WHEN EVERY SECOND COUNTS – AI AND TECHNOLOGY IN EMERGENCY CALL MANAGEMENT

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ABSTRACT

This article examines the evolution of Romania's 112 Emergency Call system, focusing on the integration of advanced technologies, including artificial intelligence (AI). Utilizing Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) -based analysis, this study systematically reviews key advancements in emergency response systems, emphasizing technologies like Advanced Mobile Location (AML), E-call systems, and wearables that enhance response accuracy and speed. It also investigates the evolution and integration of advanced technologies within Romania's 112 Emergency Call System, emphasizing the role of artificial intelligence (AI) in emergency management. Utilizing the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) methodology, this research systematically examines advancements such as Advanced Mobile Location (AML), E-Call systems, and wearables, which enhance response accuracy and speed. AI-driven innovations like real-time data analytics and automated resource allocation significantly improve incident classification and inter-agency communication. Under the framework of Next Generation 112 (NG112), these technologies support decision-making processes, streamline operations, and complement human expertise. Furthermore, the research identifies Privacy-Enhancing Technologies (PETs) as essential in safeguarding sensitive data during AI integration, including homomorphic encryption and privacy-preserving machine learning.

It invites the international community to engage in advancing emergency response systems by leveraging innovative technologies while ensuring ethical considerations and data security. The research concludes that Romania's 112 system exemplifies a progressive approach to managing emergency call systems, offering valuable insights into the potential for global adoption of similar practices.

KEYWORDS:

emergency management, artificial intelligence, technologies, high-stress environments, innovation.

DOI: 10.24818/IMC/2024/04.07

1. INTRODUCTION

At some point in our lives, each of us may need to contact the unique emergency number 112. Whether for ourselves, our loved ones, or others, we will use this service to request aid regarding property, the environment, or personal safety. In critical circumstances, time takes on different meanings, and the seconds or minutes during the processing of our call can seem like hours.

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Because an emergency call is based on an urgent need for help, the human factors involved, the caller – 112 operator-dispatches, are facing different level of psychological evolvement. In the efficiency of the call management, Fele (2023) highlights the need of understanding the psychological dynamics at play can lead to better training programs that prepare call operators and responders to handle high-stress situations effectively.

Another key role in the emergency call management effectiveness is technology. Pine (2007) spotlights the fact that while technology is a critical enabler of improved emergency response, its successful integration into existing frameworks relies heavily on the interplay between human and technical infrastructures.

During an emergency call, the person in need provides the 112 operators with confidential information according to his or her emergency and all this information must be protected. Lemieux and Werner (2023) point out that living in an era of AI technology development, this will slowly enter the emergency call processing system, and we must ensure data protection even in this new era of technology. They also mention Privacy-Enhancing Technologies (PETs) such as homomorphic encryption, secure multi-party computation, and trusted execution environments as potentially useful for protecting personally identifiable information when using AI tools to analyse archival documents. They also highlight the potential of privacy-preserving machine learning techniques for training AI models on sensitive data without compromising privacy.

The process of resolving a signalled emergency in 112 system beside technology is based on the human factors. The team involved in the emergency management needs to be guided.

Waugh (2022) emphasizes that leadership in emergency management involves not only the ability to make quick decisions but also the capacity to inspire and coordinate diverse teams under pressure. He also underlines the importance of adaptive leadership in emergency management, which involves being flexible and responsive to changing circumstances.

We considered to write this article because we wanted to provide a systematic review of the evolution of Romanian 112 emergency call system management approaching the regulations, technology, AI and leadership.

2. METHODOLOGY

We used Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) (Page at al., 2021) motivated by its ability to enhance transparency, enable thorough literature synthesis, address biases, and adopt a multidisciplinary perspective—factors that are particularly important for informed decision-making in the evolving emergency services landscape.

Based on the PRISMA framework (Page et al., 2021), we used the following steps to conduct our literature review: we first established our two research questions, then we defined six inclusion and four exclusion criteria. Then we clarified our search strategies. We explained our literature review findings and organized them in Table 1. We transformed the results of our search strategy into four tables based on the words we used as search terms. We also made a summary of our findings before each table we used in the results section. In the discussion section we analyzed our findings and answered the research questions.

Research Questions

This research aims to investigate the following key research questions:

Question 1: How has the Romanian 112-emergency system technology changed since its beginning?

Question 2: How has the innovative leadership influenced Romanian 112-emergency system technological advancement?

