

POLICE STUDIES

THE PERIODICAL OF THE POLICE SCIENTIFIC COUNCIL

CSETE, DÁNIEL

No-Go Zones and Tourism Security: Law Enforcement Challenges and Perceptions

CZIFRA, BOTOND

Examining the Attitudes of Hungarian Drivers in Domestic Road Transport Regarding Their Financial Situation

FENYVESI, CSABA – FÁBIÁN, VANESSZA

Criminalistic Lessons from the Last Death Penalty in Baranya County

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Adhesive Tape as Forensic Evidence

FÜLÖP, PÉTER

„Body physics” – Innovative options for supporting forensic medical expert practice in Hungary



2026/1-2



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CONTENTS

2026/1-2.

CSETE, DÁNIEL

No-Go Zones and Tourism Security: Law Enforcement Challenges and Perceptions (9-18)

CZIFRA, BOTOND

Examining the Attitudes of Hungarian Drivers in Domestic Road Transport Regarding Their Financial Situation (19-26)

**FENYVESI, CSABA –
FÁBIÁN, VANESSZA**

Criminalistic Lessons from the Last Death Penalty in Baranya County (27-40)

FULLÁR, ALEXANDRA

Adhesive Tape as Forensic Evidence (41-53)

FÜLÖP, PÉTER

„Body physics” – Innovative options for supporting forensic medical expert practice in Hungary (55-74)

HORVÁTH, ORSOLYA

Technological Innovation and the Pursuit of Truth: Integrating 3D Reconstruction and Artificial Intelligence into Criminalistics (75-87)

**KISFONAI, BERNADETT
PATRÍCIA**

Artificial Intelligence in Law Enforcement: International Experiences and Hungarian Prospects (89-99)

LANG-FUKSA, DOROTTYA	Speeding Regulations in Switzerland in the Light of Police Sanctions: Fine Systems, Raserdelikt and Reform Directions (101-112)
MÁGÓ, BARBARA	The Role of the Defendant's Nationality in Criminal Law (113-122)
ÖVEGES, KRISTÓF	The Significance of Law Enforcement History Research in the Development of Law Enforcement Science (123-134)
SZÉKELY, E. ÁRNIKA	What Plant Evidence Tells Us (135-153)
TÓTH, KRISZTINA – KISS, ISTVÁN	The Importance of Accreditation in Forensic Expert Examinations (155-162)
VOLARICS, JÓZSEF	Crime Scene Investigation in a CBRN Environment – Capacity Building and Innovation (163-173)

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2026/1-2.

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CSETE, DÁNIEL

No-Go zones and tourism security: law enforcement challenges and perceptions

Introduction

Tourism security¹ has become one of the most decisive dimensions of international tourism today, particularly given accelerating global mobility and urbanisation. In destination choice, beyond economic and cultural factors, the role of subjective safety perceptions and the images associated with a given place has gained increasing significance.² One of the most extreme manifestations of this is the phenomenon of so-called “no-go zones,” a term used in public discourse to describe urban or peri-urban areas that visitors perceive as dangerous or to be avoided, regardless of whether the actual public safety situation justifies such an assessment. As a result, these districts are relegated not only geographically, but also socially, economically, and in terms of tourism, to the periphery. The aim here is not to definitively settle the question of whether no-go zones exist, but rather to explore how their real or perceived safety influences tourists’ decisions.

The social narratives surrounding no-go zones often operate as self-fulfilling prophecies. Negative media coverage, political rhetoric, and fears spread via social media can substantially contribute to the stigmatisation of certain neighbourhoods, prompting tourists to avoid them. This process frequently unfolds independently of actual crime rates and stems instead from distorted perceptions of safety and shortcomings in public security

¹Michalkó, G. – Németh, J. – Ritecz, Gy.: Turizmusbiztonság [Tourism Security]. Dialóg Campus. Budapest, 2020. 463. o.

² Péter, E. – Németh, K. – Lelkóné Tollár, I.: Turizmusbiztonság, mint újonnan felmerülő fogyasztói igény [Tourism Safety as an Emerging Consumer Demand]. Turizmus Bulletin, 2. 2018. 30–37. o.

communication. The consequences extend well beyond a decline in tourism: social exclusion of residents and economic downturn also loom as risks.

Nevertheless, the relationship between tourism and no-go zones cannot be understood solely as a problem. Numerous examples demonstrate that districts once deemed unsafe can be successfully repositioned, and even transformed into attractive tourist destinations, provided the process is accompanied by community engagement, deliberate law enforcement strategies, and positive narrative-building. Alongside strengthening public safety, crime prevention, and rebuilding social trust, actors in the tourism sector—including security and law enforcement institutions—play a key role in dismantling stigma and fostering neighbourhood revitalisation.

The present study seeks to examine the tourism-related and security policy dimensions of no-go zones through the lens of law enforcement studies. Special attention is given to the role of subjective safety perceptions, the mechanisms by which negative images are formed and sustained, and how policing and community interventions can help reintegrate marginalised urban areas into the flow of tourism. By presenting international best practices, the article further highlights that no-go zones are not static or irreversibly isolated spaces, but urban environments that, with adequate policy attention and cooperation, can regain their social and touristic functions—outcomes that are both economically and socially desirable.

Theoretical and conceptual framework

The concept of the “no-go zone” cannot be understood merely as a descriptive category; rather, it is a construct shaped by complex social processes, underpinned by political, sociological, and law enforcement dimensions. Although the term lacks a unified, legally codified definition, it is

generally applied to urban areas where the presence of authorities has diminished, public order has weakened, and the subjective sense of security³ among residents and visitors has significantly declined. Thus, no-go zones appear not only as geographical spaces, but also as peripheral areas in social, political, and symbolic terms.

From a law enforcement science⁴ perspective, three main dimensions can be distinguished: weakening normative control, symbolic stigmatisation, and structural marginalisation. The decline of normative control is reflected in the limited functioning of state institutions and law enforcement: police presence is sporadic, official intervention is inconsistent or even rejected, detection rates are low, while the level of hidden (unreported) crime remains high. Symbolic stigmatisation arises from the homogenised negative image produced by public opinion and the media, which ignores the internal diversity of these neighbourhoods. Structural marginalisation, in turn, stems from limited social mobility, restricted access to education and the labour market, as well as ethnic segregation.

In the context of tourism security, the notion of subjective safety is particularly important. Research confirms that travel decisions are shaped far more by perceived security than by objective data. Such perceptions are largely influenced by information derived from the media, social media platforms, travel blogs, or online reviews. The stigmatisation of a neighbourhood is therefore often less a result of actual events than of their interpretation, visual representation, and the repeated emphasis on negative incidents. Consequently, the image formed in tourists' minds may not necessarily reflect the security situation.

³ Boda, J. (ed.): Rendészettudományi szakszótár [Encyclopedia of Law Enforcement Science]. Ludovika Egyetemi Kiadó. Budapest, 2019. 544. o.

⁴ Lippai, Z. – Sallai, J.: Helyet kér a rendészettudomány [Law Enforcement Science Claims Its Place]. Belügyi Szemle. 2022. 1829–1852. o.

No-go zones and tourism

The relationship between tourism and no-go zones is complex and often ambivalent. Tourism traditionally relies on stability, predictability, and the provision of positive experiences; therefore, any factor that undermines these expectations directly diminishes a destination's attractiveness. No-go zones, even when they do not pose an actual physical threat, are frequently associated with negative stereotypes that discourage visitors. Such stereotypes often extend beyond a specific neighbourhood, adversely affecting the overall image of an entire city or even a country as a tourist destination. The media plays a decisive role in shaping and maintaining this stigma.

Negative news reports in the press and on social media have a particularly strong impact on tourists' perceptions. It is common for a single isolated incident, an exaggerated report, or a sensationalised story to create a collective image of a neighbourhood that does not reflect its actual security situation. The digitalisation of news consumption further accelerates this process: a single negative piece of content can spread globally within moments and become deeply embedded in public consciousness. As a result, certain destinations are stigmatised, and tourists—often without conducting any real risk assessment—choose to avoid them. This not only causes economic losses for local communities and service providers but also hinders long-term social development. Thus, the media not only transmits information but also actively shapes the collective narratives of tourism security, making the promotion of accurate, nuanced, and contextualised reporting particularly important.

One of the main drivers of tourist avoidance is the lack of subjective safety. Visitors tend to steer clear of neighbourhoods associated with crime, social tensions, or cultural unfamiliarity. This process not only harms the local economy but also deepens the area's structural marginalisation. As visitor numbers decline, investment interest decreases, development projects are postponed, and social exclusion is reinforced.

At the same time, the relationship between tourism and no-go zones should not be interpreted exclusively negatively. In certain cases, tourism

itself may become a catalyst for the renewal of peripheral urban areas. Community-based tourism, social enterprises, local initiatives, and targeted development programs can all help create a new tourist identity for stigmatised districts. Of particular note in this regard is the phenomenon of dark tourism⁵, which attracts a specific visitor segment to sites linked to violence, disasters, or social trauma. These may include the scenes of past crimes, abandoned prisons, migrant camps, or memorial sites in former war zones.

Responsible tourism development is of critical importance in such contexts. It cannot be exploitative, cannot rely solely on sensationalist narratives, and must not disregard residents' interests. If these principles are respected, tourism can provide not only economic opportunities but also foster social integration and strengthen law enforcement presence.

In sum, the connection between no-go zones and tourism should not be viewed as a one-dimensional process. Tourists' avoidance behaviours can indeed perpetuate a district's peripheral status, but well-designed development strategies that leverage local resources can contribute to regeneration and the creation of safe tourist environments. In this way, policing and tourism are not conflicting domains but rather mutually reinforcing systems in the re-positioning of urban spaces as viable tourist destinations.

The significance of law enforcement measures

Law enforcement interventions related to no-go zones extend beyond public safety, as they also involve socio-political and tourism-strategic dimensions. The role of policing extends beyond crime control; it also encompasses stabilising public order and restoring trust among residents and tourism stakeholders. Restoring a sense of safety is a complex, multi-level process

⁵ Lennon, J. (2017): Dark tourism [Dark Tourism]. Oxford University Press, Oxford. 41. o.

that requires close cooperation among state authorities, municipalities, civil organisations, and local communities.⁶

The preventive approach of community policing can be particularly important in this context. This model allows police officers to act as partners within local society rather than merely as controlling or sanctioning authorities. It is particularly relevant in neighbourhoods where a crisis of trust has previously developed between residents and law enforcement agencies. Regular and predictable police presence, transparent communication, and sensitivity to local needs all help strengthen public order and enhance tourists' subjective sense of security.

Improving the physical environment is also a fundamental component of successful law enforcement interventions. Modernised street lighting, the functional redesign of public spaces, the installation of surveillance systems, and the rehabilitation of transport hubs can all help reintegrate previously avoided neighbourhoods into the flow of tourism. Yet such measures alone are insufficient: involving community actors and maintaining continuous social dialogue are indispensable for achieving sustainable outcomes.

The role of law enforcement communication is likewise crucial. Not only the implementation of measures but also their public presentation shapes how tourists and residents perceive change. The deliberate shaping of narratives, the visibility of achievements, and the incorporation of community perspectives can reduce stigmatisation and enhance credibility.

Within this framework, law enforcement science should not be regarded merely as a repository of applied knowledge but also as a strategic tool for

⁶ Christián, L. – Szabó, C. (2016): A magánbiztonság, az önkormányzati rendészet és a polgárőrség szerepe a turizmus védelmében [The Role of Private Security, Municipal Policing and Civil Guard in the Protection of Tourism]. In: Németh, K. (ed.): I. Turizmus és biztonság nemzetközi tudományos konferencia tanulmánykötet [Proceedings of the 1st International Conference on Tourism and Security]. Pannon Egyetem Kiadó, Nagykanizsa. 18–24. o.

shaping perspectives.⁷ It enables no-go zones to be seen not solely as areas of risk, but as urban spaces capable of rehabilitation and repositioning. Aligning tourism security with law enforcement presence thus serves not only to protect visitors but also to improve residents' quality of life.

International examples and best practices

Al-Abdali, Amman

The Al-Abdali project⁸ was launched in 2005 in the centre of the Jordanian capital, on land previously used for military purposes. The initiative aimed to create a modern, multifunctional urban centre, including the New Abdali district with hotels, office buildings, residential complexes, commercial units, and leisure areas. Opinions among residents, however, remain divided: while the project has introduced new infrastructure, modern public spaces, and increased investment in the area, many feel it does not adequately serve the local community's needs. One of the most frequent criticisms is that many offices and apartments remain vacant because their prices are unaffordable for the average Jordanian citizen. At the same time, public spaces—particularly The Boulevard—have become lively, safe meeting points, positively impacting the city's overall sense of security.

From a security perspective, the project has produced several positive outcomes. Modern street lighting, increased police presence, the installation of advanced surveillance systems, and the revitalisation of urban life have collectively helped transform a previously avoided district into an attractive tourist destination. Nevertheless, an important lesson is that such

⁷ Keller, K. – Tóth-Kaszás, N.: A turizmusbiztonság megjelenése az EU tagállamainak turisztikai stratégiáiban [The Appearance of Tourism Safety in the Tourism Strategies of EU Member States]. *Vezetéstudomány*, 6. 2021. 32–43. o.

⁸ Kadhim, M. – Al-Akiely, F. (2015): Al-Abdali Mega Project: Assessment of Socio-economic and Cultural Impacts on the Peripheral Edges [Al-Abdali Mega Project: Assessment of Socio-economic and Cultural Impacts on the Peripheral Edges]. In: Aboutorabi, M. – Zalloom, B. (eds.): *Transformation of the Urban Character of Arab Cities since the Late Last Century*. Birmingham. 239–255. o.

developments can only be sustainable in the long term if physical renewal is accompanied by social integration. In the case of Al-Abdali, the lack of inclusivity and affordability raises serious questions about the project's actual social utility.⁹

Molenbeek, Brussels

Molenbeek came into the international spotlight in a highly negative context following the 2015 Brussels attacks and its association with ISIS-linked terrorist networks.¹⁰ The media frequently referred to the district as a “*jihadist hub*”, which significantly contributed to the formation of the no-go zone stigma. Its case illustrates how terrorism can exert both direct and lasting impacts on tourism.¹¹

In recent years, however, civil organisations, artists, and local initiatives have been working to reposition Molenbeek. Guided tours are organised that not only address the conflicts but also highlight the district's industrial heritage, cultural diversity, and vibrant community life. Drawing on elements of dark tourism, the aim is to present not only negative narratives but also positive stories of local resistance, cooperation, and identity.

In parallel, law enforcement and community programs have been launched to rebuild trust. One notable example is a theatre project designed to foster dialogue between local youth and the police, which helps break down prejudices and strengthen both security and community cohesion.

Molenbeek's example demonstrates that even a heavily stigmatised neighbourhood can achieve a positive turnaround if local communities are empowered to shape the narrative and law enforcement agencies focus on building trust. The stories of Al-Abdali and Molenbeek together indicate

⁹ Rama Al Rabady, “Territorial Heritage Gentrification in Abdali in Amman, Jordan,” *Built Heritage* 2024, no. 1: 1–19. o.

¹⁰ Leman, J. (2016): The history, motivations, framing and processes of Belgian jihadism: the Molenbeek case [The History, Motivations, Framing and Processes of Belgian Jihadism: The Molenbeek Case]. In: Giusto, H. (ed.): *Daesh and the terrorist threat: from the Middle East to Europe*. FEPS & Fondazione Italianeuropei, Brussels/Rome. 126–134

¹¹ Ritecz, Gy. (2018): A terrorizmus hatása a turizmusra [The Impact of Terrorism on Tourism]. *Rendőrségi Tanulmányok* 2018/4. szám.3–61. o.

that no-go zones are not irreversible conditions. With appropriate institutional development, conscious social participation, and the thoughtful integration of security measures, such urban spaces can be transformed into areas that are both safe and attractive from a touristic perspective. The key to shared success lies in renewing physical infrastructure, engaging communities, creating positive narratives, and credibly embedding law enforcement presence.

Conclusions

The phenomenon of no-go zones, situated at the intersection of tourism and law enforcement studies, represents both a challenge and an opportunity, raising new research and practical questions alike. This article has sought to demonstrate that such urban spaces are not marginalised solely by objective security risks, but rather by the combined effects of social perceptions, media representations, and prior negative experiences. As a result, districts are often stigmatised even when their actual security situation no longer justifies such a negative assessment.

Bridging the gap between subjective perceptions of safety and objective risks requires complex, multi-level interventions. Successful examples—such as Molenbeek and Abdali—show that law enforcement presence by itself is insufficient. Strengthening community participation, reshaping narratives, repurposing urban spaces, and achieving symbolic repositioning are all necessary to ensure sustainable regeneration.

It is therefore essential that policymakers, law enforcement agencies, and tourism professionals jointly develop integrated urban development and tourism security strategies that take into account the local social structure, historical experiences, and the area's symbolic significance. Such strategies may be grounded in the principles of community policing, ethical tourism development, and conscious, responsible cooperation with the media.

In conclusion, no-go zones should not be regarded as permanent conditions, but rather as social constructs that can be redefined through appropriate policy, law enforcement, and community interventions. The future of tourism security will depend on our ability to responsibly reinterpret, reintegrate, and sustainably develop these urban spaces.

CZIFRA, BOTOND

Examining the Attitudes of Hungarian Drivers in Domestic Road Transport Regarding Their Financial Situation¹

Introduction

International and domestic regulatory proposals related to wealthy drivers often recommend introducing some form of income-based road fines. Similar *de lege ferenda* concepts and public opinion on road traffic are based on the hypothesis that the wealthy commit more traffic violations. However, this requires further verification. To this end, we conducted an empirical study to test this claim.

This assumption has already been confirmed in international empirical literature. Chien-Ming Tseng conducted a questionnaire survey of Taiwanese road users to examine the socio-economic factors influencing drivers' compliance with traffic rules.² The 2009 survey examined how monthly income, education, gender, age, annual kilometres driven, and driving motivation affected road behaviour. Participants were asked, via questionnaire, whether they had received any traffic fines in the past year and, if so, how many times. The findings were then examined using multivariate regression. The analysis showed that, of the factors examined, the driver's age and gender were most closely related to their compliance with the rules. The results showed that younger drivers are more likely to violate traffic rules, and that men are more likely to do so than women. According to the survey, the highest number of violations per capita (0.3 violations per person) was committed by those with the highest incomes. Although the effect

¹ This paper is based on a presentation delivered on 26 June 2025 in Pécs at the conference Law Enforcement Research and Innovation.

² Tseng, C.-M.: Frequent Driving Purpose in Taiwan's Male Population. *Safety Science*, 57. 2013. 236–242. o

of education is also significant (and may be related to income), regression showed that income has a very strong independent effect on traffic behaviour. Personal interviews were also conducted on Taiwan's highways in 2014 to determine how much drivers are willing to pay to drive faster.³ The interviews showed that the higher a driver's income, the more they are willing to pay for speeding, which may also suggest that wealthy drivers are more likely to break the rules. An American survey also showed that the number of people who say they always obey speed limits increases with age, but decreases with higher levels of education and income.⁴

Methodology

However, to date, no survey in the Hungarian empirical literature has confirmed the assumptions regarding the traffic behaviour of wealthy drivers on Hungarian public roads. We conducted our study because such research is needed, as it is not certain that the traffic attitudes of foreign drivers are the same as those of drivers on Hungarian public roads. In Budapest, we counted and evaluated traffic on József Boulevard to see if wealthy drivers break traffic rules more often. Our hypothesis (in line with international literature) was that there is a positive relationship between drivers' wealth and their willingness to break the rules. The analysis was based on video recordings made between August 2020 and February 2024 at the corner of József Boulevard and Nap Street. The recordings were made by the Department of Public Safety at NKE RTK and made available to us for the purposes of the study, for which we express our gratitude.

Methodologically, the study differs from studies described in the international empirical literature in the way traffic is counted. Its advantage is

³ Jou, R.-C. – Hensher, D. – Chen, K.-H.: Freeway drivers' willingness to pay for speeding fines. *Transportation Letters: The International Journal of Transportation Research*, 27. 2014. 16-24. o.

⁴ Shinar, D. – Schechtman, E. – Compton, R.: Self-reports of safe driving behaviors in relationship to sex, age, education and income in the US adult driving population. *Accident Analysis & Prevention*, 33/1. 2001. 111–116. o.

that it takes place in a real-life context: it provides a picture of traffic on one of Budapest's busiest road sections, which affects many parts of the city where the financial situation of residents varies, so the subjects of the experiment are diverse, reflecting the target population, although not representative. Significant through-going traffic can also be observed in the area. However, the disadvantage of the methodology is that the scope of the recordings was limited (10 hours), their processing is very time-consuming, and, compared to regression analyses, it is not possible to isolate factors with simultaneous effects. During the traffic count, we attempted to infer the drivers' financial status from the estimated value of the cars in the recordings (which, in itself, carries the possibility of error). Based on empirical experience, we were unable to identify other factors, such as age or gender, that affect the driver's attitude towards traffic. At the same time, we expected that, together with these factors, we would be able to discover correlations between the driver's financial situation and the number of violations committed. During the examination of the recordings, we were also unable to account for ownership: rented, leased, or company cars may represent additional sources of error, as in these cases, the car's value may not necessarily reflect the driver's financial situation.

During the investigation, we focused on those traffic violations specified in Section 20(1)(k) of Act I of 1988 on Road Traffic that can be detected with the naked eye. Accordingly, we counted the number of violations of the rules governing traffic lights, turn signals, lane changes, lane use, and overtaking. We attempted to infer the drivers' financial situation. For comparison purposes (given the time required to process the recordings), we took a one-hour sample from the ten hours of recordings and estimated the value of all passing cars in the one-hour sample. We tried to take samples from the recordings so that the duration would be proportional to the weekday/weekend, time of day, and season. The distribution of these is outlined in the following Figure.

Czifra, Botond: Examining the Attitudes of Hungarian Drivers in Domestic Road Transport Regarding Their Financial Situation

Date	Duration	Day	Daypart	Season	Period used for estimation
8 November, 2020	2 hours	Weekend	Morning	Normal	5 minutes
13 February, 2021	1 hour	Weekend	Morning	Normal	7,5 minutes
11 May, 2021	1 hour	Weekday	Morning	Normal	7,5 minutes
11 August, 2021	1 hour	Weekday	Afternoon	Summertime	7,5 minutes
16 November, 2021	1 hour	Weekday	Morning	Normal	7,5 minutes
16 February, 2022	1 hour	Weekday	Afternoon	Normal	5 minutes
18 August, 2022	1 hour	Weekday	Afternoon	Summertime	7,5 minutes
12 November, 2022	1 hour	Weekend	Morning	Normal	7,5 minutes
21 February 2024	1 hour	Weekday	Afternoon	Normal	5 minutes

Table 1.
Properties of processed recordings and sampling

We considered the driver to be poor if the estimate suggested that the car he was driving was originally designed as a low-end model, and was already 8-10 years old, was designed as a mid-range model but was already 12-15 years old, or was designed as a premium car but was already 18-20 years old. Their price on the used car market is less than 1.5 million forints. We considered the driver's financial situation to be average if the car they drove was classified by the manufacturer as mid-range when new, or if it was a model from the premium segment from 5-6 years ago, which is currently affordable for a driver with an average income and does not have excessive maintenance costs. The price of these cars on the used car market ranges from 1.5 to 8 million forints. We considered drivers wealthy if their cars were classified as premium by the manufacturer and if their maintenance costs were high. The estimates were assisted by BME students familiar with the used car market, to whom we would also like to express our gratitude here.

Driver	Poor	Average	Rich
Car			
Low-end	Designed, 8-10 years old		
Midrange	12-15 years old	Designed	
High-end	18-20 years old	5-6 years old	Designed
Value (estimated)	Max. 1,5 Million Ft	1,5 Million – 8 Million Ft	Min. 8 Million Ft

Table 2.
Methodological summary of the estimate

Regarding the estimate, it is important to note that the average age of the Hungarian vehicle fleet is 15 years; accordingly, we considered it appropriate to base the estimate on the used-car market price assessment. However, there is significant variation among cars in this market: even within a given type, model, and year, vehicle values differ. Accordingly, without knowledge of the engine type, technical condition, mileage, and specific parts, we based our conclusions solely on the design, brand, and additional optical elements.

The results of the count

Based on our estimates, 19% of all drivers passing by during the ten hours sampled are poor, 70% have average incomes, and 11% are rich. These conclusions can be verified using a survey conducted by the Ministry of Finance.⁵ It examined the price distribution on the *www.hasznaltauto.hu* advertising portal, where, between 2018 and 2022, approximately 40% of used cars were valued at less than 1.5 million forints, while 15% were valued at over 8 million forints. Based on the results of the traffic count, the proportion of expensive cars is similar to the national average, while the proportion of cheap cars is lower. However, due to the capital's financial

⁵ Ván, B.: A magyarországi személygépjármű-állomány árváltozása 2018–2022 [Price changes of the Hungarian passenger car fleet 2018–2022]. PM Adózási Műhelytanulmányok, 12. 2022.

Source: <https://pmkutatas.gitlab.io/papers/moftwp012.pdf>

Accessed: 31.07.2025

situation, the value of Budapest's vehicle fleet is likely higher than the national average, and the results of the count confirm this.

The findings are presented in the Figure below. In some of the recordings, it was not clear from the camera positions which signal the traffic light was giving. Although it was possible to infer from the movements of other vehicles whether the driver had violated the signal, there were 18 cases during the ten hours where it was not possible to determine clearly, but only to assume, that the drivers had violated the rules.

	Quantity				Percentage			
	Poor	Average	Rich	Total	Poor	Average	Rich	Total
Assumed offenders	34	69	21	124	27%	56%	17%	100%
Certain offenders	25	62	19	106	24%	58%	18%	100%
Total drivers (estimation)	1250	4700	750	6700	19%	70%	11%	100%
Difference between the number of assumed offenders and the number of total drivers (percent)					9%	-15%	6%	
Difference between the number of certain offenders and the number of total drivers (percent)					5%	-12%	7%	

Table 3.
Summary of traffic count results

The first two rows of the table show the results of the count, depending on whether the 18 cases where violations were only probable were included in the number of offenders. The third row shows the estimated number of all cars. The second column group shows the percentage distribution of violations committed, based on the driver's presumed financial situation, based on the estimated value of the car they were driving, and the total number of cars in that category.

The data in the table show that among the assumed offenders, the poor are underrepresented by 9 percentage points, the rich by 6 percentage points. In contrast, among the definite offenders, the poor are underrepresented by 5 percentage points and the rich by 7 percentage points relative to their estimated share of all cars, which partially supports our hypothesis. However, the overrepresentation of people with low incomes is surprising at first glance. The following table shows the proportion of offenders by

estimated income group, and it can be observed that wealthy drivers account for the largest share of violations.

	Poor	Average	Rich	Total
Assumed offenders	2,72%	1,47%	2,80%	1,85%
Certain offenders	2,00%	1,32%	2,53%	1,58%

Table 4.
Proportion of rule breakers by estimated income group

Conclusions

It can be concluded that our hypothesis was partially confirmed during the study. According to our calculations, the propensity to break the rules may be related to estimated financial status: wealthy drivers were overrepresented by 7% among certain offenders and by 6% among assumed offenders. At the same time, poor drivers are overrepresented among rule breakers by 5% and 8%, respectively. Our research shows that the willingness to break the rules in our country is also related to drivers' financial situation. However, as we can see from the example of people with low incomes, this correlation is not linear.

The behaviour of poor drivers can be explained by the fact that, due to the methodological characteristics of traffic counting, it does not separate the effect of income from other driver characteristics. The international surveys mentioned above also point to other behavioural trends. One such trend is the limited rationality of less educated (and therefore presumably lower-income) drivers, which means that, based on their knowledge, they misjudge the likelihood of being punished for violating traffic rules and are therefore more likely to break the rules. Other similar effects may also help explain the high proportion of rule breakers among poor drivers. If there were more young people or more men among drivers considered poor, this could also help explain the high proportion of rule breakers among poor drivers. However, it may be worth concluding that if we attempt to develop

a regulatory strategy to counteract rule violations by wealthy drivers, or if we observe similar discourse among professionals or the general public, we should pay attention to the road behaviour of poorer drivers as well as wealthier ones.

FENYVESI, CSABA – FÁBIÁN, VANESSZA

Criminalistic Lessons from the Last Death Penalty in Baranya County

Preface

We met Anna exactly 48 years after that fateful day. She was sitting on the terrace of her little house in Felsőgyükés, Pécs. In the silence of the green foliage, it was as if she had been waiting for us, the researchers of the past. Memories poured out of her quickly, and words flowed like those of a reliable witness in her seventies. She knows about the events of 10 May 1974 from her mother, who never let her forget it. There was a large tree in the middle of her garden. She did not allow it to be cut down. She said many times that the plum tree had to live because Évike, the cheerful girl with curly hair who lived next door, often played in its shade.

Who was this 8-year-old girl, and what happened to her? Our study is about her, the innocent victim, and the forensic lessons learned from the investigation of her brutal killer.

The initial data

At 11 a.m. on Friday, 10 May 1974, Imre M. called the Pécs police station. His daughter, Éva M., a second-year primary school pupil (who was on holiday), had left their house in Felsőgyükés, on the side of the Mecsek hills, shortly before 8 a.m. to go shopping at a small shop in Tettye, about a thousand metres away. However, she did not return home for several hours after the 45–50-minute round trip. The family dogs sent out to search for her found the little girl's nylon bag on the footpath between the house and the shop, near the quarry, with bloodstains on it.

A large-scale search operation involving the authorities and service dogs quickly located the girl's body at 12 noon, starting from the location where the bag had been found. Bloodstains and a bloody Pepsi bottle led investigators to a bushy area about 30-40 metres from the trail, where the victim, who had visible skull injuries, was lying face down.

The crime scene investigation

The crime scene unit noticed that the unknown perpetrator(s) had also pulled down the little girl's underwear. The searchers, working in clear, sunny weather, quickly determined that the location where the body was found was not the first scene of the crime, as they discovered drag marks in addition to scattered soil and bloodstains from the cola bottle. They found an intermediate area, which could be considered the second location, at the bottom of a ravine-like depression, where a significant amount of blood had dried on the leaves and a fist-sized rock. There was no reasonable explanation as to why, after the attack on the path, the perpetrator had moved from the depths of the ravine to the less hidden bushy area, the third crime scene.

The saleswoman, Mrs S., at the small shop that still stands in Tettye today, remembered the little girl well and recounted exactly what she had bought: half a litre of milk in a bag, five rolls, three bread rolls, half a litre of lemon syrup, 100 grams of Mecsek salami, a bottle of Pepsi Cola and a bar of Maci chocolate. The milk and the bottle of Pepsi were found at the site of the first attack on the well-trodden path, while the cold cuts and some of the rolls were found at the third spot. Half of the chocolate and a third of the cold cuts wrapped in paper were missing from the bag, and only the end of one of the rolls remained.

During the autopsy, forensic experts found remnants of croissants and chocolate in the little girl's stomach.¹ They also stated that blows to the head with a hard object (a glass bottle or possibly a piece of stone) caused the skull fracture and brain damage of the girl, who had blood type A-MN, leading to her death in a very short time, without hope of survival. The damage to the hymen did not indicate sexual intercourse; a finger or an object could have caused penetration.

All of the victim's clothes and the objects found at the scene (a bloody piece of stone, a nylon bag, a cola bottle) were seized and sent to the Budapest Institute of Forensic Science (now known as the Hungarian Institute for Forensic Sciences) for examination.

The course of the investigation

The search for witnesses in the immediate and wider vicinity, which was conducted in parallel with the crime scene examination, yielded several results. In addition to the four less significant witnesses, Mrs H., who is still alive today, was accompanying her young daughter down Felsőgyűlési út towards Tettye square between 8.20 and 8.25 a.m. when she encountered a man loitering by the stone cross, which still stands today. He was unfamiliar to her.

She was able to provide a relatively good description of him. (Together with other witnesses, they compiled a composite sketch of the alleged perpetrator, but no relevant information was received from the public.)

On his way down, she also met the victim, who was already on her way home from the shop along her usual route, between approximately 8:25 and 8:30 a.m. They even talked for a while. (This was probably the little girl's last communication, as she was only about 80 metres away from the first point of attack.)

¹ Bencze, L.: Tactics for investigating sexually motivated homicides. *Belügyi Szemle*, 23/6. 1975. 91–98. o.

