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Vold med skytevåpen utgjør fortsatt en tydelig trussel mot offentlig sikkerhet, og teknologi for skudd deteksjon (GDT – Gunshot Detection Technology) har dukket opp som et mulig verktøy for å møte denne utfordringen. GDT benytter akustiske sensorer for automatisk å oppdage og lokalisere skudd, noe som muliggjør nærmest umiddelbar varsling til politiet og dermed raskere respons. Teknologien ble opprinnelig utviklet under første verdenskrig, men har siden gjennomgått utvikling gjennom tre distinkte generasjoner, hvor dagens systemer benytter

kunstig intelligens for å forbedre nøyaktighet og funksjonalitet. Selv om teknologien historisk sett har vært mest brukt i USA, har den den siste tiden fått økende oppmerksomhet også i flere europeiske land. Til tross for sitt potensial, har GDT også blitt kritisert for overvåkingsproblematikk, falske alarmer og begrenset dokumentert effekt når det gjelder å redusere våpenrelatert vold.
Denne masteroppgaven undersøker hvilke implikasjoner en innføring av tredjegenerasjons GDT kan ha i Norge, med særlig fokus på hvordan teknologien påvirker sosial bærekraft. Analysen er basert på semistrukturerte intervjuer med interessenter, inkludert representanter fra politi og industri, både i Norge og Tsjekkia, samt en gjennomgang av relevant akademisk og politisk litteratur.
Funnene tyder på at GDT kan ha fordeler for nødetatenes responstid og den offentlige sikkerheten, men at teknologiens legitimitet i en norsk kontekst vil avhenge av en åpen og transparent implementering, demokratisk kontroll, respekt for personvernet og proporsjonalitet i forhold til reelle sikkerhetsbehov. Når GDT integreres på en ansvarlig måte, kan den styrke Norges beredskap og bidra til langsiktig sosial motstandskraft. Hvis ikke, kan teknologien derimot svekke tilliten til myndighetene og undergrave grunnleggende demokratiske verdier.

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Sammendrag (abstract) - oversatt til engelsk (Valgfritt. Publiseres i Brage)

Gun violence remains a distinct threat to public safety, and gunshot detection technology (GDT) has emerged as a potential tool to address this challenge. GDT uses acoustic sensors to automatically detect and locate gunfire, which allows almost instant notification to law enforcement, allowing for a faster response time. Originally developed during World War 1, the technology has since evolved through three distinct generations, with current systems incorporating artificial intelligence to enhance accuracy and functionality. While historically deployed in the United States, GDT has more recently gained traction in several European countries. Despite its promise, GDT has also faced criticism related to surveillance concerns, false alerts, and limited evidence of effectiveness in reducing gun violence.
This thesis investigates the potential implications of implementing third generation GDT in Norway, with particular attention to its impact on social sustainability. The analysis draws on semi-structured interviews with stakeholders, including law enforcement and industry representatives, in both Norway and the Czech Republic, alongside a review of academic and policy literature.
Findings suggest that while GDT may offer benefits for emergency response and public safety, its legitimacy in the Norwegian context would depend on transparent deployment, democratic oversight, respect for privacy rights, and proportionality to actual security needs. When responsibly integrated, GDT could strengthen Norway's emergency preparedness and contribute to long-term social resilience. If not, it risks undermining public trust and core democratic values.

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Implementing GDT in Norway:

A sustainability perspective

Master thesis, 2025

Master in Energy, Environment and Society

Faculty of Social Sciences

Department of Media and Social Sciences



Preface

This MSc thesis concludes master's degree in Energy, Enviroment and Society at University of Stavanger. The writing was carried out in Oslo during spring 2025. The thesis constitutes the basis for assessment in the course MEEMAS Master's Thesis, corresponding to 30 ECTS credits.

Working with this Thesis has been challenging at times, and my knowledge and experience has been tested throughout the process. Fortunately, I have been able to overcome obstacles and am truly grateful for the insight I have gained throughout the journey. It has been a highly educational and valuable experience that I will carry with me into the future.

I want to extend my gratitude to my primary supervisor Tevfik Murat Yildrim, for his support, discussions and feedback through my thesis work. Furthermore, I would like to express my gratitude to the interview participants for generously sharing their time and insights, which led to engaging and meaningful discussions. Lastly, but certainly not least, I would like to thank my family and friends for the great support during this final semester.

Abstract

Gun violence remains a distinct threat to public safety, and gunshot detection technology (GDT) has emerged as a potential tool to address this challenge. GDT uses acoustic sensors to automatically detect and locate gunfire, which allows almost instant notification to law enforcement, allowing for a faster response time. Originally developed during World War 1, the technology has since evolved through three distinct generations, with current systems incorporating artificial intelligence to enhance accuracy and functionality. While historically deployed in the United States, GDT has more recently gained traction in several European countries. Despite its promise, GDT has also faced criticism related to surveillance concerns, false alerts, and limited evidence of effectiveness in reducing gun violence.

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Denne masteroppgaven undersøker hvilke implikasjoner en innføring av tredjegenerasjons GDT kan ha i Norge, med særlig fokus på hvordan teknologien påvirker sosial bærekraft. Analysen er basert på semistrukturerte intervjuer med interessenter, inkludert representanter fra politi og industri, både i Norge og Tsjekkia, samt en gjennomgang av relevant akademisk og politisk litteratur.

Funnene tyder på at GDT kan ha fordeler for nødetatenes responstid og den offentlige sikkerheten, men at teknologiens legitimitet i en norsk kontekst vil avhenge av en åpen og transparent implementering, demokratisk kontroll, respekt for personvernet og proporsjonalitet i forhold til reelle sikkerhetsbehov. Når GDT integreres på en ansvarlig måte, kan den styrke Norges beredskap og bidra til langsiktig sosial motstandskraft. Hvis ikke, kan teknologien derimot svekke tilliten til myndighetene og undergrave grunnleggende demokratiske verdier.

Table of Contents

1 Introduction 12
1.1 Background and Motivation 12
1.2 Objectives 13
1.3 Approach 13
1.4 Limitations 14
1.5 Outline 14
2 Background 16
2.1 First generation GDT 16
2.2 Second generation GDT 18
2.2.1 ShotSpotter 20
2.3 Third generation GDT 22
2.3.1 Triangula 22
2.3.2 Sound Event Detector (SED) 23
2.4 Sustainability 24
2.4.1 Social sustainability and quality of life? 24
2.4.2 How GDT can affect reporting of gunshot 25
3 Literature Review 27
3.1 Limitations with Literature Review 27
3.2 Second generation GDT 28
3.2.1 Detection and false positives 28
3.2.2 Location accuracy 29
3.2.3 Response Times 30
3.2.4 Crime Reduction and Investigative Effectiveness 31
3.2.5 Public and Police Perception 32
3.3 Third generation GDT 34

3.3.1 Technical accuracy 34
3.3.2 Response time 36
4 Empirical Context 37
4.1 Gun ownership in USA, Norway and the Czech Republic 37
4.1.1 USA 38
4.1.2 Norway 39
4.1.3 Czech Republic 39
4.1.4 Guns per capita 41
4.2 Homicides and gun homicide rates 41
4.2.1 USA Homicide Rate 42
4.2.2 Norway Homicide rate 43
4.2.3 Czech Republic Homicide rate 44
4.2.4 Total homicide rate 44
4.2.5 Gun homicide rate 45
4.3 Extreme Acts of Gun Violence 46
4.3.1 22nd of July 2011 47
4.3.2 Al-Noor attack 2019 48
4.3.3 Charles University 2023 48
4.4 Shotspotter in Chicago 49
4.4.1 Public perception 50
4.4.2 Black Lives Matter 51
4.4.3 Trust in law enforcement and background 53
4.4.4 The Death of Adam Toledo 54
4.4.5 ShotSpotter changing name to Soundthink 56
5 Research Design and Methodology 57
5.1 Methodology and research design 57
5.1.1 Selection of interviews 58

