UDK: 343.98(497.7)

METHODS FOR DETECTING CRIMINAL OFFENSES AND OPERATIONAL PLANNING IN FORENSIC INVESTIGATIONS IN THE REPUBLIC OF NORTH MACEDONIA

Nikolcho SPASEVSKI
PhD Candidate, Faculty of Law, University Goce Delcev, Stip
e-mail: nspasevski@yahoo.com

Abstract

Crime is not a random event. Certain lifestyles increase the risk of victimization, and psychological, social, and economic factors are associated with criminal involvement. Crime varies over time: it is more common in the evening than in the morning, on weekends more than on weekdays, and in the summer more than in the winter. Crime mapping is the process by which crime analysts and researchers use location information about criminal events to discover spatial patterns in criminal activity.(Boba, 2005) In the past, crime mapping efforts typically involved placing physical markers, such as pins, on maps to indicate the locations where crimes occurred. Patterns of criminal activity were determined primarily through visual inspection of these maps. Researchers and crime analysts can then use a variety of analytical software packages to examine and discover patterns of criminal activity from these virtual maps. This paper explores the concepts, theoretical approaches, and key findings related to crime mapping, with an emphasis on its application in crime prevention and suppression strategies.

Keywords*: Crimes, Criminal information, Clues, Criminal records, Crime mapping, GIS*

Introduction

Forensic science, as a scientific discipline, plays a key role in the fight against crime, providing methods and tools for the detection, investigation and prevention of crimes. (Aleksić, 1983) In the Republic of North Macedonia, the application of forensic methods, especially crime mapping, is becoming increasingly important due to the increasing need for effective strategies for dealing with criminal activities. This paper focuses on methods for the detection of crimes, operational planning and the application of geographic information systems (GIS) in forensic research, with a special emphasis on crime mapping in the Republic of North Macedonia.

Crime is not a random phenomenon. Research shows that certain psychological, social and economic factors are associated with increased criminal activity. Furthermore, the lifestyles and behaviours of individuals can increase the risk of victimisation. Temporal variations in crime are also significant: more crimes occur in the evenings, on weekends and in the summer months. These patterns point to the need for a systematic approach to crime analysis, where crime mapping proves to be a powerful tool for identifying spatial and temporal trends.

The aim of this paper is to provide a comprehensive overview of crime detection methods, operational planning and the application of GIS in criminal investigations, with a special focus on the experiences and challenges in the Republic of North Macedonia. Through an analysis of empirical data and relevant literature, the paper offers insight into the potential of crime mapping to improve the efficiency of police services and strengthen community safety.

1. Ways to Detect Criminal Offenses

The detection of crimes is the first step in investigating and suppressing criminal activity. Police services employ several methods to gather information about committed crimes.(Aleksić, 1983) One direct approach is catching a perpetrator in the act, where professionally trained officers observe suspicious behavior or signs of criminal activity, such as a lit warehouse after hours. Operational

measures like ambushes, special surveillance, or inspections can lead to apprehending perpetrators during a crime.

Another method involves immediate awareness during operational work, where officers use information-gathering techniques like vehicle checks, searches, or raids to uncover objects or clues indicating a crime, even if they were initially unaware of it. Citizens are a vital source of information, providing reports in person, by phone, or in writing. Some choose anonymity or pseudonyms, which can complicate investigations but still offer useful data. Police must approach anonymous reports skeptically yet not dismiss them, as they may hold relevant information. Self-reporting, though rare, is significant; individuals may confess due to remorse, fear of detection, or to seek leniency, though false reports may aim to protect the true perpetrator or conceal a graver offense. Anonymous and pseudonymous reports require careful verification, as malicious filings by perpetrators or their associates may mislead police, and identifying the filer can help assess reliability. Victims and witnesses are key sources, but some avoid reporting due to fear of retaliation, shame, or distrust in police, necessitating a confidential environment to encourage reporting.

Legal entities, such as companies or institutions, report crimes like economic or property offenses, often providing detailed data to aid investigations. Operational liaisons, individuals with specialized knowledge, offer valuable insights but need careful management to protect their identity and safety. Finally, media and public rumors serve as indirect sources, which, though not always reliable, can point to potential criminal activity warranting further investigation.