Inclusion criteria

The literature and statistics review included the following criteria:
Criterion 1: Studies, articles, website data /statistics between 2020-2024
Criterion 2: Studies, articles, statistics written in English, Romanian.
Criterion 3: Full text available
Criterion 4: Emergency calls technologies development Romania
Criterion 5: AI in emergency call management Romania
Criterion 6: Innovative leadership in emergency call management Romania

Exclusion criteria

The literature and statistics review excluded by the following reasons:
Reason 1: Irrelevant Focus
Reason 2: Lack of AI Discussion
Reason 3: Absence of Leadership Analysis
Reason 4: Duplicated Works

Search Strategy

In this research, the Google Scholar and ResearchGate databases were used to identify the articles. The *set of search terms* were emergency call Romania, location technology in emergency call management Romania, AI emergency call management Romania, innovative leadership in emergency call system. Because we didn't find to many articles according our search criteria, we extended our search to websites, such as: www.sts.ro, www.eena.org, www.portal.just.ro

Our first search was on Google Scholar, which is a free search engine that lets you look at articles based on factors, such as year and importance, and then sends you to the sites where you can get the article you found. We also used ResearchGate, which lets you read or download the article for free. As we presented in Table 1, after we applied the 6 criteria based on the search terms emergency call Romania, location technology in emergency call management Romania, AI emergency call management Romania, innovative leadership in emergency call system, we found 117 articles in the mentioned database. After we applied the exclusion reasons 1,2,3,4, we excluded 111 articles, such as follows: 6 articles because R4 duplicated works, 105 articles because R1,2,3: not relevant for Romanian emergency call management 34, lack of AI discussion in the Romanian emergency call management 6, absence of leadership analyze in Romanian emergency call management 33, include focus on unrelated fields or other countries 32. The remaining six articles were included in this review.

After we searched the websites: www.sts.ro, www.eena.org, www.portal.just.ro, for terms: emergency call Romania, location technology in emergency call management Romania, AI emergency call management Romania, innovative leadership in emergency call system, we found 16 relevant articles and regulations and we included all of them in our research.

Table 1 Systematic review, identification of studies via databases and websites

Phase	Number of items analyzed	Comments on items removed
Identification	Records identified from: Google Scholar n=117 Website data/statistics n=16 www.sts.ro n=9 www.eena.org n=4 www.legisltie.just.ro n=3	Records removed *before screening*: From Google Scholar and ResearchGate Reason 4 (n = 6) duplicated Website article removed. (n=0)
Selection	Analyzed Studies (n = 117) Analyzed website data/statistics. (n=16)	Excluded Records From Google Scholar and ResearchGate Reasons 1,2,3 (n=111) Website article removed. (n=0)

Phase	Number of items analyzed	Comments on items removed
Eligibility	Studies evaluated for inclusion. (n = 6) Website data/statistics (n=16)	Exclusions after full text analysis: (n=0) Non relevant for this review Website article removed. (n=0)
Included	Studies included in review. (n = 6) Website data/statistics (n=16)	

Source: Authors' elaboration adapted from PRISMA flow diagram (Page et al., 2021)

3. RESULTS

Based on search parameters, we built four tables from database and website content. The tables contain: number, database, website, title, summary, and research, legislation, or technological phase. In 2020–2024 period, the Romanian emergency number got unexpectedly little research.

Each table starts with the articles which directly address the Romanian emergency call management between 2020 and 2024. We tried to group the retrieved website information into chronological order to see the evolution or the development of the search terms used in our search.

Table 2 includes our findings due to the search terms - emergency call management Romania. We found only one research made by Bărănescu et al. (2021) which analyze the abusive calls in Romanian emergency call system. Searching on the websites, we found nine other useful information according to our terms. Two documents were found on the www.portal.just.ro website, and they are providing information about regulations: Government Emergency Ordinance no. 34/2008 regarding the organization and functioning of the Single National Emergency Call System, also known as SNUAU and Government Decision No. 682/2009 on the National Committee for Emergency Calls, emitted by (GR, 2008; GR, 2009). The first one establishes the legal framework for the 112-emergency service in Romania and the second one approves the regulations for how Romania's National Committee for coordinating the Single National Emergency Call System (SNUAU) is organized and how it operates. The third document we found on the www.eena.org website, positions Romania among the countries that offer "multilingual support" in emergency call management (EENA, 2021b). Each emergency call received in the 112 system is considered a real emergency. The other six pieces of information we extracted from the www.sts.ro website. 112 call operators process the emergency call according to well defined requirements based on Cooperation Methodology (STS, 2020b), Incident Index (STS, 2020a) and Regulation (STS, 2020c). We also found the flow of a call to Romanian 112 emergency number, and a short review about the type of emergency calls, based on different technology, received such as: voice call, sms113, E-call, VoWifi call (STS, 2022).