5.1.2 Structuration of interview 60
5.1.3 Semi-structured interview 61
5.1.4 Interview guide 65
5.2 Methodological Limitations and Ethical Considerations 66
5.2.1 Data selection 66
5.2.2 Language 67
5.2.3 Overall research 68
5.2.4 Ethical considerations 68
6 Results 70
6.1 Overview of the interview participants 70
6.2 Interview data 71
6.2.1 Czech City and SED deployment 71
6.2.2 Traingula and Norwegian law enforcement 75
6.2.3 AI concerns 77
7 Discussion 81
7.1 Technological evolution of GDT 81
7.1.1 Development through three generations 81
7.1.2 Second generation Accuracy 82
7.1.3 Third generation Accuracy 82
7.2 ShotSpotter in Chicago 85
7.3 Sustainability 88
7.3.1 Quality of life 88
7.3.2 Objective life conditions 88
7.3.3 Subjective feelings of wellbeing 92
7.3.4 Personal values and aspirations 94
8 Conclusion 95
8.1 Technological Evolution and Ethical Complexity 95

8.2 Lessons from ShotSpotter and the Case of Chicago 95
8.3 Social Sustainability and Quality of Life 96
8.4 Should Norway implement GDT? 96
9 References 98
10 Appendix 109

List of Figures

Figure 2 - 1: Illustration of how sound ranging functions from Science News Explores (Cowen, R., 2015) 17
Figure 2 - 2: An example of an acoustic sensor during the first world war (Imperial War Museum, n.d.)..... 17
Figure 2 - 3: A second generation GDT (marked with red circle) mounted on a military vehicle (Army Recognition, 2012). 19
Figure 2 - 4: ShotSpotter installed on top of street cameras (Nickie Louise, 2020) 20
Figure 2 - 5: Illustration of how ShotSpotter works (Nickie Louise, 2020). 21
Figure 2 - 6: Illustration of how triangula operates (Triangula, n.d.)..... 23
Figure 3 - 1: Table showing officer perceptions of the Effectiveness of ShotSpotter (Mazerolle, L. G. et al., 2000, p. 52). 33
Figure 3 - 2: Some data from the study on support for use of GDT (Fallon Research & Communications Inc., 2022). 34
Figure 3 - 3: Illustrations of placement of the sensors (Galangque & Guirnaldo, 2019)..... 35
Figure 4 - 1: Official statistics published by Czech Republic showing the registered firearms in Czech Republic (Policie České republiky, n.d.). 40
Figure 4 - 2: A statistic showing number of cases and victims in Norway (Voldsseksjonen, Kripos, 2025)..... 43
Figure 4 - 3: Homicide rate statistics for the three countries presented 45
Figure 4 - 4: High ranking politicians kneeling in silence to honour George Floyd (Blow, C. H., 2020)..... 52
Figure 4 - 5: A woman holds a photo of Adam Tolerado with the text ““Say no to programs like Shot Spotter they steal lives & they steal tax dollars” (Daley, J., 2021) 55

List of Tables

Table 4 - 1: Gun Ownership per 100 people in the three countries mentioned (Pew Research Center, 2024).(Jensen, I. et al., 2024; Pew Research Center, 2024; Policie České republiky, n.d.; Time, 2018). 41
Table 4 - 2: Homicides rate per 100,000 in USA 42
Table 4 - 3: The numbers of the total homicide rate in Norway for last few years (Crimes Recorded - Inentional Homicide and Attempted Intentional Homicide, n.d.) 43
Table 4 - 4: Total homocide rate in Czech Republic for last few years..... 44
Table 4 - 5: Overview of total homicide rates in three mentioned countries 44
Table 4 - 6: Homicide by firearm rates for the three mentioned countries (Dyvik, E. H, 2025; Our World in Data, 2024; Voldsseksjonen, Kripos, 2025) 45
Table 6 - 1: Overview of Interview Participants and Relevant Information ……...70

Terminology

List of Abbreviations

AI	Artificial Intelligence
BLM	Black Lives Matter
EMS	Emergency Medical Services
GDT	Gunshot detection technology
GDPR	General Data Protection Regulation
HALO	Hostile Artillery Locator
NAACP	National Association for the Advancement of Coloured People
NATO	North Atlantic Treaty Organization
PILAR	Positioning by Inverse Location of Acoustic Radiations
SED	Sound Event Detector

1 Introduction

1.1 Background and Motivation

The development and use of gunshot detection technology (GDT) has gained growing attention globally in recent years. While there are various types of GDT, some based on visual detection, this assignment focuses specifically on acoustic-based systems. Acoustic GDT relies on a network of acoustic sensors designed to automatically detect, locate, and report gunfire to law enforcement in real time. GDT may typically be placed in public areas. It is currently deployed in numerous U.S. cities, South Africa, Brazil and has more recently been introduced in selected European countries, including the Czech Republic. The technology is often promoted as a means to support faster police response, combat gun violence, and enhance public safety. At the same time, GDT raises important legal, ethical, and social concerns. In the United States, GDT systems like ShotSpotter have been criticized for technical inaccuracies, including false classifications of gunshots, concerns about surveillance, and uncertain effects on crime reduction. In contrast, newer European systems such as Sound Event Detector (SED) and Triangula are being introduced, marking a shift towards more accurate systems by relying on artificial intelligence. However, this technological development also introduces new ethical problems, particularly regarding transparency and accountability

This master's thesis explores how the potential use of GDT could affect societal sustainability in Norway. Gun violence affects societies in a harmful way, even though this is relatively rare in Norway compared to other countries. If Norway were to implement GDT, it raises important questions about legal frameworks, public trust and safety. By drawing insight from GDT deployment in United States and Czech Republic, and conducting interviews with relevant Norwegian and Czech stakeholders, this thesis investigates how GDT is perceived in terms of usefulness, risk, and feasibility in different societies.

The idea for this study came from my personal interest in how new technologies influence society and sustainability. Technological development often comes with a form of duality, where they have the potential to improve people's lives, while at the same time introducing new challenges. Social medium is a clear example: it was originally designed to help people stay connected and enhance their social life, yet it has paradoxically been linked to increased

loneliness and social isolation. This dilemma inspired me to explore the topic of GDT and Norway, a subject that hasn't received much attention.

1.2 Objectives

The objective of this master's thesis is to explore the implications of in Norway, particularly from a social sustainability perspective. To guide this investigation, the study addresses the following research questions:

1. *How has GDT evolved, and what are the risk and benefits of third generation, compared to second generation?*
2. *What does the ShotSpotter experience in Chicago reveal about the influence of political, racial, and social contexts on the public acceptance of GDT?*
3. *In what ways can GDT contribute to social sustainability, as evaluated through the quality-of-life framework?*

By addressing these questions, the thesis critically assesses the suitability of GDT for implementation in Norway, considering both its technological capabilities and societal implications. The aim is to determine whether, and under what conditions, GDT could serve as a valuable and ethically sound addition to Norway's public safety infrastructure.

1.3 Approach

To address the research questions, this study employed a mixed-methods approach, which combined both qualitative and quantitative data. The research consisted of semi-structured interviews and desk-based research.

A total of five interviews were conducted with relevant stakeholder in both the Czech Republic and Norway. This included personnel from law enforcement, representatives from GDT companies SED and Triangula, and experts in AI ethics and IT.