2. Operational Planning in Forensic Investigations

Operational planning is a critical component of criminal investigations, enabling a systematic approach to detecting and resolving crimes through the development of criminal cases, evidence analysis, and coordination of operational activities.(Aleksić, 1983) Forensic versions, which are hypotheses about the nature, perpetrator, and circumstances of a crime, form the foundation of this process.(Mališ Sazdovska, 2005)

These hypotheses are classified based on the entities creating them, such as police or prosecution, and their criminal-legal significance, which can be general or specific. Planning these versions involves identifying possible scenarios and verifying them through evidence. The planning methodology relies on tactical rules for creating and testing these hypotheses, requiring the analysis of evidence to eliminate unsupported assumptions and focus on those backed by facts.(Mališ Sazdovska, 2005) Effective planning demands coordination among various police units and the integration of analytical tools to ensure a cohesive investigative strategy.

Crime mapping, utilizing Geographic Information Systems (GIS), further enhances this process by analyzing spatial patterns of criminal activity.(Boba, 2005) This technique enables the visualization of criminal events, identification of crime hotspots, and prediction of future criminal activity, providing law enforcement with actionable insights to optimize their efforts.

3. Geographic Information Systems (GIS)

Geographic Information Systems (GIS) are critical tools for crime mapping, offering powerful capabilities to analyze and visualize spatial patterns of criminal activity.(Boba, 2005) By integrating diverse data sources—such as police reports, census data, social media information, traffic patterns, and environmental factors—GIS platforms enable law enforcement agencies to create comprehensive, layered maps that reveal insights into where, when, and how crimes occur. These systems support the identification of crime hotspots, the tracking of criminal trends over time, and the prediction of potential future criminal activity, thereby enhancing strategic decision-making for crime prevention and resource

allocation. In the Republic of North Macedonia, the use of GIS in police services remains limited, primarily due to constraints in technological infrastructure, training, and inter-agency coordination. Currently, GIS applications are often confined to basic mapping tasks or small-scale projects, such as the "Crime Map of Macedonia," which processes Ministry of Internal Affairs (MIA) bulletins to visualize crime locations. (Temelkovski et al., 2012) However, the potential for broader adoption is significant.(Eman et al., 2013) With North Macedonia's urban and rural areas experiencing varying crime patterns, GIS could enable police to tailor interventions to specific regions, such as targeting high-crime neighborhoods in Skopje or addressing rural property crimes. For example, GIS could integrate socioeconomic data to correlate poverty or unemployment rates with theft or vandalism, providing deeper insights into crime drivers.

The limited use of GIS in North Macedonia stems from several challenges. First, the lack of standardized, structured data—such as text-based MIA bulletins—complicates data integration and requires advanced processing techniques like natural language processing (NLP). Second, police agencies often lack access to sophisticated GIS software, such as ArcGIS or IBM i2, and the hardware to support it. Third, there is a shortage of personnel trained in GIS applications, with 80% of surveyed MIA employees unfamiliar with GIS-based crime mapping tools. Finally, organizational silos hinder data sharing between police units and other institutions, limiting the ability to create comprehensive GIS datasets.

Despite these challenges, the potential for GIS expansion in North Macedonia is promising. Wider adoption could transform policing by enabling real-time crime monitoring, predictive policing models, and optimized patrol routes. For instance, GIS could help allocate police resources during peak crime periods, such as weekends or summer months, when crime rates are higher. Additionally, integrating crowdsourced data, as seen in projects like "React! Be Safe," could engage communities in crime prevention efforts. To realize this potential, investments in training programs, modern GIS software, and data standardization are essential. Collaboration with academic institutions and international partners could further support the development of GIS expertise, positioning North Macedonia's police services to leverage spatial analysis for enhanced public safety.

3.1. Application of GIS in Police Agencies

GIS is used to:

- **Crime monitoring** : Identifying hotspots and trends.
- **Data analysis** : Linking criminal events to socioeconomic factors.(Eman et al., 2013)
- **Visualization** : Creating maps to inform police officers and the public.
- **Operations Planning** : Coordination of patrols, surveillance and investigative activities.