Besides the emergency call management framework, we found on the www.sts.ro website, the importance of confidential data management. Our last finding, according to the search terms, provides statistical data analysis for the last twenty years of 112 emergency call existence. According to this, Romanian 112 operators managed over three hundred million emergency calls in the last twenty years (STS, 2024c).

Table 2 Search terms: Emergency call management Romania

No.	Database/ website	Title	Summary
1	Google Scholar	Analysis of Abusive 112 Emergency Calls in Romania. (Bărănescu et al., 2021)	The report highlights a critical emergency response issue. The authors say 112-emergency system abuse costs resources and hinders response. Reports classify abusive calls as prank calls, non-emergency requests, and system misuse. EMS operators face unique challenges in each category. Prank calls and non-emergency inquiries might cause communication congestion and delay emergency responses. Knowing abusive call patterns and intents is crucial to creating effective responses, say the authors. Romania must manage abusive 112-emergency calls, according to the study. Technology and targeted methods can assist emergency services improve operating efficiency and allocate resources to actual crises, boosting public safety.
2	www.legislatie.just.ro	Government Emergency Ordinance no. 34/2008 regarding the organization and functioning of the Single National Emergency Call System, (GR, 2008)	The regulation governs Romania's 112-emergency services organization, operations, technology, finance, and monitoring. It creates the SNUAU, specifies institution functions, and establishes the National Committee for Coordination. It covers phone handling, emergency protocols, and data management. It also describes the system's technological architecture, finance, and performance monitoring and assessment.
3	www.legislatie.just.ro	Government Decision No. 682/2009 Emergency Calls (GR, 2009)	Organizational and operational instructions from the National Committee for Coordinating the Single National Emergency Call System (SNUAU) and its Permanent Technical Secretariat are adopted. It manages Romania's 112 system.
4	www.eena.org	Multilingual 112 calls (EENA, 2021b)	This document discusses European emergency services' multilingual assistance difficulties and best practices. To increase non-native speaker results and access, emergency language barriers must be addressed. Romanian PSAPs can transfer Hungarian and Italian emergencies to neighbours. They accept English, French, German, Spanish (transfers), and Russian calls. Emergency calls are their main priority.
5	www.sts.ro	Methodology on the cooperation of specialized response agencies (STS, 2020b)	Provides emergency collaboration protocols for Romanian agencies using the 112-emergency call system. Police, medical, and other specialist intervention organizations coordinate their 112 emergency responses. The technique requires 112 operators to detect, categorize, and document emergencies and transmit calls to the proper dispatch PSAP based on an event index.

No.	Database/ website	Title	Summary
6	www.sts.ro	Incident Index (STS, 2020a)	Based on the caller's details, 112 operators classify the situation using the incident index and transmit it to the appropriate agency's dispatch center. This simplifies emergency response and agency collaboration.
7	www.sts.ro	Regulations for the operation of calls received at the emergency number (STS, 2020c)	The paper describes Romanian emergency call procedures. It emphasises 112 operators' conduct and caller contact. The regulations outline how to assess call urgency, obtain vital information, and transfer calls to relevant entities. Non-emergency calls and effective communication are also covered. This operational guide ensures effective and uniform emergency call management.
8	www.sts.ro	About the 112-emergency service (STS, 2022)	The 112-emergency service in Romania facilitates the handling of emergency calls from citizens and their transfer to specialized response agencies, ensuring a prompt and coordinated response to emergencies. Managed by the Special Telecommunications Service (STS) through the Single National Emergency Call System (SNUAU), this system includes emergency call PSAP's and integrated dispatch centers at the county level, including a dedicated center for Bucharest and Ilfov. The 112 number is accessible nationwide from all public telephone networks and operates 24/7, with STS operators conducting initial interviews and directing calls to the appropriate agencies based on the nature of the emergency. The service is equipped to respond in various international and national minority languages.
9	www.sts.ro	Calls and communications to the 112-emergency service (STS, 2024b)	Romanian 112-emergency sends citizen emergencies to specialist response agencies for timely and coordinated action. STS runs the Single National Emergency Call System (SNUAU), which comprises Bucharest and Ilfov county-level PSAPs and integrated dispatch centers. All public telephone networks have a 24/7 112 line where STS operators interview calls and direct them to the appropriate authorities. Global and national minority languages are served.
10	www.sts.ro	112, for 20 years in Romania (STS, 2024c)	Since 2004, the Romanian 112-emergency line has received about 300 million calls, enhancing emergency alerts. Using 112 instead of 955, 961, and 981 simplified crisis response, lowering non-emergency calls from 90% in 2004 to 50% presently. STS operators answered 10,489,979 calls in 2023, 53.82% of which were emergencies, up from 57.82% in 2022 and 59.27% in 2021. 46.18% of 2023 calls did not need ambulance, police, or fire.