The desk-based research involved a thorough review on mostly publicly available information, including academic articles, official reports, news articles and company documentation.

It should be noted that all work on this thesis has been conducted during the spring semester.

1.4 Limitations

This research has several important limitations that should be acknowledged. First, no public opinion survey has been conducted in Norway to assess citizens attitude towards GDT. As a result, the study does not provide insight into how the public perceives its potential impact on safety, surveillance, and civil liberties. In addition, the study did not include a cost-benefit analysis of GDT or explore whether resources might be more effectively used other ways, such as by hiring additional police officers, to address gun violence.

Furthermore, access to additional relevant stakeholders, both in Norway and abroad, was limited. The study could have benefited from interviews with politicians, legal experts within digital technologies, or representatives from civil liberties organizations critical of GDT. Their perspectives could have provided the research a greater diversity in opinions.

An interview was also planned with representatives from the GDT company ShotSpotter, but this did not materialize. Given that this research focuses on three major companies, ShotSpotter, Triangula, and SED, it would have been valuable to include the views of all three to ensure a more balanced view.

Finally, most of the studies conducted on GDT and law enforcement focuses on GDT systems that do not rely on AI and are primarily based in the USA. There is therefore a noticeable lack of academic literature on the implementation of newer forms of GDT systems, particularly in a European context. Additional research on newer systems, particularly regarding their effects on crime reduction, public perceptions of safety, and concerns about surveillance, would have further strengthened the empirical foundation of this thesis.

1.5 Outline

- Chapter 1 introduces the research topic and objectives, approach and key limitations of the study.
- Chapter 2 provides background information on GDT, tracing its technological evolution from first- to third generations systems. It also introduces the three main

GDT companies relevant to this research and explores how GDT connects to sustainability and it potential role in supporting law enforcement.

- Chapter 3 presents a literature review, summarizing key findings and debates within the academic field.
- Chapter 4 offers empirical context by comparing gun laws, gun ownership, and firearm-related homicide rates in the United States, Norway, and the Czech Republic. It also includes an analysis of major incidents of gun violence and examines ShotSpotter's deployment in Chicago, highlighting the surrounding controversies and its eventual removal from the city.
- Chapter 5 outlines the research design and methodology, explaining the approach used for data collection.
- Chapter 6 presents the results from the qualitative interviews.
- Chapter 7 discusses the findings in relation to existing literature, identifying key patterns, contradictions, and implications for policy and practice, based on the research questions.
- Chapter 8 concludes the thesis by summarizing the key findings and their implications.

2 Background

GDT has evolved significantly since its inception. To better understand this evolution, and provide a clear analytical framework, the thesis distinguishes between three broad generations of GDT: first generation, second generation, and third generation systems. This generational classification helps to illustrate how GDT has progressed over time and highlights the shifts in the technological capabilities. While each generation encompasses a range of products from different companies, the classification is used here to capture general trends and advancements, rather than focusing on specific minor differences.

Although some smaller companies are mentioned, this following chapter primarily focuses on three prominent GDT systems: second generation ShotSpotter, and third generation Triangula, and SED. Focus on these companies is a result of interviews conducted with representatives from SED and Triangula, and Shotspotter being the global leader in GDT industry.

2.1 First generation GDT

This thesis traces the origins of modern GDT to battlefields of World War 1. During the war, a technique known as “sound ranging” was introduced as a way to locate enemy artillery. The method involved strategically placing several acoustic sensors across the battlefield. When artillery was fired, each sensor would register the arrival of the sound wave at a slightly different time, e.g., microphone A might detect the blast at 0.2 seconds, B at 0.75 seconds, and C at 1.2 seconds. By calculating these time differences, it was possible to triangulate the origin of the shot. This technique was developed and refined by British physicist and military officer William Lawrence Bragg. As the war went on, the system became more widely adopted and increasingly accurate. It was actively used by Allied forces throughout the war, and for example is credited as being vital for the British victory over German forces during the Battle of Cambrai in France in 1917. There, it was effectively deployed to identify German artillery positions, enabling British forces to more accurately neutralize enemy fire (Nobel Prize Outreach, n.d.; Van Der Kloot, 2005).

Figure 2 - 1 shows an illustration from Science News Explores, which demonstrates how sound ranging operates. Multiple microphones, positioned at known distances, record the arrival times of a sound wave, indicated in red. By comparing these time differences and applying basic geometric principles, it is possible to triangulate to find the location of artillery

(Cowen, R., 2015). See Figure 2 - 2 for example of an acoustic sensor used during the first world war.

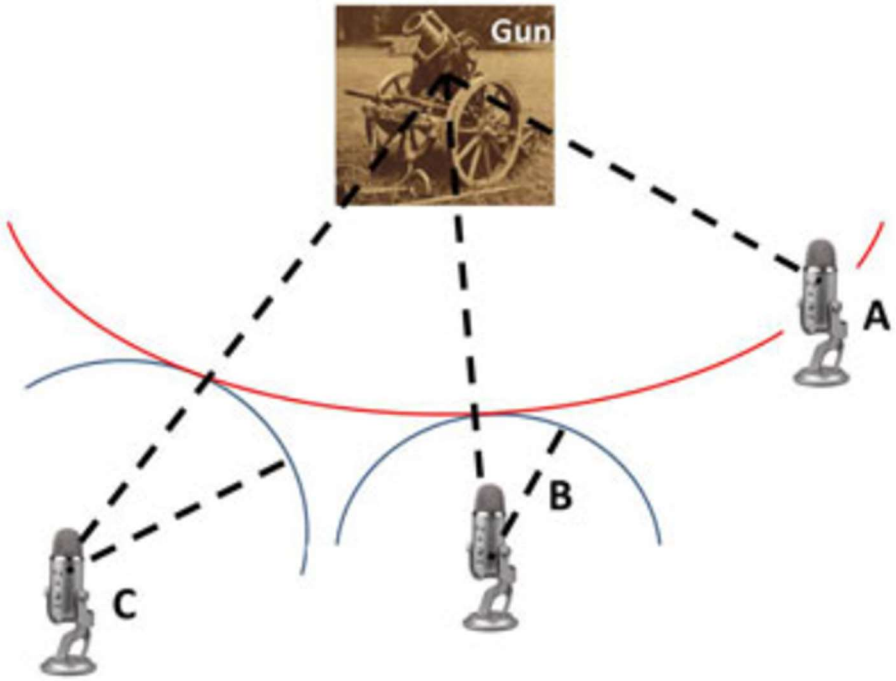


Figure 2 - 1: Illustration of how sound ranging functions from Science News Explores (Cowen, R., 2015)

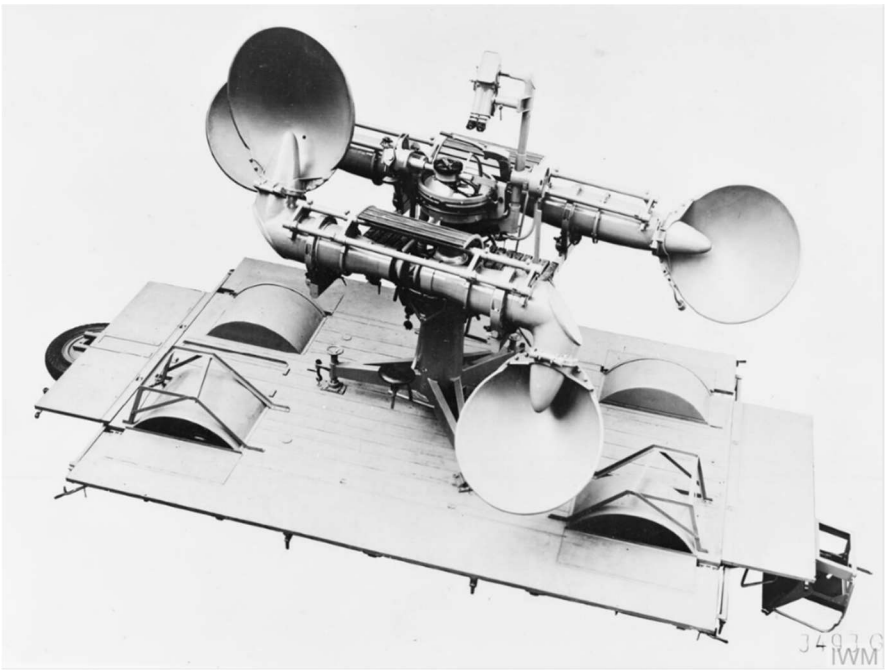


Figure 2 - 2: An example of an acoustic sensor during the first world war (Imperial War Museum, n.d.)