Investigators examined the *modus operandi*, previous police checks and control measures, convicted offenders involved in sexual offences, and recently released “dangerous criminals” who had undergone psychiatric treatment. Investigators checked approximately 3,000 people. Sixty of them were personally suspected, but none of them was found to be thoroughly suspicious. (There was one person who confessed to the crime, but it turned out that this was motivated by mental illness and was not actually related to the crime.) Local and national warrants, witness searches, local checks, informants and press releases did not yield any meaningful progress. Summer had already passed, and still no trace of the perpetrator had been found. After four months, the investigation had reached a cold end.

A well-known professional is saying that in such wide-ranging, high-profile investigations, *"the perpetrator is in the file."*² As it turned out, this conclusion holds here as well.

On 2 October, the police received a report that Erna O. knew the perpetrator's identity. The slightly intoxicated lady, who had been boasting to her friends at the Hullám restaurant, told the detectives that she believed Oszkár Nyéki was the perpetrator. Nyéki was also at the Hullám restaurant and heard his partner's betrayal. He wanted to take her home, but the staff hid the visibly intoxicated and frightened woman.

She made this claim because her partner confessed it to her on 27 August during a trip to Budapest. Due to his bad reputation in Isaszeg (he had also stolen from his parents), the family moved to Komló in 1966 and then to Pécs, but Oszkár Nyéki continued his vagrant, petty-criminal lifestyle there as well. At most, he was less noticeable in the big city and did not “damage” the family's reputation as much. He managed to get into the Aszód reformatory, then received a suspended prison sentence, followed by several enforceable sentences.

However, they agreed that she would not tell anyone if he did not abuse her again. Because this had happened before, especially when “Oszi” had drunk his favourite beer and mixed drink. The emotionally unstable, skinny

² Ibid. 91–98. o.

man, who his miner father often beat as a child, promised his partner that this would never happen again in the future. However, he was unable to keep his promise. He got drunk again and beat the woman once more. After that, she no longer kept quiet.

The investigation also revealed that Erna O. had already blabbed about Oszkár's actions in September at the Olimpia restaurant, but her listeners did not take the drunk woman's words seriously. Then, in early October, she blurted out what she knew at the Aranykacsa restaurant. From there, she and Nyéki went to the Napsugár café, then to the Hullám restaurant, where they believed her story and notified the police.

As it turned out, Oszkár Nyéki, born in Isaszeg in 1951, was wandering around Tettye Square. He had already been checked and questioned by the police in June. The unskilled labourer, who had failed several times and finally graduated from primary school with a satisfactory grade, claimed that he had accompanied a girlfriend to the amusement park and was walking down the street afterwards when he was stopped and asked for his ID. He cited his work commitments on 10 May, which his half-brother, Tibor Ny, confirmed. The investigators overlooked this, even though it emerged in October that he had not gone to work on that fateful day, nor had he done so for several days.

On 3 October, a search was conducted at Nyéki's flat on Állomás street in Pécs. The investigators confiscated all his clothes, including the ones he was wearing.

O. Erna had already been convicted four times for theft and property offences, and was released from Sopronkőhida-prison on 15 January 1974 after serving a sentence of 4 years and 8 months. Oszkár Nyéki was arrested for receiving stolen goods.

The evidence

The interrogators did not stop at reporting the crimes against property. After initially denying the charges, on 7 October, the 23-year-old young man

also confessed to the murder, which was motivated by aberrant (paedophilic fantasies) sexual motives (and excessive alcohol consumption). He revealed such details that on 12 November, as part of an attempt to prove his case, he used a doll at the actual scene to show the meeting point, his movements as he pulled her aside and attacked her, his punches, the relevant locations, his blows to kill the little girl (hitting her on the head with a glass bottle and a stone) due to her resistance and cries for help, and his use of his fingers. Afterwards, he showed the locations in the Mecsek Mountains where he had hidden for two days.

He also revealed that a patrolling police car with a radio almost hit him while he was wandering in the woods, but he managed to jump out of the way of the blue-and-white Zsiguli and, despite the police's warnings, fled into the woods. They found no trace of him.

On 10 May, Nyéki, who had a tattoo of a legionnaire's coat of arms on his chest, was still living with another woman, whom he broke up with in June. Sz. Ilona's testimony was also incriminating for her partner, who was described as a pervert, 174 cm tall, with brown eyes and missing teeth. She stated that he had not slept at home for three days, specifically on 9, 10 and 11 May, and had been staying at an unknown location.

The investigation revealed that on Thursday, 9 May 1974, the day before the crime, Oszkár Nyéki met a doctor he knew, with whom he had a homosexual relationship and who allowed him to sleep in his surgery. The next morning, after drinking a decilitre of red wine, he left wearing pinkish-purple trousers made of "Tekla" fabric, a cherry-red jumper, a blue work coat and unlined mid-calf boots. He downed a mixed drink and two beers at the Pályán pub, then set off for Tettyé, thinking of a 10-12-year-old girl. As a booster, he drank another beer at the Piros Rózsa on the way. On one of the benches in Tettye, near the so-called "Tornyos villa", he ate the sausage and bread he had brought with him, drank his cola, and then waited.

After his return home, he behaved in a noticeably agitated and confused manner, his clothes were muddy and wet, and his face was scratched. He

did not tell her specifically what he had been doing for two or three days. He lied that he had spent some money from work unlawfully.

This was partly true because his supervisor at work, the lady in the warehouse, gave him 270 forints to pay his heating bill, but he spent it on booze instead. Later, his half-brother helped him out and gave the money to his boss, who gave him a "warning" but did not dismiss him from the Pécs Municipal Unified Health Institution, where his work was not criticised, although he was known to be a very reserved person.

However, the witness also said that he had had homosexual relationships since the age of 14 with his gaunt-faced partner, about whom he also knew that he had been in hiding and wandering around as a teenager and had lost three toes on his left foot while escaping from an institution. They had frozen and had to be amputated.

The investigators created a route-time diagram showing the movements of the girl and the perpetrator in time and space. The meeting point where Oszkár Nyéki deliberately collided with the schoolgirl on her way home was clearly marked. (According to our current measurements, the exact location coordinates are: latitude 46° 5'22.96" N, longitude 18°14'12.38" W in decimal format: 46.089711, 18.236772 (46°05'22.96"N 18°14'12.38"E).

One of the pairs of trousers found and seized during the house search (now referred to as a search) is very special, made of fabric manufactured by the German company Hoechst. It is woven with purple, pink and black elemental fibres. These were found on the victim's body. After comparison, a chemist from the Institute of Forensic Science identified the special material residue, which had a sponge-like cross-section.

Bloodstains were also found on the fabric of the special trousers.

It was also established that the victim's clothes had come into contact with the defendant's trousers.

The experts also stated that five distinct morphological material residues characteristic of the crime scene were found on the clothes the defendant wore at the time of the crime. In contrast, no such residues were found on his other clothes. Serological experts found that the blood on the seized

stones, the cola bottle and the nylon bag found at the scene was of the same blood type as that of the little girl.

The opinions of psychiatric experts did not find any pathological condition or any slight limitation of his mind. They found antisocial and psychopathic traits, emotional poverty, bisexual tendencies with a tendency towards perversion, unreliability, moral insensitivity, aggressiveness, impulsiveness and average intellectual capacity.

Summary of the court (trial) phase – the verdict

The Baranya County Chief Prosecutor's Office brought charges of murder committed in a particularly cruel manner and for a despicable reason in its indictment No. B. 10.055/74/1. The Chief Prosecutor's Office did not press charges for the minor (and, we might say, insignificant in comparison to the main offence) embezzlement and fraud committed by Nyéki.

In view of the enormous interest in the case, the Baranya County Court held its open hearings in the large hall of the Ságvári Cultural Centre, which seats several hundred people, on 13, 14 and 15 January 1975.

The County Court did not hear Éva M.'s mother as a witness because she was already in a high-risk pregnancy. According to our research, the family later had two children and moved from their home in Pécs to a village. We found only traces of their house in Felsőgyükés during my personal visit to the site in May 2022.

Oszkár Nyéki admitted his guilt at the trial, but he did so dispassionately, without emotion or sincere remorse, according to the reasoning section of the judgment. His only substantive defence was that if the little girl had not resisted, the killing would not have happened. The presiding judge was Dr József Tamásfy (now deceased), who also taught the author in a criminal law seminar at the Faculty of Law of Janus Pannonius University in Pécs between 1980 and 1985. According to our research, neither of the two judges nor the prosecutor who presided over the case is still alive. According

to our research, the two layman judges and the chief prosecutor are also no longer alive.

During the investigation and at the trial, Mrs H. positively identified the defendant as the person she saw between 8.15 and 8.30 a.m. on the morning of the crime above the Tettye quarry, near the stone cross.

The broad team of experts maintained the opinion given during the investigation.

On 15 January 1975, the council announced its judgment in case no. 1. B. 907/1974/7.

Based on the facts and classification of the charges, it imposed the death penalty.

According to the record found in the archives, Nyéki was transferred from the Pécs Prison to the Budapest Penitentiary and Maximum Security Prison the very next day, on 16 January 1975.

Péter Dulai, a doctoral student at the Doctoral School of Law Enforcement Sciences at the University of Public Service, actively participated in exploring the past and acquiring archival data. He also wrote about the results of his research.³

From there, he was escorted to the Supreme Court building for a public hearing on 27 March 1975, held in response to his appeal for a reduction in sentence. There, he heard the ruling upholding the first-instance sentence. The council, led by László Egeli, did not consider the Chief Prosecutor's motion, which it considered premeditated, to be well-founded, nor did it consider the defence's reference to the defendant's psychopathic personality as a mitigating circumstance.

According to the Supreme Court's argument, since the defendant had sexual intentions, he did not plan the killing. This intent developed in him only at the scene, as a result of the victim's resistance, and he resorted to the most serious act out of fear of being caught. (Agreed with the other two aggravating circumstances, namely, particular cruelty and base motives.)

³ Dulai, P.: Bloodstains on the path. 168 Óra. 23. 2022. 40–45. o.

In the early hours of 29 April 1975, the death penalty was carried out by hanging in the prison.

1. Forensic conclusions and lessons learned 51 years later

- A) The authorities must take very seriously and deal with cases of disappearance, especially when people who are unable to defend themselves, including minors, do not return home. We do not have accurate statistics on this, but as the above case shows, very often homicide is behind these disappearances. From the outset, the possibility of homicide must be taken into account, and the "first strike" measures must be taken with this in mind.⁴⁵
- B) Recognising and inspecting multiple locations is an extremely important factor, as each one offers clues and material evidence, and logical conclusions can often be drawn about all the basic questions of criminal investigation. (What, where, when, how, who, with whom, why did they commit the crime?)
- C) The use of a "bio-detective", a dog to track scents (and possibly identify them later), can be useful in detection and evidence gathering. This applies to the initial search for clues, material remains and bodies, and later to the identification and verification process.
- D) A description of the perpetrator based on witness statements, drawings and images can greatly assist the investigation, especially with the involvement of the media and, nowadays, social networks.
- E) An accurate *modus operandi* can effectively assist in the verification of potential suspects. Incomplete records, on the other hand, do not help in the "search for a needle in a haystack". It is an old truth that only what has ever been entered into the databases can be retrieved from them.

⁴ Fenyvesi, Cs.: Trends in criminalistics. Dialóg Campus Publishing. 2017.

⁵ Fenyvesi, Cs.: The crime scene investigation as the first step in criminalistics. In: Bárd, P. – Hack, P. – Holé, K. (eds.): In memory of László Pusztai. OKRI, ELTE ÁJK. 2014. 111–123. o.

- F) The same applies to other registers, such as the list of persons released from penal institutions. Presumably, this works more accurately in today's computerised data management than it did in 1974.
- G) Many experts believe that the methods used by individual offenders are "banded". According to their view, property offenders (such as "thieves") do not resort to violence, so we should not look for them among murderers. The case of Oszkár Nyéki refutes this assumption. Unfortunately, even thieves and fences who do not use violence (no burglary, no robbery) can become perpetrators of horrific acts of violence. Therefore, they cannot be ignored or left out of the picture when the investigating authorities carry out routine identity checks.
- H) In the case of every potential suspect, the alleged alibi must be examined and verified with particular care. Failure to do so, or doing so superficially, is a serious professional error. Negligence is so delicate and dangerous that it can bring the investigation to a standstill.⁶
- I) Sometimes, the only way to move an investigation that has reached a dead end forward is with luck or the "greatest policeman", chance. Or by combing through the entire file again and rethinking the "dead case". Keeping the above-mentioned principle in mind, the perpetrator is in the file.
- J) According to French criminologists, there is a woman in some form in every (mysterious) criminal case. *Cherchez la femme!* – they say. Look for the woman! And in this case, too, the key to the solution was handed over to the police by a woman in the background.
- K) In the case of a reasonable suspect, it is desirable to seize all their clothes, real estate and movable property as part of the "first strike" and then subject them to expert examination.

⁶ Fenyvesi, Cs. – Kodba, F.: Investigation of brutal homicide committed against a young child. *Belügyi Szemle*, 38/4. 1990. 106–113. o.

- L) There is no need to break down the door when interrogating a potential suspect. The correct tactic is to start with something minor, less serious, and gradually, gently build the person's trust to get to the main offence.⁷
- M) The perpetrators of repulsive acts that shock many people, no matter how depraved they may be, want to ease their oppressive psychological burden. They want to talk about it, they want to tell someone, they want some relief for themselves. Oszkár Nyéki couldn't keep it to himself either. This could and should have been used as a basis for his interrogation, and some "acknowledging" tactic should have been used to get him to make a full confession.
- N) In any case, an on-scene interrogation must be conducted as soon as possible (in today's terminology) with the accused who has confessed to the crime. In the case of an on-the-scene confession recorded in image and sound, the interrogator conducting the investigation must strive to uncover as many facts as possible known to the perpetrator. This information can be compared with data from the crime scene investigation, expert opinions, and witness statements (and, in some cases, co-defendants' statements).
- O) It is the responsibility of the authority or authorities to verify the authenticity of the confession. False confessions, which can lead to miscarriages of justice, have also occurred in Hungarian legal history. Thus, we say, theoretically, that even confessions that sometimes seem credible or appear to be easy solutions may be untrue and misleading.
- P) Edmond Locard was not mistaken: the principle of "*principe de l'échange*" (in English: "*theoretical exchange*" or "*transfer principle*")

⁷ Elek, B.: Interrogation. In: Fenyvesi, Cs. – Herke, Cs. – Tremmel, F. (eds.): Criminalistics. Ludovika University Press. 2022. 435–472. o.

works. *"Every contact leaves a trace."* Traces and material residues must be consciously sought at the scene, on the victim, and on the potential perpetrator.⁸

Q) There is always something to look for, because material residues are "partisans". Our choice of words is based on that:

- they are hidden and often cannot be seen with the naked eye;
- yet they exist and are almost everywhere, popping up from behind every tree and under every bush;
- they often pop up in the most unexpected places, and we find them at crime scenes;
- they are almost impossible to eradicate, they are permanently embedded, resistant (bloodstains were still visible on Oszkár Nyéki's washed trousers five months later);
- they are highly effective, as even a single micro-hair or speck of dust can be enough to impose the most severe penalties after providing an exact, unique answer to the question "Who did it?"
- we could also say that it is almost impossible to defeat them if we search for, record and examine them intelligently;
- They can be played back over a long period of time and can also answer the question WHEN?
- they describe the entire causal process, the HOW?, the logical connections between events, and with their help, the past, even the distant past, can be reconstructed;
- they show the actual place or places where the crime was committed (see the three locations in this case);
- they almost always arise from the interaction of people and objects; think of dust and smell, for example.
- they are constantly evolving, we are discovering more and more about them, their scope is widening, and at the same time,

⁸ Locard, E. (1931–1940): *Traité de criminalistique*. II. Desvigne

we are seeing them more and more accurately, thanks to the dynamic, wide-ranging scientific research associated with them.

Final thoughts

Presumably, under today's circumstances, DNA testing and electronic data, which have become widespread in recent decades, would contribute to effective investigation (without repeating the mistakes of 1974). Detectives would collect and check data from public cameras, the mobile phones and computers of potential suspects, their correspondence, and their social media activity. With all this, there is a greater likelihood today that the investigation will not reach a cold end, and there will be no need for blind luck, chance, or a confidant.

FULLÁR, ALEXANDRA

Adhesive Tape as Forensic Evidence

Introduction

This research introduces a professional whose role is already well-defined. In recent years, mapping the competency boundaries of various forensic expert fields and the possibilities for their collaboration has become a focus of my research. Working hand in hand with my expert colleagues, we have examined the activities of forensic pathologists, anthropologists, physicist experts and mark examiner fields through several publications, along with

their innovative results stemming from joint opinion formation that advance cases^{1,2,3,4,5}. Our most recent manuscript presented complementary examination methods, including dactyloscopy and mark examiner fields, in the context of palm-print examination⁶. My colleague Péter Fülöp, a forensic physicist, describes the physics expert's potential to support the medical examiner in this context in this volume⁷. At the same time, the co-authors, Krisztina Tóth and István Kiss, discuss a quality-assured examination

¹ Dudás-Boda, E. – Fullár, A.: Examination methods at the intersection of forensic anthropologist and forensic mark expert competencies in Hungarian practice [Examination Methods at the Intersection of Forensic Anthropologist and Forensic Mark Expert Competencies in Hungarian Practice]. *Police Studies*, Issue 2024/1–2. 63–74. o.

Source: <https://doi.org/10.53304/PS.2024.1-2.05>

² Kiss, I. (2024): The system of opportunities for expert cooperation in international and national practice [The System of Opportunities for Expert Cooperation in International and National Practice]. *Police Studies*, Issue 2024/1–2. 110–119. o.

Source: <https://doi.org/10.53304/PS.2023.1-2.09>

³ Fülöp, P. – Ujvári, Zs. – Petrétei, D. – Kiss, I. – Dudás-Boda, E. – Metzger, M. – Fullár, A.: Modern tools and possibilities of forensic expert illustration [Az igazságügyi szakértői szemléltetés modern eszközei és lehetőségei]. *Ügyészek Lapja*, Issue 2024/5–6. 91–102. o.

⁴ Petrétei, D. – Fullár, A. – Ujvári, Zs. – Metzger, M.: Innovative and traditional techniques in crime scene reconstruction – a case study [Innovative and Traditional Techniques in Crime Scene Reconstruction – A Case Study]. In: Kovács, G. – Mészáros, B. – Czenczer, O. (eds.): II. Ludovika international law enforcement research symposium. Magyar Rendészettudományi Társaság. Budapest, 2024. 247–255. o.

⁵ Fullár, A. – Fülöp, P. – Ujvári, Zs. – Metzger, M. – Szécsi, A. – Varga, Gy. – Varsányi Balogh, M. – Petrétei, D.: Empirical and virtual experiments: reconstruction of an extraordinary death [Empirical and Virtual Experiments: Reconstruction of an Extraordinary Death]. *Police Studies*, Issue 2025/1-2. 81-96. o.

Source: <https://doi.org/10.53304/PS.2025.1-2.06>

⁶ Fullár, A. – Petrétei, D. (2025): “I know it as my hand” – possibilities of multi-expert analysis of crime scene palm prints [„Ismerem, mint a saját tenyerem” – a helyszíni tenyérnyomok többszakértős vizsgálatának lehetőségei]. *Scienta et Securitas* 6:3, 279-291. o.

Source: <https://doi.org/10.1556/112.2025.00304>

⁷ Fülöp, P. (2025): „Body physics” – Innovative options for supporting forensic medical expert practice in Hungary. *Police Studies* [under review]

methodology that supports reliable opinion formation in criminalistics⁸. This year's conference, themed "*Law Enforcement Research and Innovation*" on St. László Day, provided me, like my colleagues, with an excellent opportunity to further immerse myself in the topic, though from a slightly different perspective. Through an everyday object from our daily lives - adhesive tape - I demonstrate the collaboration possibilities of different forensic fields and the innovative opportunities of modern law enforcement.

What's worth knowing about adhesive tapes

Adhesive tapes are primarily items used in the packaging industry, but they also frequently come into our hands during DIY activities and daily tasks. Their widespread use is driven by their affordability, ease of access, size, variety, simplicity of use, and versatility of application. Different fastening challenges can be solved comfortably and quickly with their use. Some types can be torn off the tape roll, while others require a sharp cutting tool to section them. Their positive properties are well exemplified by the fact that this object is an indispensable component of survival kits even in space. In 1970, the crew of the Apollo 13 spacecraft was saved by fabric-reinforced adhesive tape, the so-called "duct tape," which helped them stably connect the air filter systems⁹.

Adhesive tape is a self-adhesive tape that consists of a carrier surface and a pressure-sensitive adhesive. Different types of tapes differ in the materials of the two components and in their combination, which also influence the tape's behaviour and compatibility. The carrier surface can be, for

⁸ Tóth, K. – Kiss, I. (2025): The importance of accreditation in forensic expert examinations [The Importance of Accreditation in Forensic Expert Examinations]. Police Studies [under review]

⁹ (n.d.): Hogyan mentette meg az Apollo 13 legénységét a duct tape [How Duct Tape Saved the Apollo 13 Crew].

Source: <https://raketa.hu/hogyan-mentette-meg-az-apollo-13-legenyseget-a-duct-tape>
Accessed: 30.07.2025

example, paper, plastic, foil, fabric, or metal foil, while the adhesive material can be, for example, natural/synthetic/silicone rubber or acrylic-based. Depending on these, they can be bonded to materials such as paper, plastic, wood, ceramics, glass, or even metal. When using single-sided adhesive, we can bond objects placed side by side using an overlapping technique. In contrast, a double-sided adhesive can fix two materials together¹⁰.

Adhesive tape from an expert perspective

Given the widespread distribution and use of adhesive tape, it can frequently be found at crime scenes as well. Perpetrators of crimes often use various tape types for restraining persons and securing them in a state incapable of defence and escape. By quickly taping the victims' eyes, it is possible to prevent potentially accurate personal descriptions of the attackers later, and by taping the mouth, help-seeking can be prevented. Insulation tape frequently turns up at bombing attack scenes as well, where it can remain undamaged on the surfaces of device components used in the explosion.

During the use of adhesive tapes, traces, biological, and micro-material residues from both victims and perpetrators can transfer to both the adhesive-coated and adhesive-free surfaces of the tapes, which can later be subjected to expert examination. Since adhesive tapes are good trace carriers, they can provide diverse information during the proof of crimes; however, they are also difficult-to-handle pieces of evidence due to their sticky surface. For this reason, it became necessary to map and summarise the examination methods for this type of evidence. The Fire and Explosion Working Group of the European Network of Forensic Science Institutes (ENFSI) developed a best practice manual and guidelines on this topic in 2013¹¹. Using flowcharts, they illustrate which examinations should be performed

¹⁰ (n.d.): Ragasztószalagok [Adhesive Tapes]. Source: <https://www.frogpack.hu/kategoriak/ragasztoszalagok> Accessed: 30.07.2025

¹¹ (2013): Forensic tape examination guidelines [Forensic Tape Examination Guidelines]. 30.10.2013

in what order to extract the most relevant information from adhesive tape as evidence. Since in most crime investigations we first seek to identify who committed the act, source-level personal identification examinations, such as genetic and dactyloscopy examinations, are placed at the beginning of the sequence. After these, sampling procedures can also be performed that try to answer the what and how questions, so activity-level results can be obtained with their help. As a consequence, a presentation by Richard Visser, a colleague from the Netherlands Forensic Institute, was given at the 2024 ENFSI SPTM (Shoeprint and Toolmark Working Group) meeting in The Hague, in which he detailed the investigative examination of the manufacturing characteristics of "duct tape"- type adhesive tape. He demonstrated that, in addition to the proper examination of adhesive tape ends, they evaluate the linear impressions formed on the carrier material during the winding of the tape roll, as well as the structure of the carrier material and the textile reinforcement fibres.

The Hungarian Institute for Forensic Sciences (HIFS), as an ENFSI member institution, strives to incorporate best-practice guidance into the working methods of accredited laboratories. The application of proficiency tests serves as a good basis for standardising, developing, and controlling individual examination methods. To demonstrate proficiency in adhesive tape examination, we chose the FTS (Forensic Testing Service) proficiency test round for 2025. The test's speciality is that the task spans two expert fields, so cooperation between a mark examiner and a forensic chemistry expert is required to complete it successfully. This year's test contained a tape roll with a torn end and two tape pieces with torn ends. The goal was to prove in the most detailed way possible that the tape pieces originated from the same tape roll.

Mark examiners evaluate the possibility of physical matching through part-whole examination of tape ends (Figure 1). The size and formal properties of the tape roll are similar to both examination samples; however, only one end of one tape piece can be fitted completely to the questioned tape end. Therefore, the piece with the fittable tape end definitely originates

from the tape roll, while the other piece shows group-level matching in size and formal properties with both the tape roll and the other tape piece.

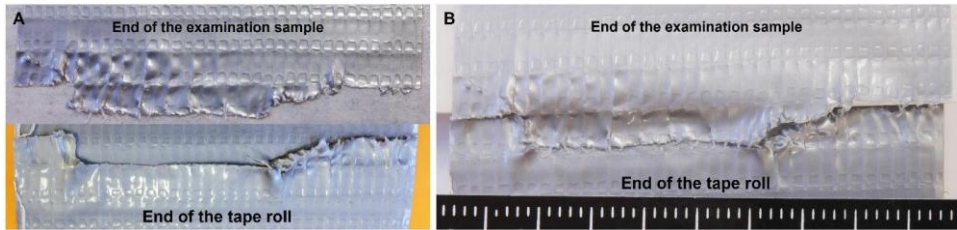


Figure 1.

A: The size and formal properties of the end of the tape roll show similarity with the end of the examination sample.

B: Physical match in metrical photo. (Recordings by Péter Lapis.)

Forensic chemistry experts first examine the layering and optical properties of the tapes using stereo and research microscopes, then reveal the chemical and elemental compositions of the plastic foil, adhesive, and textile reinforcement layers through infrared, Raman, laser-induced spectroscopy, and laser ablation inductively coupled plasma spectrometry. Based on the obtained spectra, the results confirmed the mark examination results, namely that both tape pieces could originate from the tape roll or from a roll with identical manufacturing properties.

Adhesive tape as evidence

Through practical examples, I would like to demonstrate, in the following, how experts can encounter adhesive tape as evidence across different case types and what methods they can use to make it speak during the proof process. I will present interesting cases from my mark examiner practice related to this topic through different types of tapes, that is, tape types that can be used in different ways.

In the first example case, a large quantity of weapons was seized hidden in the body elements of a vehicle inspected at the border. The weapons and separately stored magazines emerged wrapped in plastic wrap from cavities

created in the vehicle's body. Presumably to facilitate later pairing and assembly, they were wrapped with masking tape before packaging, on which number markings were written with a felt-tip pen. The weapons and magazines (Figure 2) underwent latent-print, genetic, and firearm-expert examinations. At the same time, the adhesive tapes peeled from the evidence were sent to forensic chemistry and handwriting experts, after a mark examiner. By examining the adhesive tapes, the appointing authority sought to determine whether the seized weapons were packaged at the same or different locations. The characteristic of masking tape is that it does not absorb moisture and can be easily and completely removed from surfaces without leaving adhesive residue. Markings can be applied to their thin crepe surface, and they can be easily torn by hand. For handwriting expert examination, photographs of the tapes in their original, adhered state were sufficient, while for forensic chemistry expert examination, smaller samples were adequate. The part-whole examination of the tape, based on more than 80 pieces of evidence, promised to be challenging. For the mark examination, I prepared the peeled tape pieces on transparent document film so that the torn tape ends could be easily fitted next to each other during pre-sorting. The beginning and end points of unwinding were marked and documented in photographs. Based on examinations by the mark examiner and a forensic chemistry expert, conducted following the pattern of proficiency tests, adhesive tape wound on both weapons and magazines could have originated from the same type of tape roll. Through part-whole examination, nine longer and shorter tapes were fitted together. Based on the handwriting expert's results for the number markings applied with a similar-coloured felt-tip pen, and considering the expert examinations, it could be concluded that the packaging of weapons and magazines occurred at one location.



Figure 2.

A-D: Number-marked magazine wrapped with masking tape, recovered from the car door.

**E: Number-marked masking tape from the magazine.
(The author's own recordings.)**

Surprisingly, I encountered electrical tapes in connection with death case investigations during my expert work. This tape type, used in electrical work and available in multiple colours, is also suitable for mechanical fastening when needed; however, this function is not permanent. In both example cases, the perpetrator exploited this latter property. In one homicide case, a bloody garbage bag wrapped in a rubber glove with red electrical tape wound around it was found in the trash at the crime scene (Figure 3). As a result of a detailed examination of the criminal case examined by a medical expert and a mark examiner, it could be established that the killer used the adhesive tape to fix the garbage bag in front of the victim's mouth. This was most evident from bloody impressions on the face and from hair strands stuck in the adhesive tape. Changes indicating suffocation could not

be established, nor did the fastening method of the adhesive tape indicate that the perpetrator intended to block the airways with the garbage bag. Overall, it could be concluded that the hastily improvised device assembly rather served the purpose of preventing blood coughed up by the victim from getting on the perpetrator due to prolonged stab wounds targeting the lungs and internal organs.

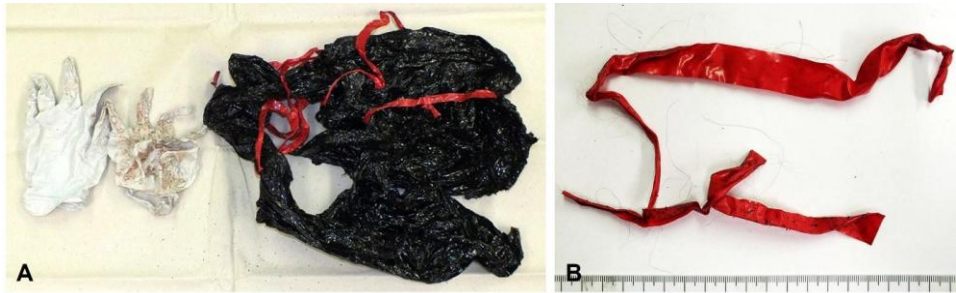


Figure 3.

A: A bloodstained trash bag wrapped in a bloody rubber glove and sealed with red electrical tape, recovered from the trash bin at the crime scene.

B: Electrical tape with adhered hair. (The author's own recordings.)

In the other homicide case, which was a case of my expert colleagues, the victim's companions fastened two plastic chairs with electrical tape to a victim who had fallen asleep from alcohol intoxication. The person who became incapable of self-rescue could not free himself from the captivity of the chairs and died because of hypothermia. The tensile strength test and model experiment performed during the physics expert examination vividly demonstrated what problem the victim might have faced when trying to free himself from his shackles. The mark examination noted that, in this type of case, adhesive tapes can only be examined in their original state; packaging them as evidence makes it impossible to determine which tape was applied to the plastic chairs in what order (Figure 4).

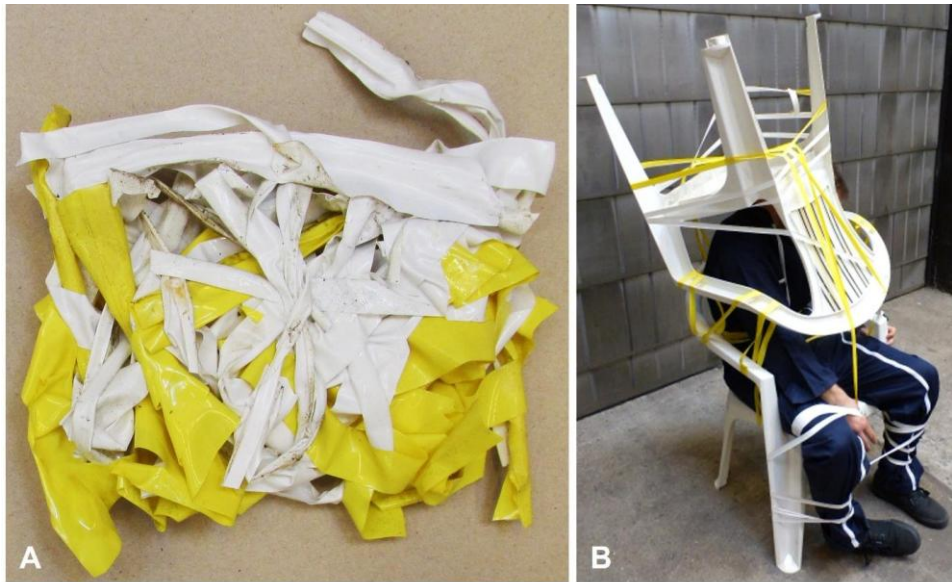


Figure 4.

