author was held. They are regular participants of the Szombathely Minority Day. Their folk culture is primarily nurtured by the Szombathelyi Nefelejcsek song circle. Their recurring program for years is the Slovenian Film Days at the AGORA–Savaria Film Theatre, where the interested audience can view contemporary Slovenian cinematographic works.

The Croatian nationality is larger in number; therefore, they perform more tasks. They also operate a Croatian elementary school and kindergarten in the town in addition to their programs and NGOs. These communities also serve as cultural bases. Their artistic groups include the choir, the tramp band, and the folk dance circle. They take care of their traditional culture: there is a mass held in Croatian; they organize carnivals, balls, and in the winter, an event to make sausages together. In the summer, they participate in the Szombathely Minority Day, but they also organize an independent Croatian day. Important Croatian national and international holidays (Mother's Day and Children's Day) are also commemorated. Their civil organization is the Szombathely Croatian Association. The community also has outdoor sports groups in the town.

Children belonging to the German nationality can have their education in Szombathely in two kindergartens and a primary school. These educational facilities – like in the case of the Croatians – also help the cultural

goals of the minority community. They organize art groups and a summer reading camp and participate in the Szombathely Minority Day, but their primary focus is the operation of the elementary school.

The operation of the local Gypsy minority differs from the previous ones in certain elements. They do not maintain an institution, but they have a community space suitable for holding cultural and other events. It does not have a classical art group, but thanks to the active artistic and cultural organizing work of the Roma artist József Ferkovics, there are regular Gypsy art exhibitions and equal opportunity events in the city. Every year, a Roma creative camp is held in the northern part of Szombathely, to which artists come from all over the country. Instead of art groups, the Gypsy nationality focuses on other civil communities. For example, they operate a civil guard association, as well as a social organization that helps young people. During the operation of the community it focuses more on social activities, and helping the disadvantaged is more emphatic. Commemorations of the victims of the Roma Holocaust are regular in the life of the community. There is a plaque in the town that helps preserve the memory of the victims.

3. Conclusions

In our study, we demonstrated that diverse, accepting cities promote the creation of a tolerant yet creative settlement. Cultural diversity can be helped not only by subcultural minority groups but also by indigenous nationalities. Urban sustainability is also a condition for liveable and creative settlements. We argued that, during their operation, the ethnic communities primarily display a more traditional, smaller-scale culture that is closer to nature, which also points towards the sustainability of cities.

The operation of the ethnic communities of Szombathely in Hungary was presented as a case study through the example of the Slovenian, Croatian, German, and Gypsy communities. As a summary of the case study, we can make the following conclusions:

1. Even small ethnic communities can be strongly present in the life of a city. These communities can complement the mainstream culture, which they also influence. Nationalities, therefore, have a greater impact on the life of a city than their real weight would suggest.

2. The operation of educational institutions can be of high importance for an ethnic community. These organizations are not only places for continuous resupply of mother tongue speakers and nationality education but also community and cultural institutions, the background bases of the nationalities. They are also regionally important since they can also receive the children of ethnic families from the villages and smaller settlements around the city. In addition to the city and regional level, educational institutions also have an impact on their close surroundings, the neighborhoods, so the nationalities are also present in the everyday life of these parts of the cities (they take care of parks, raise traffic problems affecting the school, etc.)

3. The operation of art groups and civil organizations is also highly important in the life of ethnic communities. In the case of each nationality, we can find such organizations that provide a non-profit basis for the realization of their goals. With these organizations, it is possible for them to access civil funds, which can supplement their operations.

4. Urban nationalities do not shut themselves up in their own communities. They are present in the life of the settlement with their cultural programs: minority day, Croatian Day, and Slovenian Film Days. In this way, they help those belonging to the majority culture to get to know and experience their ethnic culture, which, in addition to the visible diversity, can strengthen the cultural diversity and tolerance of the cities.

5. Traditional cultural care is used to implement environmentally sustainable programs on a sustainable scale linked to community events that respect and recognize natural values.

The case study thus shows a link between tolerance, human capital, development, and sustainable economic growth expressed in terms of competitiveness in the region under study.

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