After World War 1 sound ranging was further developed to improve it reliability and precision. However, during World War 2, its use declined significantly. This was largely due

to advancements in other technologies, most notably radar, which emerged as a more effective and reliable system (Tagg, L. S, 2017). Even though the technology was only developed to locate large guns, such as artillery, the fundamental principles it relied on laid the groundwork which modern-day GDT is built upon. As such, the original sound-ranging systems are classified in this thesis as first generation GDT. Since its not relevant for civilian law enforcement, they are not a central focus of this research.

A substantial leap in GDT capabilities would not occur until several decades later. Next generation is presented in the following section.

2.2 Second generation GDT

GDT again emerged and developed through the war in the former Yugoslavia in the 1990s. Compared to previous generation, it was now sophisticated enough to detect and locate gunfire from smaller firearms, like rifles. In response to widespread the violence and ceasefire violations, NATO intervened, and the United Nations deployed peacekeeping troops in the region. Among the technologies used to monitor compliance with ceasefire agreements was an updated form of sound ranging. The Hostile Artillery Locator (HALO) system was one such development.

HALO employed arrays of microphones connected to a computer capable of locating gunfire through triangulation. Building on HALO, the Positioning by Inverse Location of Acoustic Radiations (PILAR) system emerged as a more advanced and versatile solution. The size of audio sensors had significantly decreased, which allowed them more easily to be placed in strategic locations, or mounted on vehicles. By analysing the acoustic data, the system could estimate the trajectory, azimuth, range, and elevation of incoming fire. This information allowed military and peacekeeping forces to find which side was responsible for ceasefire violations based on the location of the shooter (Aguilar, 2013).

Compared to first generation systems, second generation GDT devices were significantly smaller and more mobile. These systems could be mounted on vehicles, which enabled movement and repositioning based on tactical needs, see Figure 2 - 3. However, despite their success in open field military contexts, systems like PILAR encountered limitations in urban environments. Tall buildings, ambient noise, and reverberation frequently interfered with sound wave propagation and made accurate triangulation far more difficult (Aguilar, 2013)



Figure 2 - 3: A second generation GDT (marked with red circle) mounted on a military vehicle (Army Recognition, 2012).

In 1994, the United States Congress allocated several million dollars to support the development of an urban focused GDT. To adapt it for domestic law enforcement, the government contracted Alliant Techsystems Inc., a private defence contractor. Their task was to modify and reengineer the military grade acoustic system into a version suitable for use in American cities. This involved creating a system that could not only detect high calibre gunfire but also smaller firearms like pistols, which are more commonly used in urban gun violence. This initiative was part of a wider effort to combat the rise in gun related crime across the United States. For instance, in 1995 alone, there were approximately 243,900 arrests for weapons offenses in the country. GDT was promoted as a promising new technological solution, one that could enable police to reach crime scenes faster, improve emergency response times, help save lives, and increase the chances of arresting suspects involved in shootings (Mazerolle et al., 1998).

The development of second generation GDT marked a turning point in the broader application of acoustic detection systems. These systems were the first to effectively detect and locate

gunfire from handheld firearms. Crucially, they represented a shift from strictly military applications to civilian law enforcement, particularly in urban settings (Aguilar, 2013; Mazerolle et al., 1998).

2.2.1 ShotSpotter

Most of the research and public discourse surrounding second generation GDT has centred around the ShotSpotter system. As a result, this thesis primarily refers to ShotSpotter when discussing second generation GDT. A brief overview of the company and product is therefore included here to provide context.

ShotSpotter was founded in 1996 by American physicist Dr. Robert Showen. Initially he was working on seismic detection to locate earthquake epicentres. Showen recognized the potential for applying similar acoustic triangulation methods to detect gunfire, apparently after personally hearing gunshots in his own neighbourhood. This marked a key conceptual shift: unlike earlier GDT systems that evolved from military tools, ShotSpotter was specifically designed for civilian use in urban law enforcement. By the late 1990s, ShotSpotter had already been adopted by several police departments across the United States (SoundThinking, 2025).

ShotSpotter sensors are often installed in heightened public areas, such as on rooftops, light poles, or mounted above street cameras, see Figure 2 - 4.



Figure 2 - 4: ShotSpotter installed on top of street cameras (Nickie Louise, 2020)

Today, ShotSpotter is deployed in over 170 American cities, including major metropolitan areas like New York City and Washington D.C., and has expanded internationally to countries like Brazil and South Africa (SoundThinking, n.d.b). The company has been recognized as the global industry leader in GDT (Piza, E. L. et al., 2024). In 2023, ShotSpotter rebranded as "SoundThinking". For clarity, this thesis continues to use the name ShotSpotter, as this remain the dominant name academic literature and public discussions.

An illustration taken from an article written by Nickie Louise, explains how Shotspotter operates, as shown in Figure 2 - 5:

1. A gun is fired. Sensors placed in elevated positions, such as rooftops or light poles, record the sound.
2. At least three sensors register the noise and triangulate the location of the gunshot.
3. The data is sent to a control centre where analysts listen to the recording and confirm whether the sound is gunfire or not.
4. If confirmed, the information is forwarded to police, who receive the location and audio file and dispatch units accordingly