A: Adhesive tapes collected at the crime scene by the forensic technician, in the condition submitted for expert examination.

B: Close-up from the experiment reconstructing the original position of the adhesive tapes and the chairs. (Recordings by Péter Fülöp.)

In my last example case, the previously mentioned "duct tape"- type adhesive tape, consisting of a plastic carrier surface with textile reinforcement fibres and a strong adhesive, came to the centre of the case and the proof. The characteristic of this tape is its mechanical resistance; elongation changes occur under longitudinal force. It can only be torn by hand after the tape edge has been initiated, for example, by cutting or biting. Through multi-expert examination of the adhesive tape, using the preparation of joint expert opinions, a final condemnatory judgment was reached after more than 10 years. During an armed robbery, two perpetrators attacked a couple in their own home while sleeping, wanting to obtain valuables stored in the safe. During the examined act, a pillowcase was fastened to the male victim's head with adhesive tape so he could not see, while one perpetrator locked the female victim in the bathroom. They forced the man

to open the safe, then finally fastened him to a lounge chair with adhesive tape. After the attackers left the house, the man was able to slip out of the restraint and call the police. Genetic and fingerprint experts first examined the adhesive tape wound on the armchair upholstery. The dactyloscopy examination did not lead to results; according to the victims' testimony, the perpetrators wore gloves. The geneticist cut off three free adhesive tape ends from the evidence ensemble originally sent with the armchair upholstery, for further examination. At one end, in addition to the male victim's biological sample deposit, a foreign profile was detected. Two years after the crime, one perpetrator was captured thanks to the stolen items, but his companion remained unknown to the authorities. Ten years later, the genetic database showed no match for the unknown profile from one tape end. At this point, the investigating authority faced a situation in which only the incriminating genetic sample deposit pointed to the suspect's guilt. The suspect explained that he could have touched the adhesive tape roll in the store from which the on-site tape pieces originated. Ten years after the crime, the authority again sent the adhesive tape remnants for expert examination, so that the forensic chemistry expert and mark examiner could determine from which part of the tape the detected genetic profile originated. Additionally, it sent an adhesive tape roll seized in the case of the other previously captured perpetrator for examination to determine whether the adhesive tape pieces found at the scene could have originated from it. The size and pattern of the carrier surface of the seized tape roll, and the course of the textile reinforcement fibres, differed from those of the on-site samples, while the latter were similar to each other. The morphological examination of the tape pieces was also confirmed by the forensic chemistry expert's results, which indicated that all tape pieces found at the scene could have originated from a single tape roll, but not from the one we examined. The trace evidence examination was greatly hindered because, during the previous chemical trace detection procedure, the three tape units, which were stuck together in multiple layers, were cut, and the procedure partially dissolved the adhesive material. Based on the forensic chemistry expert's guidance,

the textile reinforcement and adhesive layers can be removed from the tape pieces using an acetone solution and scraping, so that, when prepared on transparent document film, the tape ends become suitable for fitting examination. Fortunately, cut ends were created during chemical trace detection and genetic sample collection. In contrast, torn ends were created during the examined act, so the relevant tape ends became clearly distinguishable from one another. Based on the male victim's account, the tape piece first went around his head, whose diameter was significantly smaller than the other two tape units wound around his body, so even after this much time, the original position of the tape pieces became reconstructable. To my great surprise, inside the tape unit, wound around the head, I found a folded-back tape end. From this, I concluded that the perpetrators did not bring a store-condition tape roll with them, but started one with a pre-folded starting end for easier use. This recognition also provided the opportunity to determine the starting point of the tape sections unwound during the crime. Based on part-whole examinations conducted from this starting point, I finally concluded that during the examined act, at least 10 meters of tape was unwound from the adhesive tape roll, from the last, torn-type end of which the forensic genetic expert colleague detected the suspect's genetic profile. Through collaborative thinking and joint work across different forensic fields, the suspect's defence could be refuted, since his biological sample deposit could have been deposited only on the last torn tape end during the examined event.

Summary

Adhesive tape is a common tool in everyday life that also appears as increasingly important evidence in criminalistics. Through this study, I sought to highlight how adhesive tapes can contribute to the detection and proof of crimes through cooperation among different expert fields.

The diversity of adhesive tapes – in material composition, carrier surface type, and adhesive material – provides numerous examination possibilities. From an expert perspective, these objects can carry information that can be

examined from genetic, dactyloscopy, physical, chemical, and mark evidence standpoints. Through examinations performed in a specific order based on proficiency testing certification and ENFSI recommendations – such as biological trace analysis, material structure investigation, and fitting examination – both the origin of tape pieces and the method of their use can be reconstructed.

The study illustrates, through several practical examples, that adhesive tape is relevant to numerous crime types, including weapons smuggling, homicide, and armed robbery. The study emphasises the significance of cooperation between multiple fields – mark examiners, chemists, geneticists, and fingerprint experts. The complexity and precision of forensic expert work can only be ensured through such interdisciplinary cooperation, especially in cases involving complex evidence such as adhesive tape. Supported by evidence from practical experience, the study points out that, with appropriate examination methodology and coordinated work, adhesive tape can serve as valuable evidence in law enforcement.

FÜLÖP, PÉTER

„Body physics” – Innovative options for supporting forensic medical expert practice in Hungary¹

Introduction

It is a frequently stated assertion that intelligent, cultured, dialogue-based debate advances the parties involved. In everyday life, however, conflict resolution sometimes deviates from this ideal scenario. It happens that the unleashing of emotions overrides the rational approach, and the process leads to physical violence, the consequences of which are only weighed in court. The characteristic of such situations is that the bodies of the persons involved are subjected to various mechanical forces, the objective examination of which using natural scientific tools may be essential for establishing responsibility.²

The study places particular emphasis on demonstrating the interdisciplinary possibilities inherent in collaboration between physics and medicine. At the boundary of these two professional areas, a new approach emerges, to which the term "body physics" may provide a more precise framework. In this context, the concepts of force and energy appear not merely as textbook definitions, but also from a unique perspective, offering the opportunity to better understand the relationship between the human body and physics from the perspective of assaults.

¹ This study is the English version of a presentation delivered at the conference Research and Innovation in Law Enforcement, Pécs

² Fülöp, P.: Brutális fizika másképp – Fizikusok az igazság nyomában [Brutal Physics Revisited – Physicists in the Pursuit of Truth]. Magyar Rendészet, Issue 2019/2–3. 67–87. o.

„Body physics”

If a peaceful resolution of an imaginary dispute does not occur and an individual uses, for example, a knife or a snow shovel, such actions often result in criminal proceedings. In such cases, with expert involvement, it may be necessary to uncover the criminally relevant details of past events to clarify the facts. From the authority's side, when compiling the appointment order or decision, the following questions may arise - without claiming completeness:

- What could have been the mechanism of injury formation?
- What trajectory could the thrown object have followed?
- What magnitude of force could it have experienced?
- What could have been the applied force during stabbing?
- What injury did it cause, could it have caused, if...?

Practising police officers, prosecutors, and judges may subsequently face the question of whether to appoint a forensic medical expert or a forensic physicist for these matters. In expert practice, the appropriate answer is “both” rather than “either”.

It is a commonplace thought that wherever we look, physics surrounds us, but we can hardly name an area where it does not appear. It explains most of the phenomena occurring in our material world and is also one of the engines of technological development. It is also encountered in medicine; medical biophysics deals with phenomena related to the human body as a living organism and the physical foundations of various life processes within the body, one of its special branches being biomechanics. The criminalistic application of physics in Hungary is an extremely diverse field³,

³ Fülöp, P. – Varsányi, I.: Az igazságügyi fizikus szakértői terület jelen és jövője [The Present and Future of the Field of Forensic Physics Expertise]. In: Kosztya, S. J. et al. (eds.): Forenzikus füzetek: A Nemzeti Szakértői és Kutató Központ jelene és jövőképe II. Budapest, 2024. 63–72. o.

and, based on the above line of thought, we find several points of connection among biophysics, biomechanics, and forensic medical expert practice. These may include, for example, falls from heights, various motions (e.g., projectile motion), or even thermal phenomena (e.g., hypothermia).

Based on the methodological letter on forensic medical opinion on bodily injuries and health damage, which is being prepared and will appear soon, determining the nature, magnitude, and direction of the effects of force is fundamentally a matter of medical expert competence. Starting purely from the characteristics of the injury, medical experts can, based on their professional knowledge and experience, estimate the minimum force that could have contributed to the development of the given alteration. In practice, it is customary to distinguish between small, medium and large forces, as well as force effects exceeding human force exertion. As a physics expert, my goal is always to examine events from multiple perspectives using the methods of physics from the available information, revealing the most objective reality possible. Based on the examination results, the aim is to support law enforcement's work by providing objective findings. During the opinion-giving process — alongside impartiality and neutrality, refraining from the legal qualification of cases — from an expert perspective, it often arises whether the end users of the expert opinion were actually curious about the magnitude of the actual force acting on the body surface or, in given cases, the force exerted by a person? This uncertainty may stem from the fact that natural scientific and legal concepts can be interpreted differently and operate within different logical frameworks. Nevertheless, it must be kept in mind and striven for that the expert opinion is substantively usable in the given procedure. To illustrate the importance of an interdisciplinary approach, the dual nature of light is often cited as an illustrative example: one of the great questions of physics at the end of the 19th century and the beginning of the 20th century was whether light was

wave-like or particle-like.⁴ Quantum mechanics, which describes the phenomena of the microworld, then pointed out that the question itself was wrong. Light is both a wave and a particle, just as a rotating cylinder appears rectangular from the side view and circular from the top view. We see the same object, just from a different perspective. Based on this consideration, the analysis of injuries on the human body may also be justified from multiple viewpoints, and, if necessary, the involvement of co-experts (e.g., forensic physicists, engineers, forensic mark and firearms experts) may be appropriate⁵.

The international literature includes the work of Lawrence Davis, *"Body Physics: Motion to Metabolism,"* which demonstrates the movement, metabolic processes, and biomechanical functioning of the human body through the application of the laws of physics—primarily for educational purposes.⁶ In this study, the term "body physics" is reinterpreted by experts. In this context, "body physics" denotes an interdisciplinary approach that combines physics methods with forensic medical expert practice. This special field contributes to a more accurate description of the forces acting on the body, interactions, and their consequences, providing an opportunity specifically for the interpretation, modelling, and objective explanation of injuries sustained during assaults.

Physical foundations of force effects acting on the human body surface

According to the constructivist pedagogical model of learning, naive theories and misconceptions hinder the acquisition and deepening of natural

⁴ Nagy, K.: Kvantummechanika [Quantum Mechanics]. Nemzeti Tankönyvkiadó. Budapest, 1978. 34–37. o.

⁵ Lontai, M. – Kosztya, S. J.: Az intézményi szakértés kihívásai a technológiai fejlődés tükrében [The Challenges of Institutional Expert Practice in the Context of Technological Development]. *Ügyészek Lapja*, Issue 2023/5–6. 78–80. o.

⁶ Davis, L.: *Body Physics: Motion to Metabolism* [Testfizika: Mozgástól az anyagcseréig]. Open Oregon Educational Resources. 2018.

Source: <https://openoregon.pressbooks.pub/bodyphysics/>

Accessed: 10.07.2025

scientific knowledge.⁷ One of the best examples of this in physics is the nearly 2000-year-old prevailing view, i.e., the Aristotelian worldview, according to which, using our modern concepts, force is necessary to maintain motion as a process.⁸ This model was based on everyday experiences and persisted until Newton's work, until the birth of classical mechanics. Everyone had prior knowledge about force before sitting in school desks and hearing about Newton's laws in physics lessons. This knowledge may later be so strongly opposed to what was learned that the so-called conceptual change does not occur, and the acceptance of new knowledge becomes impossible.⁹

The misunderstanding of the concept of force presents a problem not only from a pedagogical perspective but also in legal and forensic professional fields. The difference between the everyday and physically exact interpretation of force can lead to serious misunderstandings, for example, in official procedures. Whether we ask a small child or an adult about this, they will certainly have some knowledge and experience related to force. For many of us, the strength of our muscles comes to mind first, while for others, the "Force" from Star Wars, which permeates the entire Empire, comes to mind. With force, we move bodies, set them in motion. However, it is well known that bodies move without human intervention or muscle force.

⁷Nagy-Czirok, L.: Tévképzetek és fogalmi váltások – Hogyan változik a tanulók természettudományos gondolkodása [Misconceptions and Conceptual Change – How Students' Scientific Thinking Changes]. *Új Pedagógiai Szemle*, Issue 2018/3–4. 47–50. o.

Source: <https://folyoiratok.oh.gov.hu/uj-pedagogiai-szemle/tevkepzetek-es-fogalmi-valtasok-hogyan-valtozik-a-tanulok-termesztudomanyos>

Accessed: 10.07.2025

⁸Simonyi, K.: A fizika kultúrtörténete a kezdetektől a huszadik század végéig [A Cultural History of Physics from the Beginnings to the End of the Twentieth Century]. Akadémiai Kiadó. Budapest, 2021. 86–87. o.

⁹Kiss, Cs. (n.d.): A konstruktivista tanuláselmélet bemutatása a mechanika példáján keresztül [Presentation of Constructivist Learning Theory through the Example of Mechanics].

Source: <http://sac.web.elte.hu/sulaj/didaktika/konstr/modszer.htm>

Accessed: 10.07.2025

In physics, force is nothing other than the mutual effect of bodies (or fields) on each other, which we experience in the form of changes in motion and/or shape. In the language of mathematics, force is the time derivative of momentum (quantity of motion) with respect to time, which is the basic equation of mechanics¹⁰:

$$\vec{F} = \dot{\vec{p}} = \frac{d\vec{p}}{dt} = m \cdot \frac{d\vec{v}}{dt} = m \cdot \vec{a}$$

The measure of force effect is the force F , which has magnitude and direction (point of application and line of action), thus it is a vector quantity. The unit of force is the newton (N), and it follows from the above that 1 N is the force effect required to accelerate a body of mass 1 kg by 1 m/s² to a velocity of 1 m/s (3.6 km/h) in 1 second. Expressed somewhat more comprehensibly, the magnitude of force is given by the product of the change in speed per unit time, i.e., acceleration, and the inertial mass of the body to be accelerated.

The fundamental difference between the Aristotelian conception of motion and Newtonian mechanics is that force can accelerate (decelerate) bodies, can change their shape, and can exert a rotational effect, as expressed by the torque detailed later.

Forces occur in many forms in nature. Force effects can arise through direct contact, which we call surface forces distributed over a surface, and also through volume forces acting on the entire mass without contact. Surface forces can be further grouped into those acting along a surface or line and those acting at a point¹¹. The effects of other bodies cause so-called external forces, while internal forces are the effects of one part of a body on another. External forces also have two types: one is an active force, such

¹⁰ Budó, Á.: Kísérleti fizika I [Experimental Physics I]. Tankönyvkiadó. Budapest, 1986. 56–58. o.

¹¹ Kocsis, L. – Kocsis, L.-né: Mechanikai alapok [Fundamentals of Mechanics]. In: Kocsis, L. – Kiss, G. – Illyés, Á. (eds.): Mozgásszervek biomechanikája. Terc Kft. Budapest, 2007. 20. o.

as the weight of bodies; the other is a passive force, or reaction force, which arises on support surfaces, such as a compressive force.¹² If we have found a group of motions that similar mathematical relationships can describe, then we have created a force law (e.g., a linear force law, a gravitational force law, a friction force law, etc.). The force law is not characteristic of the body exerting the force effect itself, but of the properties and capabilities of the bodies participating in the interaction.

Strength as a conditional ability of the individual

In sports science, according to the training theory approach, strength is one of the basic conditional abilities. Muscle strength is such an internal force when muscle contraction occurs as a result of a stimulus. During contraction, the muscle itself performs work, so a person — through the active force exertion of their musculature — is capable of overcoming external resistances. Muscle movement is a series of chemical reactions taking place in muscle cells, and the muscle fibres' contraction thus formed brings the joint between the origin and insertion of the muscle into motion, which manifests as rotation, for example, when lifting a weight held in our hand. The movement of joints can be described by torque based on the following relationship:

$$\vec{M} = \vec{r} \times \vec{F}, \text{ from which the magnitude of torque is}$$
$$|\vec{M}| = \pm F \cdot r \cdot \sin \varphi = F \cdot k, \text{ where } F \text{ is the (muscle) force, } k \text{ is the}$$

leverage, r is the distance between the tendon attachment site and the pivot point.¹³

¹² (n.d.): Biomecha jegyzet 2012 – klasszikus mechanika [Biomechanics Notes 2012 – Classical Mechanics].

Source: https://vik.wiki/F%C3%A1jl:Biomecha_jegyzet_2012_klasszikus_mechanika.pdf

Accessed: 10.07.2025

¹³ Ángyán, L.: Az emberi test mozgástana [Kinesiology of the Human Body]. Motio Kiadó. Pécs, 2005. 50–51. o.

Muscle activity also significantly affects movement speed. From the interactions of basic abilities such as strength, speed, and endurance, we also distinguish special abilities according to the type of muscle force exerted:¹⁴

- maximum strength,
- rapid reaction force,
- stamina.

The theoretically achievable greatest, so-called absolute strength, may be 30% greater in untrained individuals than what we are voluntarily capable of exerting maximally. The remaining 30-35% of absolute performance is under inhibition under everyday circumstances. This autonomous protected reserve can be depleted by emotions and stress, ultimately leading to complete exhaustion.¹⁵ The magnitude of maximum force depends on the cross-section of muscle fibres and the number of simultaneously activated motor units, i.e., the cooperative ability of individual muscle fibres. Generally speaking, maximum force ranges from 23-42 $\frac{N}{cm^2}$ when broken down to the cross-section of human musculature.¹⁶ Rapid reaction force involves short-term, vigorous muscle tension, during which the muscle overcomes resistance corresponding to approximately 30-40% of maximum force with relatively high-speed contraction.¹⁷ This ability plays a role in the majority of assaults, the magnitude of which depends on the degree of intra- and intermuscular coordination.

Based on the above, it is clear that applied force and resulting force are distinct concepts that do not necessarily correspond. In many cases, there

¹⁴ Pavlik, G.: Élettan – Sportélettan [Physiology – Sports Physiology]. Medicina Könyvkiadó. Budapest, 2011. 238. o.

¹⁵ Barton, J.: Biomechanika [Biomechanics]. Nemzeti Tankönyvkiadó. Budapest, 1983. 110–111. o.

¹⁶ Pavlik, G.: i.m. 240. o.

¹⁷ Petridis, L. (2015): A sportteljesítmény fizikai összetevőinek diagnosztikája [Diagnostics of the Physical Components of Sports Performance]. Campus Kiadó. Debrecen, 2015. 32. o.

is no causal relationship between the exerted (muscle) force and the resulting injury, or between the actual force acting on the body surface and the injury. As a result, conclusions cannot be drawn about the perpetrator's motivation or intention. Therefore, in expert appointments, it is necessary to ask precise questions that take professional aspects into account so that the expert can provide the most satisfactory answer to establish the facts.

Deformations and stress

According to the definition in the previous point, the effect of force can also manifest as deformation. Based on one of our most fundamental everyday experiences, if we compress, for example, a ball, its shape changes. In physics, we interpret the pressure on the ball as a compressive force acting perpendicularly to the unit surface, the magnitude of which can be given by the following relationship:

$$p = \frac{F}{A}$$

This definition is somewhat incomplete from a physical perspective, since pressure is a quantity not related to direction, unlike vectorial compressive force. Let us take a solid body on which an external force acts! Under this loading force, the body deforms and internal stress develops. The resulting deformations can be traced back to a few well-defined types¹⁸:

- tension,
- compression,
- shearing,
- bending,
- torsion.

¹⁸ Kocsis, L. – Kocsis, L.-né (2007): i.m. 43–47. o.

Materials often differ in their ability to withstand tensile or compressive loads. In the case of homogeneous, isotropic bodies and small deforming forces, the deformation is directly proportional to the load and inversely proportional to the cross-section of the body. The proportionality factor is the elasticity coefficient or Young's modulus characteristic of the elasticity and material quality of the given body. In the case of elongation, it takes the following form¹⁹:

$$\begin{aligned}\frac{F_{tensile}}{A} \cdot l &\sim \Delta l \\ \frac{F_{tensile}}{A} &\sim \frac{\Delta l}{l} \\ \sigma_{tensile} &= E \cdot \varepsilon\end{aligned}$$

This relationship is the material law of an elastic body subjected to simple stress, Hooke's law. Here we call the ratio $\frac{F}{A}$ stress (force acting over an area) more specifically tensile stress, and E denotes Young's modulus and ε called strain deformation (i.e., relative length change).

Biomechanical applications of force in forensic medical expert practice

When we discuss deformations in relation to the human body, most people probably first think of bone injuries. Fractures are the most vivid examples of when the structure of a material permanently changes under the effect of external force. Bone is actually a material with viscoelastic properties (more precisely, an anisotropic, heterogeneous, non-linear, rheologically complex one). Viscoelastic behaviour means that they simultaneously show properties characteristic of elastic materials and viscous liquids.²⁰

¹⁹ Budó, Á. (1986): i.m. 209–221. o.

²⁰ Kocsis, L. – Kocsis, L.-né (2007): i.m. 59–62

One of the main characteristics of these materials is that under the effect of loading, the material response depends, among other things, on the elapsed time and the loading rate. In the case of short-duration, high loading, the material's viscous behaviour dominates, whereas in the case of long-duration, low loading, elastic behaviour dominates. The relationship between stress and relative elongation is not linear, as in the case of Hooke's law, but both are functions of time. From this, behaviour proportional to the deformation rate, relaxation under stress ($\frac{d\varepsilon}{dt} = 0$), as well as creep ($\frac{d\sigma}{dt} = 0$) can also be observed.²¹

The examination of bone properties is similar to that of the structural examination of metals, ceramics, and plastics. Under different stress conditions, the load-bearing capacity of bones and the forces required to fracture them can be measured using specialised equipment. From the measurements shown in the educational film "*Secrets of Bones*", we can see that a deer's femur can withstand a transverse force of approximately 4500 N and a longitudinal force of approximately 17000 N. The strength of human bones also depends on the direction of loading (anisotropy). If we know the external diameter and wall thickness of a given bone, e.g., the tibia, then, using the compressive strength data from tables and the previously discussed relationship, we can estimate the maximum static compressive force (uniform loading) it can withstand without fracture. According to my calculations, not detailed here, it could withstand a load of up to 55000 N (55kN), i.e., the weight of a body with a mass of approximately 5.5 tonnes. The question arises: what magnitude of effects could we say in forensic medical practice constitutes small, medium, or large force effects? Can forces of a few tens or hundreds of N also create serious injuries on the human body?

²¹ Tamás, P. – Bojtos, A. – Décsei, A. – Paróczy, A. – Fekete, R. T. (n.d.): Végeelem módszerek, 2.4. Anyagmodellek létrehozása [Finite Element Methods, 2.4 Creation of Material Models].

Source: https://mogi.bme.hu/TAMOP/vegeelem_modszerek/math-ch02.html

Accessed: 10.07.2025

Compressive force on the skin can typically be discussed in terms of injuries caused by tools with points and edges. The magnitude of forces transmitted by knife stabs depends on the thickness and elastic properties of clothing items worn by the victim, human factors such as the mechanical properties of the skin, stabbing technique, and the morphological and geometric characteristics of the tool.^{22, 23, 24} In addition to measuring the width, length, and possibly thickness of the knife blade, determining the opening angle and radius of curvature of the point is of paramount importance. These parameters decisively influence the magnitude of the penetration force through the skin, which can be measured with a universal material testing device under static stress, or even with a digital scale in the absence of such equipment, but numerical methods are also applied.²⁵ Penetration force is the minimum force required with which the given material (human skin and/or clothing) can be pierced with the available tool using uniform compressive force. Test stabs can be performed on young pig skin with elastic properties similar to those of human skin that has not been previously frozen, or on ballistic gel²⁶. If we know the penetration depth of the knife (the length of the stab channel), then from this and the penetration force, we can derive the magnitude of (penetration) energy suitable for predicting injury potential, discussed later.²⁷ Generally, for knives, the smaller

²² Hoguea, M. – Fairgrieve, S. I. – Lievers, W. B. (2020): Stabbing angle alters peak force and work during sharp force trauma of porcine ribs. *Forensic Science International*, 314. 110373

²³ Ankersen, J.: Quantifying the forces in stabbing incidents [Quantifying the Forces in Stabbing Incidents]. University of Glasgow. 1999. 18–34. o.

²⁴ Horsfall, I. – Watson, C. – Champion, S. – Prosser, P. – Ringrose, T.: The effect of knife handle shape on stabbing performance. *Applied Ergonomics*, Issue 2005/36. 505–511. o.

²⁵ Ní Annaidh, A. – Cassidy, M. – Curtis, M. – Destrade, M. – Gilchrist, M. D.: A combined experimental and numerical study of stab-penetration forces. *Forensic Science International*, Issue 2013/233. 7–13. o.

²⁶ Terefe, T. O. – Chawla, A. – Datla, N. V.: Low-velocity nail penetration response of muscle tissue and gelatin. *Forensic Science International*, Issue 2024/361. 112082

²⁷ Bolliger, S. A. – Kneubuehl, B. P. – Thali, M. J. – Eggert, S. – Siegenthaler, L. (2016): Stabbing energy and force required for pocket-knives to pierce ribs. *Forensic Science, Medicine, Pathology*, Issue 2016/4. 394–398. o.

the opening angle (and radius of curvature) of the blade point, the smaller the penetration force, and the smaller the penetration angle, the larger the penetration force. Based on the measurement results of various studies, it can be said that in the case of tools with points and edges, the penetration force is typically 30-300 N.²⁸ Experiments have also established that the measured values can be categorised analogously to forensic medical terminology, i.e., in the case of stabs, penetration force below 50 N can be classified among effects with low-force impacts, forces between 50-150 N among medium forces, while force above 150 N among effects involving high-force impacts.²⁹

An interesting question for football fans, important from a health perspective for sports specialists, and also a professional question in litigation, is: how hard can a ball be hit?³⁰ During a break between classes at an educational institution, a student was hit from behind by a misdirected football under disputed circumstances. The purpose of the expert appointment was to explore the relationship between the presumed health damage and the magnitude of the blow to the head, for which the district court could not provide objective data. On the one hand, this made the task difficult. It fell to the physics expert to support the medical expert's work by providing data on distance and velocity. On the other hand, this information does not provide real help from a professional perspective. Velocity alone does not reveal much about the dynamics of motion, so instead the analysis focused on determining the change in speed over time, i.e., acceleration, and the force exerted on the head by the ball, which is proportional to this.

²⁸ Heckmann, V. – Engum, V. – Simon, G. – Poór, V. S. – Tóth, D. – Molnár, T. F.: Piercing the surface: A mechanical analysis of stabbing with household tools. *Journal of Forensic Sciences*, Issue 2023/4. 1218–1227. o.

²⁹ Nolan, G. – Hainsworth, S. V. – Rutty, G. N.: Forces generated in stabbing attacks: an evaluation of the utility of the mild, moderate and severe scale. *International Journal of Legal Medicine*, Issue 2018/1. 229–236. o.

³⁰ Nauheim, R. S. – Bayly, P. V. – Standeven, J. – Neubauer, J. S. – Lewis, L. M. – Genin, G. M.: Linear and angular head accelerations during heading of a soccer ball. *Medicine and Science in Sports and Exercise*, Issue 2003/8. 1406–1412. o.

During a collision, the ball undergoes elastic deformation. At the moment of impact, the head becomes flattened (to an extent depending on the kicking force and the pressure prevailing in the ball). If we had a recording of the moment of collision, from which we could measure the extent of the ball's flattening and the path length of its deformation, then the force could also be estimated from the pressure exerted on the head.

In the absence of such a photograph, an alternative approach was chosen to address the question: estimating the collision time and the magnitude of impact velocity. After impact, the ball regains its original shape. We call this process an elastic collision, during which the ball bounces back from the head with the same speed with which it collided. From this, the velocity change of the football can be determined, which is twice the impact velocity ($\Delta v = 2v$). The force exerted by the ball on the head during collision accelerates the head, the magnitude of which, according to calculations not detailed here, is approximately 600-1100 N based on the second law of Newton. Such a force effect could have accelerated the child's head with an acceleration of up to 19g, a value that barely falls short of the magnitude of blows measured on boxers' heads that are equivalent to a K.O.³¹

Based on the above example, there is very rarely an opportunity to calculate the magnitude of forces occurring during interactions between everyday objects and the human body without knowledge of the deformation path length and collision time. In these cases, we can indirectly determine the impact energy, which also refers to the force exerted by the perpetrator's limb muscles, which we can then compare with the characteristic impact energy of other objects and their physical effects. Impact energy can be approximated as kinetic energy and cannot be measured directly; for its

³¹ Horváth, G. – Juhász, A. – Tasnádi, P.: *Mindennapok fizikája* [Physics of Everyday Life]. ELTE TTK Továbbképzési Csoport, Budapest, 1989. 157–162. o.

calculation, it suffices to specify the most important factor in the interaction, the impact speed of the colliding body, and the so-called impacting (effective) mass, which also cannot be measured directly.³²

The role of kinetic or impact energy in injury development

Energy is one of the fundamental concepts of physics; numerous forms of its manifestation are known (e.g., kinetic, potential, elastic, thermal, binding, or collision energy). In understanding the mechanical background of injuries, the kinetic energy that is converted to the deformation of bodies, i.e., their shape change and motion state change, plays a key role based on the work theorem ($\Delta E_{total} = \sum W$).³³ If the attacked body region or body surface is not supported or in a fixed position, then the external force (e.g., a thrown object hitting the head) does not purely cause deformation of the target (e.g., in the form of laceration, skull fracture), but also partially accelerates the head and neck, as well as the trunk connected to the neck (i.e., the force also performs acceleration work). Staying with this example, particularly in assaults with rod-like, blunt objects, the energy that the perpetrator's muscle force converts into kinetic energy through acceleration is important, resulting in the victim being hit at high speed.³⁴ The following table shows the maximum achievable impact speeds of some characteristic blunt objects:

³² Adamec, J. – Praxl, N. – Schneider, K. – Graw, M.: Estimation of effective mass of longish rigid instruments in head impacts. *International Journal of Legal Medicine*, Issue 2011/6. 763–771. o.

³³ Budó, Á.: *Kísérleti fizika I. kötet – Mechanika* [Experimental Physics, Vol. I – Mechanics]. Tankönyvkiadó. Budapest, 1986. 99–103. o.

³⁴ Trinh, T. X. – Heinke, S. – Rode, C. – Schenkl, S. – Hubig, M. – Mall, G. – Muggenthaler, H.: Maximum striking velocities in strikes with steel rods—the influence of rod length, rod mass and volunteer parameters. *International Journal of Legal Medicine*, Issue 2018/2. 499–508. o.

Blunt instruments	Gender	Max. impact velocities (m/s)	Max. impact velocities (km/h)
Aluminium rod (296 g, 100 cm)	Male	34,89	125,60
	Female	25,93	93,35
Aluminium rod (690 g, 100 cm)	Male	30,02	108,07
	Female	21,36	76,90
Wooden stick (452 g, 100 cm)	Male	31,56	113,62
	Female	23,63	85,07
Steel rod (1278 g, 100 cm)	Male	26,48	95,33
	Female	17,28	62,21
Wooden baseball bat (870 g, 86,4 cm)	Male	30,4	109,44
Aluminium baseball bat (840 g, 86,4 cm)	Female	31,8	114,48
Golf club head	Male	40	144,00
	Female	37,7	135,72
Earthenware beer stain (0,5 l)	Male	4,9-14,3	17,64-51,48
Glass beer stain (0,5 l)	Male	3,1-14,8	11,16-53,28

Table 1.