3.1.1 Mapping Techniques

- **Single symbol mapping** : Marking the locations of criminal events with a single symbol. (Boba, 2005)
- **Buffers** : Analysis of areas around certain locations.
- **Graduated Mapping** : Using different colors or sizes to show the intensity of crime.
- **Density mapping** : Visualization of the concentration of criminal events.
- **Interactive Mapping** : Allowing users to filter data by city, crime type, or date.

3.1.2 Limitations

The crime mapping system in Macedonia faces challenges, including:

- **Unstructured data** : Ministry of Interior bulletins are in text format, which requires complex processing. (Temelkovski et al., 2012)
- **Limited accuracy** : NLP methods can miss events or make geocoding errors.
- **Limited coverage** : The system does not include all criminal events, but only those published in the bulletins.

4. Empirical Research

The empirical research conducted within the framework of this paper includes a survey of 10 employees of the Ministry of Interior of the Republic of North Macedonia. The survey was conducted via Google Forms and examined attitudes towards the use of GIS in police activities.

4.1. Results

The conducted research included examining the opinions and attitudes of employees in police agencies in the Republic of Macedonia on the possibilities of using GIS in their analytical and prognostic work. The data were collected using a questionnaire created on the GSuite platform, i.e. in the form of a Google Forms form. The questionnaire was distributed electronically to 10 employees of the Ministry of Internal Affairs.

The majority of respondents (90%) responded that they use analytical methods and tools in their daily work. Among the basic methods used by the respondents are: induction and deduction methods, analysis and synthesis, abstraction and generalization, comparative methods, statistical methods, content analysis method, SWOT analysis, hypothetical approach, simulation method, etc. On the other hand, some of the techniques and tools used by the respondents: combining numerical and letter strings, as well as other mathematical techniques, experiment, Excel and Access programs, tracking tools and individual tools of Interpol and Europol.

The majority of respondents (90%) are satisfied with the results obtained in the work with the tools used. On the other hand, the lack of specific tools in the segment of analysis and assessment of threats and other security analyses, legal software, but also education on new approaches in data processing (especially in relation to databases, as well as the use of more complex statistical-analytical operations and formulas) was highlighted. Tools that could contribute to the improvement of work activities according to the respondents are analytical IBM i2 software as well as GIS.

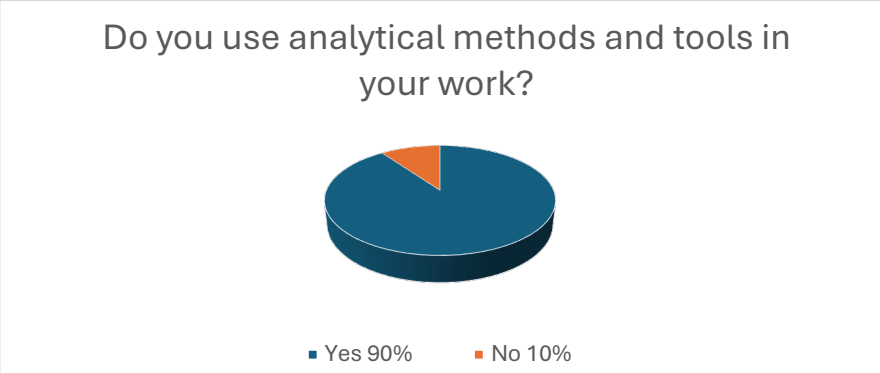

Chart No. 1. Use of analytical methods and tools in the work of police agencies in the Republic of Macedonia

When it comes to familiarity with analytical tools based on the GIS platform that can be used in crime cartography, 80% of respondents responded that they are not familiar with them. The remaining 20% of respondents who responded affirmatively point out that they are tools for visualization, search, geocoding, partial organization, IBM i2 and ArcGIS - Esri.