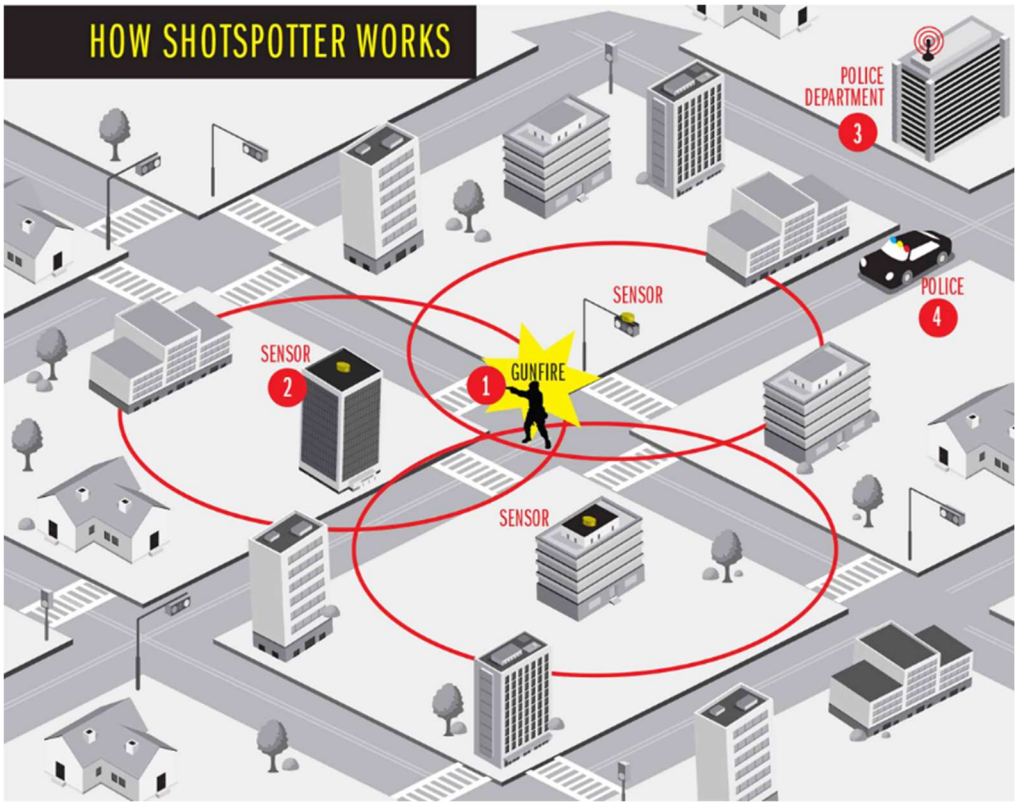


Figure 2 - 5: Illustration of how ShotSpotter works (Nickie Louise, 2020).

2.3 Third generation GDT

With the rise of AI and algorithmic processing, a new generation of GDT emerged in the 2010's, referred to in this thesis as third generation GDT. Third generation GDT utilize AI to interpret and classify sound. These systems are trained on large datasets consisting of thousands of gunshot recordings, enabling them to distinguish gunfire from other common urban noises with high accuracy. By applying machine learning techniques, the systems continuously improve over time (AmberBox, n.d.) . Another key difference is that third generation GDT are designed not to record or store audio, whereas earlier versions relied on human operators to review recorded sounds for verification. This makes them the comply with the General Data Protection Regulation (GDPR), the European framework governing personal data processing (JALUD Embedded, n.d.b; Triangula, n.d.).

This thesis focuses on two distinct third generation GDT products: Triangula and SED. While both systems rely on AI to detect gunfire, they have both approached gunshot detection in two different ways.

2.3.1 Triangula

Triangula is a Norwegian third generation GDT company founded in 2017. The development of Triangula's system has been supported by the Norwegian Military and the Research Council of Norway. What sets Triangula apart is its mobile based solution. The company has developed an app that can be installed on smartphones, effectively turning them into gunshot detection sensors. This removes the need for external audio sensors. When three or more mobile devices with the app are present in the same area, they can work together to triangulate the location of the gunshot, see Figure 2 - 6 for an illustration of how it operates. The system can also identify the type of weapon fired and the direction of the shot. The location of the gun fire can be shown on the phone in a map for first responders and routed into the police operation room. Triangula can also function as fixed in public places by placing a mobile phone with the app installed there (Triangula, n.d.).

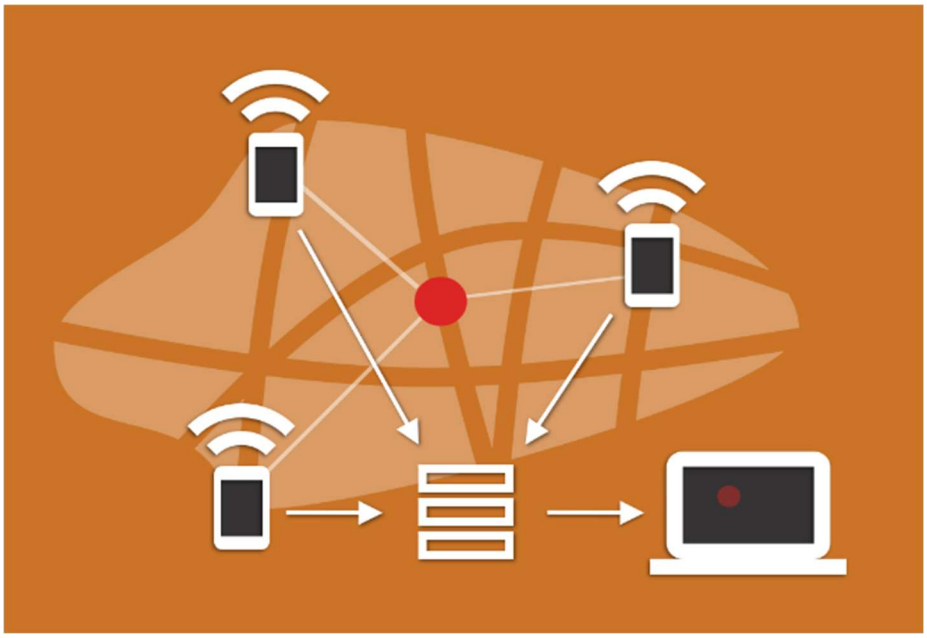


Figure 2 - 6: Illustration of how triangula operates (Triangula, n.d.)

2.3.2 Sound Event Detector (SED)

Sound Event Detector (SED) is a third generation GDT system developed by the Czech tech company JALUD Embedded in 2017. The company describes its product as “AI-powered smart ears” (JALUD Embedded, n.d.a). Like Triangula, SED uses AI to classify sound events in near real-time through triangulation. However, while Triangula operates mainly via mobile apps, SED is a stationary, sensor-based system designed for permanent installation in public spaces, more similar in form to ShotSpotter. SED differs from both Triangula and ShotSpotter is its expanded detection capability. In addition to gunshots, SED is trained to recognize a wide variety of sounds, including human screams, breaking of glass, drone activity, and even the sound of graffiti spray. SED can also be integrated with smart-camera systems, which may automatically divert camera attention towards the area where the acoustic alert was triggered and start filming. This allows for early visuals of any potential perpetrators. This broader functionality reflects its design as a general-purpose public safety tool, intended to improve urban security and protecting citizens in real-time (JALUD Embedded, n.d.b).

2.4 Sustainability

The concept of sustainable development gained attention after 1987, when the World Commission on Environment and development published the report "Our Common Future". The Commission chairwoman was former Norwegian prime minister, Gro Harlem Brundtland. This lead the document later to be referred to as the "Brundtland report". The report defines sustainable development as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (World Commission on Environment and Development, 1987, p. 37). The report states there are three interconnected dimensions of sustainability: environmental sustainability, economic sustainability and social sustainability. Sustainability thus encompasses more than environmental concerns like reducing greenhouse gas emissions and promoting renewable energy. In order for a society to truly be sustainable, it also has to contribute to social justice and improving the quality of life (European Environment Agency, 2024). One aim for this research is to explore whether the implementation of GDT in Norway could contribute to positively to social sustainability.

The following section presents the framework of quality of life, which will later be used when discussing how GDT can affect sustainability. The last part of the chapter showcases one example where GDT can affect safety in society, and therefore in a bigger extent sustainability as a whole.

2.4.1 Social sustainability and quality of life?

Social sustainability can be defined as a *"... vital cog of sustainable development which takes care of social aspects by giving importance to social values, equity and justice; addressing basic needs, safety and health; bringing sense of community, social capital and diversity; respecting human rights, and thereby paving the way to eliminate poverty, bringing higher quality of life and augmenting the standard of living*" (Shaw et al., 2022, p. 3). It refers to societies ability to maintain and improve well-being for the citizens over time. Others also highlight safety and crime prevention as key factor in social sustainability (Szalkowski & Johansen, 2024). Colantonio (2011) argues that social sustainability also entails increasing public safety, social cohesion and the quality of life.