Maximum impact speeds of blunt objects frequently used in assaults, Source: T. X. Trinh et al. - *Maximum striking velocities in strikes with steel rods—the influence of rod length, rod mass and volunteer parameters*

The effectiveness of such tools is significantly influenced by their mass, length, and mass distribution — based on these, the following main groups can be distinguished:³⁵

- short (e.g., frying pan, glass bottle, wrench),

³⁵ Siegenthaler, L. – Sprenger, F. D. – Kneubuehl, B. P. – Jackowski, C.: Impact energy of everyday items used for assault. *International Journal of Legal Medicine*, Issue 2018/1. 211–217. o.

- medium length, uniform mass distribution (any rigid, rod-like object, such as aluminium pipe, spade handle, rods and sticks made from different materials),
- medium length, uneven mass distribution (e.g., golf club, hammer),
- long, heavy and uneven mass distribution (tools for specific tasks, such as spade, shovel, etc.).

The kinetic energy of these objects is proportional to their mass and the square of the velocity they achieve, and can be calculated with the following relationship:

$$E_{kinetic} = \frac{1}{2} \cdot m \cdot v^2$$

The development of injury and its severity — i.e., the potential injury hazard — can be interpreted as resulting from several interrelated physical factors. From the perspective of impact effects, the geometry of the injury-causing object and the injured area, collision speed, effective impacting mass, impact surface size, as well as collision time and deformation path length are essential. All these factors influence energy density, i.e., the amount of energy required to cause the injury when absorbed in a given surface or volume. Although precise estimation would require consideration of material properties (elasticity, hardness, internal structure), in practice, in accordance with forensic medical methodological recommendations, impact energy is a useful quantity for illustrating injury hazard. This kinetic energy can be transmitted actively during assault, with or without tools, e.g., by hitting, kicking, or stabbing, as well as passively when striking an object or surface. The toolkit of physics and ballistics enables objective comparison of the danger posed by various everyday objects based on the energy absorbed per unit surface area or per unit volume—for example, using the minimum energy required to fracture human bones. The

following tables contain the impact speed and kinetic energy of such objects - including rod-like tools frequently used in assaults - in comparable form:

The moving object	Mass (kg)	Velocity (m/s)	Velocity (km/h)	Kinetic energy $\frac{1}{2} \cdot m \cdot v^2$ (J)
(puff tonometry) air	$5,5 \cdot 10^{-7}$	9	32,4	$2 \cdot 10^{-5}$
eye drop	$6 \cdot 10^{-5}$	1,2	4,32	$4 \cdot 10^{-5}$
champagne cork	$9 \cdot 10^{-3}$	30	108	4
paintball	$3 \cdot 10^{-3}$	70	252	7
squash ball	$2,4 \cdot 10^{-2}$	45	162	2,4
racquetball	$4,2 \cdot 10^{-2}$	45	162	4,2
tennisball	$5,7 \cdot 10^{-2}$	45	162	5,7
baseball	$1,5 \cdot 10^{-1}$	40	144	120
golf ball	$4,6 \cdot 10^{-2}$	76	274	130
.22 caliber rifle bullet	$3 \cdot 10^{-3}$	344	1239	170
water balloon	$3,5 \cdot 10^{-1}$	38	137	250
416 Magnum rifle bullet	$2,6 \cdot 10^{-2}$	730	2628	6900
automobile	$1,9 \cdot 10^3$	27	97	692000

Table 2.

Kinetic energy of various objects in increasing order ³⁶

Source: Bullock et al. - Ocular and Orbital Trauma from Water Balloon Slingshots.

³⁶ Bullock, J. D. – Ballal, D. R. – Johnson, D. A. – Bullock, R. J.: Ocular and orbital trauma from water balloon slingshots. *Ophthalmology*, Issue 1997/5. 878–887. o.

Different rods	Mass (kg)	Velocity (m/s)	Velocity (km/h)	Kinetic energy $\frac{1}{2} \cdot m \cdot v^2$ (J)
Light aluminium pipe	0,151 (0,136-0,168)	34,89 (29,77-46,06)	125,60 (107,17-165,82)	92,7 (67,3-144,2)
Wooden stick	0,233 (0,176-0,286)	31,56 (25,14-41,64)	113,62 (90,50-149,9)	109,9 (78,2-151,0)
Aluminium pipe	0,326 (0,232-0,356)	30,02 (24,92-39,60)	108,07 (89,71-142,6)	145,4 (102,8-182,1)
Steel pipe	0,563 (0,401-0,632)	26,48 (20,68-46,06)	95,33 (74,45-165,82)	194 (134,7-269,0)
Aluminium pipe, hitting zone at 0,94 m	0,151 (0,131-0,168)	34,89 (29,77-46,06)	125,60 (107,17-165,82)	92,7 (67,3-144,2)
Aluminium pipe, hitting zone at 0,68 m	0,278 (0,247-0,317)	25,78 (22,28-30,28)	92,81 (80,21-109,01)	92,4 (70,8-127,9)
Aluminium pipe, hitting zone at 0,44 m	0,647 (0,554-0,778)	18,43 (15,48-20,79)	66,35 (55,73-74,85)	107,4 (91,6-125,2)
Steel pipe with relocatable mass at 0,44 m	0,645 (0,478-0,770)	23,00 (17,69-32,50)	82,80 (63,68-117,00)	168,2 (129,1-282,6)
Steel pipe with relocatable mass at 0,70 m	0,811 (0,591-0,942)	22,16 (16,56-30,95)	79,78 (59,62-111,42)	196 (129,1-282,6)
Steel pipe with relocatable mass at 0,95 m	0,930 (0,656-1,099)	21,42 (16,43-30,82)	77,11 (59,15-110,95)	208,4 (143,6-311,5)

Table 3.

Impact speed and kinetic energy of rod-like tools were determined in experiments

Source: F. D. Sprenger et al. – The influence of striking object characteristics on the impact energy.

Summary

The concept of "force" plays a central role in legal practice in all cases where the human body is subjected to external mechanical effects and injury results. In criminalistic practice, the magnitude of force may arise as a professional question primarily in connection with violent events — falling, hitting, kicking, collision, stabbing — whether it concerns accidental, incident-like or intentional acts, suspicion of harm by others or self-harm. Although, as physics experts, our natural aspiration is quantifiability, in the analysis of specific cases — due to the lack of uniform measurement procedures and numerous unknown variables — precise determination of force magnitudes is usually only possible approximately, or not at all. Moreover, force values expressed in newtons are often difficult for laypeople to interpret on their own, especially when their magnitudes vary widely. Significant differences can also be observed in measurement methods across

the medical and forensic literature, and the diversity of constitutional characteristics, applied tools, and circumstances of assault decisively influences the assessability of the effects of force.

One of the aims of this study was to help appointing authorities formulate appropriate professional questions by clarifying fundamental physical concepts—particularly force and energy—and to contribute to the interpretability of professional answers. The presented theoretical foundations and practical examples hopefully advance the integration of the physics expert perspective into forensic medical expert work.

The other goal for the future is to develop methods that are reproducible and comparable from a natural scientific perspective, thus suitable for establishing a uniform forensic practice. To this end, we would like to collaborate with colleagues from the Institute of Forensic Medicine at the University of Pécs on the biomechanical examination of soft tissue injuries, and with forensic medical experts from HIFS and the Institute of Forensic Medicine at Semmelweis University on modelling injuries caused by 3D-printed weapons. These joint research projects may, in the long term, help strengthen the scientific basis of expert opinions.

HORVÁTH, ORSOLYA

Technological innovation and the Pursuit of Truth: integrating 3D reconstruction and artificial intelligence into criminalistics

Introduction

One of the fundamental tasks of criminalistics is reconstructing past events. In answering its core questions (what happened, where, when, how, who, with whom, and why), crime scene investigation plays a pivotal role. By locating traces and material residues, subsequently analysing them, examining witnesses, and collecting physical evidence, the groundwork for fact-finding can be established.¹ To support this task, crime scene sketches, photographs, and expert interpretations are traditionally employed. At the same time, the technological advancements of the 21st century open new dimensions in evidentiary practice. Digital tools and methods such as photogrammetry, laser scanning, drone imaging, and virtual reality offer previously unforeseen opportunities for accuracy and visualisation.

Beyond technical innovations, the development of digital forensics also impacts the quality of investigations, the evidentiary process, and ultimately public trust in the justice system. Through a three-dimensional model, jurors, experts, and judges can virtually explore the crime scene, thereby gaining more direct knowledge and forming a clearer understanding of past events.²

As part of digital forensics, generative models—continuously developed over the past decade and still evolving—must also be considered. These

¹ Fenyvesi, Cs. – Herke, C. – Tremmel, F. (eds.) (2022): *Kriminalisztika [Criminalistics]*. Ludovika Egyetemi Kiadó, Budapest

² (n.d.): *Forensic animation for legal cases [Forensic Animation for Legal Cases]*. Source: <https://courtroomanimation.com/forensic-animation-legal-cases-guide/> Accessed: 30.08.2025

tools assist in the analysis of crime scene data, enabling the identification of patterns, the establishment of timelines, and even the reconstruction of bullet trajectories.³ At the same time, we must also ask ourselves the following questions: can a model created or interpreted by artificial intelligence be deemed admissible in court? Who bears responsibility if the algorithm errs?

This study presents the potential applications of digital technologies and the legal, evidentiary, and procedural issues associated with them. Following a summary of the possibilities for reconstructing crime scenes, we outline the modern toolkit and then illustrate the technological opportunities, challenges, and questions of AI-based evidence admissibility through brief case studies. Cases from the United States, Canada, and Europe clearly demonstrate that digital reality is not a prospect of the future but an integral part of contemporary justice systems.

Foundations of Crime Scene Reconstructions

One of the oldest and most important acts in criminal procedure is the crime scene investigation. Beyond documenting traces and material residues, its task is to interpret them and connect them to the sequence of past events—criminalistic reconstruction bridges observable traces and the acts in question. In addition to data collection, the interpretive process helps determine the further direction of the investigation and the success of evidentiary proceedings in court.⁴

Formulating different versions is a logical operation that constitutes part of the reconstruction, outlining hypotheses about past events. At the same time, reconstruction is also a spatial and visual interpretation, as the

³ Herke, C.: Hogyan segítheti a mesterséges intelligencia a bűnügyi szakértők munkáját? [How Can Artificial Intelligence Support the Work of Forensic Experts?]. In: Petrétai, D. (ed.): Angyal 60. Ünnepi tanulmányok Angyal Miklós 60. születésnapjára. Jurisconsultus, Budapest–Pécs, 2025. 42–49. o.

⁴ Gárdonyi, G.: A bűnügyi szemle [Criminal Investigation Review]. Ludovika Egyetemi Kiadó. Budapest, 2024.

presumed course of events must be compared with the observed material alterations. If the reconstruction is flawed or incomplete, it may lead to erroneous conclusions.⁵

Distortions of human perception and memory can characterise the limitations of cognitive reconstruction. These include prejudice, fear, or even selective perception, all of which influence the interpretation of events. Cognitive psychology has identified numerous mechanisms that may distort the perception and thus the evaluation of evidence. Among these are the formation of false memories, excessive generalisation, and confirmation bias, all of which jeopardise the objectivity of reconstruction.⁶ In addition, the presence of irrational elements in violent crimes must be emphasised, as these often conflict with the expectations of logical reconstruction. Consequently, classical methods such as crime scene sketches, photography, and written records are not always capable of conveying the actual sequence of events.

The reliability of the reconstruction is of paramount importance in the context of judicial proof. In the absence of direct perception, the court relies on witness testimonies, expert opinions, and evidence. However, the logical chain built from such evidence may become distorted if the underlying documentation of traces is incomplete or inaccurate. As Gunyecz emphasises, the legality of evidence is a primary concern, since any error may lead to the loss of evidence, thereby constituting a failure of justice.⁷

The application of modern technologies is therefore not optional but necessary. Three-dimensional scanning, photogrammetry, and drone imaging provide reproducible, objective data that can mitigate errors arising from

⁵ Fenyvesi Csaba: A justizmordhoz vezető kriminalisztikai hibák. *Belügyi Szemle*, Issue 2024 /3. 30-59. o.

Source: <https://doi.org/10.38146/bsz-ajia.2014.v62.i3.pp30-59>

⁶ Angyal, M. (ed.): *Kognitív kriminalisztika: Ismeret – elmélet – történet* [Cognitive Criminalistics: Knowledge – Theory – History]. Dialóg Campus Kiadó. Budapest, 2019.

⁷ Gunyecz, Z.: *Bizonyítás a perbíró szemével* [Evidence from the Perspective of the Trial Judge]. *Büntetőjogi Szemle*, Issue 2024/2. 24–33. o.

human subjectivity. With the aid of modern tools, reconstruction thus becomes a measurable and visualizable process, rather than one confined solely to cognitive interpretation.

In summary, crime scene investigation and reconstruction are central elements of criminalistics, and modern technologies may help address their inherent limitations. It is important to emphasise, however, that these technologies do not replace cognitive reconstruction; rather, they support it by reinforcing the guarantees of objectivity. In this way, the interpretation underlying judicial proof can be elevated to a more reliable level, thereby contributing to the fairness of proceedings and strengthening public trust.

Digital Tools in Crime Scene Documentation

Among the classical tools of crime scene documentation mentioned earlier are sketches and photographs. Their use is quick and cost-effective, yet they also have limitations. A crime scene sketch contains subjective elements because the drafter decides which features to emphasise. Photographs provide a more objective record, but their two-dimensional representation may distort spatial relationships.⁸

Digital technologies offer the possibility of overcoming or mitigating these limitations. Photogrammetry, for instance, enables the stitching together of hundreds of photographs to create a three-dimensional model. This can even be accomplished with a simple smartphone, thus providing a rapid and cost-effective reconstruction of the scene. Its quality, however, is influenced by factors such as lighting conditions, sharpness, and angle settings. When combined with other technologies, however, it can yield a comprehensive representation.

Laser scanning provides a similarly precise technology. The device emits millions of laser pulses and calculates the distance of objects based on

⁸ Gárdonyi, G. (ed.): Módszertani útmutató 1: bűnügyi technikusok részére [Methodological Guide 1: For Crime Scene Technicians]. Nemzeti Közzolgálati Egyetem. Budapest, 2014.

the time it takes for the beams to be reflected. The resulting point cloud produces a digital replica that reproduces the original scene conditions with millimetre accuracy. However, the high equipment cost and the extremely time-consuming data processing are among its current limitations.⁹

The emergence of drones has introduced new opportunities for documenting outdoor crime scenes and traffic accidents. Aerial footage enables the mapping of locations that are otherwise difficult to access. When combined with photogrammetry software, drones can also generate three-dimensional models. Their limitations, however, stem partly from weather conditions and partly from regulatory authorisation requirements.¹⁰

Undoubtedly, the use of virtual and augmented reality (VR/AR) technologies ranks among the most advanced. These tools allow crime scenes to be “walked through” while modelling the incident's dynamics and spatial relationships. Their application provides participants in the proceedings with a direct means of obtaining information about the events. Future challenges and tasks, however, lie in addressing data protection issues and the high equipment requirements and resource-intensive nature of these technologies.¹¹

⁹ Ujvári, Zs. – Metzger, M.: A fotogrammetria kriminalisztikai alkalmazása – tudományosan megalapozott módszerek fényképezőgép segítségével történő 3D képrögzítéshez [The Forensic Application of Photogrammetry – Scientifically Grounded Methods for 3D Image Capture Using Cameras]. *Rendőrségi Tanulmányok*, Issue 2024/(különszám). 78–220. o.

DOI: 10.53304/RT.2024.ksz.02

Fülöp, P. – Ujvári, Zs. – Petréttei, D. – Kiss, I. – Dudás-Boda, E. – Metzger, M. – Fullár, A.: Az igazságügyi szakértői szemléltetés modern eszközei és lehetőségei [Modern Tools and Possibilities of Forensic Expert Demonstration]. *Ügyészek Lapja*, Issue 2023/5–6. 91–102. o.

¹⁰ Petréttei, D.: A drónok krimináltechnikai és rendészeti felhasználása [The Forensic and Law Enforcement Use of Drones]. *Magyar Bűnüldöző*, Issue 2015/1–3. 70–81. o.

¹¹ (n.d.): Forensic animation for legal cases [Forensic Animation for Legal Cases].

Source: <https://courtroomanimation.com/forensic-animation-legal-cases-guide/>

Accessed: 30.08.2025

Each of these digital tools is thus capable of reducing distortions arising from human subjectivity. They serve a complementary rather than a substitutive role alongside traditional methods, ensuring that reconstructions become more comprehensive.

Case Studies – impacts of digital evidence

The significance of digital technologies can best be understood through concrete cases. In recent years, several proceedings have been influenced by three-dimensional reconstruction or artificial intelligence. Digital evidence is thus no longer an experimental possibility but a living issue of legal practice.

Case of Antonio Jerome Greenlee

In 2009, a court in Georgia authorised jurors to virtually explore the crime scene using a 3D model. The visualisation, created with the Leica and Tru-View system, enabled direct perception of the spatial relationships among the witnesses, the defendant, and the victim. The demonstration significantly contributed to the jury's understanding and to the prosecution's success. The importance of the case lies in showing that digital reconstruction, beyond its illustrative role, can also be utilised as evidence.¹²

McCloud and Cameron – Exoneration of the Innocent

In 1995, two young men were convicted of a shooting that occurred in the hallway of an apartment building. Nearly thirty years later, as part of the Innocence Project and with the involvement of university students, laser scanning was carried out at the scene to reconstruct the events and verify the accuracy of witness statements. The new documentation demonstrated

¹² (n.d.): Leica 3-D laser-scan data provides forensic evidence at murder trial [Leica 3-D Laser-Scan Data Provides Forensic Evidence at Murder Trial].

Source: <https://www.policemag.com/technology/news/15344099/leica-3-d-laser-scan-data-provides-forensic-evidence-at-murder-trial>

Accessed: 10.06.2025

that the version described in the testimonies was physically impossible. Impact marks in the wall, previously concealed with plaster, revealed that the shooting had in fact taken place elsewhere. Thanks to the reconstruction, McCloud and Cameron—who had earlier confessed under coercion—were exonerated.¹³ The case serves as an excellent example of the role of digital forensics in preventing miscarriages of justice.

Archiving of Remains Documentation in Canada

The Royal Canadian Mounted Police initiated the documentation of human remains using 3D scanning. This method made it possible to preserve the original remains while creating digital replicas that will remain suitable for examination for decades. Its advantage lies in the fact that, as new scientific methods become available, the archived material can be re-evaluated without risking damage to the original evidence. In this way, digital recording will serve as a valuable resource for future generations as well.¹⁴

The Case of Michel Serge – Forensic Animations in Court

Michel Serge, a retired investigator, killed his wife. During the trial, a forensic animation was presented that illustrated the trajectory of the bullets, as well as the victim's movements and body positions. This provided the jury with a clearer understanding of the events in question. In the United States, such visualisations are sometimes referred to as “junk science,” sug-

¹³ (n.d.): How an NJIT forensic team helped exonerate two men wrongfully imprisoned for murder [How an NJIT Forensic Team Helped Exonerate Two Men Wrongfully Imprisoned for Murder].

Source: <https://news.njit.edu/how-njit-forensic-team-helped-exonerate-two-men-wrongfully-imprisoned-murder>

Accessed: 11.06.2025

¹⁴ (n.d.): 3 court cases that used forensic 3D scan data [3 Court Cases that Used Forensic 3D Scan Data].

Source: <https://datumtechsolutions.com/blogs/public-safety-industry/3-court-cases-that-used-forensic-3d-scan-data>

Accessed: 10.06.2025

gesting that they rest on pseudo-scientific foundations. In practice, however, they can help shorten trial duration and facilitate agreements between the parties.¹⁵

The Case of Christopher Pelkey – An AI-Generated Victim Message

In 2021, at a court in Arizona, the victim's family presented a video created with artificial intelligence in which the murdered man "spoke" through deepfake technology. In the video, delivered in his own voice, the man forgave the perpetrator—a statement the judge treated as an aggravating factor. The video sparked intense debate within the legal community, as it may have influenced the judicial decision and served as a precedent demonstrating the impact of AI on sentencing.¹⁶

The briefly summarised cases clearly illustrate that digital tools shape not only investigations but also judicial decision-making. Alongside the promise of greater objectivity and transparency, they raise new types of evidentiary and ethical questions, thereby charting the path forward for legislators and legal practitioners alike.

The Role of Artificial Intelligence in Reconstruction

The assistance provided by digital tools in reconstruction processes is undeniable; however, the full potential of artificial intelligence in forensic

¹⁵ (n.d.): Forensic animation gets more realistic [Forensic Animation Gets More Realistic].

Source: <https://abcnews.go.com/WNT/story?id=129973&page=1>

Accessed: 30.06.2025;

Source: <https://www.wired.com/2002/05/forensics/>

Accessed: 19.06.2025

¹⁶ (n.d.): From AI avatars to virtual reality crime scenes, courts are grappling with AI in the justice system [From AI Avatars to Virtual Reality Crime Scenes, Courts Are Grappling with AI in the Justice System].

Source: <https://apnews.com/article/ai-virtual-reality-courtrooms-legal-challenges-arizona-f47bfd50bd22469388082169ee77b7f0>

Accessed: 05.06.2025

practice can be realised through its integration. Modern crime scene recording technologies generate vast amounts of data. Processing, organising, and interpreting these data opens possibilities beyond the capacity of human experts. In this domain, artificial intelligence offers solutions by recognising patterns, modelling event sequences, and generating alternative scenarios.¹⁷

In bloodstain pattern analysis, AI can calculate the angle of impact of blood droplets through image processing, thereby providing insights into the victim's body position and the direction of the attack. It also plays a significant role in analysing bullet trajectories. Based on traces found on objects or walls, it can reconstruct the direction of the shots and the shooter's possible position. AI can further assist with identification, capable of recognising footwear impressions and even firearms.¹⁸

An advantage of its application is its ability to recognise patterns that may easily escape the human eye. It can perform analyses on recorded digital models according to various criteria, ensuring that examinations are both reproducible and resource-efficient.

Among the drawbacks, as Nyitrai points out, is that the spread of digitalisation has been accompanied by the emergence of new methods of crime — such as deepfakes and other forms of falsified digital content— which pose serious challenges for law enforcement.¹⁹

¹⁷ Herke, Cs. (2025): i.m. 42–49. o.

¹⁸ Jain, D. – Kher, S. – Liang, L. – Wu, Y. – Zheng, A. – Cai, X. – Plantinga, A. – Upton, E.: Improving and evaluating machine learning methods for forensic shoeprint matching [Improving and Evaluating Machine Learning Methods for Forensic Shoeprint Matching]. arXiv. 2024.

Source: <https://doi.org/10.48550/arXiv.2405.14878>

Sirisathitkul, C. – Sirisathitkul, Y.: Bloodstain in forensics: from visual inspections to AI-assisted pattern analysis and age estimation [Bloodstain in Forensics: From Visual Inspections to AI-Assisted Pattern Analysis and Age Estimation]. History of Science and Technology, Issue 2025/1. 26–46. o.

Source: <https://doi.org/10.32703/2415-7422--2025-15-1-26-46>

¹⁹ Nyitrai, E.: A digitális adatok és a modern technikai eszközök jelentősége a kriminalisztikában [The Importance of Digital Data and Modern Technical Tools in Criminalistics]. Nemzeti Közzolgálati Egyetem. Budapest, 2025.

Among the risks of applying AI, the most well-known is the “black box” phenomenon. The decisions and conclusions of machine learning algorithms are often not traceable. If an analysis is presented before a court whose methodology neither the expert nor the judge can understand, the question naturally arises: can it be accepted as evidence? Alongside the black-box issue, bias poses another serious problem: if the system is trained on distorted data, its conclusions will be distorted as well. The PredPol system exemplifies this in practice, as the overrepresentation of certain ethnic groups in the training data has led to flawed law enforcement practices²⁰. Thus, this danger may also arise in criminalistics, particularly in the context of crime scene reconstructions.

This is why AI must be used as a supporting tool rather than as an autonomous decision-maker in criminal proceedings. Responsibility must remain with the human expert. AI cannot become an independent source of evidence; it may only be used as supplementary data to complement human evaluation.

In summary, the application of artificial intelligence is dual in nature: it presents both opportunities and risks. It opens new horizons for enhancing objectivity and accelerating evidentiary processes. At the same time, transparency and accountability remain paramount, meaning that AI can only be used within appropriate legal frameworks. The challenge of the future is therefore not merely technological, but primarily legal and ethical: how to integrate AI into criminal proceedings in a way that strengthens, rather than undermines, the legitimacy of justice.

Legal and Regulatory Issues

²⁰ (n.d.): The disparate impact of predictive policing software [The Disparate Impact of Predictive Policing Software].

Source: <https://themarkup.org/newsletter/hello-world/the-disparate-impact-of-predictive-policing-software>

Accessed: 10.06.2025

The tools of digital evidence, 3D reconstruction, and artificial intelligence can only become truly usable in criminal proceedings if they comply with the legal criteria for admissibility. The central question is what qualifies as evidence. A digital model on its own does not possess probative value: it can only be regarded as such if its origin is verified (chain of custody), its methodology is documented, and an expert carries out its interpretation.²¹ A model, therefore, is not an independent source of evidence but rather a demonstrative tool forming part of the expert opinion.

However, the application of artificial intelligence raises further questions. As noted above, the conclusions generated by machine learning are not traceable. They cannot be verified by either the expert or the judge, thereby raising concerns about the admissibility of such evidence.²² In the United States, AI-based evidence is admissible only if the system's operation is properly documented, its developer is subject to audit, it remains under human oversight, and it is free from bias.²³ This also helps to prevent bias, that is, distortions which could otherwise compromise the evidentiary process.

²¹ Nath, S. – Summers, K. – Baek, J. – Ahn, G. J.: Digital evidence chain of custody: navigating new realities of digital forensics [Digital Evidence Chain of Custody: Navigating New Realities of Digital Forensics]. In: Proceedings of the 2024 IEEE 6th International Conference on Trust, Privacy and Security in Intelligent Systems and Applications (TPS-ISA 2024). Institute of Electrical and Electronics Engineers Inc. 2024. 11–20. o. Source: <https://doi.org/10.1109/TPS-ISA62245.2024.00012>

Kreitz, Z.: A chain of custody digitalizálásának lehetőségei [Possibilities for the Digitalization of the Chain of Custody]. *Hadmérnök*, Issue 2025/4. 131–142. o. Source: <https://doi.org/10.32567/hm.2024.4.9>

²² (n.d.): Ensuring chain of custody and verifiability for AI-generated content [Ensuring Chain of Custody and Verifiability for AI-Generated Content]. Source: <https://sealstorage.io/resources/blog/ensuring-chain-of-custody-and-verifiability-for-ai-generated-content>
Accessed: 30.06.2025

²³ (n.d.): AI-generated evidence: a guide for judges [AI-Generated Evidence: A Guide for Judges]. Source: <https://www.ncsc.org/resources-courts/ai-generated-evidence-guide-judges>
Accessed: 30.06.2025

The question of responsibility is likewise a crucial one: who bears it—the developer, the police officer, or the expert? Since AI can only appear as a supporting tool, responsibility must rest with the human expert. This ensures that decisions are grounded in human judgment, which necessarily entails criminal liability as well.²⁴

The European Union's AI Act, adopted in 2024, has elevated the use of AI in the justice system to a new level. The regulation classifies all such systems as “high-risk AI” and imposes strict requirements: CE marking, audited and documented operation, and continuous human oversight are mandatory.²⁵ The regulation makes it clear that AI cannot serve as an independent source of evidence and may be used only if transparency and verifiability are guaranteed.

In addition to legal concerns, attention must also be given to the principle of procedural fairness. The acceptance of digital evidence can only be legitimised in society's eyes if its application occurs within a fair, respectful, and transparent process.²⁶

Overall, it can be concluded that 3D reconstructions and AI tools can only become part of evidentiary practice under strict legal and ethical conditions. The challenge of the future does not lie in what these technologies are capable of, but in how legislation and legal practice can frame their application so that they strengthen, rather than weaken, the legitimacy of justice.

²⁴ (n.d.): Who's liable when AI makes legal mistakes? [Who's Liable When AI Makes Legal Mistakes?].

Source: <https://aicompetence.org/whos-liable-when-ai-makes-legal-mistakes/>

Accessed: 20.06.2025

²⁵ (n.d.): EU AI Act [EU AI Act].

Source: <https://artificialintelligenceact.eu/>

Accessed: 20.06.2025

²⁶ Vári, V.: Az eljárási (procedurális) igazság jelentősége a rendőri munkában [The Importance of Procedural Justice in Police Work]. In: Barabás, A. T. – Christián, L. (eds.): *Ünnepi tanulmányok a 75 éves Németh Zsolt tiszteletére. Navigare necesse est*. Ludovika Egyetemi Kiadó. Budapest, 2021. 509–518. o.

Summary

Digital technologies — such as photogrammetry, laser scanning, drone imaging, and VR/AR — have revolutionised the practice of forensic reconstruction. These tools have introduced more precise and detailed methods of documentation while also offering new possibilities for visualisation, thereby opening new dimensions in judicial decision-making. Artificial intelligence supports the processing of the resulting datasets, the recognition of patterns, and the reconstruction of sequences of events, thus enhancing the objectivity and efficiency of the evidentiary process.

Alongside the opportunities inherent in these technologies, their application also entails risks. Algorithms may be opaque, distorted data can produce bias, and questions of responsibility may confront practitioners with ethical dilemmas. If transparency and expert oversight cannot be ensured in the use of such tools, both the fairness of proceedings and public trust may be undermined. The EU AI Act stipulates that all systems intended for judicial purposes fall into the high-risk category and may therefore be used only under strict safeguards.

The study concludes that digital tools, and thus digital reality, are not the future but already an integral part of contemporary justice. They complement rather than replace human expertise, thereby strengthening the objectivity of evidentiary processes.

The challenge of the future is twofold: on the one hand, to ensure the integration of technological innovations into the processes of investigation and evidence; on the other, to establish the safeguards under which society can accept such evidence with confidence. The pursuit of truth remains a human responsibility - and digital tools can only fulfil their true role if they reinforce, rather than replace, that responsibility.

KISFONAI, BERNADETT PATRÍCIA

Artificial Intelligence in Law Enforcement: International Experiences and Domestic Prospects

Introduction

Nowadays, the rapid growth of artificial intelligence (AI) is fundamentally transforming the operation of law enforcement agencies worldwide, including in Hungary. AI applications developed to support more efficient, faster and targeted task performance are increasingly popular. Still, in recent years, so-called predictive policing has received increasing attention, aiming to anticipate crimes and identify potential perpetrators by analysing existing data. Based on patterns inherent in police data, some systems can “predict” the expected location, time, or even the persons involved in crimes, enabling the police to intervene proactively. The specific goal of these systems was to optimise the deployment of already overburdened police forces in specific urban districts.

In addition to predictive analysis, AI also supports law enforcement through facial recognition, video analytics, automatic number plate recognition (ANPR), and digital forensics.

This study primarily examines complex networks, especially their effects on crime prevention, and supports these findings with international examples, thereby reinforcing the importance of systems. A relatively new research field in Hungary holds great potential, as network analysis can help us better understand crimes. AI is a particularly useful tool for uncovering hidden connections, and a deeper understanding of the complex network approach is not only scientifically interesting but also has practical significance for developing crime-prevention strategies.

The Predictive Policing and Network Approach

In the early stages of AI's development, it focused primarily on solving problems that, while intellectually challenging for humans, were relatively simple for computers—especially those that could be described formally, using mathematical rules. The real challenge, however, was the tasks that we humans perform instinctively, almost without thinking, but are difficult to codify into rules. Such tasks include recognising spoken words or faces—activities that we perform intuitively yet are extremely difficult to model at the machine level.¹ Based on this approach, the essence of predictive policing is that the police use large amounts of data to predict and prevent crimes.² Analytical models have made it possible to model where and when an increased risk of crime is expected. Traditional predictive models focus more on spatial-temporal data. Still, the network approach, which analyses the relationships among offenders and other relevant actors to predict future crime, has increasingly become the focus of research.³ The approach applies tools from complex network systems to law enforcement, seeking to leverage network research results to support crime prevention. However, crime does not occur in a vacuum; perpetrators, victims, and locations are often embedded in interconnected networks. Criminological research from the ROXANNE project also supports the fact that crimes and victimisations are not randomly distributed in either social or geographical space.⁴ Understanding an individual's social connections can help predict

¹ Goodfellow, I. – Bengio, Y. – Courville, A.: Deep Learning. MIT Press. Cambridge, 2016. 15–20. o.