Source: Authors' elaboration

In the third table, we grouped our findings based on the search terms - location technology in emergency call management Romania. Due to our research criteria, we were able to find only one article that examines advancements in driver monitoring systems, particularly for E-Call connected and autonomous vehicles, in response to the rising number of traffic accidents (Minea et al., 2021). We also found an emergency call location and technology review on the www.sts.ro website, from the basic Cell-ID location to the most precise ones -AML, Call 112 App, Geolocation (STS, 2024d). When we searched about location technology in emergency call management, on the www.eena.org website, Romania was mentioned as the 25th country in the world to implement Advanced Mobile Location (AML) for emergencies (EENA, 2020). Our search also revealed mentions about next generation technology in 112 emergency call management on the www.sts.ro website, promising faster, more precise, and accessible services to better meet public needs and enhance safety (STS, 2024e). The www.eena.org website, next generation 112 technology was mentioned in providing a brief overview of NG112 projects across Europe, citing examples like North Macedonia, Switzerland, Austria, and Romania (STS, 2024e). We also found a new Romanian legal framework on the www.portal.just.ro website, a Government Decision which refers to adjustments by which measures will be implemented that will ensure an increase in the accuracy of the location of calls made to the Emergency Service 112. This new type of location with increased accuracy will only be provided during the management of an emergency and will be able to be carried out independently of the type of mobile phone used, including those in older technologies, and the location determination areas will be restricted by up to 25 times in some cases (GR, 2023).

Table 3 Search terms: Location technology in emergency call management Romania

No.	Database/Website	Title/phase	Summary
11	Google Scholar	Advanced e-Call Support Based on Non-Intrusive Driver Condition Monitoring for Connected and Autonomous Vehicles (Minea et al., 2021) / Project phase	As traffic accidents occur, networked and autonomous car driver condition monitoring systems develop. EEG and ECG sensors scan drivers' physiological signals in real time, turning automobiles into mobile sensors that monitor health and emotions, improving safety. Without driving interruption, capacitive ECG sensors detect fatigue and inattention-related brain wave activity. The study suggests engaging drivers with physiological monitoring, emotional evaluations, and facial recognition.
12	www.sts.ro	Emergency call's location (STS, 2024d) / Implemented phase	Romania's 112 emergency service uses numerous technologies to find callers: Cell-ID, AML, Geolocation, Call 112 App For higher accuracy, AML leverages the phone's GPS and other location services but needs internet or SMS. 112 Mobile App: When the app is active, 112 operators get location data. Callers can read app coordinates. Operator 112 SMS geolocation. Giving 112 operators location information speeds emergency response.

13	www.sts.ro	The future technologies used in emergency calls handling (STS, 2024e) / Project phase	Next Generation 112 revolutionizes emergency calling by leveraging technology to improve response efficiency and effectiveness. It offers a more inclusive and comprehensive communication platform for all citizens, especially those with disabilities. Key improvements include: Rich Communication: Real-time text, images, videos, and data enhance emergency assessments and responses. Precise Location: Accurate caller location pinpointing speeds up assistance. Streamlined Call Handling: Prioritized calls through a tiered system minimize delays and missed calls. Fast Agency Coordination: Single button alerts to all relevant agencies improve large-scale incident management. Efficient Resource Allocation: Dispatchers use GIS maps to track resources and responders. Seamless Mobile Access: The PEMEA app ensures location accuracy across geographical boundaries. NG112 prioritizes accessibility with features like Total Conversation for diverse formats and tools for vulnerable populations. Built on a microservices architecture managed by Kubernetes, the system is flexible, resilient, and reliable. NG112 represents a major leap forward in emergency response, promising faster, more precise, and accessible services to better meet public needs and enhance safety.
14	www.legislatie.just.ro	Government Decision no. 48 (GR, 2023) / In implementation phase	Government Decisions aim to enhance Emergency Service 112 call location accuracy. This new, more accurate location will only be offered during emergency management and will be independent of mobile phone type, including older technology. Location determination zones may be reduced by twenty-five times.
15	www.eena.org	Advanced Mobile Location deployed in Romania (EENA, 2020) / implemented phase	In 2020 Romania is the 25th country in the world to implement Advanced Mobile Location (AML) for emergencies.
16	www.eena.org	NG112 implementation in Europe – Demystifying the ESInet and Next Generation Core Service (EENA, 2024) / In implementation phase	The article explains the transition to Next Generation 112 in Europe. NG112 uses an IP-based network called the ESInet and Next Generation Core Services to manage emergency calls. It also provides a brief overview of NG112 projects across Europe, citing examples like North Macedonia, Switzerland, Austria, and Romania.