This thesis focuses primarily on the concept of quality of life as a core component of social sustainability. However, it is essential to acknowledge that quality of life is a somewhat vaguely defined term, with no universally accepted or fully objective definition. As a result, how it is understood and measured can often be inconsistent (Felce & Perry, 1995). As Felce & Perry (1995) point out, the measurement and interpretation of quality of life often vary across studies and context. They write that quality of life can be understood as a multidimensional concept that includes the combination of:

- Objective life conditions: *Measurable and observable factors such as physical safety, income and access to basic services.*
- Subjective feeling of wellbeing: *How individuals personally feel about their lives and their circumstances.*
- Personal values and aspirations: *The importance each individual places on different life aspects, such as safety, privacy, or freedom.*

According to this model an individual's quality of life is greatest when, they live under favourable conditions, they are satisfied with those conditions, and those conditions align with their personal values. In this thesis these elements are used as tools to assess whether and how GDT might enhance the quality of life, and by extension, social sustainability in Norway. For example, if GDT leads to less crime and a safer society, it could improve people quality of life. However, if the technology is ineffective and perceived to be intrusive, this could in term leads to lower life quality.

2.4.2 How GDT can affect reporting of gunshot

One potential benefit with GDT is that it allows law enforcement to detect and respond to gunfire without relying on citizens notifying them. Several police departments have highlighted the issue of significant underreporting of gunfire incidents. For example, in 2015 after the installation of GDT in Milawaukee, the Police Chief, Ed Flynn said that the instalment of GDT revealed that 86% of gunfire incidents were never reported to the police ("The 'Crime Gun Intelligence Center' Model: Case Studies of the Denver, Milwaukee, and Chicago Approaches to Investigating Gun Crime," 2017). Other studies have found similar pattern of underreporting, claiming that 80 % of gunfire incidents don't get reported to police (Mares, D., 2022).

There are several reasons that can explain why gunfire incidents might be frequently underreported. One explanation can be the bystander effect, which is a social psychological phenomenon in which individuals are less likely to take action when others are present, leading them to assume that someone else will notify law enforcement (Ai et al., 2024). Or it can be ambiguity, where citizens mistake sound of gunshot, believing it to be a firecracker or construction work,. It can be from simply not hearing it. It can also be from mistrust in law enforcement, leading them to assume police presence won't make the situation any better. Additionally, fear of retaliation or potentially becoming involved in legal proceedings may further deter people from coming forward. Kirk and Matsuda (2011) emphasize that such underreporting is greater in high-crime, marginalized neighbourhoods, where distrust in the police tends to be more deeply rooted. Further on, even when citizens report incidents, there are some issues involved. Research points out how callers can often be unclear and inaccurate when describing incidents (Klinger & Bridges, 1997). Furthermore, even just talking to the police can be stressful, especially if they have been near a traumatic episode like gunfire. Other studies show how human decision-making during crisis is often flawed due to stress confusion or cognitive overload (George, A. L., 1986). This can delay or compromise the accuracy of emergency calls. GDT system can address such challenges by receiving automated and objective data when a gunfire is happening, and limiting any human errors in the process (Choi et al., 2014)

3 Literature Review

This chapter reviews existing research on GDT, focusing on both technical aspects, such as functionality and accuracy, and societal impacts, which includes its effect on gun violence and crime. The goal is to understand how GDT has been applied in practice, identify major debates, and assess how the technology is evaluated by different researchers and institutions over time.

The chapter begins by addressing the limitations of the existing literature. Due to significant technical differences between second and third generation systems, the review is divided into two main sections: the second part focuses on second generation GDT, while the third and final part examines third generation.

3.1 Limitations with Literature Review

Finding literature involved searching platforms like Google Scholar or SCOUPS using terms such as "*law enforcement gunshot detection*". However, it appears that this topic is less researched compared to other law enforcement technologies. For example, a search on Google Scholar for *"law enforcement body cameras"* gives around 180.000 results, while *"law enforcement gunshot detection"* only gives around 20.000 results. In the Norwegian context, I also explored Politiforum (*Police Forum*), a popular journal among police officers, often featuring articles about new policies and technologies, directed towards the police segment. A search in Politiforum for *"skuddeteksjon"* (gunshot detection) gave 7 results, while *"kroppskamera"* (body camera) gave 235 results. This could suggest that GDT has received less attention than body-worn cameras when it comes to policing technology, indicating that the topic is less studied and less debated in Norway and abroad.

It was also challenging to find studies conducted outside the United States, or research specifically focused on third generation GDT. A likely explanation is that third generation systems are relatively new and not yet as widely adopted, limiting their presence in academic literature. The dominance of U.S.-based studies may also reflect the fact that the United States was among the first countries to implement GDT and remains the largest global market for the technology (Mazerolle et al., 1998; MarketsandMarkets, 2023).

This creates a significant limitation when considering how GDT might function in different social or policing contexts, such as in Norway. Findings and challenges identified in U.S. based studies may not directly translate to a Norwegian context. The United States differs significantly from Norway in various dimensions, including the prevalence of gun violence, public trust in law enforcement, legal frameworks, and demographic composition, which will be discussed more about in later chapters. While it's a strength that many U.S. studies examine different cities, as this offers more diverse insights than studies focused on one single city, it is important to note that these cities are often characterized by particularly high rates of gun crime, which might have had a strong incentive to invest in GDT early on. As a result, findings from such contexts may be less applicable to societies with low rates of gun violence.

3.2 Second generation GDT

The literature review on second generation GDT is divided into five different parts, each addressing different aspects relevant for this research. This structure is intended to improve clarity and provide a distinct and more accessible overview of the topic.

3.2.1 Detection and false positives

One of the earlies field trials assessing the accuracy of GDT in an urban environment was conducted in 1999 in Redwood City, California (Mazerolle, L. G. et al., 2000). The study involved firing 37 shots of different firearms at predetermined locations selected by local police. GDT was successfully able to identify nearly 80 % of the test shots. However, the testing had one notable limitation, the police wouldn’t allow them to fire live ammunition, so they had to use blank rounds. Blank ammunition produces a different muzzle blast waveform then live ammunition. As a result, they hypnotized that the systems detection rate would have been even higher under more realistic conditions with live ammunition.

Ratcliffe et al. (2019) conducted a field experiment in Philadelphia where they deployed GDT in 17 areas in the city. Over an eight month period, the presence of GDT led to a 259% increase in police deployments to these areas. Yet there was no significant increase in confirmed shooting incidents, those where physical evidence, like bullet cases, of gunfire was found. The researchers concluded that GDT did not significantly affect the number of confirmed shootings but increased the workload of police officers attending incidents in

which no evidence of shooting was found. Their findings suggest that GDT might produce a considerable number of false positives (incidents when GDT wrongfully marks a sound as gunshot).

Mazerolle et al. (1998) also cited the same issue, reporting a 287 %increase in police dispatches in areas with GDT. They noted that if a high percentage of these dispatches were due to false reports, this could drain police resources that might otherwise be used for other essential duties.

A study focused on Newport News and Hampton also raised concerns about false positives (Litch, M & Orrison, G. A., 2011). In Newport News, only 24 %of GDT alerts had a corresponding 911 call, and in Hampton, just 18 %. This means that 76 % and 82 %of dispatches in Newport News and Hampton, respectively, would not have occurred without GDT.

Mares (2022) speculated that GDT was expected to become a common technology in US law enforcement, especially in communities with high incidence rate of gunfire. He emphasized that it could lead to faster police response and evidence collection. Although he highlighted the system's ability to accelerate response and evidence collection, he noted the lack of reliable data on how often GDT misidentifies sounds and that the actual proportion of false alarms remains unclear.