² Bezerédi, I.: Complex law enforcement AI policy: strategic and technological proposals from the perspective of ChatGPT and other LLMs. Law Enforcement Scientific Journal (Online), Issue 2024/1. 41–63. o.

³ Link, S. N.: Social network analysis in predictive policing: concepts, models and methods. In: Social Network Analysis in Predictive Policing. Springer, 2016. 7–13. o. Source: <https://doi.org/10.1007/978-3-319-41492-8>
Accessed: 19.07.2025

⁴ ROXANNE Project (2021): Social network analysis for criminology in ROXANNE.

their future behaviour, movements, and risk of criminal activity. Mapping these relationships enables the reconstruction of broader networks of crime and victimisation. From a network research perspective, we look for patterns of connections – for example, networks of cooperation among criminals – but the analysis of complex networks reveals critical nodes. Network analysis has been shown to reveal common properties of connections and networks, thereby enhancing the predictability of criminal events. Below, we first review theoretical network concepts and models, then present some practical applications – international experiences and, finally, domestic opportunities – that fall within the scope of network-based predictive policing.

Network concepts in law enforcement

Complex network theory offers several concepts that are considered extremely useful for analysing crime data. First, centrality measures highlight which nodes (persons, locations) in a network are most influential. In law enforcement networks, high-centrality actors are typically individuals who maintain many connections, who function as intermediary bridges between others, or who are relatively close to other members of the network (closeness centrality).⁵ The results of ROXANNE showed that, in a real investigation of an anonymous telephone network (based on 124 actors, 178 call/SMS connections), a few individuals played an exceptionally central

Source: <https://www.roxanne-euproject.org/news/blog/social-network-analysis-for-criminology-in-roxanne>

Accessed: 16.07.2025

⁵ Johnson, J. – Reitzel, J. – Norwood, B. – McCoy, D. – Cummings, B. – Tate, R. R. (2013): Social network analysis: a systematic approach for investigating. FBI Law Enforcement Bulletin

Source: <https://leb.fbi.gov/articles/featured-articles/social-network-analysis-a-systematic-approach-for-investigating>

Accessed: 18.07.2015

role, suggesting they may be the network's controllers or information centres.⁶

Community detection in network research identifies groups of nodes whose members are more closely connected than to the rest of the network.⁷ Network analysis can reveal, for example, if there are actually distinct groups within a seemingly dispersed set of offenders.

However, we can discuss the scale-independent properties of many real-world networks, including social and potentially criminal networks. According to the theory, a few nodes have unusually high numbers of connections, while the majority have few, so that, mathematically, their degree distribution approaches a power law.⁸ In criminal networks, this means there are often “hub actors” connected to many other offenders, while most offenders have few points of connection.

Finally, dynamic graph models should be mentioned, meaning that criminal networks are not static; their connections are always changing. New actors can enter, old ones can drop out. A dynamic network model can help deal with changes over time⁹. The link prediction method is the best example of this, as they try to model which two actors are expected to

⁶ ROXANNE Project (2021): i.m.

⁷ Yang, J. – Leskovec, J.: Overlapping community detection at scale: a nonnegative matrix factorization approach. In: Proceedings of the Sixth ACM International Conference on Web Search and Data Mining. ACM, 2013. 587–596. o.

Source: <https://doi.org/10.1145/2433396.2433471>

Accessed: 19.07.2025

⁸ Xu, J. – Chen, H.: The topology of dark networks. Communications of the ACM, Issue 2008/10. 58–65. o.

Source: <https://doi.org/10.1145/1400181.140019>

Accessed: 19.07.2025

⁹ Yang, C.: CrimeGraphNet: link prediction in criminal networks with graph convolutional networks. arXiv. 2023.

Source: <https://doi.org/10.48550/arXiv.2311.18543>

Accessed: 19.07.2025

form a connection within the network in the future.¹⁰ Another aspect of dynamic networks is real-time analysis, meaning modern systems strive to detect changes in the network by working with constantly updated data.¹¹

Complex network systems in crime prevention

Building upon the theoretical concepts outlined above, this section explores how various network systems are applied in crime prevention. Based on the above, it can be concluded that the applicable networks are extremely diverse; essentially, any system in which relationships or interactions connect elements falls within this classification. Social networks are the most obvious application area in crime prevention. It has long been known in criminology that offenders often act in groups and in pairs; the so-called co-offending networks are also often active.¹² Social networks, in a broader sense, also include networks of friends, relatives, and acquaintances. Whether a person becomes a criminal or a victim can be greatly influenced by their environment.¹³ A pilot program in Chicago, US, became known as the Strategic Persons List. It was a person-based predictive model that assigned people a score based on their likelihood of being perpetrators or victims of serious crimes.¹⁴ However, such an approach is susceptible to false alarms

¹⁰ Al Hasan, M. – Zaki, M.: A survey of link prediction in social networks. In: Aggarwal, C. C. (ed.): *Social Network Data Analytics*. Springer, 2011. 243–275. o.

Source: https://doi.org/10.1007/978-1-4419-8462-3_9

Accessed: 19.07.2025

¹¹ Of course, all this requires strong computational support and often the application of machine learning models. For example, graph neural networks can be used for predictive purposes; one experimental model is CrimeGAT, which applies such techniques to make predictions in criminal networks (Yang, 2023).

¹² Di Méo, G.: Historical co-offending networks: a social network analysis approach. *The British Journal of Criminology*, Issue 2023/6. 1591–1611. o.

Source: <https://doi.org/10.1093/bjc/azad057>

Accessed: 19.07.2025

¹³ Di Méo (2023): 1604. o.

¹⁴ 5 Peteranderl, S.: *Under fire: the rise and fall of predictive policing*. American Council on Germany. 2019.

and ethical issues – the Chicago “heat list” program was ultimately criticised. Nevertheless, social network analysis is now standard practice in supporting investigations.

Telecommunications networks are extremely valuable to modern law enforcement, as they serve as maps of electronic communication between people (phone calls, SMS, and Internet messages). Since criminals often use these channels to communicate, graphs constructed from communication data can reveal the hidden structure of criminal organisations.¹⁵ It is important to emphasise that the analysis of telecommunications networks also raises significant privacy and ethical issues. However, the raw technological opportunity is given. Urban transportation networks – such as road networks, public transport routes and human mobility systems – play a key role in the geographical distribution and spread of crime. The street network of cities can be interpreted as a graph in which the nodes are intersections and the edges are streets. Empirical research has shown that certain topological characteristics of the street network – such as throughput or centrality – correlate with crime frequency.¹⁶ High-traffic routes and busy intersections with large numbers of people offer more opportunities for both random and planned crimes. In addition, perpetrators often take advantage of the easy access and quick escape routes of such places. New-generation predictive policing tools analyse the relationship between crime

Source: https://www.acgusa.org/wp-content/uploads/2020/03/2020_Predpol_Peteranderl_Kellen.pdf

Accessed: 19.07.2025

¹⁵Ferrara, E. – De Meo, P. – Catanese, S. – Fiumara, G.: Detecting criminal organizations in mobile phone networks. *Expert Systems with Applications*, Issue 2014/13. 5733–5750. o.

Source: <https://doi.org/10.1016/j.eswa.2014.03.024>

Accessed: 19.07.2025

¹⁶Mao, Y. – Huang, S. – Ning, Y. – Wang, C.: Unraveling the nexus: how street network morphology influences crime in Detroit. *Humanities and Social Sciences Communications*, Issue 2025/12. 981. o.

Source: <https://doi.org/10.1057/s41599-025-01558-2>

Accessed: 19.07.2025

and the road network in real time using geospatial data and are increasingly being used to predict traffic accidents.

In the field of road safety, Sweden provides an effective example, with around 2,200 fixed speed cameras operating nationwide that significantly contribute to compliance with speed limits, thereby reducing road accidents. In Hungary, amendments to the legal environment may be justified to allow for the expansion of the speed camera network – for example, by installing it more densely, introducing average speed measurement systems, and including smaller settlements. Stricter sanctions and a consistent police presence could be additional tools to encourage compliance.¹⁷ In Sweden, the development of traffic culture is largely due to the conscious education of road users beginning in childhood: road safety education in schools has been a mandatory part of the basic curriculum since 1936. This long-term attitude formation has contributed to compliance with traffic rules becoming a social norm. It may also be worthwhile for Hungary to incorporate road safety knowledge into the school curriculum, from the basic rules of pedestrian and bicycle traffic to preparatory education for driving.¹⁸

Last but not least, a broader category of criminological relational networks can be highlighted, within which we can classify all networks exhibiting criminological connections. This could include, for example, networks of connections between crimes. Its analysis can help identify serial crimes and determine whether an event is connected across multiple networks. Europol uses such a network-based criminal intelligence analysis when it researches connections between cases in different countries (based on aspects such as weapons, car registration numbers, money movements,

¹⁷ Lang-Fuksa, D.: Swedish road to transport safety. In: Bándi, G. – Pogácsás, A. (eds.): *Law in the Service of the Sustainable Development Goals: Selected Doctoral Studies*. Pázmány Press. Budapest, 2025. 143–158. o.

¹⁸ Lang-Fuksa (2025): 145. o.

passport numbers).¹⁹ In a broader sense, criminal knowledge graphs also belong here, because we understand them as a set of networked databases in which people, crimes, physical evidence, locations, and the relevant relationships among them are represented as “edges”. Such graphs serve to support complex investigations. A special relational network is the criminal life-path network, in which the nodes are persons, and the edges do not represent a specific social relationship but rather some kind of criminological relation.

Network type	Field of application	Examples	Advantages	Challenges
Social networks	analysis of relationship systems (perpetrators, victims)	Chicago “heat list” program (Strategic Subject List)	Targeted prevention, identification of key actors, recognition of network patterns	Ethical issues, privacy concerns, false positives
Telecommunications networks	Analysis of phone calls, SMS, and on-line communication data	European ROXANNE project, mobile communication analysis of police investigations	Revealing hidden connections, real-time data analysis, and the possibility of rapid intervention	Serious data protection and ethical issues, risk of misuse of personal data

¹⁹ Europol: Decoding the EU's most threatening criminal networks [Decoding the EU's Most Threatening Criminal Networks]. European Union Agency for Law Enforcement Cooperation. Luxembourg, 2024. 6–30. o.

Transportation networks	Analysis of urban road networks, public transport routes, geographic prediction of crimes, and increasing traffic safety	Swedish speed camera system, predictive GIS analyses	Precise identification of spatial hot-spots, discovery of quick escape routes, linking accident and crime prevention	The need for legislative amendments, the cost, and the practical obstacles to network deployment
Criminological relational networks	Uncovering connections between crimes, supporting complex investigations	Europol crime analysis, criminal knowledge graphs, criminal life-course networks	Supporting complex investigations, effectively combating international crime, and identifying previously unnoticed connections	Complexity of data integration, emergence of false correlations, and handling large amounts of data

Table 1.
Comparison of network types used in law enforcement

Domestic situation and opportunities

In Hungary, predictive policing and network analysis are still in their early stages, but the interest is already palpable. Despite varying capacities, Hungarian police forces are beginning to explore how existing databases might be integrated into network-based predictive models. Future initiatives

within the Hungarian police could focus on launching pilot projects to explore the spatial dynamics of organised crime and vehicle-related offences. AI-based network analysis tools can help identify key players or explain why new transport routes may correlate with increased crime in a given area.

Future systems will also be affected by EU regulations, as the AI Act will strictly prohibit systems that score people based on personal data or past profiles. Finally, when examining the domestic opportunity, it is advisable to learn from international examples, which Hungary can use to develop a cautious yet smartly implemented network-based predictive policing model. The most effective approach combines human expertise with AI: while machines map networks and identify risks, final decisions remain with law enforcement professionals. The advantages of network analysis are effectively applied – such as better recognition of connections, faster data processing and proactive action – in crime prevention, while respecting the rule of law and ethical principles.

Conclusions

The application of AI to law enforcement carries both enormous promise and significant risk. The essence of the promise is that, for the first time, law enforcement agencies will have a tool that allows them to step out of their purely reactive role, improve city safety, and allocate resources more efficiently. This potential is also evident from international examples, as more and more countries and cities are experimenting with such systems to increase public safety. However, experience suggests that this technology is not a “magic wand” and, if used without supervision and control, it can become a tool for cementing prejudices. Whether it is about racial inequalities in American cities or the stop-and-search practice of the British police, AI is only as “smart” as the smart data it is fed with. The importance of algorithmic auditability and accountability should be emphasised.

Opaque “black box” AI solutions can undermine public trust and even the rule of law. The way forward is certainly to integrate AI into police work, but with human oversight and adherence to ethical standards. Innovation should be welcomed only if it does not violate fundamental rights and if democratic control over its use remains.

In conclusion, AI in the service of law enforcement is like a double-edged sword. While AI can be a powerful tool against crime, it must be wielded with caution to avoid unintended harm. International experiences offer abundant lessons that Hungary can draw on as well. The domestic opportunities are given, as we have the expertise and cautious openness to AI. The most important thing is that these technologies are introduced in the future in a responsible, transparent, and law-abiding manner. This is how artificial intelligence can truly enhance society's security without destroying its sense of justice. While AI is not a panacea, it can, if used wisely, become a valuable supporting tool for 21st-century law enforcement – both in Hungary and around the world.

LANG-FUKSA, DOROTTYA

Speeding Regulations in Switzerland in the Light of Police Sanctions: Fine Systems, Raserdelikt and Reform Directions

Introduction

Road safety is a priority area of public policy in modern states, particularly due to the serious personal injuries and deaths resulting from traffic accidents, as well as the significant social and economic burdens they cause. According to public data from the World Health Organisation (WHO), more than 1.3 million people die each year from road accidents worldwide, which is a major cause of death.¹ These tragic indicators show a direct correlation with one of the most common forms of contributory behaviour. Speeding increases the chance of accidents and aggravates their consequences, especially in cases involving death or permanent injury. Given these circumstances, the effective protection of road safety is a state task, which includes the development and consistent enforcement of legislative and law enforcement tools to curb speeding. The effectiveness of norms sanctioning violations of road traffic rules – especially to curb speeding – can only be ensured if the state takes preventive and repressive measures against illegal behaviour, while taking into account the principles of proportionality and differentiation. Switzerland has developed a long-term, sustainable, and effective road safety practice, as confirmed by favourable statistics in inter-

¹ WHO, Global status report on road safety 2023. Geneva, World Health Organization, 2023.

Source: <https://www.who.int/teams/social-determinants-of-health/safety-and-mobility/global-status-report-on-road-safety2023>

Accessed: 01.07.2025.

national comparison. According to a 2023 report by the OECD and the International Transport Forum (ITF), the number of road deaths per million inhabitants in Switzerland was 23, compared to the European average of 50.² This favourable result is supported by a comprehensive legal and institutional system of instruments, as reflected, among other things, in the strictness of the regulation, the efficiency of control, and the high degree of compliance with social norms. The Swiss regulatory model deserves special attention in the approach to speeding. On the one hand, the relevant normative system adopts a differentiated approach, prescribing varying sanctions depending on the severity of the act and the personal circumstances of the perpetrator, especially his financial situation. On the other hand, in some cases, it recognises serious speeding as an independent crime. Of particular importance is the system of income-based fines, which aims to distribute sanctions according to equal burden, and the use of psychological aptitude tests, which serve to filter out persons who are unsuitable in terms of traffic morality. The primary objective of this study is to analyse the Swiss sanction system for speeding comprehensively, taking into account both dogmatic and comparative legal aspects. The research focuses on the connections between criminal and administrative law regulatory elements, their demarcation and functional cooperation. The study discusses in a separate section the legal principles of road safety, the levels of sanctioning, the mechanism of income-based fines, and the normative and practical role of psychological aptitude testing. The study also provides an international comparative analysis, with particular attention to German, Austrian, and Hungarian regulatory and judicial practice, to evaluate the Swiss model in a broader European context. Finally, the study also formulates *de lege ferenda* proposals based on Swiss experience, taking into account the specificities of individual national systems. The study is based on the Swiss Road Traffic Act.

² OECD–ITF, Road Safety Annual Report 2023, OECD Publishing, Paris, 2023.
Source: <https://www.itf-oecd.org/roadsafety-annual-report-2023>
Accessed: 01.07.2025.

(Strassenverkehrsgesetz - SVG), the related implementing regulations, relevant judicial practice, and domestic and international literature.

Basic principles of the Swiss road safety system

One of the defining principles of Swiss road safety legislation is the primacy of prevention, which is applied both in the legislative and the enforcement perspective. The declared aim of the Road Traffic Act (Strassenverkehrsgesetz, hereinafter: SVG) is to ensure the safety and smooth running of road traffic, with particular regard to accident prevention. Article 1 of the SVG states: “*This Act aims to ensure the safety and smooth running of traffic on public roads.*”³ The Swiss legal system aims to achieve the statutory objective through a complex set of instruments that include legal, police, and educational elements. The preventive approach has a dual structure. On the one hand, general prevention is applied, the aim of which is social deterrence: it aims to orient potential violators toward compliance with the law through the adverse legal consequences associated with violating the norm. On the other hand, special prevention seeks to influence the future behaviour of the individual offender, i.e., to encourage future compliance with the rules. In the application of Swiss law – especially in cases of serious traffic violations, such as significant speeding – the principle of zero tolerance prevails. This principle embodies the normative approach according to which the sanctioning of traffic violations is not based on subjective considerations, but on objective normative requirements, especially if the committed behaviour involves obvious danger. According to the consistent case law of the Swiss Federal Court (Bundesgericht), serious speeding is not to be regarded as a mere violation of the rules, but as a deliberate and dangerous attack on traffic morality, to which

³ Strassenverkehrsgesetz (SVG), Art. 1, Bundesgericht, Urteil 6B_686/2017 vom 8. Januar 2018, BGE 144 IV 313. Source: https://www.fedlex.admin.ch/eli/cc/1959/678_678_678/de Accessed: 01.07.2025.

the state must respond effectively and consistently. The court stated in a case-by-case decision: *“Die massive Geschwindigkeitsüberschreitung ist nicht nur eine Ordnungswidrigkeit, sondern eine bewusste Missachtung der Verkehrsregeln, die eine ernsthafte Gefährdung für andere darstellt.”* (“Severe speeding is not just a violation of the rules, but a deliberate disregard for traffic regulations that poses a serious danger to others.”).⁴ A strict normative approach contributes to maintaining a high level of road safety and strengthening social respect for the law. A specific and outstanding element of the Swiss criminal and administrative sanction system, even in European comparison, is the income-based fine, which is implemented in the form of the

Tagessatzsystem (daily fine system). This system, based on the provisions of the Swiss Criminal Code (Strafgesetzbuch, StGB) and the SVG, allows the amount of the fine to be determined in accordance with the offender's daily net income and the seriousness of the offence.⁴ Income-based sanctions aim to enforce proportionality and social justice, ensuring that the sanction carries a noticeable weight for all social groups. Offenders with higher incomes are subject to significantly higher fines for the same violation of norms. In contrast, low-income individuals are assured that the sanction does not exceed the subsistence minimum. In addition, the system also enhances the effectiveness of general prevention: by perceptibly differentiating the financial consequences by social strata, the incentive to comply with the law is universally effective.

Speeding penalty system in Switzerland

The current legal framework – in particular Article 90 of the Road Traffic Act (Strassenverkehrsgesetz, SVG) and the Regulation on Fines for Road

⁴ Criminal Code (StGB), Art. 34; Article 90 SVG

Source: https://www.fedlex.admin.ch/eli/cc/1938/948_948_948/de

Accessed: 01.07.2025.

Traffic Offences (Ordnungsbussenverordnung, OBV)⁵ – regulates speeding in three categories: minor offence, serious offence and criminal offence, the latter category being the so-called Raserdelikt. According to the law, an administrative fine applies to speeding in built-up areas at just 16 km/h. From 25 km/h onwards, the offence is considered serious, while criminal liability can be established for exceeding 50 km/h. On motorways, the lower limit for criminal liability is 80 km/h. The sanctions range from a fine to a temporary or permanent suspension of a driving licence to imprisonment. If the speeding offence exceeds the threshold of criminal relevance – especially in cases falling under the category of Raserdelikt – the assessment can no longer remain within the competence of the administrative authorities, but is diverted to criminal proceedings, which fall under the jurisdiction of the cantonal court. According to the provisions of the Swiss Code of Criminal Procedure (Strafprozessordnung, StPO), proceedings are initiated by the competent public prosecutor's office, and the court decides on the sanction after the evidentiary procedure is completed.⁶ Although the number of court proceedings has decreased due to the introduction of the OBV, serious speeding – in particular Raserdelikt – is regularly subject to judicial review. The jurisdictional regulations are differentiated at the cantonal level, but the federal regulations provide a uniform interpretative framework that makes judicial application coherent and predictable. The temporary or permanent withdrawal of a driving licence is based on Article 16 of the SVG, which states that if a driver seriously endangers road safety or commits a repeat offence, the licence must be withdrawn. In the case of serious speeding – including the Raserdelikt category – the authority is obliged to order a driving ban of at least three months. These provisions aim to exclude persons who are unfit to drive, either temporarily or permanently. In Swiss law, the term Raserdelikt refers

⁵ Article 90 of the SVG

⁶ Schweizerische Strafprozessordnung (StPO), SR 312.0

Source: <https://www.fedlex.admin.ch/eli/cc/2007/758/de>

Accessed: 01.07.2025.

to a separate criminal category for particularly serious speeding offences, introduced by the Via Sicura road safety program adopted in 2013. According to Article 90(3a) SVG, *“Whoever exceeds the permissible speed limit by at least 50 km/h in built-up areas, by at least 60 km/h outside built-up areas or by at least 80 km/h on motorways commits a crime.”* (*“Whoever exceeds the permissible speed limit by at least 50 km/h in built-up areas, by at least 60 km/h outside built-up areas or by at least 80 km/h on motorways commits a crime.”*).⁷ The mandatory penalty for a Raserdelikt is at least one year of imprisonment. This legal institution is a particularly strict example of the criminalisation of traffic offences, which serves to combat the most dangerous forms of driving behaviour. One of the lesser-known yet highly significant tools of the Swiss traffic safety system is the so-called Medizinisch-Psychologische Untersuchung (MPU), i.e., the medical-psychological fitness test. Section 15d of the SVG allows the traffic authority to order a psychological and medical examination if there is reasonable doubt about the driver's fitness.⁸ The purpose of the procedure is to determine whether the person being examined is mentally and psychologically capable of consistently complying with traffic regulations and of recognising and dealing appropriately with dangerous situations arising in traffic. The examination is particularly justified for speeding offenders and repeat speeders, as identifiable risk factors, such as irresponsibility or impulsivity, often accompany these behaviours. The cantonal traffic authority (Strassenverkehrsamt) is responsible for initiating the procedure and can do so ex officio or based on a police report. The assessment is carried out jointly by a specialist psychologist and a doctor, and a written expert opinion is drawn up on the results.⁹ The test consists of several parts. Personality diagnostic questionnaires, reaction time and attention tests, and a structured interview. The purpose of the test is not only to map the current

⁷ SVG Article 90(3a)

⁸ Article 15d of the SVG

⁹ Zürcher Strassenverkehrsamt - MPU

Source: <https://www.stva.zh.ch/internet/sicherheit/mpu.html>

Accessed: 01.07.2025.

state, but also to predict future traffic behaviour. Three possible outcomes of the MPU are known: positive, conditionally positive, and negative. Based on a positive result, the driving license can be returned; a conditionally positive assessment may, for example, only link the restoration of the right to specific vehicle categories, periodic control tests, or completion of refresher training. In the event of a negative result, the license cannot be returned, and a new test can only be ordered after a specified period has elapsed.¹⁰ Although the MPU result is not a formal administrative decision, it is binding. According to Swiss law, a driver's license withdrawn for a Raserdelikt offence can only be returned with a positive or conditionally positive MPU opinion.

Specific features of income-based fines

One of the unique legal institutions of Swiss criminal law, one that is also noteworthy in European comparative jurisprudence, is the so-called daily fine, or Tagessatzsystem. The codified basis of the legal institution is set out in Articles 34 and 36 of the Swiss Criminal Code (Schweizerisches Strafgesetzbuch, StGB).¹¹ The regulation aims to adapt criminal sanctions to the offender's individual financial situation, thereby ensuring that the punishment is proportionate and socially just in concreto. The amount of the daily fine is determined based on the offender's daily net income, taking into account their living expenses, financial circumstances, and maintenance obligations. The minimum daily amount is CHF 30, while the maximum limit is CHF 3,000.¹² The number of days that can be imposed ranges from 1 to 180, so the theoretical maximum fine can be up to CHF 540,000.

¹⁰ Verkehrssicherheitszentrum Zürich – Informationen zur MPU

Source: <https://www.vsz.ch/mpu/>

Accessed: 01.07.2025.

¹¹ Swiss Criminal Code (StGB), Art. 34–36.

Source: https://www.fedlex.admin.ch/eli/cc/1938/948_948_948/de

Accessed: 01.07.2025.

¹² Article 34(2) of the German Criminal Code

In practice, this regulation differentiates punishment based on equal burden, which can be interpreted as a response to criticism of classic sanction systems.¹³ Income-based sanctions play a prominent role in sanctioning serious speeding offences, especially in cases that fall under criminal law and are not assessed as administrative fines. In the case of offences falling within the category of Raserdelikt, the courts often apply the daily fine system either as an alternative to conditional imprisonment or as a supplement to it. This type of sanction can be considered a more effective tool in terms of deterrence than fixed-amount fines, since “*the burden is realistically and perceptibly distributed between social classes*”.¹⁴ Swiss case law shows that the daily fine system is consistently applied in speeding cases, sometimes resulting in significant fines. One of the most famous cases came to international attention in 2010, when a luxury car owner was caught driving at 290 km/h on a Swiss motorway. The court imposed a fine of 300 daily units, based on the offender's income, equivalent to CHF 3,000 per day, totalling CHF 900,000. The vehicle was also confiscated.¹⁵¹⁶ As Ackermann puts it: “*the daily fine is a suitable means for the sanction to penetrate social structures in a just manner.*”¹⁷ The deterrent effect of a fine cannot be measured in its absolute amount, but in its value relative to the social realities of the offender—this approach, I believe it is in line with the preventive and educational goals of modern criminal law doctrines, which assess the effectiveness of a sanction not by its size but by its actual

¹³ Hans-Heinrich Jescheck and Thomas Weigend, *Lehrbuch des Strafrechts: Allgemeiner Teil*, 5th ed. (Berlin: Duncker & Humblot, 1996), 893–896. o.

¹⁴ Matthias Bock and Bernd Stein: *Geldstrafen als Steuerungsinstrument in der Verkehrssicherheit*. Nomos, BadenBaden, 2015. 91–97. o.

¹⁵ BBC News, *Swiss speeder fined record \$290,000*. 7 January 2010.

Source: <https://www.bbc.com/news/10542126>.

Accessed: 01.07.2025.

¹⁶)

¹⁷ Thomas Ackermann: *Die Geldstrafe als gerechte Sanktion?* *Zeitschrift für Internationale Strafrechtsdogmatik*. 2013/4. 121–129. o.

impact on the offender.¹⁸ However, the system has also been criticised. According to some analyses, the attempt to conceal income or assets carries significant potential for abuse. To address this, Swiss judicial authorities are increasingly relying on cooperation with tax authorities and on examining objective living conditions to reliably estimate income status.¹⁹

Switzerland's achievements in road safety

One of the primary indicators for an objective assessment of road safety is the development of accident statistics, especially for fatal and serious injury accidents. According to the Swiss Federal Statistical Office (Bundesamt für Statistik, BFS), there were fewer than 200 fatal traffic accidents in the country in 2022, corresponding to 2.3 deaths per million inhabitants.²⁰ This indicator is exceptionally low not only among European countries, but also globally. Over the past two decades, the number of fatal road accidents has decreased by more than 60%, while the incidence of serious injuries has also decreased markedly.²¹ *"This favourable trend cannot be interpreted solely as a result of technological progress or infrastructure development, but can primarily be explained by the consistent enforcement of normative and enforcement rigour."*²² I want to highlight the preventive effect of the speeding penalty system, which has helped reduce the frequency of major speeding offences. Statistical data indicate a stagnant or declining trend in

¹⁸ Hans-Heinrich Jescheck - Thomas Weigend: Lehrbuch des Strafrechts: Allgemeiner Teil. 5th edition. Berlin. Duncker & Humblot. 1996. 893–896. o.

¹⁹ Reto König, "Einkommensverhältnisse in der Strafzumessung: Praxis und Probleme," Schweizerische Juristen-Zeitung (SJZ) 2 (2021): 101–110. o.

²⁰ Bundesamt für Statistik (BFS), Strassenverkehrsunfälle und Opfer – Schweiz, 2022. Source: <https://www.bfs.admin.ch/bfs/de/home/statistiken/mobilitaet-verkehr/unfaelle.html>.

²¹ OECD/ITF, Road Safety Annual Report 2023, Paris: OECD Publishing, 2023.

²² Reto Küng and Andreas Balthasar: Effizienz von Verkehrssicherheitsstrategien in der Schweiz. Zürich. Seismo Verlag. 2019. 42–45. o.

this area, especially regarding cases classified as Raserdelikt.²³ The effectiveness of Swiss regulations can be measured not only by accident rates but also by their direct and indirect effects on traffic culture. Direct effects include a reduction in speeding offences and increased road safety. These results are closely linked to the predictability and consistency of the fines system and to the active presence of law enforcement agencies in the enforcement area.²⁴ The indirect effects, however, are at least as significant. Obeying the rules and following traffic norms is a deeply embedded value in Swiss society, one that is shaped by educational and communication tools. Road safety is already part of the school curriculum, and public service media also regularly deal with road hazards and changes in legislation. *“This comprehensive approach reinforces the legal and sociological thesis that the effectiveness of traffic legislation does not depend on the norm itself, but on the social embeddedness of the norm.”*²⁵ Social acceptance also legitimises the effectiveness of regulation.²⁶ According to the latest opinion polls, the majority of the Swiss population supports strict action against speeding, especially in cases of acts falling under the legal category of Raserdelikt.²⁷

²³ ASTRA (Bundesamt für Strassen), Via Sicura – Jahresbericht 2022, Source: <https://www.astra.admin.ch> Accessed: 01.07.2025.

²⁴ Martin Killias - Marcelo Aebi: Crime Trends in Switzerland: The Role of Law Enforcement. European Journal of Criminology. 2018/1. 31–47. o.

²⁵ Urs Walser: Verkehrsdelinquenz und Gesellschaft: Normbefolgung im Straßenverkehr. Nomos. Baden-Baden. 2016. 122. o.

²⁶ Bernadett Patricia Kisfonai: The role of artificial intelligence in future crime prevention in Europe. In: Gyula Bándi – Anett Pogácsás (eds.): Law in the Service of the Sustainable Development Goals. Selected Doctoral Studies – Law in the Service of the Sustainable Development Goals. Selected Doctoral Studies. Budapest. Pázmány Press, 2025. 125–141. o.

²⁷ GfS Bern: Verkehrssicherheit und öffentliche Meinung. Representative poll, December 2021.

Conclusion

Given the complexity and consistency of the Swiss speeding penalty system, it can be clearly stated that the model implements a regulatory and enforcement structure that reflects not only normative rigour but also social sensitivity and preventive effectiveness. The income-based fine mechanism, the traffic psychological aptitude tests, and the differentiated application of criminal law classification together contribute to the system's ability to suppress behaviours that endanger road safety. Empirical research and statistical data also support the view that strict penalties, especially the criminalisation of Raserdelikt, have had a positive impact on traffic morale and on accident rates.²⁸ *"The effectiveness of road safety regulations is guaranteed not only by the existence of standards, but also by their consistent and socially accepted application."*²⁹ Many elements of Swiss practice represent legal policy and practical experience that, in my opinion, may be relevant for other European states, including Hungary. The following areas may be particularly justified in adapting the Swiss model:

- Introduction of a system of income-based fines³⁰
- Legally enshrining the institution of psychological aptitude testing;
- Strengthening the involvement of digital tools in detecting and proving violations;

²⁸ Bundesamt für Statistik (BFS), Strassenverkehrsunfälle – Jahresbericht 2022, Bern, 2023.

Source: <https://www.bfs.admin.ch>

Accessed: 01.07.2025.