Source: Authors' elaboration

The fourth table includes our findings based on the search terms - AI in emergency call management Romania. The first two articles refer to AI project research, both are in the experimental phase. The first article presents an interactive voice response system designed to improve the efficiency of Romania's 112 emergency services and argues that this IVR system can significantly reduce operator workload, prioritize critical calls, and improve overall response times (Mocanu et al., 2022). The second article describes the system, called ODIN112, uses speech recognition and natural language processing to analyze emergency calls, assisting human operators by filtering non-emergency calls, identifying keywords and critical information, and providing real-time contextual suggestions. The system aims to improve response times, reduce operator workload, and save lives by enabling faster and more informed decision-making in emergency situations (Ungureanu et al., 2023). During our search, we found an article that explores the potential benefits and challenges of integrating AI into Romanian public services. It discusses how AI can improve efficiency, reduce costs, and enhance citizen interaction in various sectors like healthcare, transportation, and social security. The author emphasizes the need for careful consideration of potential challenges, including data security, transparency, and the digital divide. Voinea (2023) suggests addressing these challenges through robust data protection measures, clear ethical guidelines, and public awareness campaigns to ensure responsible and equitable AI adoption in Romania.

Table 4 Search terms: AI in emergency call management Romania

No.	Database/ Website	Title/Phase	Summary
17	Google Scholar	ODIN IVR-Interactive Solution for Emergency Calls Handling (Mocanu et al., 2022) / Project phase	Gives Romania's 112 emergency services an interactive voice response system to improve efficiency. The ODIN112 IVR automates caller interaction for high call volumes, notably during crises. Emergency calls are prioritized using pre-recorded questions and decision-tree logic. Web and phone-based proof-of-concepts were contrasted. Telephones fit the infrastructure; thus, they were chosen. The report argues that IVR system may reduce operator workload, prioritize important calls, and accelerate response times.
18	Google Scholar	ODIN112–AI-Assisted Emergency Services in Romania (Ungureanu et al., 2023) / Project phase	AI enhances Romania's 112 emergency response. The speech recognition and natural language processing technology ODIN112 lets operators filter non-emergency calls, locate keywords and relevant information, and deliver real-time contextual support. To address limited Romanian language resources, the research produced a large Romanian speech dataset for AI models. The technology makes emergency judgments faster and smarter, improving reaction times, operator effort, and lifesaving.
19	Google Scholar	The Impact of Artificial Intelligence on Public Services in Romania (Voinea, 2023) / Review phase	Compares Romanian public service AI pros and disadvantages. AI increases efficiency, lowers costs, and engages individuals in healthcare, transportation, and social security. Addressing citizen chatbots, automated payments, and sickness monitoring using AI. Technology dependence, transparency, and data

			security are emphasized. The article is optimistic about AI improving Romanian public services but emphasizes ethics and planning. The digital divide, data security, and openness were stressed. The author suggests robust data protection, clear ethical guidelines, and public awareness for responsible and equitable AI implementation in Romania.

Source: Authors' elaboration

The fifth table includes our findings based on the search terms - innovative leadership in emergency call management Romania. We found only one research which approached our search. Tabarcia et al. (2023) analyzed the connection between online training and improved performance assessment for Romanian emergency call centre employees. They advocate for a more data-driven approach to knowledge management practices within these emergency services, moving away from reliance on intuition and experience. We also found the Quality Certification Program for PSAPs, on the www.eena.org website. This certification aims to standardize and improve various aspects of PSAP operations, such as: call handling, resource management, and technology utilization. These improvements naturally lead to increased efficiency in emergency response (ENNA, 2021a). The last finding, based on then search terms, was on the www.sts.ro website: Performance indicators regarding the operation of the Emergency Service 112 for the period 2018-2023 (STS, 2024a).