3.2.2 Location accuracy

Several studies have examined the accuracy of GDT systems by comparing the reported coordinates from the GDT systems to the actual location of gunfire. Aguilar (2015) reviewed tests conducted in urban environment, which included tall buildings and noisy traffic, and open field military environments. He found that reported locations were typically within 10 to 25 meters of the actual location. According to the study, this level of accuracy was regarded as enough to identify shooter location in terms of the correct street. However, he also noted that GDT had a relatively high sensitivity to things like background noise and wind, which would affect the accuracy of GDT. For example, under wind conditions less than 3.5 m/s, the error rate remained under 4%. When wind speeds increased to between 3.5 and 7 m/s, localization errors doubled to 8%.

In the aforementioned study in Redwood city, California (Mazerolle, L. G. et al., 2000), they found GDT coordinates to be off by about 7,6 meters in average. Other studies comparing GDT data to citizen-reported locations have revealed larger discrepancies. For instance, others found that the distance between GDT coordinates and citizen reported shooting location, ranged from 18 to 27 meters (Wheeler, A. P. et al., 2020).

A more recent study by Piza et al. found that the average discrepancy was significantly greater, 132 meters, with a median of 72 meters (Piza et al., 2023). The authors also observed that in more than half of the incidents, GDT data and citizen calls were coded to entirely different streets, which could potentially misguide officer response.

3.2.3 Response Times

Several studies have looked at how GDT affects police response times. Choi et al. (2014), using data from Brockton, Massachusetts, found that the implementation of GDT reduced dispatcher response times by 33% and improved officer arrival times by 12%. Dispatcher response time refers to the period between when a gunshot is detected and when the operations centre notifies a patrol unit. Officer arrival time is the time from when the police unit receives the call to when they arrive at the scene. The study also highlights the potential of integrating GDT with other digital systems, as this could allow police officers to view gunshot alerts directly on in-car screens or mobile devices, claiming that this allows police officers to automatically respond to the gunfire, rather than waiting to be dispatched.

Similarly, Lawrence et al (2019) examined GDT deployments in Denver, Milwaukee, and Richmond, all three major U.S. cities. They found that police response times improved by 14-28%, when comparing GDT alerts with regular citizens calls (Lawrence, D. S. et al., 2019).

However, other studies provided more modest outcomes observing only a 7% reduction in police response times after implementing GDT, not deeming it statistically significant (Mazerolle et al., 1998).

Mares and Blackburn (2012, 2021) evaluated GDT in in St. Louis in 2012 and again a few years later, when the city increased the GDT coverage, they found it to have no meaningful impact on reducing police response times.

Beyond law enforcement, other research has focused on non-police emergency responders, such as paramedics and ambulance crews, Emergency Medical Services (EMS). Goldenberg

et al. (2019) analysed 627 shootings in Camden, New Jersey, to assess the impact of GDT on emergency response times. The study found that 30 % of emergency responses were initiated by GDT alerts, and these alerts led to faster deployments of both police and EMS. The researchers concluded that GDT reduced both response and transport times, thereby increasing the likelihood of timely medical treatment and trauma care. The study also observed that victims in GDT-initiated incidents were often more severely injured and, as a result, were more likely to be transported by law enforcement rather than waiting for EMS to arrive.

3.2.4 Crime Reduction and Investigative Effectiveness

The evidence regarding GDT's impact on crime reduction and investigative outcomes is mixed. Mares and Blackburn (2012, 2021) and their studies on GDT in St. Louis found that in neighbourhoods with GDT coverage, they found no measurable decrease in gun crime. In terms of investigative effectiveness, only about 2 % of GDT alerts led to the recovery of ballistic evidence. Stating this was substantially lower than the 17 % recovery rate in incidents reported by citizens. They also noted that while GDT provided precise location data, it is limited since it can't determine the identity or escape route for the perpetrator. Many alerts, they argued, likely originated from non-criminal activities such as celebratory or recreational gunfire. Overall, their findings suggest that GDT had minimal impact on deterring gun violence or enhancing investigative outcomes in the St. Louis context.

Vovak et al (2021) investigated a similar case in Wilmington, Delaware, where GDT was first introduced in 2013 and later expanded in 2018 with the addition of CCTV integration. Their studies did not find any measurable improvements in crime reduction. Homicides and shootings actually increased following the expansion. Additionally, law enforcement cleared fewer homicides and shooting cases in court after the expansion.

A broader study examined 68 large metropolitan counties in the U.S. between 1999 and 2016 (Doucette et al., 2021). Their results showed that GDT had no statistically significant impact on firearm-related homicides, arrest rates for murder, or weapons-related charges. Interestingly, they found that policy context mattered: in counties with permit-to-purchase firearm laws, homicides fell by 15%, while those with right-to-carry laws experienced a 21% increase.

In Milwaukee and Richmond, GDT implementation created no statistically significant changes in gun crimes. On the investigative side, the researchers observed a modest increase in the collection of ballistic evidence, but no significant improvement in arrest rates or in the likelihood of retrieving a weapon at the scene of a shooting (Lawrence, D. S. et al., 2019).

Several studies highlight how GDT can help uncover the “dark figure” of gun crime; incidents of illegal gun use that would otherwise not get brought to law enforcement attention. When Carr and Doleac (2019 analysed data from Washington D.C. and Oakland, California, they found that severe underreporting of gun violence was occurring in both cities, only 12 % of gunfire incidents detected by GDT, lead to a corresponding 911 call. They claim that data from GDT provides a more complete understanding of firearm-related crime, which can be valuable for both criminal justice research and policy development.

In a related study from Washington D.C, Irvin-Erickson et al (2017) found that, on average, for every one citizen-reported gunshot, GDT detected approximately 1.5-2.3 incidents within the same 20-minute window. This varied from hours of the day, day of the week and seasonality. The researchers concluded that GDT enhances law enforcement's understanding of gunfire trends and improves situational awareness by identifying incidents that would otherwise remain unreported.

3.2.5 Public and Police Perception

Perceptions of GDT systems seem to vary significantly among both law enforcement and the general public. One early study by Mazerolle et. al (2000) examined attitudes toward GDT among police officers (sample size of 26) and citizens in Redwood City, California. Citizens were asked to share their thoughts in focus groups, divided into groups based on whether they supported or opposed the use of GDT. Proponents of the technology believed that GDT benefitted the community by quickly and accurately identifying the location of gunfire, creating a greater sense of public safety. In contrast, opponents argued that the system did not result in any increases in arrests for firing weapons in public, suggesting it provided only a false sense of security. They also expressed low confidence in the system's ability to distinguish between actual gunshots and similar sounds, such as fireworks or car engine backfires. Many participants critical of GDT felt that public funds would be better spent on hiring more police officers.

Local police officers were surveyed through a questionnaire, as presented in Figure 3 - 1. Officers' views on GDT were somewhat conflicted. While 56 % of respondents believed that GDT would make citizens feel safer, 44 % did not agree. Although officers generally viewed the system somewhat favourably, over 90 % stated they did not believe it would increase the likelihood of arrest. None believed it would improve the chances of survival for shooting victims. Nevertheless, more than 80 % preferred being dispatched through ShotSpotter alerts rather than relying solely on citizen reports, and nearly 90 % believed the system could help identify shooting patterns and inform police strategy.