²⁹ Thomas Ackermann: Die Zukunft des Verkehrsstrafrechts: Zwischen Prävention und Technologieregulierung. Zeitschrift für Schweizerisches Recht (ZSR). 2022/1. 33–54. o.

³⁰ Hans-Jörg Albrecht – Michael Kilchling: Monetary Sanctions in Comparative Perspective, in: Michael Tonry (szerk.): Crime and Justice: A Review of Research, 27. kötet. University of Chicago Press. 2000. 143–200. o.

Normatively rethinking the principle of proportionality in responses to serious speeding cases.³¹ New challenges in the field of road safety – the legal status of self-driving vehicles, legal harmonisation issues for intelligent traffic management and new forms of mobility – require a forward-looking and adaptive approach to legislation. The Swiss model offers an exemplary model in this area as well. The Via Sicura programme is not just a response to the tragic traffic incidents of the past, but also a forward-looking regulatory toolkit that can keep pace with technological and social changes. I can only agree with Christian Schwarzenegger, who said that *“the future of road law does not lie in the quantity of sanctions, but in their quality and the intelligence of their application”*.³² From this perspective, Swiss practice also sets a strategic direction that can serve as an example for other nations, especially if traffic safety is treated not only as a technical but also as a socio-political priority.

³¹ Marc Thommen: Strafrechtliche Konsequenzen bei Raserdelikten – Eine kritische Analyse des Via SicuraProgramms. Schweizerische Zeitschrift für Strafrecht. 2019/2. 103–120. o.

³² Christian Schwarzenegger: Verkehrsrecht im Wandel – Zwischen Tradition und Digitalisierung, in: Schweizerischer Juristentag 2021. Zürich. Dike Verlag. 2022. 77–93. o.

MÁGÓ, BARBARA

The Role of the Defendant's Nationality in Criminal Law **The path of drugs today**

*„The criminal can evolve and become a decent member of society.
A foreigner cannot develop. Once a foreigner, always a foreigner.”
/Mikes: How to be an Alien, 1946/*

Foreword

The complex nature of the citizenship procedure means that it is linked to many areas of law.¹ This study aims to examine the criminal law aspects of citizenship law, in addition to the obvious administrative, constitutional and immigration law links. It can be assumed a priori that citizenship permeates the institutional framework of criminal law at several points and that the existence or otherwise of a citizenship status also plays a significant role in criminal proceedings.

The relationship between criminal law and citizenship law

In the times before the first modern criminal codes, the punitive norms were based primarily on the figure of the citizen, or the “son of the country”, as it was called at the time in Hungarian. The parallel legislative processes of the Csemegi Code and the first Hungarian Citizenship Act (Act L of 1879) had a reciprocal influence on each other. It is interesting to note that it was

¹Mágó, B. (2024): Az állampolgársági eljárás mint speciális közigazgatási hatósági eljárás [The Citizenship Procedure as a Special Administrative Authority Procedure]. In: Gaál, Gy. – Hautzinger, Z. (eds.): Pécsi Határőr Tudományos Közlemények XXVI. Pécs. 233–237. o.

the first criminal bill to use the term “citizen” in Hungarian legislation.² The concept of citizenship, as defined during the parliamentary debate on Act V of 1878, served as the public-law basis for the scope of the criminal law.³ From that time onwards, Hungarian criminal law applied, within its territorial and personal scope, to offences committed in Hungary, irrespective of whether the offender was a Hungarian citizen.⁴ These provisions make it clear that criminal prosecution does not require citizenship; the primary objective of criminal proceedings is to protect society against perpetrators of crimes, irrespective of their citizenship.

Additional criminal law obligations for foreigners?

The state's criminal jurisdiction extends to foreigners as well, and foreigners can be prosecuted on equal terms. However, the literature on aliens focuses on the need to meet the additional criminal law obligations arising from the specific situation of aliens, without specifically examining their nationality. While these approaches are correct in the vast majority of cases, they often overlook the specific legal characteristics of special categories of citizenship. Although the majority of criminal law provisions relating to foreigners have not been given a separate chapter in Hungarian legislation, there are rules in both substantive and procedural law and in the penal system which are indispensable for the application of the rules to foreign nationals.

²Varga, N.: Az állampolgárság fogalmának kialakulása a magyar közjogban [The Development of the Concept of Citizenship in Hungarian Public Law]. *Acta Universitatis Szegediensis – Acta juridica et politica*. 2008. 508–510. o.

³Barna, A.: Az állam elleni bűncselekmények szabályozása a 19. századi Magyarországon, különös tekintettel a büntettekről és vétségekről szóló 1878. évi 5. törvénycikk előzményeire és megalkotására [The Regulation of Crimes against the State in 19th-Century Hungary, with Particular Regard to the Antecedents and Enactment of Act V of 1878]. *Universitas-Győr Nonprofit Kft. Győr*, 2015. 251. o.

⁴Csemegi-kódex, 5–6 §; Btk., 3 §

In Act XC of 2017 on Criminal Procedure (hereinafter referred to as the "Act"), such general additional obligations include the right to use the mother tongue, the provision of mandatory protection, the possibility of contacting the consular representative and the requirement to notify the aliens and asylum authorities. Although these additional obligations seem to apply to foreign nationals without exception, a closer examination of the legal situation from a nationality law perspective call into question their exclusivity. The Act, correctly, does not state that foreigners have the right to use their mother tongue in criminal proceedings, but rather grants this right to all persons who do not understand or speak Hungarian.⁵ It cannot be excluded that a Hungarian citizen — typically a foreigner, but also a resident — may lack Hungarian language skills. While in the case of Hungarian citizenship acquired by naturalisation, knowledge of Hungarian is a statutory prerequisite, in the case of citizenship by descent, there is no such requirement. In their case, therefore, it is just as necessary to use an interpreter and translator at all stages of the procedure as it is for persons who are exclusively foreign nationals.⁶ By the same analogy, providing compulsory defence for the accused is also not a matter of nationality, but of language skills. As a result, defence counsel's participation in criminal proceedings is not mandatory if the accused is a foreign national who does not know Hungarian.⁷ Thus, there are only two formal additional obligations for non-Hungarian nationals: the right to consular assistance and the obligation to report to the aliens' police.

Similar conclusions can be drawn regarding the penitentiary system, even though the act on the penitentiary system devotes a separate chapter to prisoners of non-Hungarian nationality.⁸ This classification of foreigners is justified by the difficulties of communication during the detention of persons of another nationality, as well as by the tensions arising from their

⁵ Be., 8 § (2)–(3)

⁶ Be., 78 § (1)–(2)

⁷ Be. 44. § d

⁸ Bv. tv., 207–215 §

cultural habits and possible religious differences.⁹ However, the need for an interpreter, the free practice of religion, the provision of food in accordance with religion, the prevention of national and ethnic conflicts, and the requirement of Hungarian language education are not really additional obligations based on citizenship, but rather requirements of security, peaceful coexistence, successful communication within the prison, freedom of religion and, above all, effective reintegration. It would be a mistake to treat the former as a purely national issue.

The only additional obligation in criminal law based on real nationality, beyond the formal consular contacts and the flow of information between institutions discussed earlier, is found in substantive criminal law. This additional obligation, however, can be seen more as an option for the state's self-defence mechanism than as a procedural requirement or a legal expectation. However, in an era of codification tendencies that exclude or restrict judicial discretion¹⁰, the possibility cannot be ruled out that in the future expulsion could become a mandatory element in the imposition of penalties on foreign offenders, particularly given that it is currently not excluded for certain offences, such as border control and trafficking in human beings.¹¹

In addition to the above, it is also justified to deal separately with those criminal offences that presuppose special intent, i.e., an exclusively Hungarian citizen perpetrator, as these cases can be interpreted as a specific, negative aspect of citizenship from the point of view of criminal liability. The special intent requirement for the offences of treason and infidelity is based on the rights and obligations of citizenship, which do not extend to foreign citizens and thus do not affect them as either rights or obligations.

⁹ Hautzinger, Z.: A külföldiekre vonatkozó normatív szabályozás a magyar büntetésvégrehajtási jogban [Normative Regulation Concerning Foreigners in Hungarian Penitentiary Law]. *Börtönügyi Szemle*, Issue 2015/1. 55. o.

¹⁰ Ambrus, I.: Se veled, se nélküled – a pénzbüntetés és a kiutasítás kötelező együttes kiszabásának problémái [Can't Live With It, Can't Live Without It – Problems of the Mandatory Joint Imposition of Fines and Expulsion]. *Belügyi Szemle*, Issue 2021/1. 75. o.

¹¹ Btk., 60 § (2a) [On this issue, see also court decisions: BH 2022.31; BH 2023.55]

The nationality aspect of expulsion

The only legal institution in criminal law that presupposes an effective nationality test is expulsion. According to the fundamental right declared in the Fundamental Law, Hungarian citizens cannot be expelled from Hungarian territory.¹² The inverse, negating statement of this right, where the condition and the result are exchanged for their opposite, only mechanically, without further examination of the conditions of life, is: foreign nationals may be expelled from the territory of Hungary. Criminal law and aliens' law use precisely this inverse formulation, of course, in a formulation specific to certain groups of foreigners. According to the Criminal Code, a non-Hungarian offender whose stay in Hungary is undesirable must be expelled from Hungarian territory.¹³ EEA citizens and their family members can be subject to expulsion under the Szmtv.¹⁴, while third-country nationals can be subject to expulsion under the Btátv.¹⁵ Thus, a criminal court order and an expulsion order may never be imposed on a citizen (in this case, a Hungarian citizen).

However, certain categories of non-citizens may be exempted from the general expulsion rules, so that the sanction of expulsion does not apply to them, despite their foreign status. In particular, persons enjoying international protection, such as refugees and beneficiaries of subsidiary protection, are exempted.¹⁶ However, the principle of non-refoulement¹⁷ applies not only in the field of asylum law, but also in the field of aliens policing law, so that the non-refoulement principle can be considered as one of the most important principles of expulsion. Persons enjoying the right of

¹²Alaptörvény XIV. cikk (2)

¹³ Btk. 59. § (1)

¹⁴ Act I of 2007 on the entry and residence of persons with the right of free movement and residence [Detailed rules on expulsion are set out in § 40–49]

¹⁵ Act XC of 2023 on the General Rules on the Entry and Residence of Third-Country Nationals [Detailed rules on expulsion are set out in Chapter XIII]

¹⁶ Btk. 59. § (2)

¹⁷ Principle of non-refoulement [No one may be returned to a country where they face persecution, torture, inhuman or degrading treatment, or other serious violations]

free movement and residence, and long-term residents, may be removed from the country only in exceptional cases of very serious crime; the freedom of movement and compensation for long-term legal residence granted by the Union will give them exceptional protection status. In addition, expulsion can only be considered lawful if it does not disproportionately affect the right to family life of the person concerned. Individual living conditions must always be taken into account by the authorities, in particular where the person concerned has a long-lasting and deep family connection in the country. The more deeply rooted one's family and cultural roots are in a given society, the greater the protection against expulsion.

The relationship between "special" categories of citizenship and expulsion

In a binary system, the prohibition on expelling a Hungarian citizen and the possibility of expelling a foreigner seem straightforward, since all that is needed is to decide whether the person is Hungarian. However, the field of nationality law is much more complex, and the decision-maker is often unable to take a clear position on the Hungarian or foreign nationality of the person concerned due to a lack of specialised knowledge. In the following, these specific categories of citizenship will be analysed, without revisiting the "close to citizenship" statuses described above (refugee, long-term resident — previously settled, family member of a Hungarian citizen). The two-tier system is based on the principle that a person has a single nationality. However, under legal pluralism, a person can be a citizen under the laws of several states; they are called dual, or more correctly, multiple, citizens. Their number has multiplied due to the disintegration of nation-states, globalisation, and increased migration. In their case, it is necessary to examine whether one of their multiple citizenships is Hungarian, since the applicable outcome for Hungarian citizens is then applied by ignoring

the foreign citizenship(s).¹⁸ In cases involving multiple foreign nationalities, the basic rules for foreign nationals apply.

Stateless persons are at the opposite pole of the multiple nationality provision. Statelessness is not specifically regulated in the field of expulsion. However, from a practical point of view, it can be concluded that, although neither the UN Convention on Statelessness¹⁹ nor the Civil Code contain any obstacles to their expulsion, and the latter clearly states that stateless persons are third-country nationals, the implementation and enforcement of their expulsion in the absence of a country of origin or a readmission obligation is practically unenforceable.

The obstacle to expulsion presupposes existing Hungarian citizenship. However, it is wrong to sanction a formally unknown citizenship with expulsion. Hidden or latent citizens are persons who qualify as Hungarian citizens under the country's citizenship law (for example, based on descent), but whose citizenship is not evidenced by official records or the exercise of rights. In the event of the discovery of this potential Hungarian citizenship during criminal proceedings, it is necessary to clarify the exact citizenship status, since the decision to expel is conditional on the possession of only foreign citizenship.

The near-citizenship statuses discussed in the previous chapter are, in fact, categories of "not yet citizens", but their legal and social embeddedness is such that they have every chance of acquiring citizenship. National citizenship legislation usually includes naturalisation benefits. In addition to "not yet citizens", it is also worth mentioning "no longer citizens". Following an effective renunciation or announced revocation procedure, the person concerned is considered a foreigner even if the renunciation of nationality was not ideologically motivated but was required solely by the

¹⁸ Ápt., 2 § (2) [A Hungarian citizen who is also a citizen of another state shall, unless otherwise provided by law, be considered a Hungarian citizen for the purposes of Hungarian law]

¹⁹ Act II of 2002 on the proclamation of the Convention relating to the Status of Stateless Persons, done at the United Nations in New York on 28 September 1954, Article 31

legal provisions of the country of naturalisation, which excludes dual nationality.

It should be noted that at the time of finalising the manuscript of this study, the amendments to the legislation on the suspension of citizenship had already entered into force. Still, in the absence of experience of procedural practice, the topic will not be dealt with in detail here. At the outset, it is only necessary to state that a person whose Hungarian citizenship has been suspended and who also holds the citizenship of a third country may be expelled from the territory of the country in accordance with the rules applicable to foreigners for the duration of the suspension.

Deprivation - an alternative criminal sanction

The unilateral, punitive termination of citizenship by the authorities is not a new institution. It was also used in Hungarian law before the regime change, primarily to retaliate and exclude people who opposed or were considered undesirable to the system at the time. In the decades following the fall of communism, during the period of EU integration and the emergence of humanitarian ideals, few would have imagined that citizenship management would eventually revert to a protective role, becoming a central element of action against persons posing a risk to national security. Recently, an increasing number of European countries have reintroduced rules on deprivation of nationality, adapted to national security. This trend may also signal a shift in the direction of citizenship legislation towards criminal law.²⁰ So far, European deprivation measures have mainly been used to protect against persons linked to terrorism, but rapidly changing international trends suggest that confidence in their effectiveness could lead to their extension to other areas. The UK is considered to be at the forefront of deprivation, but France and Germany are also leading the way. In addition,

²⁰Mágó, B. (2023): Az állampolgárság nyújtotta védelem irányai [Directions of Protection Provided by Citizenship]. In: Gaál, Gy. – Hautzinger, Z. (eds.): *Pécsi Határőr Tudományos Közlemények XXV.* Pécs. 273–278

Austria, Italy, Finland, Denmark, the Netherlands, and Bulgaria also use exclusion through sanctions.

- Deprivation, although not a criminal sanction in the classical sense, has become an effective instrument of state power. Criminal proceedings under the rule of law are a long and costly process, surrounded by procedural safeguards. In contrast, deprivation of nationality provides a swift and cost-effective response to high-security policy situations, thanks to its swift procedures, cost-effectiveness, and limited appeal possibilities. However, such deprivation of citizenship may raise serious concerns about fundamental rights, in particular regarding procedural guarantees and respect for human rights. The balance between the security interests of states and the rule of law is essential when considering the use of these two forms of sanctions. In many cases, the institution of modern-day deprivation is not primarily intended to punish past violations, but is clearly aimed at preventing future risks. This preventive focus on administrative measures rather than criminal sanctions calls for a change of perspective that requires a redefinition of the boundary between classical criminal law and administrative instruments.

Conclusion

Criminal liability is not dependent on nationality, but certain elements of criminal procedure and the enforcement of sentences, such as interpretation, mandatory protection, and the specifics of the prison environment, reflect, in part but not exclusively, the accused's nationality status. Expulsion, as a sanction on the borderline between criminal law and aliens' law, is essentially the only response by the criminal justice authorities to foreign suspects. The applicability of this sanction can only be determined based on an assessment of the existence or absence of nationality, in which the

specific categories of multiple nationality, latent nationality and statelessness are of particular relevance. Without a precise classification of the status in terms of immigration status and nationality, criminal law decision-making cannot be lawful.

The line between classical criminal sanctions and administrative mechanisms of national defence is often blurred today²¹. The administrative instrument of the redefined deprivation of nationality is a good example of this trend. Although deprivation of citizenship is not formally a punishment, its function, effect, and purpose are akin to those of criminal sanctions.

Overall, it can be concluded that legal institutions at the intersection of criminal law and citizenship, such as modern-day deprivation and expulsion, are not only legally significant but also of strong security and social policy significance. Thorough and careful regulation of this complex system is essential to ensure the rule of law, legal certainty, and the exercise of fundamental rights.

²¹Zoltán Hautzinger: Migration Impacts on Law Enforcement. In: Zoltán Hautzinger (ed.): Dynamics and Social Impact of Migration. Dialóg Campus, Budapest, 2019. 168. o.

ÖVEGES, KRISTÓF

The Significance of Law Enforcement History Research in the Development of Law Enforcement Science

Introductory thoughts

Domestic traditions in law enforcement science played a significant role in the accreditation process. Although at different times in the legal histories and scientific developments of individual states, the independence of law enforcement science emerged in most places. Following the establishment of modern policing, the need for policing science has been a constant topic of discussion in Western Europe and Hungary. Historically, scientific journals on policing have been available since 1869, and civil organisations dedicated to law enforcement were established shortly after. At the same time, policing has been taught in higher education for more than 150 years. These antecedents formed the basis for Academician András Szabó's speech at the Hungarian Academy of Sciences in 2003, delivered at the 9th class meeting. The academician supported his application for a doctoral program in law enforcement with 13 well-reasoned, scientifically rigorous points under the title *"A Place for Law Enforcement Studies."*¹ The next milestone was the accreditation of law enforcement science in 2012. Practitioners of law enforcement science, from Ágoston Karvasy to Géza Finszter, have done a great deal to raise awareness of the field and promote its acceptance within the scientific community.

¹ Sallai, J.: A rendészettudomány megalapítása és akkreditációja Magyarországon [The Establishment and Accreditation of Law Enforcement Science in Hungary]. RTT. Budapest, 2021. 114. o.

A frequently repeated negative claim among law enforcement practitioners is that the organisation has no memory. In addition to advancing science, research into the history of law enforcement aims to refute this claim once and for all.

The dilemmas of police history research

Looking back on the last 100 years of Hungarian police history, we can see three quite different police models. Despite the relative efficiency of the police and gendarmerie under the Horthy regime, it is clear that such a system could not function in a modern democratic state. The same can be said of the unified police force reorganised after 1945, which operated in Hungary during the socialist regime and the period of one-party rule. The police force, which underwent a system change in 1990, sought to move away from the model that embodied its former repressive function towards a service-oriented approach. During the regime change, the theory and history of law enforcement, which had been taboo for nearly forty years, gained momentum, as did research and publication on the concept of law enforcement in professional circles. Géza Katona, Géza Finszter, and István Szikinger played a significant role in this at the end of the 1980s and the beginning of the 1990s.² The legal environment is evolving in the same way, and studying it is also part of research into the history of law enforcement. Looking at the regulation of various police activities in chronological order, we can make several interesting observations. The dilemma comes up when law enforcement, as part of the executive power, becomes a tool for enforcing morally unacceptable political goals. We can think of examples like the persecution of people involved in the illegal communist movement between the two world wars or the Hungarian phase of the Holocaust. We could continue the list with the “attic sweeps” or the reprisals after 1956, and researchers will eventually begin to explore police activities in 2006 as well. It is also the task of researchers to present the negative

² Ibid., 26. o.

aspects, as this is the only way to obtain an objective overview of the period under examination. From the perspective of law enforcement theory, it can be stated as a fact that the qualitative transformation of law enforcement in the founding countries of the EU could only begin after the constitutional consolidation of democratic institutions. For historical reasons, Hungary not only missed out on this process before 1990 but also lost the virtues of the rule of law it had enjoyed before 1945, especially before the First World War. Since 1949, Hungary has had a centralised, military-based state police model separate from the civil administration. This was enshrined in the 1989 amendment to the republican constitution, followed by the adoption of the Police Act in 1994. Hungary's Fundamental Law did not change this model either,³ so here too we find an interesting point of intersection regarding continuity.

History of law enforcement and organisational culture

The constant interruption of continuity mentioned in the introductory remarks led successive law enforcement systems not to consider their predecessors as legal predecessors and, in many cases, to reject them outright. One of the most important tasks of contemporary law enforcement science is therefore to identify those junctures in organisational and legal development which, despite the negative influences of political systems, can serve as building blocks for the historical part of law enforcement science. To explore and systematise these, it is essential to promote research into the history of policing and to publish the results as widely as possible. Let us take a look at what these cornerstones and intersections might be, which could serve as a starting point for today's researchers in the history of policing.

³ Finszter, G.: A rendészet elmélete [Theory of Law Enforcement]. National University of Public Service, Faculty of Law Enforcement. Budapest, 2014. 58. o.

First, we can highlight the Police Museum's collection and the decades of effort that have gone into creating a vivid presentation of law enforcement history. Several decades amount to more than a century, since the museum began collecting and organising artefacts in 1908. According to the founding legislation: *"Any object confiscated by a judicial or administrative authority, if found suitable for further education in criminal law, or if it appears to shed light on new methods of committing crimes, shall be sent to the Crime Museum organised by the Chief of Police of the Royal Hungarian State Police in Budapest."*⁴ Unfortunately, the ever-expanding collection was almost destroyed during the siege of Budapest in 1945, but in 1958, the collection and systematic display of artefacts began again. In 1963, the Crime Museum was established in a new location (1087 Budapest, Mosonyi u. 9. – former prison), in the building that now houses the Institute of Forensic Sciences and Research. It received its operating license in 1967 as a national museum. The museum operated in this building until 1997, when it was "closed," meaning that only a specific group of visitors (police officers, police academy students, volunteer police officers, law students, medical students, etc.) were allowed to view it. The "closed" nature of the museum was determined by the character of its collection and the building's protected status. In August 1997, the Crime Museum closed its doors, and on April 26, 1999, it reopened in a new location, with a new name and renewed content, now known as the Police Museum, at 5 Mosonyi Street. From that date onwards, the museum's entire exhibition material became publicly available, meaning anyone can view it. The crime museum is one of the most visible guardians of law enforcement traditions. The crime museum plays a role in criminal science and law enforcement similar to that of illustrations in a book or a laboratory in chemistry.⁵ The museum also plays a significant role in the training of students at law enforcement

⁴ The Crime Museum was established on the basis of Ministerial Decree No. 20001/1908. 20001/1908. sz. miniszteri rendelet [Ministerial Decree No. 20001/1908]

⁵ Sallai, J.: A rendészettudomány megalapítása és akkreditációja Magyarországon [The Establishment and Accreditation of Law Enforcement Science in Hungary]. RTT. Budapest, 2021. 100. o.

educational institutions. Still, it also provides new knowledge to law enforcement professionals who have served for decades, and, last but not least, it has the important task of creating, maintaining, and nurturing the organisational culture of law enforcement.

Another important area of research in law enforcement history today is the exploration of law enforcement education and the history of educational institutions. Researchers can discover interesting parallels between the general state of society and the quality of law enforcement education. Is it true that every society has the police force it deserves? Is there a correlation between the level of education in a society and the standard of police training? What should we teach police officers and for how long? Over the past 150 years, many different solutions have been developed for police training in our country, and the process is far from over. The task of law enforcement history research is to find, systematise, and present the good and perhaps forgotten approaches. The founding of the Police Academy in 1970 was, of course, a milestone in its development. From the beginning, high standards were set for law enforcement training and education. After the nationalisation of the police force, the Ministry of the Interior and police leaders recognised that only high-quality courses could adequately prepare police officers and detectives for their duties. The quality of law enforcement training declined after World War II, but in the 1970s, the training provided at the Police Academy was raised to a college level, putting it back on the right track.⁶ The launch of college-level training was the first step towards integrating law enforcement into the higher education system. Without completing law school, or instead of or in addition to it, it provides society with educated, well-trained police officers with the appropriate theoretical knowledge. Today, we know that establishing the RTF was a good, forward-looking decision for several reasons. On the one hand, it served officer training excellently, providing college graduates with the necessary professional and theoretical background, and on the other hand, it became

⁶ Ibid., 104. o.

capable of training young civilians from civilian life to become well-prepared police officers, border guards, correctional officers, and finance officers. Its success and popularity are also evidenced by the fact that, even after the change of regime, applicants could be admitted only after significant oversubscription. After graduation, they had the opportunity to study law at university without an entrance exam during a shortened training period, which many took advantage of.

After 42 years of existence, the Faculty of Law Enforcement Sciences of the National University of Public Service was established as the legal successor to the college, raising the level of education even higher. Following the establishment of law enforcement science, the Doctoral School of Law Enforcement Science was founded, which, through its research and training, is capable of educating and retaining true law enforcement intellectuals. As a precedent, it is important to note that the special relationship between military science and law enforcement science stems from the fact that military science was classified much earlier by the Hungarian Academy of Sciences' IX. Department, which is why, for years, doctoral schools of military science became the recipients of scientific theses on law enforcement topics.⁷ In the future, the Doctoral School of Law Enforcement may also provide a forum for this research into the history of education, where the educational activities and their background in each historical period can be studied.

Current trends and methods in law enforcement history research

The great challenge of law enforcement methodology is to find methods that reveal the defining, constant laws governing the functioning of organisations and the knowledge, thinking, and actions of leaders and subordinates that significantly influence the performance of law enforcement

⁷ Hautzinger, Z.: A rendészet határtudományai [The border sciences of law enforcement]. Hungarian Law Enforcement Issue 2020/3. 142. o.

agencies.⁸ Regarding methods, it is important to note that neither law enforcement science nor law enforcement history research can do without interviews and questionnaire-based research techniques. Today, interviews are particularly important in research on law enforcement under socialism. The leaders and staff who served before 1989 can be interviewed for the last time in the next few years, as 36 years after the change of regime, many of them are now in their advanced years. In the mid-2000s, Miklós Tátrai, former secretary general of the National Police Headquarters, published two excellent collections of interviews with national police chiefs who had been in office since 1977, and later with county police chiefs who had won their positions through competitive selection. Unfortunately, even then, the volume could not be complete, as Chief Commissioner László Forgács was no longer among the living.⁹ In the first work, we can read, among other things, about the exact circumstances of how the first national chief commissioner became a police officer. In the interview volume, Károly Ladvanszky confesses his personal motivations: *"I joined them and stayed there because I was outraged by the abuse of the defenceless and vulnerable, the violent seizure of others' property, and all acts that violated my sense of justice."*¹⁰ The young volunteer police officer was later dismissed due to his age (he was under 18), but at his own request, he was ultimately allowed to remain with the organisation. Personal accounts such as these can only be uncovered through interviews, which is why they are particularly important and cannot be replaced by any other means.

The three and a half decades that have passed since the change of regime now provide an opportunity for an unbiased assessment of the period. During the research on the history of the organisation conducted at the Doc-

⁸ Finszter, G.: A rendészet elmélete [Theory of Law Enforcement]. National University of Public Service, Faculty of Law Enforcement. Budapest, 2014. 60. o.

⁹ Tátrai, M.: A rendszerváltás kapitányai [The Captains of the System Change]. Magyar Közlöny Lap- és Könyvkiadó. Budapest, 2010. 126. o.

¹⁰ Tátrai, M.: Szent György védelmében [In Defense of Saint George]. Duna Palota Kulturális Kht. Budapest, 2007. 13. o.

toral School of Law Enforcement Sciences, these recorded life story interviews can provide a wealth of material for future scholars. The use of questionnaire-based research is less common in law enforcement history research, but it can still provide valuable insights into organisational culture. How well do staff members know the history and symbols of their own organisation? Do they remember their great predecessors and cherish their own traditions? Are there any small exhibitions, memorial rooms, or collections? These questions can be interesting topics for investigation, even at a police station or border guard office.

Another possibility is to link historical police research to specific crimes committed decades ago. The analysis of investigative documents found in archives can provide relevant information not only for investigative work but also for the organisation's functioning. In addition to the above data, individual reports, decisions, indictments, and court judgments may also contain a wealth of information of interest to sociologists. The rapid, professional, and effective investigation of crimes can also be considered a common positive aspect of the police forces of all previous systems. Not to mention that we can also draw on criminal procedure law and criminalistics, among the criminal sciences, to support law enforcement science. The added value of these two sciences to policing science lies in the fact that their results are used in law enforcement practice. Their research focuses on current phenomena in the interest of public order and public safety, and their theoretical work deviates only to a limited extent from practice.¹¹ It is therefore worthwhile to conduct research into the history of policing from the perspective of crime, i.e., using long-closed criminal case files that have been forgotten and conducting archival research.

¹¹ Zoltán Hautzinger: The border sciences of law enforcement. Hungarian Law Enforcement Issue 2020/3. 142. o.

Law enforcement history research at the lowest levels

Some law enforcement agencies have already recognised that law enforcement history is fundamental to the development of organisational culture. More and more regional and local police agencies have begun researching their own histories. At the end of the 1990s, one of the first to appear was the Csongrád County Police Headquarters' own historical work, published in 1999. The 87-page book covers the history of the police in the county from the expulsion of the Turks to the time of the book's publication.¹² The publication pays tribute to former captains and county leaders with a photo supplement and also includes photos of police buildings.¹³ Twenty years later, the Zala County Police Headquarters undertook to publish a similar publication. In addition to the historical description,¹⁴ the 185-page book also includes the results of archival research and interviews with former leaders about their lives.¹⁵ Contemporary newspaper articles and photographs in the appendix make the volume even more informative. In 2020, the 100th anniversary of the police force also gave a big boost to publications on police history, with several high-quality articles detailing the histories of individual agencies. At the same time, enthusiastic retired and active colleagues are also working on an "amateur basis" – compiling old management tables, arranging display cases, collecting photographs, and laying the foundations for the future operation of a home museum. It is interesting to note that the older surviving photographs can basically be divided into two groups. One group documents various ceremonies and staff meetings. At the same time, the other consists of photos taken at unit events and informal team-building meetings (Women's Day, the end-of-year ball, etc.). Unfortunately, disproportionately few photos of actual

¹² Dr. Zoltán Fülöp: History of the Police Forces of Csongrád County. Csongrád County Police Headquarters. Szeged, 1999. 7. o.

¹³ same place 76. o.

¹⁴ Katalin Simonyi: Chapters from the history of the police forces in Zala County. Zala County Police Headquarters. Zalaegerszeg, 2019. 21. o.

¹⁵ same place 59. o.

work have survived, as cameras were used less frequently in such situations.

The internal organisational history exhibition is also relevant to the Faculty of Law Enforcement Sciences at the National University of Public Service, as on September 11, 2025, as part of the ALUMNI Day, a summary exhibition entitled *"Excerpts from the History of Law Enforcement Education"* will open in the gallery of the St. László Chapel in the Ludovika Main Building.

The exhibition, which presents the history of education within the interior and law enforcement agencies, provides a comprehensive overview of the training instituted since 1971 and of the organisations whose officers have been educated and trained in higher law enforcement education in recent years. This presentation of organisational culture provides an accurate picture of the entire spectrum of law enforcement science, showcasing the professional organisations that perform law enforcement tasks, as well as their past and present. The exhibition panels also highlight the predecessor institutions that provided training for law enforcement agencies before the Police Academy, such as the Ybl Miklós Technical College and the Kosuth Lajos Military College.

The basic idea behind the exhibition was that, on the 30th anniversary of the Department of Border Guard Studies at the Faculty of Law Enforcement, the Border Guard Culture Foundation would host it. This room, which also serves as a classroom, was well received by visitors and the university and faculty leaders alike. After viewing the memorial room, Rector Gergely Deli suggested that the history of the National University of Public Service should also include an exhibition on the history of higher education in law enforcement. He offered the gallery of the St. László Chapel as the venue for this, and the Border Guard Culture Foundation was asked to develop the concept.