Table 5 Search terms: Innovative leadership in emergency call system Romania

No.	Database/ Website	Title/Phase	Summary
20	Google Scholar	Knowledge management and assessment of the online learning system of Romanian emergency call center employees. (Tabarcia et al., 2023) / Implemented phase	The paper analyzes how online training improves Romanian emergency call center performance assessment. Initial and continuous training for these operators, with a focus on online learning, is stressed in the study. Online training improves evaluation results, suggesting further online training for these personnel. Online compliance training is ideal, although new hires are often trained in specialist facilities, according to the article. The authors recommend data-driven knowledge management in emergency services instead of intuition and experience.
21	www.eena.org	EENA's Quality Certification Program for PSAPs (EENA, 2021a) / Implemented phase	The EENA Quality Certification Programme for PSAPs emphasises efficiency. The programme standardises and improves PSAP call handling, resource management, and technology use. These enhancements automatically boost emergency response efficiency. Standardized processes may speed up call handling and response times, while resource management helps optimize staff and equipment allocation.

22	www.sts.ro	Performance indicators regarding the operation of the Emergency Service 112 (STS, 2024a) / Implemented phase	It represents an analysis of performance indicators for the period 2018-2023

Source: Authors' elaboration

4. DISCUSSION

As we presented in Table 6, In our research we examined 6 research articles published as follows: 2 in 2021, 1 in 2022, 2 in 2023 and 1 in 2024. According to our search criteria we did not find research-based articles in 2020. 13 articles were retrieved from websites, these were published such as follows: 4 in 2020, 2 in 2021, 1 in 2022, 1 in 2023 and 6 in 2024. We included 2 legal frameworks from 2008-2009 because they are relevant for our research.

Table 6 Articles and information included by year

Type	2008-2009	2020	2021	2022	2023	2024
Database articles	0	0	2	1	2	1
Websites information	2	4	2	1	1	6

Source: Authors' elaboration

According to STS (2022), we grouped the information in the Figure1 and we observed that in this year 2024, Romanian 112-operators can handle four types of calls arrived in SNUAU: voice call, sms113, E-Call and Vo-Wifi calls.

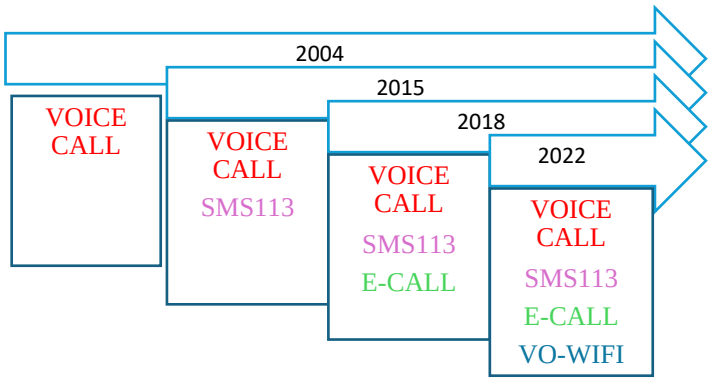

Figure 1 Type of emergency calls, based on the technology used to generate them
Source: Authors' elaboration based on STS (2022)

We found out that in the first year of 2004 more than 90% were non-emergency calls, in 2023 the non-emergency calls were only 46,18%, as we illustrated in Figure 2.

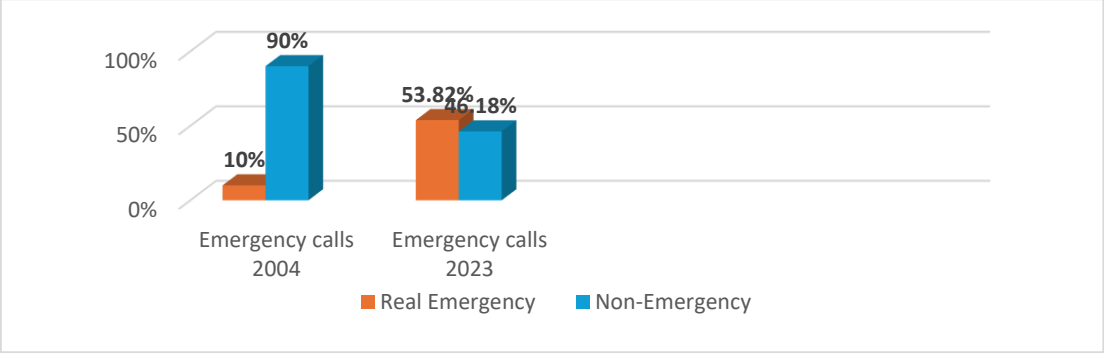

Figure 2 Comparison of emergency calls 2004 and 2023
Source: Authors' elaboration based on STS (2024)

In Figure 3 we grouped the location technology existing in Romanian emergency call system based on STS (2024b).