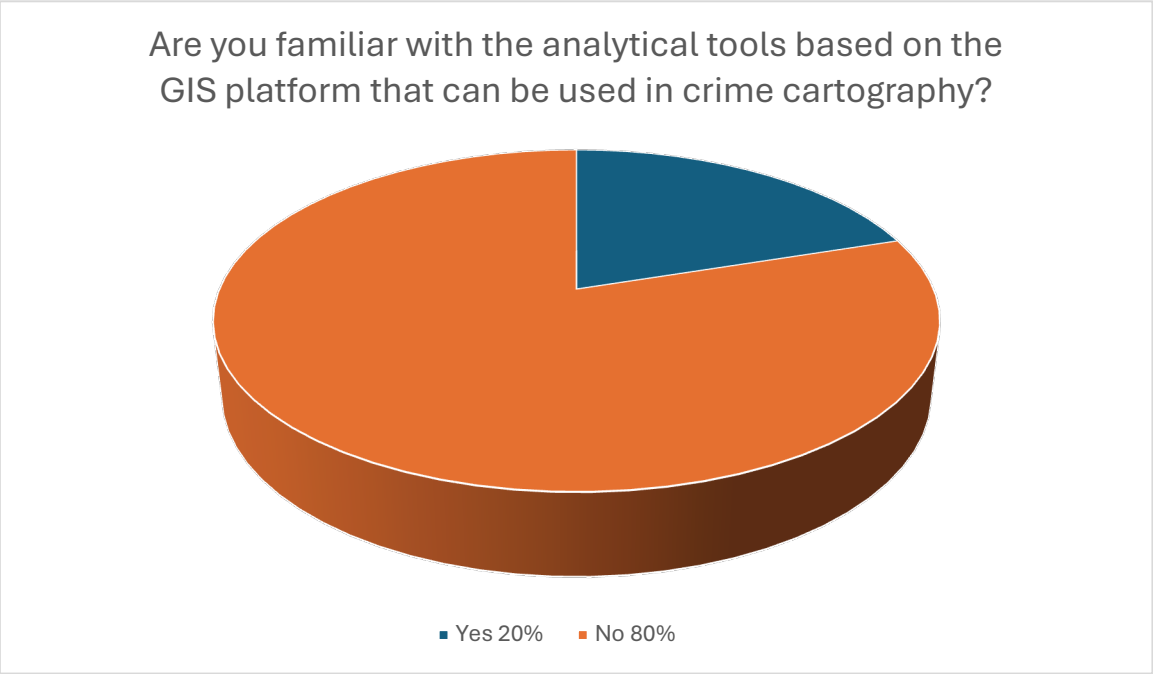

Chart 2. Introduction to analytical tools based on the GIS platform

67% of respondents agree with the statement that crime cartography helps in the management of crime services in decision-making, while the remaining 33% of respondents disagree. On the other hand, 78% of respondents agree with the statement that crime cartography helps in formulating better quality control strategies, and the remaining % of respondents are neutral in their response.

With the claims that crime cartography improves tactical analyses in terms of predicting the movement of criminal groups or helps in geographic profiling to enable clearer statistical analyses to uncover the causes of crime, 33% of respondents completely agree, 56% agree, while the remaining 11% are neutral.

Furthermore, respondents were asked to rate the quality of the conditions for establishing and operating a criminal cartography in their service, according to the basic components of GIS: hardware, software, data, methods and personnel. When it comes to hardware and software, 67% of respondents rated the quality of the conditions for their establishment and operation as average, 11% worse than average, and 22% much worse than average. Methods and personnel were rated by 89% of respondents as average, while 11% of respondents rated them worse than average.

The data was rated average by 89% of respondents, and better than average by 11% of respondents. Citing some of the most important areas of GIS use, such as crime monitoring, crime data analysis, their interconnection, and visual presentation, respondents were asked to indicate whether or how often they perform these functions and apply them in their work.