In addition to the rector of NKE, RTK also contributed to the necessary installation and material expenses to the extent possible, with the Development Department coordinating the purchases.

The Border Guard, Customs and Finance Guard, Penitentiary, and Immigration Departments, as well as the staff of the Disaster Management Institute and the Police Museum, played a key role in the current implementation of the exhibition, the selection of artefacts, and their acquisition and display. The Department of Law Enforcement Theory and History staff carried out the final coordination tasks.

The exhibition will continue to expand, allowing other departments to showcase their past. The artefacts, photographs, educational materials, and period uniforms displayed by the field of study provide an excellent illustration of the centuries-long history of law enforcement education. The exhibition is an excellent opportunity for university students and lecturers to expand their knowledge of the history of law enforcement education, while also commemorating former lecturers, commanders, and students alike.

The moving film history of law enforcement

Recently, some extremely interesting material for researchers of law enforcement history was posted on one of the most popular video-sharing sites, titled *"Once Upon a Time There Was a Police Academy."* Following digitisation, the RTF's own archive materials are now available to anyone. The former meetings, films depicting the internal life of the academy, and reports are of great interest to researchers, interested civilians, and former students alike. New films are constantly being added to the site, expanding the range of material on offer. Another excellent resource is the collection of educational films produced by the BM film studio, which has also been digitised in recent years. These materials are excellent chronicles of the socialist police force and other aspects of the first such film materials in the entire history of the Hungarian police force. The educational films often show a particular field of study or procedural method at the original locations with real actors, and thus serve as irreplaceable source material.

Summary

Research into the history of law enforcement undoubtedly creates new value. It is necessary to explore the positive and negative trends that characterised law enforcement activities in different periods. An objective, unbiased approach is essential for this, which is why a thorough exploration of the history of law enforcement around the time of the regime change can only really begin now. It is also important to find role models, outstanding professionals who have been forgotten today, "police scientists" whose life paths we can present to posterity as examples to follow. Historical research must serve organisational culture effectively and efficiently, and strengthen the organisation's closest possible ties. This is why it is important to expand the field of law enforcement history researchers continuously.

SZÉKELY, E. ÁRNIKA

What Plant Evidence Tells Us

Introduction

When hearing the term "forensic botanist," many people immediately associate it with narcotic plants, primarily hemp. However, forensic botany encompasses far more than that. In this study, I aim to present cases that illustrate another aspect of forensic botany and highlight its potential applications.

Dr. Balázs Kenyeres, forensic medical expert, emphasised the importance of examining plant remains in a study published following the 1912/13 session of the Law and Social Sciences Department of the Transylvanian Museum Society.¹ He mentioned three cases in which the analysis of plant evidence helped solve crimes. The first involved a knife blade on which plant hairs were found; the examination revealed that the weapon had been used to destroy a neighbouring hop plantation. The second case was similar: sawdust found between the teeth of a saw proved that the tool had last been used to cut cherry wood. The third case concerned a murdered landowner, who had been beaten with oak and cherry stakes. During the autopsy, a wood fibre was discovered in the fatal skull fracture. The fibre analysis revealed that the oak stake had caused the lethal injury².

¹ Kenyeres, B.: A növényi nyomok jelentősége a bűnügyek felderítésében [The significance of plant traces in criminal investigations]. Erdélyi Múzeum-Egyesület Közleményei. 1913.

² Kenyeres, B.: Az orvos-természettudományok a büntetendő cselekmények nyomozásában [The role of medical and natural sciences in the investigation of criminal offences]. Erdélyi Múzeum, V. füzet. Ajtai K. Albert könyvnyomdája. Kolozsvár, 1914. 108–110. o.

Objects subjected to examination in forensic botany may include whole plants, plant parts or fragments, as well as fungi. Any case may yield botanical material as evidence, which can be submitted to the forensic botany laboratory. The case studies presented below all belong to the field of classical criminalistics. Overall, forensic botany is well-suited to complement, support, and reinforce the findings of other forensic disciplines.

Botanists conduct identification and comparative analyses and can also determine the origin or provenance of plant material. For these identification and comparative studies, they rely on reference samples collected by the investigating authorities, on Hungarian and international literature, and on the internal collections of the Hungarian Institute for Forensic Sciences (HIFS). Like other forensic disciplines, forensic botany also has limitations, primarily related to the size and condition of the material under examination.

"Poisoning" in the Kindergarten

A report was received by the County Police Headquarters Operations Control Centre stating that children in the yard of one of the municipal kindergartens had consumed the leaves of plants growing there. Six children were examined in the Pediatric Department of the local hospital; however, no signs of poisoning or clinical symptoms were observed. Nevertheless, criminal proceedings were initiated for suspected negligent endangerment in the course of duty. It was suspected that the children had ingested leaves of the poisonous daffodil (*Narcissus* sp.). Consequently, the plants and leaves collected from the kindergarten yard were seized by the investigating authority and submitted for botanical analysis at the Hungarian Institute for Forensic Sciences (HIFS) (Figure 1). The authority's primary question was whether the seized plants and leaves truly belonged to poisonous species. Based on external morphological characteristics, the seized plants and plant fragments were identified as specimens or parts of daylily (*Hemerocallis* sp.), a member of the family Hemerocallidaceae (Figure 2).



Figure 1

Plants tasted by children in the kindergarten yard

Source: Hungarian Institute for Forensic Sciences (hereinafter: HIFS), internal documentation.



Figure 2

Seized plant remains

Source: HIFS, internal documentation.

At first glance, daylilies and daffodils closely resemble each other, but a more detailed examination reveals several distinguishing features. The daylily, a member of the family Hemerocallidaceae, is native to East Asia and Europe. In Hungary, it used to occur in several natural habitats but is now found only in the most secluded areas. It is strictly protected, with a

conservation value of 100,000 HUF per individual³. The daffodil, on the other hand, belongs to the family Amaryllidaceae. In Hungary, numerous daffodil species and hybrids exist, with the two most common being the poet's narcissus (*Narcissus poeticus* L.) and the yellow daffodil (*Narcissus pseudonarcissus* L.). Both daylilies and daffodils are popular perennial ornamental plants, widely available in the horticultural trade in a range of hybrids and cultivars.

Key morphological differences include the following: the daylily is a rosette-forming plant with long, pointed, and recurved leaves. A distinct central midrib runs along each leaf, allowing it to fold like a book. In contrast, daffodil leaves emerge directly from the bulb, are narrow and straight, and end in a blunt tip. Their inflorescences also differ markedly, but since the plants had already flowered by the time of seizure, floral characteristics were not relevant for this case (Figure 3). A crucial morphological marker, however, was the root system: the daylily is rhizomatous, with cylindrical underground stems bearing adventitious roots, often with fibrous clusters⁴. The daffodil, by contrast — like tulips and hyacinths — is bulbous (Figure 4).

³ 13/2001. (V. 9.) KöM rendelet: A védett és a fokozottan védett növény- és állatfajokról. [Decree No. 13/2001 (V. 9.) of the Ministry of Environment on protected and strictly protected species]. 1. számú melléklet

⁴ Simon, T. – Seregélyes, T.: Növényismeret – A hazai növényvilág kis határozója [Plant Knowledge – A Field Guide to the Native Flora of Hungary]. Nemzeti Tankönyvkiadó. Budapest, 1998. 194



Figure 3

Daylily (1) and daffodil (2)

Source: <https://florapont.hu> (1) and www.sarahraven.com (2)



Figure 4

Roots of the daylily (1) and daffodil (2)

Source: HIFS (1) and gardenis.decorapro.com (2)

Unlike daffodils, daylilies do not contain compounds harmful to humans and are therefore non-toxic. In fact, in some countries (e.g., China), their

young leaves, shoots, and buds are consumed raw or cooked. Daffodils, by contrast, are toxic, containing the alkaloids lycorine and galantamine, found in both bulbs and leaves⁵. Ingesting daffodil leaves can be highly toxic and even fatal. The botanical examination confirmed that the leaves consumed by the kindergarten children belonged to the non-toxic daylily rather than the poisonous daffodil.

Suicide or Homicide?

The County Police Headquarters Operations Control Centre received a report that the body of a hanged man had been found on an unmarked trail, approximately 1 km from the village, suspended from a tree. The deceased was identified during the scene investigation. Based on preliminary findings, suicide was suspected, but the possibility of homicide could not be excluded. Unlike in routine procedures, the investigating authority decided not to submit the rope used for hanging to the Hungarian Institute for Forensic Sciences (HIFS). Instead, comparative samples of the tree bark and vegetation present on the trunk were collected for the forensic botanists. During the autopsy, swabs were taken from the palm and inner fingers of the deceased's left hand, while the right hand and the inner surfaces of the fingers were examined using micro-trace foil. These three samples were then submitted for forensic botanical analysis (Figure 5).

⁵ Dános, B.: Farmakobotanika – A gyógynövénytan alapjai (kemotaxonómia) [Pharmacobotany – Fundamentals of Medicinal Plant Science (Chemotaxonomy)]. Argumentum. Budapest, 1997. 346. o.

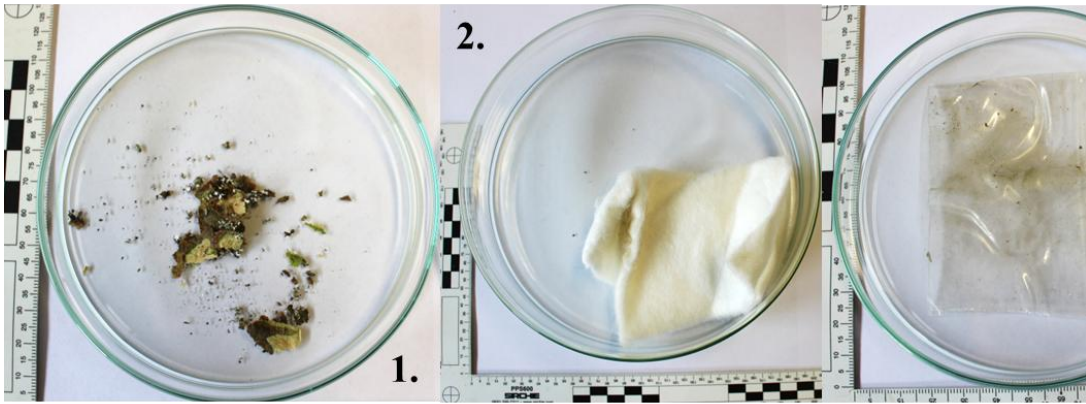


Figure 5

Comparative sample collected from the tree bark (1), as well as samples obtained from the left (2) and right hands (3)

Source: HIFS

The comparative sample from the tree bark contained several millimetre-sized bark fragments and numerous lichen thalli. Microscopic examination revealed that the bark fragments were too small for reliable identification, whereas the lichens were highly suitable for taxonomic characterisation (Figure 6).



Figure 6

Millimetre-sized bark fragment and lichen thallus

Source: HIFS

The lichen thalli exhibited the following traits: their upper (adaxial) surfaces were light grey to ash grey, while the lower (abaxial) surfaces were whitish or brownish. The thalli were non-venated, with a heteromerous (layered) structure, and the medulla lacked cavities. The lobes were simple, non-branching, and erect, bearing distinctive marginal cilia approximately 1 mm in length, white with darkened tips. Attachment to the substrate occurred via dull, dark-colored holdfasts. On the abaxial surface, rhizines were present, also white with blackened tips, extending as far as the margins. Certain lichen species are known to produce secondary metabolites that yield diagnostic colour reactions with specific reagents. In this case, applying potassium hydroxide (KOH) to the upper cortex produced a yellow reaction (KOH+)⁶. Based on the characteristics established during the examination, the lichen colonies obtained from the bark of the affected tree are colonies of the lichen species *Physcia* sp., which belongs to the family Physciaceae, among the foliose lichens.

The left-hand swab sample contained six small fragments of plant material ranging in colour from light to dark brown. Due to their size and condition, the wood fragments did not exhibit identifiable morphological features (Figure 7).

⁶ Kecskés, M. – Naár, Z. – Padisák, J. – Tóth, S. – Babos, L.-né – Rimóczi, I. – Versegly, K. – Orbán, S. – Simon, T. (ed.): Baktérium-, alga-, gomba-, zuzmó- és mohahatározó [Guide to Bacteria, Algae, Fungi, Lichens and Mosses]. Nemzeti Tankönyvkiadó. Budapest, 2001. 644, 691. o.



Figure 7
Swab from the left hand
Source: HIFS

The right-hand sample collected with micro-trace foil contained similar brown to greenish-brown wood fragments, along with ash-grey and greenish-grey lichen fragments, and white cilia with darkened tips matching those of the comparative *Physcia* thalli (Figure 8).



Figure 8
Sample obtained from the right hand secured with micro-trace foil
Source: HIFS

While the wood fragments could not be conclusively identified, the lichen material exhibited identical characteristics to those of the specimens

collected from the tree bark. The forensic botanical analysis confirmed the investigating authority's assumption: the presence of identical lichen taxa in both the comparative bark samples and the right-hand traces supported the conclusion that the death had resulted from suicide rather than homicide (Figure 9).

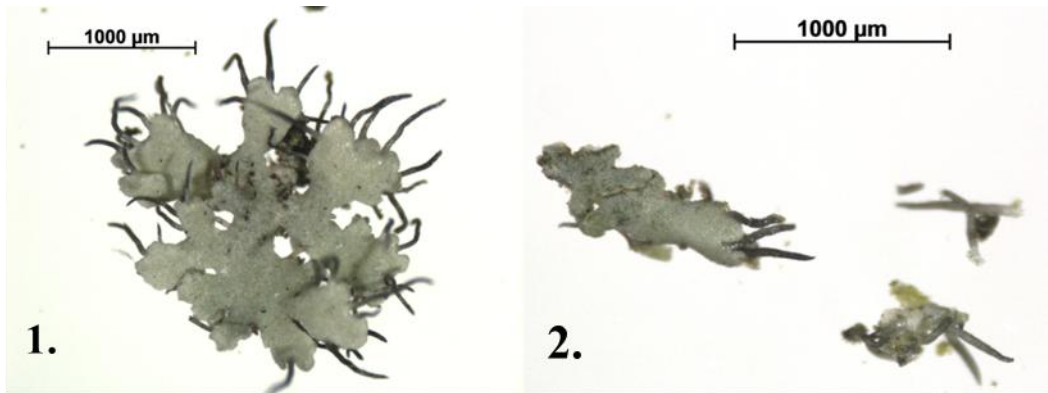


Figure 9
Lichen samples secured from the affected tree (1) and fixed from the right hand
using micro-trace foil (2)
Source: HIFS

"Inside the house"

Based on a report, a criminal investigation was launched against an unidentified perpetrator for suspected theft. According to the complainant, the offence occurred between May 10 and 14, during which approximately 4 cubic meters of cut and prepared poplar wood were stolen from an agricultural plot located on the outskirts of the settlement. The estimated financial loss was approximately 100,000 HUF.

The investigating authority provided two wood samples for forensic botanical analysis, with the key question being whether the submitted specimens originated from poplar trees. Sample 1 consisted of a half-cut log measuring 268×156 mm, while Sample 2 was a log slice with a diameter of 230 mm and a thickness of 72–93 mm (Figure 10).



Figure 10
Wood sample 1 and wood sample 2
Source: HIFS

During the preparatory phase, subsamples were extracted from both logs for microscopic anatomical examination.

It was at this stage that lower plants (e.g., mosses, lichens) adhering to the bark were also noted, and samples of these were collected for identification and comparative purposes. Subsamples of the wood were sectioned in three planes — transverse, radial, and tangential — and sliced into micrometre-thin sections. These histological preparations, stained with toluidine blue, were mounted for microscopic examination. The use of three sectioning planes was necessary because the anatomical features of wood elements vary with orientation, and these differences provide critical diagnostic information for species identification.

Both wood samples exhibited identical microscopic anatomical features across all three planes. In transverse section, the wood was diffuse- to semi-ring-porous, with vessels occurring singly or in groups of two or three. Growth ring boundaries were only moderately distinct (Figure 11). The parenchyma was diffuse apotracheal, i.e., independent of the distribution of vessels. In radial section, the rays were homogeneous, with simple perforation plates between vessel elements, no tracheids, and recognisable lib-

riform fibres (elongated, thick-walled, dead fibres with tapering ends) (Figure 12). In the tangential section, the rays were also homogeneous, with axially oval ray cells. Ray height was 9 - 11 cells in Sample 1 and 12 - 13 cells in Sample 2⁷ (Figure 13).

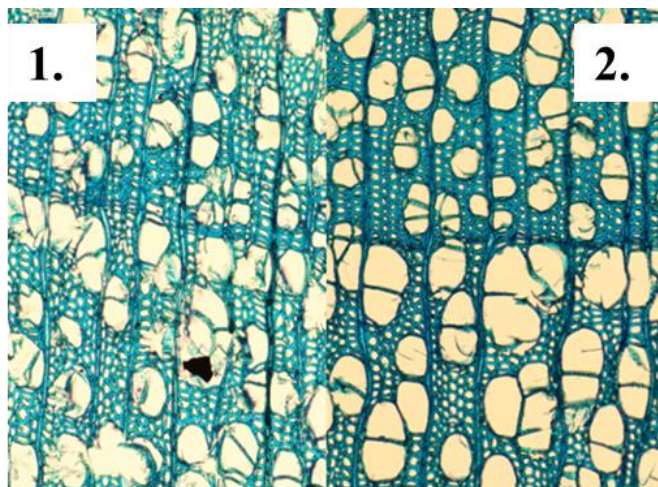


Figure 11
Cross-sections of wood samples 1 and 2
Source: HIFS

⁷ Schoch, W. – Heller, I. – Schweingruber, F. H. – Kienast, F.: Wood anatomy of central European species. 2004.

Source: <http://www.wsl.ch>

Accessed: 11.04.2026

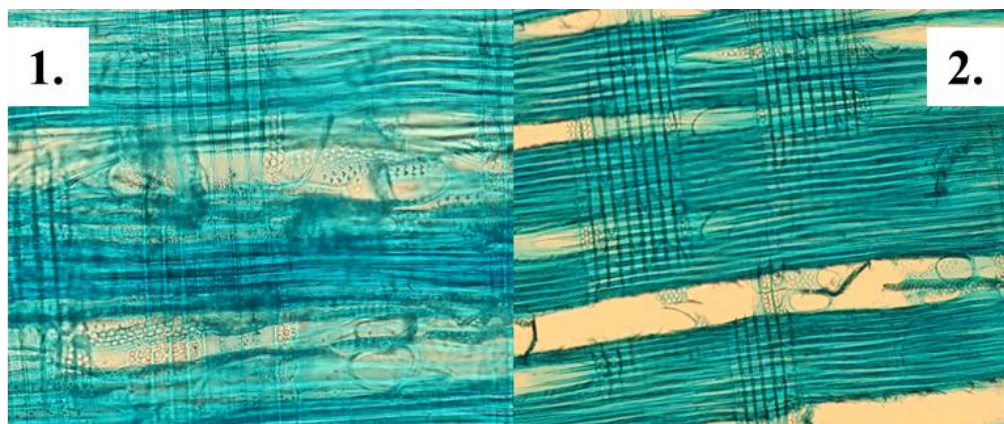


Figure 12
Radial longitudinal sections of wood samples 1 and 2
Source: HIFS

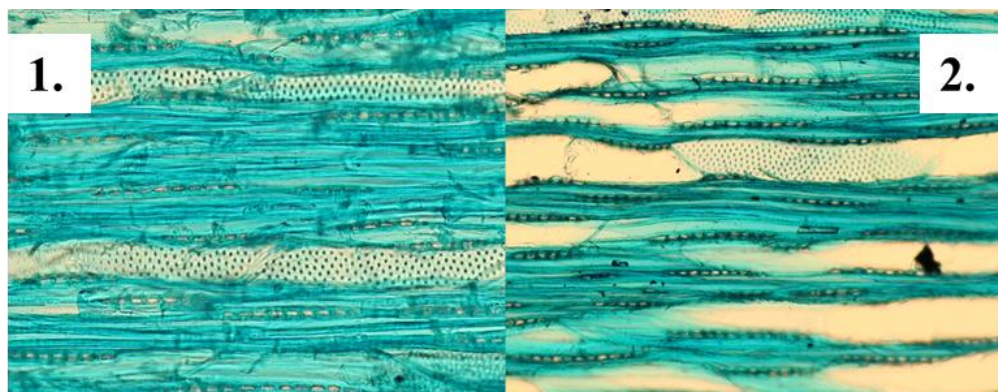


Figure 13
Tangential longitudinal sections of wood samples 1 and 2
Source: HIFS

Based on these micro-anatomical features, the samples were consistent with wood of poplar (*Populus* sp.) or birch (*Betula* sp.), two taxa with highly similar wood anatomy⁸. Thus, further botanical examinations were required. One supplementary method was to assess the bark's external

⁸ Sárkány, S. – Szalai, I.: Növényyszervezettani gyakorlatok [Plant Histology Practices]. Tankönyvkiadó. Budapest, 1966. 262–264. o.

characteristics, including colour and patterning. The characteristics of the bark - e.g., colour, pattern - were typical of the poplar tree (*Populus* sp.), which belongs to the willow family (*Salicaceae*).

At the HIFS, a new supplementary method was recently introduced, particularly in wood theft investigations, to support the results of anatomical analyses. When lower plants such as mosses or lichens are present on bark, their identification and comparison can provide additional evidentiary information. During sampling, lichen thalli were found on the bark of both wood specimens. At least two distinct lichen taxa were represented. One lichen species collected from the bark of Sample 1 exhibited yellow, orange, or yellow-green colouration on the upper surface and a white underside. The thallus lay flat on the substrate, with lobes that lifted at the margins and were broad, flat, or slightly concave. A distinctive feature was the abundance of apothecia (disk-shaped or cup-like fruiting bodies), with entire margins and soft, inflated discs. When tested with potassium hydroxide (KOH), the thallus yielded a deep red colour reaction (KOH+)⁹. These characteristics identified the species as the common orange lichen (*Xanthoria parietina* (L.) Th. Fr.), a foliose lichen of the family *Teloschistaceae*. This taxon is widespread on bark, calcareous rocks, and anthropogenic substrates, with habitats ranging from poplar groves and floodplain forests to cultivated lands and urban environments. A second lichen collected from the bark of Sample 1 had a grey, dull upper surface, a heteromorous structure, and a smooth, non-venated underside. The abaxial rhizines were dense, extending fully to the thallus margins. The thallus adhered loosely to the substrate. When treated with KOH, the upper cortex produced a yellow colour reaction (KOH+)¹⁰. Based on these properties, it is a colony of the lichen species *Physcia* sp., which belongs to the family

⁹ Kecskés, M. – Naár, Z. – Padisák, J. – Tóth, S. – Babos Lórántné – Rimóczi, I. – Ver-seghy, K. – Orbán, S., szerk. Simon, T. (2001): i. m. 642, 688. o.

¹⁰ Kecskés, M. – Naár, Z. – Padisák, J. – Tóth, S. – Babos Lórántné – Rimóczi, I. – Ver-seghy, K. – Orbán, S., szerk. Simon, T. (2001): i. m. 644, 691. o.

Physciaceae, among the foliose lichens. *Physcia* species occur on deciduous trees, e.g. poplar, ash, willow, etc., on calcareous or silicate rocks (Figure 14).

Microscopic examination confirmed that both *Xanthoria parietina* L. and *Physcia* sp. were also present on the bark of Sample 2 (Figure 15). The combined anatomical and morphological evidence, supported by the newly introduced lichen-based supplementary analysis, confirmed that the seized wood samples originated from poplar (*Populus* sp.).

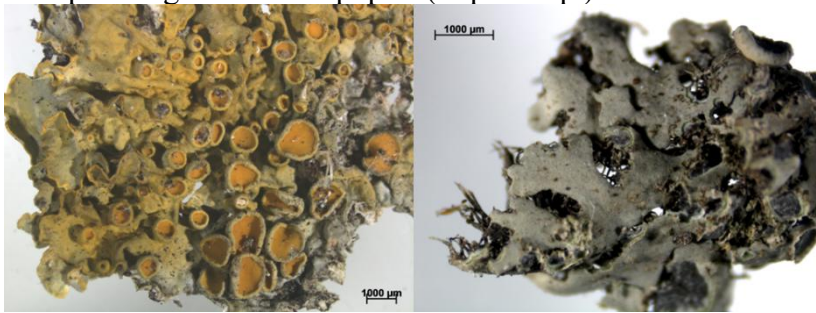


Figure 14
***Xanthoria parietina* L. and *Physcia* sp. secured from wood sample 1**
Source: HIFS

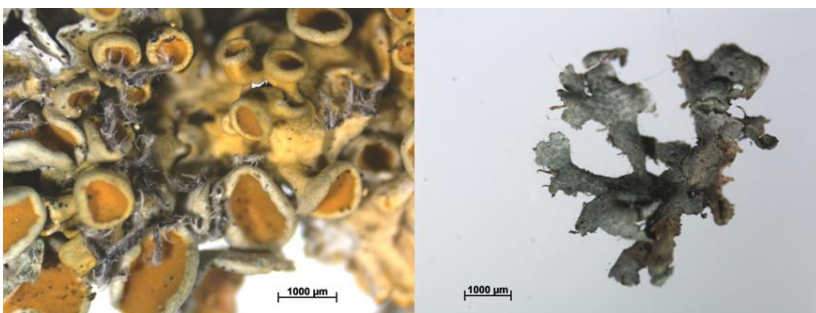


Figure 15
***Xanthoria parietina* L. and *Physcia* sp. secured from wood sample 2**
Source: HIFS

What did you eat last?

An administrative investigation was initiated following the death of an individual at home. The on-call physician at the scene excluded both suicide

and homicide. However, during the autopsy, plant material was found in the stomach contents of the deceased, raising suspicion of yew (*Taxus* sp.) poisoning. At the forensic medical expert's request, the material was submitted for botanical analysis. The stomach contents were delivered in a sealed plastic container and consisted of mucous material intermixed with brownish needle leaves and needle fragments (Figure 16). As a first step, the plant material was washed twice to remove the mucus. The cleaned remains were then sorted to recover as many intact or partially preserved needles as possible for microscopic identification. The external morphology of the needles was as follows: they were elongate and flattened, with a pointed apex and a narrowed basal portion forming a petiole-like clasp around the twig. A single midrib ran through the centre, with stomata arranged in two rows along the abaxial surface. The colour was brown, most likely due to chemical interaction with gastric fluids (Figures 17 and 18).



Figure 16
Container holding the stomach contents of the deceased
Source: HIFS

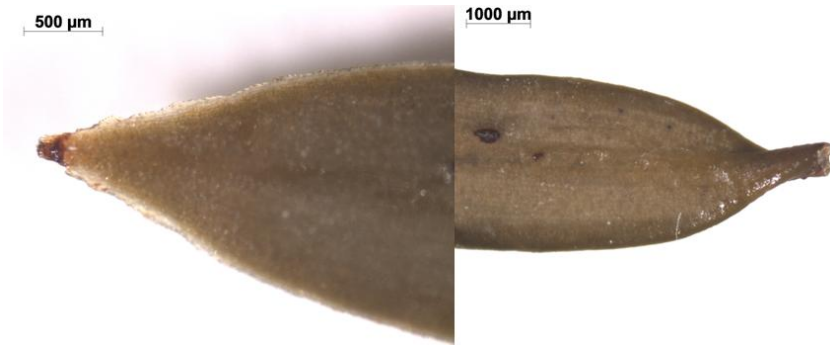


Figure 17
Coniferous needles were found in the stomach contents
Source: HIFS



Figure 18
Coniferous needle found in the stomach contents and comparative sample collected from the garden
Source: HIFS

To achieve higher accuracy, a histological analysis was performed in addition to external morphological assessment. A transverse section was prepared from an intact needle, stained with basic toluidine blue, and mounted for microscopic examination. The micro-anatomical features included: an epidermis composed of thick-walled cells; a central vascular bundle consisting of xylem and phloem; transfusion tissue flanking the vascular bundle on both sides; and a heterogeneous mesophyll dominated by

spongy parenchyma (Figure 19). Importantly, the needle lacked resin canals¹¹.

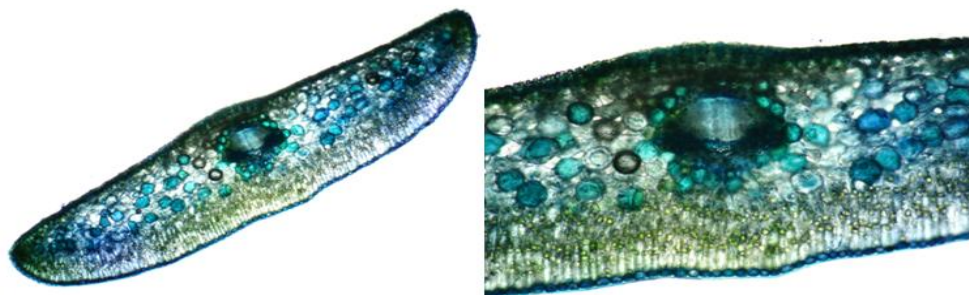


Figure 19

Histological image of the coniferous needle found in the stomach contents
Source: Kovács, J. S. (n.d.): Histological image of coniferous needle. Personal contribution.

These external and microscopic features were consistent with the family Taxaceae, genus *Taxus*, specifically the common yew (*Taxus baccata* L.). The yew is a slow-growing, native Hungarian species widely planted as an ornamental tree. Its most distinctive feature is the bright red, fleshy, berry-like aril surrounding the seed. The seed itself is hard, covered by protective scales, and matures within the aril after pollination¹². While the fleshy aril is non-toxic and sometimes even consumed, all other parts of the plant (needles, bark, seeds) are highly poisonous. The toxic compounds are diterpenoid alkaloids (e.g., taxine, taxicine) and cyanogenic glycosides¹³. The botanical examination confirmed the suspicion of yew poisoning and suicide.

¹¹ Hamidipour, A. – Radjabian, T. – Charlet, D. A. – Zarrei, M. (2011): Leaf anatomical investigation of Cupressaceae and Taxaceae in Iran. *Wulfenia*, 18. 95–111. o.

¹² Coombes, A. J.: *Határozó kézikönyvek: Fák* [Identification manuals: Trees]. Taramix Kft. 2009. 79. o.

¹³ Dános, B.: *Farmakobotanika – gyógynövényismeret* [Pharmacobotany – medicinal plant knowledge]. Semmelweis Kiadó. Budapest, 2006. 29. o.

Summary

Forensic botany, as a special branch of forensic activities, can contribute significantly to forensic investigations. The study aims to demonstrate the role and evidentiary power of plant evidence - such as needles, lichens and plant specimens - in investigative work through the examples of several domestic cases. The botanical methods used during the examinations, such as external morphological characteristics and histological examination, enable the precise identification of the samples. The cases described in the study (e.g. suspicion of poisoning, wood theft, exclusion of suicide) highlight that the examination of plant evidence not only enables a more accurate reconstruction of the facts but also effectively complements the work of other forensic disciplines (e.g. medical experts, toxicologists).

TÓTH, KRISZTINA – KISS, ISTVÁN

The Importance of Accreditation in Forensic Expert Examinations

Introduction

This study is based on a presentation delivered at this year's St. László Day Conference and examines the significance of accreditation in forensic expert activities. The presentation showcased the experiences of specialised fields, which have held accreditation for more than 12 years, from both quality management and criminalistic perspectives.

The Hungarian Institute for Forensic Sciences (HIFS, NSZKK), including its accredited forensic departments, such as the Department of Criminalistics, increasingly relies on laboratory analyses and objective evidence as technology advances. In this context, accredited testing methods play a prominent role. Accreditation, as an independent certification system, guarantees that laboratories operate in accordance with strict quality management and competence requirements set by international standards.

This system ensures that the methods applied during criminalistic examinations are authentic and validated, the instruments are calibrated, and the expert colleagues who use the instruments and conduct the examinations have received appropriate training for their activities. Accreditation directly increases the legal acceptability of expert opinions and helps ensure credibility in court proceedings. Furthermore, accreditation supports international cooperation and the broad acceptance of results, which is crucial for both cross-border law enforcement and forensic work.

This study aims to demonstrate the significance of applying accredited methods in criminalistic laboratory examinations.