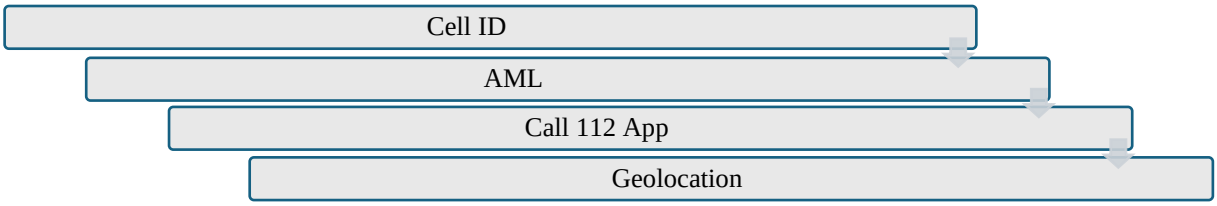

Figure 3 Location technology in Romanian emergency call management
Source: Authors' elaboration based on STS (2024)

The last finding based on then search terms, mentions the "performance indicators regarding the operation of the Emergency Service 112, for the period 2018-2023. The average call response time for Romanian 112-operators is in 2023 is 5,09 seconds, it's 6,91 seconds lower than the recommended EENA response time <12 seconds (STS, 2024b). As we can see in Figure 4, the average call response time for Romanian 112-operators is in 2023 is 5,09 seconds, it's 6,91 seconds lower than the recommended EENA response time <12 seconds. (STS, 2024b).

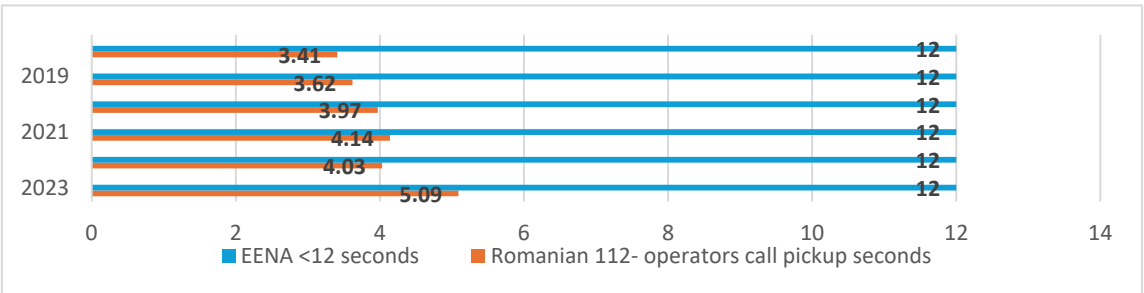

Figure 4 Average call response speed
Source: Authors' elaboration based on STS (2024b)

When we compared the performance indicators aimed at percentage of calls under 20 seconds, the Romanian 112 operators are performing even better than the average time recommended, as we illustrated in Figure 5.

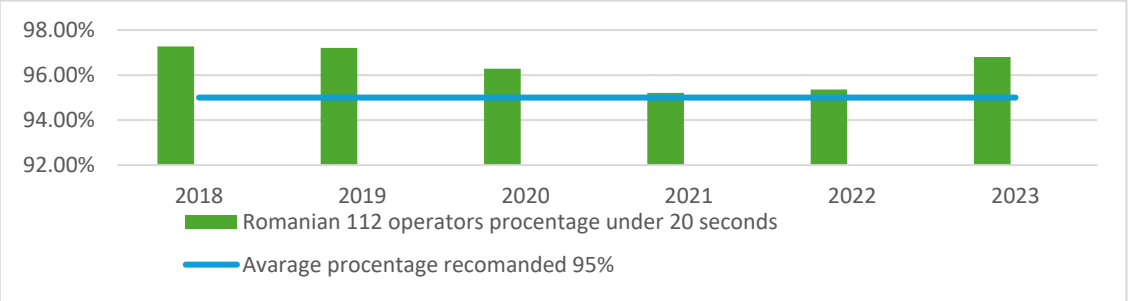

Figure 5 Percentage of emergency calls answered in less than 20 seconds
Source: Authors' elaboration based on STS (2024b)