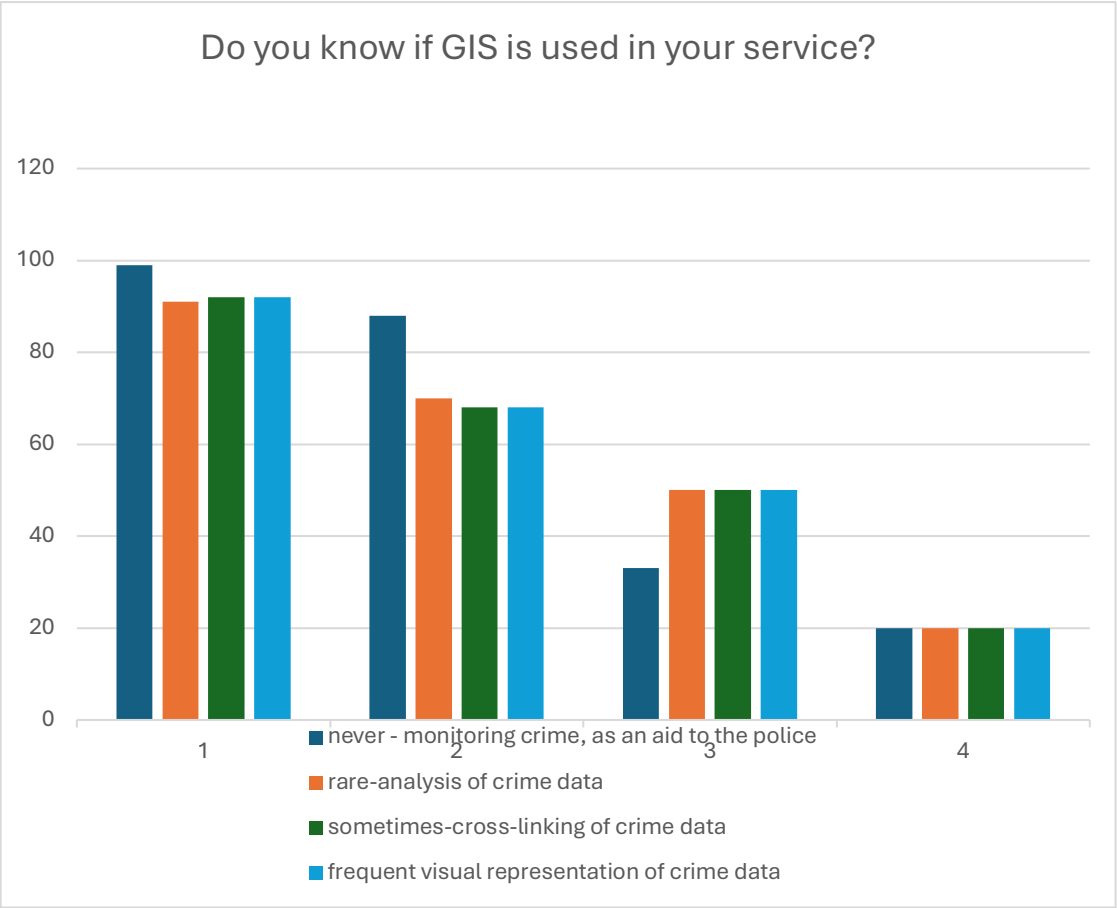

Chart 3. Areas of use of GIS in the work of law enforcement agencies in the Republic of Macedonia

56% of respondents indicated that GIS is never used for crime monitoring, with 22% of respondents rarely and 11% of respondents saying sometimes. 56% of respondents said that GIS should never be used for crime data analysis, 11% said that they rarely use it. When it comes to the use of GIS for visual presentation of crime data, 63% of respondents said that GIS is never used for these purposes, 13% of respondents said rarely, and 25% of respondents said sometimes.

Finally, respondents rated the importance of GIS in the following areas: monitoring, controlling, analyzing and investigating crime, tracking criminal networks, patrolling and other scene activities. 33% of respondents completely agree that GIS is important for crime monitoring, 50% agree, while 17% of respondents neither agree nor disagree with the statement.

Furthermore, 17% of respondents completely agree that GIS is significantly used for crime control, 67% agree, while 17% neither agree nor disagree with the statement, 33% of respondents completely agree that GIS is significant in analyzing and researching crime, 50% of respondents agree, while 17% of respondents neither agree nor disagree. The use of GIS for monitoring criminal networks is completely significant for 33.3% of respondents, 33.3% of respondents consider it significant, and the same number of respondents neither agree nor disagree with the statement. When it comes to the significance of GIS for patrolling and other scene activities, 50% of respondents completely agree with the given statement, 33% agree, and 17% neither agree nor disagree.