The study also draws on practical examples from accredited, quality-assured HIFS institutes.

The ISO/IEC 17025¹ Quality Management Standard

The purpose of the standard is to ensure confidence in laboratory operations. It formulates requirements that enable laboratories to demonstrate proper operation and to produce reliable and traceable testing results. The standard requires implementing laboratories to plan and execute measures to address risks and opportunities related to their operations.

The application of the standard facilitates cooperation between laboratories and other bodies, promotes a unified approach, supports the exchange of information and experiences, and coordinates standards and procedures. This is of particular significance not only for coordinating the workflows of different laboratories, but also for coordinating workflows that span across national borders. A good example of this is the operation of expert fields that use international databases.

Technical Competence and Quality Assurance

According to the provisions of the ISO/IEC 17025² standard, criminalistics laboratories are required to apply documented, regularly validated testing procedures. They must ensure the calibration of measuring instruments, the continuous training of personnel, and the verification of their competence. According to the ISO/IEC 17043³ standard, participation in regular proficiency testing provides objective evidence of the correctness and compara-

¹ Source: <https://www.iso.org/ISO-IEC-17025-testing-and-calibration-laboratories.html>
Accessed: 01.07.2025

² Source: <https://www.iso.org/ISO-IEC-17025-testing-and-calibration-laboratories.html>
Accessed: 01.07.2025

³ Source: <https://www.iso.org/standard/80864.html>
Accessed: 01.07.2025

bility of the laboratory's results, significantly reducing errors and maintaining examination accuracy⁴. Proficiency testing conducted in accordance with the ISO/IEC 17043 standard is a fundamental tool for the continuous evaluation of laboratory performance. Thus, quality assurance helps ensure that examinations conducted with technical competence lead to authentic and validated results.

Court Acceptance and Legal Credibility

In court proceedings, the value of expert opinions depends not only on the substantiation of the testing method, but also on the laboratory's accreditation⁵. The results of accredited criminalistic laboratories carry greater weight in court because they are prepared in a transparent, standardised, and controlled environment⁶. This transparency and standardisation create legal certainty and reinforce the credibility of forensic expert work.

International Cooperation and Recognition

Accreditation under the ISO/IEC 17025⁷ standard provides international recognition for criminalistics laboratories, which is crucial for cross-border law enforcement cooperation and the exchange of forensic information⁸. Hungary's national accreditation organisation, NAH⁹, is a signatory to the

⁴ Okezue, M. A. – Adeyeye, M. C. – Byrn, S. J. – Abiola, V. O. – Clase, K. L.: Impact of ISO/IEC 17025 laboratory accreditation in sub-Saharan Africa: A case study. BMC Health Services Research, Issue 2020/20. 1065. o.

DOI: <https://doi.org/10.1186/s12913-020-05934-8>

⁵ Doyle, S. (): A review of the current quality standards framework supporting forensic science: Risks and opportunities. WIREs Forensic Science, 2020/2/3. e1365.

DOI: <https://doi.org/10.1002/wfs2.1365>

⁶ NAH (2024): National Accreditation Authority Annual Report 2024. NAH, Budapest

⁷ Source: <https://www.iso.org/ISO-IEC-17025-testing-and-calibration-laboratories.html>
Accessed: 01.07.2025

⁸ NAH (2024): National Accreditation Authority Annual Report 2024. NAH, Budapest

⁹ Source: <https://nah.gov.hu/hu/oldal/bemutatkozas/>

ILAC MRA¹⁰ and the EA¹¹ MLA¹². NAH's membership and status were reviewed and confirmed by the EA Multilateral Agreement Council (MAC) in 2024, verifying compliance with the ISO/IEC 17011¹³ standard. This guarantees that examinations accredited by NAH are internationally accepted. The mutual recognition agreements and guidelines (e.g., ILAC G19) concluded by ILAC¹⁴ (International Laboratory Accreditation Cooperation) and other international organisations ensure that the results of examinations conducted in one country are also acceptable in other countries, thereby supporting the global justice system.

Challenges and Development Opportunities

Although accreditation is a fundamental guarantee of quality, it does not, in itself, mean complete error-free performance or professional excellence¹⁵. The administrative burdens of the accreditation system frequently pose problems, which can divert attention from actual professional work. The problem can also be caused by formal, inactive application of accreditation¹⁶. Meeting the complex requirements of ISO/IEC 17025¹⁷ and

Accessed: 01.07.2025

¹⁰ Source: <http://ilac.org/ilac-mra-and-signatories/>

Accessed: 01.07.2025

¹¹ Source: <https://european-accreditation.org/about-ea/who-we-are/>

Accessed: 01.07.2025

¹² Source: <https://european-accreditation.org/mutual-recognition/the-ea-mla/>

Accessed: 01.07.2025

¹³ Source: <https://www.iso.org/standard/67198.html>

Accessed: 01.07.2025

¹⁴ Source: <http://ilac.org/about-ilac/>

Accessed: 01.07.2025

¹⁵ Doyle, S. (2020): i.m.

¹⁶ ¹⁶ NAH (2024): National Accreditation Authority Annual Report 2024. NAH, Budapest

¹⁷ Source: <https://www.iso.org/ISO-IEC-17025-testing-and-calibration-laboratories.html>

Accessed: 01.07.2025

ISO/IEC 17043¹⁸ standards poses particular challenges for smaller criminalistic laboratories. Successful implementation depends equally on management commitment, adequate resources, and continuous professional training¹⁹. Efforts should be made to achieve the necessary level of administration and to exploit the opportunities provided by the standardised management system, thereby minimising risk factors and ensuring optimal operation.

Accreditation is not a one-time event, but continuous compliance with standard requirements. Audits, inspections, and self-improvement mechanisms promote the professional development of criminalistic laboratories, the correction of identified errors, and the application and widespread adoption of the best testing methods. For laboratories to keep pace with scientific development, it is equally necessary to provide resources for expert training, quality assurance, and technological developments.

The Hungarian Situation

In Hungary, several criminalistic laboratories of the HIFS²⁰ hold accreditation according to the ISO/IEC 17025²¹ standard, which is regularly audited

¹⁸ Source: <https://www.iso.org/standard/80864.html>

Accessed: 01.07.2025

¹⁹ Arıcan, M. – Yalçın, A. (2025): ISO 17025 and ISO 9001: A review on quality management in digital forensics laboratories.

Source: <https://dergipark.org.tr/en/pub/isrjournal/issue/90669/1521028>

Accessed: 03.07.2025

Einseln, A. (2019): The Evolution of ISO/IEC 17025 and Accreditation Requirements.

Source: <https://www.sciencedirect.com/science/article/pii/S2589871X19300518>

Accessed: 01.07.2025

²⁰ Nemzeti Szakértői és Kutató Központ: Szervezet és tevékenység [Organisation and activities].

Source: <https://nsszk.gov.hu/szervezet-es-tevekenysege>

Accessed: 01.07.2025

²¹ Source: <https://www.iso.org/ISO-IEC-17025-testing-and-calibration-laboratories.html>

Accessed: 01.07.2025

and reviewed by NAH²². Domestic regulation and practice are increasingly aligned with European Union norms, which in the long term improves the reliability, credibility, and legal acceptance of expert work.

The accredited central departments of the HIFS under ministerial guidance are the Dactyloscopic Expert and Facial Analysis Department, the Genetic, Physical and Chemical, Drug Testing, Criminalistic (trace, weapon, handwriting and document analysis), and Toxicological Expert Departments, in which expert work is conducted with a total of 248²³ accredited testing methods.

The management systems of accredited organisations, their procedures, risk management, and continuous internal and external control of operations ensure compliance with standard requirements.

Potential Consequences of Lack of Accreditation

The use of non-accredited testing methods may pose risks with significant consequences. One of the most significant risks is that the court may declare the examined evidence invalid. Persons previously wrongfully convicted based on such testing methods may request a retrial of their case, as a result of which the professional reputations of the investigating authority and the criminalistic laboratory may be damaged, and their professional credibility may be lost.

There is also a risk that other countries will not accept the laboratory's results, potentially leading to international isolation.

²² NAH (2024): National Accreditation Authority Annual Report 2024

²³ Nemzeti Szakértői és Kutató Központ: Minőségbiztosítás [Quality assurance].

Source: <https://nszkk.gov.hu/minosegbiztositas>

Accessed: 01.07.2025

Summary²⁴

This publication highlights the significance of accreditation in criminalistic examinations. Criminalistics, as the scientific foundation pillar of justice administration, increasingly relies on laboratory examinations and objective evidence during technological development. In the case of criminalistic quality examinations, experts evaluate the test results, and the main factor influencing their assessments is professional experience, based on identification theory. Quality assurance is particularly important in our criminalistic specialties because, in the case of expertise based on professional experience, only this way can the greatest possible objectivity be ensured.

In practice, accredited testing methods play a prominent role during the examination of evidence, as well as the complex and regulated quality management system based on the MSZ EN ISO/IEC 17025:2018²⁵ standard that provides an appropriate background for the examinations, which ensures professional competence, reliability and accuracy of procedures, reproducibility of examinations, and legal acceptability. However, for effective operation, the commitment of the organisation's management and staff to continuous quality improvement and professional development is essential.

Accredited testing methods are, on the one hand, technical regulations, and on the other hand, guarantees of legal certainty and the enforcement of

²⁴ Bócz, E. (2008): A kriminalisztika elmélete és gyakorlata [Theory and practice of criminalistics]. KJK-Kerszöv, Budapest, European Network of Forensic Science Institutes (2015): ENFSI vision on the role and value of forensic science in the criminal justice system.

Source: https://enfsi.eu/wp-content/uploads/2016/09/ENFSI_Vision_paper_final.pdf
Accessed: 01.07.2025

International Organization for Standardization (2017): ISO/IEC 17025:2017 – General requirements for the competence of testing and calibration laboratories.

Source: <https://www.iso.org/standard/66912.html>
Accessed: 01.07.2025

²⁵ Source: <https://ugyintezes.mszt.hu/webaruhaz/szabvany-adatok?standard=134618>
Accessed: 01.07.2025

human rights. The activities of criminalistic laboratories have a direct impact on the fate of people involved in proceedings; therefore, the scientific foundation, consistency, and accountability of the applied testing methods must be basic conditions, whether it concerns the establishment of innocence or guilt.

One of the most important tasks of future criminalistics is to preserve the objectivity and legality of examinations despite the challenges associated with technological development, for which accredited testing methods provide both assistance and a professional framework.

VOLARICS, JÓZSEF

Crime scene investigation in a CBRN environment – Capacity building and innovation

The study focuses on the specific characteristics of forensic crime scene investigation related to criminal offences involving the malicious use of CBRN materials and devices. The introductory section outlines the definitions of CBRN agents, materials, and devices, provides an overview of CBRN-related terrorist incidents recorded in the European Union between 2001 and 2023, and considers short-term trends in emerging threats. The paper examines the general characteristics of crime scene investigations conducted in contaminated CBRN environments, with particular attention to scene safety, contamination control, evidence preservation, and interagency cooperation. It also analyses innovation-driven approaches relevant to forensic crime scene management and realistic directions for capacity building. The study presents the Hungarian procedural framework developed for conducting forensic crime scene investigations involving radioactive materials.

Chemical, Biological, Radiological, and Nuclear (CBRN) – definitions

CBRN materials and agents are defined differently across international organisations and institutional actors, depending on their operational mandates and regulatory focus. As the present study addresses forensic crime scene investigation in a CBRN environment, a brief review of selected institutional definitions is necessary to clarify the conceptual framework applied in the analysis.

European Union: „*The acronym ‘CBRN’ defines chemical, biological, radiological and nuclear materials and agents that could potentially harm*

society through their accidental or deliberate release, dissemination, or impacts.”¹

European Union Agency for Criminal Justice Cooperation: „*Chemical, biological, radiological and nuclear substances and explosives (CBRN-E) include substances and agents conceived, synthesised, extracted, processed and eventually produced, distributed and used by different actors.*”²

EU CBRNe Glossary: „*CBRN is the abbreviation commonly used to describe the use of Chemical, Biological, Radiological and Nuclear materials or weapons.*”³

North Atlantic Treaty Organisation: „*CBRN materials refer to any chemical, biological, radiological, or nuclear substance that may pose a hazard to NATO populations, territories and forces, regardless of origin or whether the material was originally conceived as a weapon.*”⁴

Despite differences in terminology, the reviewed definitions share several common characteristics. Each definition refers to chemical, biological, radiological and nuclear materials or agents capable of causing harm to human health, infrastructure, the environment or public safety. The main differences concern conceptual scope: some institutions primarily emphasise hazardous materials and their potential release, whereas others explicitly include weapons, explosives and scenarios involving malicious use.

¹ European Commission (n.d.): Chemical, Biological, Radiological and Nuclear Risk Mitigation.

Source: https://cbrn-risk-mitigation.network.europa.eu/index_en

Accessed: 17.07.2025.

² Eurojust (n.d.): CBRN-E.

Source: <https://www.eurojust.europa.eu/crime-types-and-cases/crime-types/cbrn-e>

Accessed: 17.07.2025.

³ Joint Research Centre: EU Glossary on Chemical, Biological, Radiological, Nuclear, and Explosive Risks. Publications Office of the European Union. Luxembourg, 2022.

⁴ NATO: NATO's Chemical, Biological, Radiological and Nuclear (CBRN) Defence Policy. 2022.

Source: https://www.nato.int/cps/en/natohq/official_texts_197768.htm

Accessed: 17.07.2025.

There is no generally accepted definition of CBRN materials. In the present study, the term CBRN is understood in a broader sense and encompasses chemical, biological, radiological and nuclear materials, agents and devices, including those associated with malicious use and weapon-related purposes.

CBRN terrorism

According to Briefing Paper 2 of the MASC-CBRN⁵ programme: „WMD⁶/CBRN terrorism - cases related to the illicit use of WMD / CBRN materials and information by non-State actors for the purpose of carrying out large-scale politically motivated attacks.”⁷

Nowadays, the CBRN threat is a part of terrorist propaganda; the probability of such attacks occurring is rather low, but their potential impact is considerable.⁸ The probability is low due to the technological and logistical requirements of producing, acquiring, handling, and using CBRN materials, which demand specialised expertise and advanced infrastructure. However, such an attack poses a high risk due to its complex, potentially catastrophic impact across nearly all dimensions of security.⁹

⁵ MASC-CBRN: Methodology for Assessing States' Capacity for Countering the Hostile Misuse of CBRN Knowledge and Materials. 2022.

Source: https://csd.eu/fileadmin/user_upload/publications_library/files/2022_11/MASC-CBRN_Methodology_EN.pdf

Accessed: 17.07.2025.

⁶ WMD: Weapons of Mass Destruction.

⁷ MASC-CBR: MASC-CBRN Briefing Paper #2: CBRN Risk Management. 2021. 3. o.

⁸ European Commission: Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. Action Plan to Enhance Preparedness against Chemical, Biological, Radiological and Nuclear Security Risks. European Commission. Brussels, 2017. 2. o.

⁹ Despite their low probability, terrorist attacks involving CBRN materials pose a real risk. On March 20, 1995, members of the Aum Shinrikyō terrorist organization carried out a coordinated sarin attack on five lines of the Tokyo subway system. The incident resulted in 13 fatalities and over 6,000 injuries. (USHIYAMA 2023:54)

Between 2001 and 2023, in the territory of the European Union, perpetrators motivated by jihadist ideology were the most active in the terrorist use of CBRN materials. However, the activities of right-wing extremists were also significant. A total of 13 incidents involving CBRN materials were recorded. In addition to these, during the period examined, two further targeted attacks involving CBRN materials were carried out against specific individuals, in which state actors or intelligence operations are suspected of having played a role. The relevant cases have been summarised in a table.

The illegal acquisition or production of CBRN materials in sufficient quantities for committing terrorist acts poses significant challenges for terrorist actors.¹⁰ However, technological advancements and the increasing availability of information online are steadily reducing these barriers. Potential impacts of armed conflicts in the Middle East and the Russia–Ukraine war must also be taken into account. Ukraine had already been involved in the illicit trade of firearms and radioactive materials before the outbreak of the Russia–Ukraine war.¹¹ In several terrorist incidents in the Middle East, chemical agents were used. The online sharing of information related to the production and deployment of IEDs capable of dispersing CBRN substances represents a serious risk.

CBRN materials at a crime scene

The main components that determine on-scene operations are the technical equipment (with what), the responsible unit (by whom), and the methods and procedures applied (how).¹² While organisational and technical aspects

¹⁰ Europol: European Union Terrorism Situation & Trend Report 2020 (EU TE-SAT 2020). Publications Office of the European Union. Luxembourg, 2020. 21. o.

¹¹ Zaitseva, Lyudmila – Steinhäusler, Friedrich: Nuclear Trafficking Issues in the Black Sea Region. Non-Proliferation Papers, No. 37. EU Non-Proliferation Consortium. 2014. 7–87. o.

¹² Hausner, Gábor (ed.): Fundamentals of National Defence [Honvédelmi alapismeretek, in Hungarian]. Ludovika. Budapest, 2022. 41. o.

play an important role in shaping the protocol for the crime scene investigation, the procedure is ultimately determined by the specific characteristics of the scene - such as its scale, the number of victims, and any special conditions (e.g., the presence of CBRN materials) - as well as the objective of the investigation (the mission).

CBRN materials have a dual nature in the context of crime scene investigation. On the one hand, they are hazardous materials whose presence at the scene requires special safety measures. On the other hand, due to their malicious release, they also serve as instruments of the crime - meaning they are simultaneously pieces of evidence.

A crime scene investigation requires scientific and technical support to ensure both safety and effectiveness. Safety measures include the detection of CBRN materials (their localisation and identification), the designation of zones or perimeters¹³, the determination of appropriate levels of personal protective equipment (such as protective suits and respiratory protection), and the provision of a decontamination station. The effectiveness of the investigation is supported by the professional use of specialised equipment, such as detectors, manipulators, and storage and transport devices.

As outlined above, CBRN incidents are low-probability but high-risk events with potentially catastrophic consequences. CBRN response capability is a niche capability that is rarely deployed; however, it is highly costly due to the specialised equipment and expertise required. For effective capacity development, it is advisable to coordinate and utilise existing CBRN capabilities. This requires an appropriate legal framework and the regular organisation of exercises involving the relevant agencies and units.

¹³ At crime scenes of this type, a three-zone system is typically applied. The immediate area contaminated by CBRN materials is referred to as the red or hot zone. This is followed by the yellow or warm zone, which includes entry and exit points, contamination control, and decontamination stations. Outside of these lies the green or cold zone, which contains the command post, medical support, and other logistical facilities.

The Hungarian Radiological Crime Scene Management (RCSM) procedure

The Hungarian operating procedure for radiological crime scene management is based on international trends and guidelines,¹⁴ and adapted to the Hungarian legal system and professional experiences. The method has been developed in collaboration with the staff of the Nuclear Forensics Laboratory of the HUN-REN Centre for Energy Research¹⁵ and the Criminal Forensics Department of the National Bureau of Investigation within the framework of a project supported by the Home Affairs Security Fund.¹⁶

The main goal was to establish a harmonised procedure in which each actor (conventional crime scene investigators and nuclear forensic experts) performs their task, all in a way that best serves safety and the purposes of the criminal investigation. A specific feature of the procedure is that police officers and radiation/nuclear forensic experts work together at the crime scene.

In crime scene investigations involving RN (radiological and nuclear) materials, the key distinction lies in the radiological component, which may consist of radiation from a sealed or intact radioactive source present at the scene or contamination with radioactive substances. RN materials and conventional evidence contaminated by them are given priority during scene processing. Once radioactive materials have been collected, the handling of the scene proceeds similarly to that of conventional crime scenes. This is not a rigid rule; priorities may shift depending on the circumstances. In the event of a suspected terrorist attack, the primary task may be to extract

¹⁴ International Atomic Energy Agency: Radiological Crime Scene Management. IAEA Nuclear Security Series, No. 22-G. International Atomic Energy Agency. Vienna, 2014. 1–93. o.

¹⁵ The analysis of nuclear or other radioactive materials and traditional evidence contaminated with radionuclides is the task of nuclear forensics. In Hungary, the dedicated Laboratory for this purpose is the Nuclear Forensic Laboratory of the HUN-REN CER.

¹⁶ The development of the operating procedure was supported by the Hungarian Ministry of Interior and the European Union within the framework of the Internal Security Fund of Hungary (BBA-5.3.3/3-2017-00010).

data from information-bearing objects (e.g., documents, electronic devices) to prevent the commission of the crime.

To ensure safety and effectiveness, scientific and technical support is essential. This includes the designation of operational zones at the scene, the determination of the appropriate level of personal protective equipment, implementing radiation protection measures (such as defining the allowable time spent on the scene, maintaining safe distances from radiation sources, and applying shielding), radiation detection, and handling other specialised equipment (e.g., manipulators, storage devices).

At radiological crime scenes, the investigation team is supplemented by three radiological experts¹⁷ from the Nuclear Forensic Laboratory of the HUN-REN CER, who support the implementation of procedural protocols. One expert operates in the red (hot) zone. Their tasks include measuring radiation levels, identifying hotspots (radiation sources), detecting RN materials and conventional physical evidence contaminated with such substances, and collecting them (in cooperation with a forensic technician). The second expert, known as the radiation protection specialist, works in the yellow zone at the entrance to the red zone. Their responsibilities include checking items exiting the hot zone for contamination, providing clean equipment, assisting with glove changes, and ensuring the safe removal of personal protective gear. The third expert is the nuclear forensic specialist, whose role is to categorise materials at the scene using gamma spectrometry.

Summary

Terrorist attacks involving the use of CBRN materials are low-probability but potentially catastrophic events. The CBRN threat forms part of terrorist propaganda; however, it represents a real risk, as evidenced by smaller-

¹⁷ A radiological expert is a nuclear physicist or radiochemist who is capable of identifying radioactive materials, detecting them using instruments, and collecting and handling them professionally.

scale incidents in our region and by acts detected during the preparatory phase of planned attacks involving CBRN materials.

Following such an attack, conducting a crime scene investigation requires specialised equipment, expert knowledge, and specialised procedures. CBRN capability is rarely deployed, but because of the expertise and equipment required, it requires substantial financial resources. One possible solution is to integrate and coordinate existing CBRN capabilities across different organisations and units.

In Hungary, experts from the Nuclear Forensic Laboratory of the HUNREN CER and the Criminal Forensics Department of the National Bureau of Investigation have developed a procedure for processing crime scenes affected by nuclear and radioactive materials. This procedure has been applied in real criminal cases over recent years. Its development is ongoing, with recent efforts focusing on implementing the DVI (Disaster Victim Identification) protocol in CBRN environments and refining the methodology for examining conventional physical evidence contaminated with radionuclides.

Table of CBRN Terrorism and Assassinations Involving CBRN Materials in the EU between 2000 and 2023. Edited by the author.

Incident/Method	Substance used	Year	Country	Motivation
Postal item containing chemical agent (12 cases). ¹⁸	Adamsite ¹⁹	2003	Belgium	unknown

¹⁸ Europol: EU Terrorism Situation & Trend Report 2002–2003. Europol. The Hague, 2003. 20. o.

¹⁹ European Union (2020): Common Military List of the European Union (equipment covered by Council Common Position 2008/944/CFSP, which defines common rules governing the control of exports of military technology and equipment). Official Journal of the European Union, ML 7.d.

Production of a biological agent ²⁰	Ricin ²¹	2003	UK	jihadism
Postal item containing a chemical agent. (8 cases). ²²	Adamsite	2004	Belgium	jihadism
Murder committed with a radioactive substance. ²³	Polonium-210 ²⁴	2006	UK	assassination
Contamination of the public water supply (in preparatory phase). ²⁵	unknown	2011	Spain	jihadism
Online publication of training material related to biological toxin processing. ²⁶	Ricin	2016	Online	jihadism
Postal item containing radiological	Americium ²⁸	2016	Slovakia	unknown

²⁰ Europol: EU Terrorism Situation & Trend Report 2002–2003. Europol. The Hague, 2003. 40. o.

²¹ Ujváry, István: This isn't just a bean game — ricin is deadly [A mérgező ricin. Nem babra meg a játék]. Élet és Tudomány, Issue 2003/6. 173–174. o.

²² Europol: EU Terrorism Situation & Trend Report 2003–2004. Europol. The Hague, 2004. 11. o.

²³ The assassination of Alexander Litvinenko, a former agent of the FSB (Federal Security Service, successor to the KGB).

²⁴ Highly toxic alpha-emitting radioactive material.

²⁵ Europol: EU Terrorism Situation & Trend Report 2012. Europol. The Hague, 2012. 18. o.

²⁶ Europol: EU Terrorism Situation & Trend Report 2017. Europol. The Hague, 2017. 16. o.

²⁸ A synthetic metallic element, with all isotopes exhibiting radioactivity through alpha decay and weak gamma emission.

material (unknown number of cases). ²⁷				
Preparation of an IED ²⁹ intended for biological agent dispersal (in preparatory phase). ³⁰	Ricin	2018	France	jihadism
Production of a biological agent. ³¹	Ricin	2018	Germany	jihadism
Contamination of the public water supply (in preparatory phase). ³²	unknown	2018	Sardinia	jihadism
Attempted murder committed with a radioactive substance. ³³	Novichok ³⁴	2018	UK	assasi- nation
Exploration of COVID-19 deployment as a biological weapon. ³⁵	COVID-19	2020	Online.	right-wing extremism

²⁷ Ibid. 16

²⁹ Improvised Explosive Device.

³⁰ Europol: EU Terrorism Situation & Trend Report 2019. Europol. The Hague, 2019. 19.

o.

³¹ Ibid. 19

³² Ibid. 19.

³³ The attempted assassination of Sergei Skripal, a former Russian military intelligence officer convicted of treason and released in a 2010 US-Russia spy swap. Following his resettlement in the United Kingdom, Skripal and his daughter Yulia were poisoned with Novichok.

³⁴ A chemical agent belonging to the nerve agent category of chemical weapons.

³⁵ Europol: EU Terrorism Situation & Trend Report 2021. Europol. The Hague, 2021. 30.

o.

Scenarios involving the intentional spread of COVID-19 through means such as distributing contaminated masks. ³⁶	COVID-19	2020	Online	jihadism
Construction of an IED ³⁷ with radioactive content. ³⁸	Uranium (The specific isotope or chemical compound is not identified.)	2021	France	right-wing extremism
Online publication of training material related to dirty bomb (RDD) processing. ³⁹	unknown	2022	Online	right-wing extremism

³⁶ Ibid. 30

³⁷ A dirty bomb is a form of Radiological Dispersal Device (RDD) designed to release radioactive substances through the detonation of conventional explosives.

³⁸ Europol: EU Terrorism Situation & Trend Report 2022. Europol. The Hague, 2022. 17. o.

³⁹ Europol: EU Terrorism Situation & Trend Report 2023. Europol. The Hague, 2023. 18. o.

Summary

Csete, Dániel: No-Go Zones and Tourism Security: Law Enforcement Challenges and Perceptions

This study examines the concept of “no-go zones” from the perspective of tourism security and law enforcement. It analyses how tourists’ perceptions are shaped by media narratives, personal experiences, and policing practices, highlighting the gap between perceived and actual safety. The study argues that effective communication, community involvement, and consistent law enforcement strategies are essential for restoring trust and reintegrating these areas into the tourism landscape.

Czifra, Botond: Examining the Attitudes of Hungarian Drivers in Domestic Road Transport Regarding Their Financial Situation

This study examines the relationship between drivers’ financial status and their compliance with traffic regulations. Based on empirical research using traffic observation methods, it analyses whether wealth influences the likelihood of committing traffic violations. The findings confirm international trends, showing that wealthier drivers are more likely to commit traffic violations; however, those in poorer financial situations are also prone to such behaviour.

Fenyvesi, Csaba – Fábián, Vanessza: Criminalistic Lessons from the Last Death Penalty in Baranya County

This study reconstructs the investigation and trial of a 1974 homicide case involving an eight-year-old victim in Pécs, based on archival and forensic sources. It analyses key lessons in criminalistics, including investigative errors and the evidential value of traces, while highlighting the continued relevance of Locard’s exchange principle. The study contrasts the limited forensic tools of the past with modern developments such as DNA analysis and digital investigation methods.

Fullár, Alexandra: Adhesive Tape as Forensic Evidence

This study examines the forensic relevance of adhesive tapes frequently found at crime scenes. Through practical case examples, it presents the investigative potential of tape residue and highlights its evidentiary value. The study also emphasises the importance of interdisciplinary cooperation in extracting as much information as possible from such traces.

Fülöp, Péter: „Body physics” – Innovative options for supporting forensic medical expert practice in Hungary

This study explores the application of physical principles in the forensic examination of bodily injuries. It explains how force and energy can be quantified from a forensic physics perspective and what types of data are required for accurate assessment. Through practical examples, the study highlights the importance of interdisciplinary cooperation between forensic medicine and physics in improving the interpretation of injury mechanisms.

Horváth, Orsolya: Technological Innovation and the Pursuit of Truth: Integrating 3D Reconstruction and Artificial Intelligence into Criminalistics

This study explores the role of digital technologies and artificial intelligence in criminal investigations and courtroom proceedings. It examines how tools such as photogrammetry, laser scanning, drones, and VR/AR enhance the reconstruction of crime scenes, and how AI supports the interpretation of complex forensic data. Drawing on international case studies, the study highlights both the opportunities and challenges of integrating these methods into the evidentiary process, with particular attention to legal admissibility, expert responsibility, and the requirements of the EU AI Act. The study concludes that while digital technologies are already integral to modern criminal justice, their legitimacy depends on transparency, expert oversight, and clear procedural safeguards.

Kisfonai, Bernadett Patrícia: Artificial Intelligence in Law Enforcement: International Experiences and Hungarian Prospects

This study examines the growing role of artificial intelligence in law enforcement, particularly in crime prevention and predictive policing. It highlights how AI tools and network analysis can support the identification of criminal patterns and enable proactive interventions. The study also addresses ethical and regulatory challenges, emphasising the importance of safeguarding fundamental rights in the Hungarian application of these technologies.

Lang-Fuksa, Dorottya: Speeding Regulations in Switzerland in the Light of Police Sanctions: Fine Systems, Raserdelikt and Reform Directions

This study analyses Switzerland's strict legal and administrative approach to speeding, focusing on traffic safety principles, income-based fines, and the role of police sanctions. It examines the criminalisation of extreme speeding offences, such as Raserdelikt, and compares the Swiss model with regulatory frameworks in Germany, Austria, and Hungary. The study also outlines possible reform directions based on international best practices.

Mágó, Barbara: The Role of the Defendant's Nationality in Criminal Law

This study examines the role of the defendant's nationality in criminal law, focusing on its relevance in criminal proceedings and the enforcement of sanctions. It highlights that while criminal liability is not dependent on nationality, certain procedural guarantees and legal institutions, such as expulsion, are closely linked to the accused's status. The study also addresses the challenges posed by multiple nationality, statelessness, and the emerging use of deprivation of nationality in the context of state security.

Öveges Kristóf: The Significance of Law Enforcement History Research in the Development of Law Enforcement Science

This study examines the role of research on law enforcement history in the development of law enforcement science. It highlights its importance in shaping organisational culture and supporting academic work, while also encouraging further research in this field.

Székely, E. Árnika: What Plant Evidence Tells Us

This study presents the forensic applications of botanical analysis through selected domestic case studies. It demonstrates how plant-based traces, such as leaf fragments and lichens, can provide valuable evidentiary information in criminal investigations. The study highlights the role of botanical expertise in supporting and complementing other forensic disciplines.

Tóth, Krisztina – Kiss, István: The Importance of Accreditation in Forensic Expert Examinations

This study examines the concept and significance of accreditation in forensic expert work. It highlights the role of standardised methodologies and organisational requirements in ensuring the reliability of expert results. Drawing on practical experience, the study emphasises the importance of maintaining accredited systems in supporting the credibility of judicial proceedings.

Volarics, József: Crime Scene Investigation in a CBRN Environment: Capacity Building and Innovation

This study examines the specific characteristics of crime scene investigation in a CBRN environment. It outlines the definitions of CBRN materials, reviews relevant incidents within the European Union, and analyses the key features and innovative aspects of investigations conducted under such conditions. The study also presents domestic procedures developed for handling cases involving radioactive materials and highlights directions for capacity development.