Based on the analyzed articles and information, our research answers the questions studied as follows:
Question 1: *How has the Romanian 112-emergency system technology changed since its beginning?*
The Romanian 112 emergency system serves as the nation's Single National Emergency Call System (SNUAU), managed by the Special Telecommunications Service (STS), which was formed under Government Emergency Ordinance No. 34/2008 (GR, 2008). According to www.sts.ro website, the system is engineered to deliver a coordinated and efficient emergency response, with call operators managing each emergency call in accordance with established protocols and procedures (STS, 2020c). The legislative foundation for Romania's 112 emergency service is defined by Government Emergency Ordinance No. 34/2008. The National Committee for Emergency Calls oversees the functioning of the Single National Emergency Call System (SNUAU). The organization and operation are governed by Government Decision No. 682/2009 (GR, 2009).
The primary emergency communication systems were basic, relying on fundamental telephone networks. Emergency call management systems have progressively included more advanced location tracking technologies. According to www.sts.ro and www.eena.org websites, the first location information used was a basic one, Cell-ID location, which may identify the precise cell tower from whence a call originated Emergency call management systems have progressively included more advanced location tracking technologies such as AML, implemented in Romania in 2020, improves the precision of caller location. Caller location with mobile apps, Call 112 App and Geolocation technologies (STS, 2024e; EENA, 2020). In 2023, a new Romanian legal framework will improve location accuracy for 112 calls, including on outdated mobile technologies (GR, 2023). Based on our websites findings, such as www.sts.ro and www.eena.org , Next-generation 112 (NG112) technology provides quicker, more precise, and improved accessibility for emergency services. NG112 projects are in North Macedonia, Switzerland, Austria, and Romania (EENA, 2024). The NG112 emergency call management will use several innovative technologies, including video-based emergency reporting, cyber-physical systems integrating sensors, decision support systems, and human responders; AI-driven tools for optimizing emergency call management and dispatch. Emerging technologies present both challenges and opportunities for improving emergency call management (EENA, 2024; STS, 2024).
Question 2: *How has the innovative leadership influenced Romanian 112-emergency system technological advancement?*
We examined the integration of artificial intelligence technologies into Romania's 112 emergency call handling system through two primary initiatives: one involves an interactive voice response (IVR) system designed to enhance efficiency and reduce operator workload (Costel et al., 2022). And the second the ODIN112 system screens non-emergency calls and offers real-time recommendations using speech recognition and natural language processing to assist operators (Ungureanu et al., 2023). These AI initiatives are not used yet in the Romanian 112 emergency system but aim to enhance

efficiency by improving response times, reducing operator stress, and ultimately saving lives. Voinea (2023) enumerates applications of artificial intelligence, including disease surveillance, automated payment processing, and citizen assistance chatbots. The author highlights the necessity for robust data security regulations. To ensure responsible and equitable AI implementation in Romania, the author recommends addressing these concerns through robust data protection regulations, clear ethical standards, and public awareness campaigns.

There is no research based on the selected terms that approach the innovative leadership terms in the Romanian 112 emergency call management. But we found research which analyzes alternative human resource guidance and teaching (Tabarcia et al., 2023). On the www.sts.ro website, we also found that Romanian emergency call has a performance indicator (STS, 2024a).

5. CONCLUSION

The Single National Emergency Call System (SNUAU), or Romanian 112, ensures public safety and fast emergency response nationwide. The Special Telecommunications Service (STS) manages the system, which is governed by Government Emergency Ordinance No. 34/2008 and Government Decision No. 682/2009. Technology for the 112 system has advanced throughout time. After using basic telephone networks, technology now uses Advanced Mobile Location (AML) to improve caller location accuracy. Next-generation 112 (NG112) technology will offer video-based reporting and AI-driven solutions to enhance emergency call handling and response times. While AI integration is still in its infancy, projects like the interactive voice response (IVR) system and the ODIN112 project will improve operational efficiency and minimize operator strain. These advances show how AI may change emergency response, but data security and ethics must be considered. Finally, creative leadership is crucial to the strategic management of the 112 system, but research is few. Development of performance metrics and alternative human resource solutions shows emergency services are committed to continual improvement. We observed a lack of researched based articles about Romanian 112 emergency call management, about the 112-operators performance or innovative leadership-based decisions.

In conclusion, the Romanian 112 emergency system adapts to technical advances and changing social demands to deliver prompt and effective emergency aid to its residents. According to this research, the administrator of SNUAU, STS, has made permanent improvements and promises to do so related to the technology of managing emergency calls processed by 112 operators to assure all citizens that every second is important for the entire team of SNUAU.

6. ACKNOWLEDGEMENT

This paper is a result of the research performed within the Doctoral School of Management of The Bucharest University of Economic Studies.

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