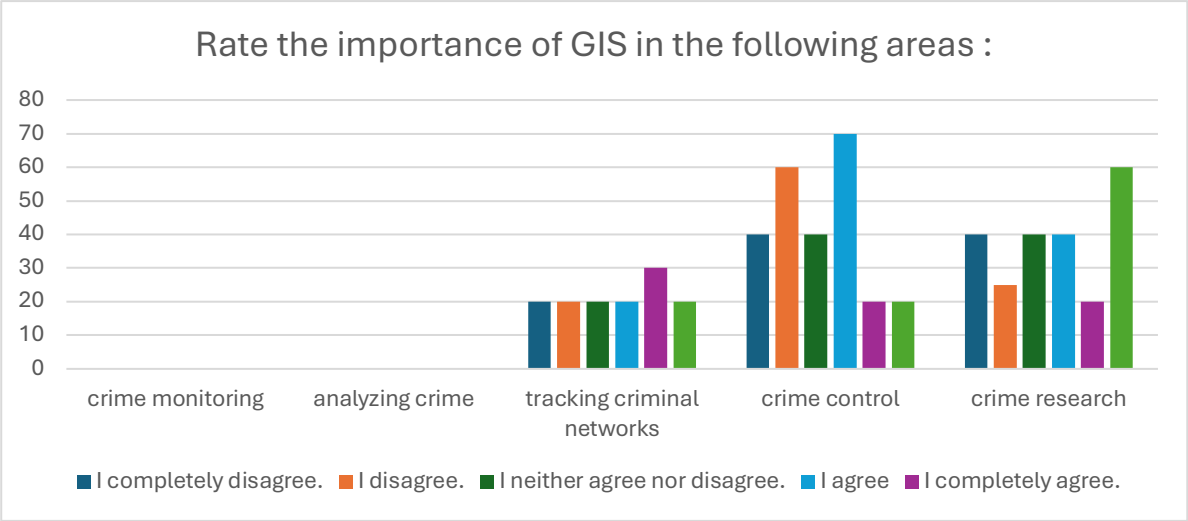

Chart 4. The importance of GIS in the work of law enforcement agencies

4.2 Concluding observations after the empirical research

As a relatively new research tool in crime prevention and suppression, GIS is today an inevitable factor of any policy in the fight against crime. Its development is far from complete. However, the techniques that have been developed and applied within this scientific discipline have significantly improved the work of modern security services. When it comes to P.S.Macedonia, according to available sources, GIS is widely used in a number of areas such as cartography, spatial planning, water and electricity infrastructure, etc. When it comes to law enforcement agencies, unfortunately, this is not the case.

The results of the survey indicate that law enforcement agencies use only basic analytical methods and tools in their daily work. Although respondents are satisfied with the results obtained in their work, there is a lack of specific, interchangeable tools in the segment of threat analysis and assessment and other security analyses, as well as specialized legal software and of course efforts to suppress restrictions and fight crime.

Although the respondents are familiar with all the advantages of crime cartography, 8 out of 10 respondents are not familiar with the analytical tools used for these purposes and are based on a GIS platform. In their opinion, the conditions for establishing and operating crime cartography in police agencies, according to the quality of the basic components of GIS hardware, software, methods and personnel, are average and below average, while according to the quality of the available data, they are average and better than average. Some of the most important functions of GIS, such as crime monitoring, crime data analysis, their interconnection and visual representation, are never or rarely used in police services in the RSM. On the other hand, the respondents almost equally emphasize the importance of GIS in the areas of monitoring, control, analysis and research of crime, monitoring criminal networks, patrolling and other scene activities.

From the presented data, numerous advantages of using GIS platforms are visible. Also, from them, possible future directions for using such platforms in the RSM are clearly visible. The results of the research showed that law enforcement agencies have high-quality data, but do not have more sophisticated dedicated software and educational programs that would contribute to making timely and appropriate conclusions. In addition, the current complex structure of the police organization in the RSM potentially complicates the coordinated approach to implementing this type of system in the work of police agencies, both procedurally and from the aspect of possible incompatibility of data exchange between different agencies. In this sense, if these systems are used, it is necessary to take into account

that the applications that will be used are mutually compatible. In the future, existing procedures should be adapted to the use of GIS and by-laws that regulate the manner of processing, use and storage of data.

5. Recommendations for Future Directions

Based on the analysis and empirical findings, the following recommendations are proposed:

1. **Invest in training** : Police officers should be trained in the use of GIS and other analytical tools.
2. **Software Development** : Introduction of specialized platforms, such as ArcGIS and IBM i2, for crime mapping and analysis.
3. **Data Improvement** : Standardization and structuring of police bulletins for easier processing.
4. **Agency Integration** : Enhanced coordination between different police units and institutions for data exchange.
5. **Public engagement** : Expanding initiatives like "Respond! Be Safe" to involve citizens in crime prevention.

Conclusion

Crime mapping, bolstered by Geographic Information Systems (GIS), represents a transformative approach to analyzing and combating criminal activity in the Republic of North Macedonia. As outlined in this paper, crime is not a random phenomenon but is influenced by psychological, social, economic, and temporal factors that manifest in discernible spatial patterns. By leveraging GIS, law enforcement agencies can visualize crime hotspots, track trends, and predict future criminal activity, thereby enhancing their ability to allocate resources effectively and devise targeted prevention strategies. However, the current application of GIS in North Macedonia's police services is limited, constrained by challenges such as unstructured data, inadequate technological infrastructure, lack of specialized software, and insufficient training. Despite these obstacles, the potential for GIS to revolutionize policing in the country is undeniable, offering a pathway to greater efficiency and community safety.

The empirical research conducted among Ministry of Internal Affairs (MIA) employees underscores both the promise and the limitations of GIS adoption. While 90% of respondents utilize basic analytical methods, 80% are unfamiliar with GIS-based crime mapping tools, and the majority report that GIS is rarely or never used for critical functions like crime monitoring, data analysis, or visualization. Yet, there is a strong recognition of GIS's importance, with over 80% of respondents acknowledging its value in monitoring, controlling, analyzing, and patrolling. This dichotomy highlights a critical gap between awareness of GIS's potential and its practical implementation, driven by organizational complexities and resource constraints. The "Crime Map of Macedonia" project, which processes MIA bulletins to create interactive crime maps, serves as a promising example of GIS application, but its reliance on text-based, unstructured data and limited coverage underscores the need for systemic improvements.

To unlock the full potential of GIS, North Macedonia must prioritize investments in training, software, and data standardization. Training programs can equip officers with the skills to use platforms like ArcGIS and IBM i2, while standardized data formats can streamline processing and integration. Enhanced inter-agency coordination is also essential to facilitate data sharing and overcome organizational silos. Initiatives like "React! Be Safe," which engage citizens through crowdsourcing, demonstrate the value of public participation in crime prevention, suggesting a model for future community-driven efforts. By addressing these challenges, North Macedonia can build a robust GIS framework that supports predictive policing, optimizes resource allocation, and fosters transparency.

Ultimately, the integration of GIS into North Macedonia's policing strategies aligns with global trends toward data-driven law enforcement.(Eman et al., 2013) Open data initiatives, such as the "Crime Map of Macedonia," exemplify how transparency and collaboration with citizens can strengthen trust and efficacy in crime suppression.(Temelkovski et al., 2012) With sustained commitment to technological advancement and capacity building, North Macedonia's police services can harness GIS to not only combat crime more effectively but also contribute to a safer, more resilient society. The path forward requires overcoming current limitations, but the rewards—improved public safety and enhanced police performance—are well within reach.

Bibliography

Aleksić, Ž. (1983). Kriminalistika. Belgrade: Privredna štampa.

Boba, R. (2005). Crime analysis and crime mapping: An introduction. Thousand Oaks, CA: SAGE Publications.

Eman, K., Györkös, J., Lukman, K., & Meško, G. (2013). Crime mapping for the purpose of policing in Slovenia: Recent developments. Revija za kriminalistiko in kriminologijo, 64(3), 287–301.

Mališ Sazdovska, M. (2005). Priracnik za razuznavacki ciklus. Skopje: Jofisken.

Temelkovski, D., Jovanovik, M., Mishkovski, I., & Trajanov, D. (2012). Towards open data in Macedonia: Crime map based on Ministry of Internal Affairs' bulletins. In Proceedings of the 9th Conference for Informatics and Information Technology (CIIT 2012) (pp. 123–128). Bitola, Macedonia.