	True		False	
	N	%	N	%
The ShotSpotter system will increase the likelihood someone will be arrested	2	7.4	25	92.6
The ShotSpotter system will help detect shooting patterns	19	86.4	3	13.6
The ShotSpotter system will help the police focus on shots fired hot spots	10	37.0	17	63.0
The ShotSpotter system will increase the likelihood that the victim of a shooting will survive	0	0.0	26	100.0
The ShotSpotter system has decreased the number of random gunfire incidents	16	59.3	11	40.7
The ShotSpotter system makes citizens feel safer	14	56.0	11	44.0
The ShotSpotter system has made me more effective when handling shots fired incidents	2	7.4	24	88.9
I prefer using the ShotSpotter system over just using citizen calls	22	81.5	5	18.5

Figure 3 - 1: Table showing officer perceptions of the Effectiveness of ShotSpotter (Mazerolle, L. G. et al., 2000, p. 52).

More recent data from a 2022 survey conducted by Fallon Research & Communications Inc. (2022) provided additional insight into public opinion regarding GDT in Chicago, see Figure 3 - 2 for an overview of some of the data. The survey included 801 residents from all districts of the city and was conducted via SMS and telephone in both English and Spanish. Results showed broad support for the use of GDT: 72 % of respondents supported its use.

Furthermore 63 % believed GDT was a good use of public funds. With regard to public safety, 51 % reported feeling that GDT made them feel safer, while 38 % disagreed to some extent.

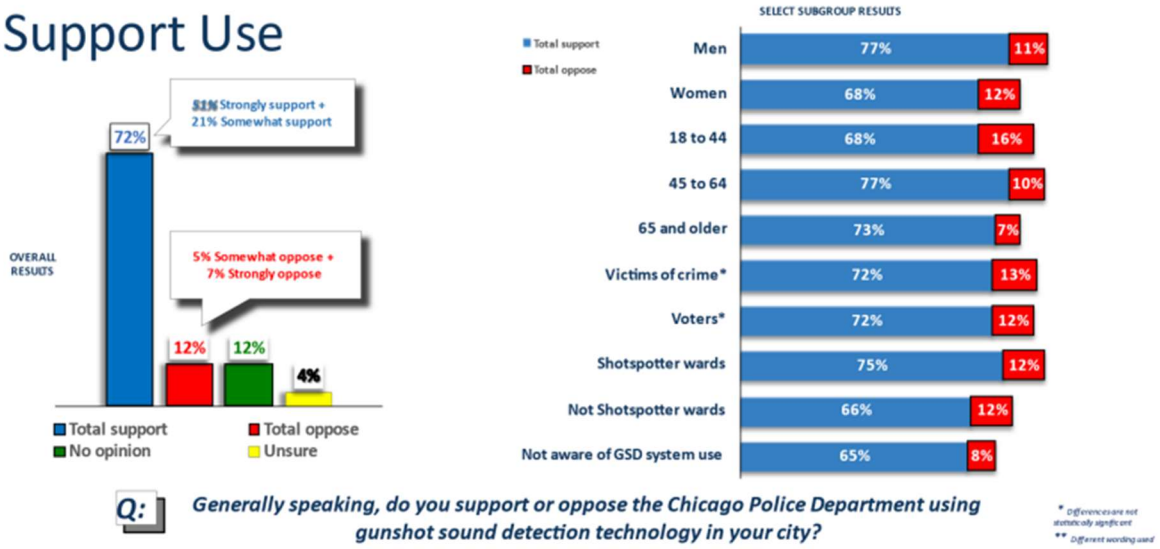


Figure 3 - 2: Some data from the study on support for use of GDT (Fallon Research & Communications Inc., 2022).

3.3 Third generation GDT

Research on third generation GDT remains limited, especially in terms of its longterm implementation by law enforcement and its impact on crime and public safety. Most available studies focus on technical performance rather than operational outcomes. This part is divided in two. The first part focuses on technical capabilities of the GDT, while the second part on its potential effect on police response time.

3.3.1 Technical accuracy

Third generation GDT have shown good results in differentiating between different types of firearms. A Czech study, tested the firing of ten different handguns, using an unspecified number of recordings, and achieved a classification accuracy of 96 % in correctly identifying the right type of handgun (Navrátil, M. et al., 2011).

Djeddou and Touhami (2013) recorded gunshots from five different firearms, including both handguns and rifles, with ten recordings for each weapon. The GDT successfully classified the type of firearm with an accuracy of 96.29%.

Galangque and Guirnaldo (2019) fired approximately 1,000 live rounds with an M16 rifle to evaluate the GDT system under varying conditions, including different background noise and similar sounds to gunshot like firecrackers. The system achieved a 99% accuracy rate in distinguishing actual gunfire from other noises. The shooting occurred at distances ranging from 50 to 100 meters from the GDT. The system demonstrated over 90% accuracy in estimating the shooter's orientation within ±15 degrees and the distance within ±5 meters.

Lojka et al. (2016) evaluated the performance of a GDT system in distinguishing between gunshots and glass-breaking sounds within a noisy environment. The researchers used 463 pre-recorded gunshot samples and 150 glass-breaking samples, all played against a background of recorded ambient noises such as traffic and bird sounds. The system demonstrated a high overall detection accuracy of 98.89%. This showcases how GDT can also be used for more sounds than gunshot.

Figure 3 - 3 illustrates how closely the different acoustic sensor were put together in one of the studies (Galangque & Guirnaldo, 2019). The sensors are all deployed on the same stand, while still being able to triangulate. Compared to previous generations, who had to be placed strategically apart, this allows for an easier set-up

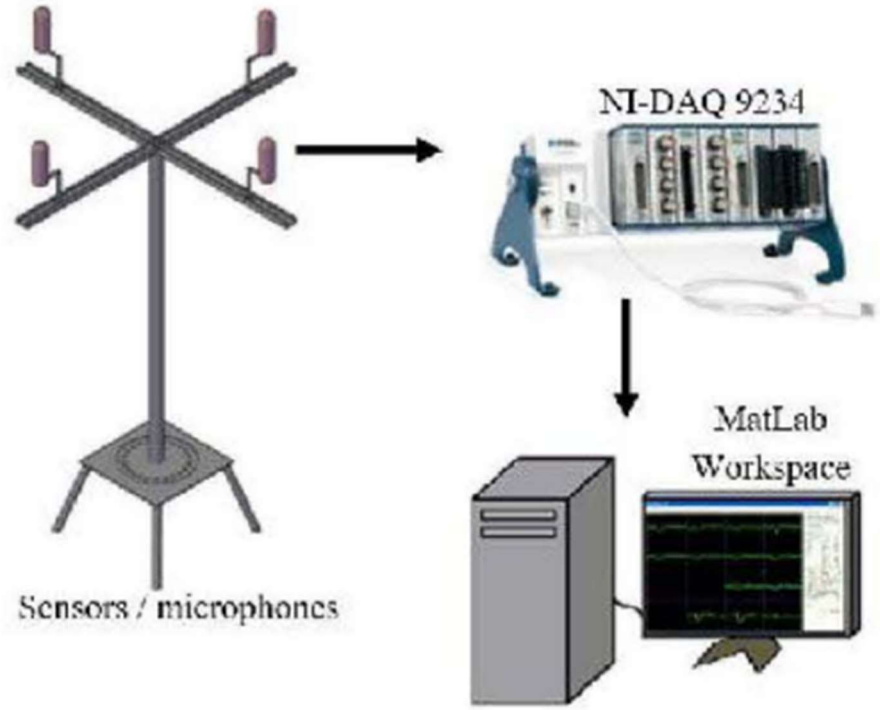


Figure 3 - 3: Illustrations of placement of the sensors (Galangque & Guirnaldo, 2019)

3.3.2 Response time

Studies on the impact of third generation GDT on law enforcement response times remain severely limited. However, one unpublished study was made available to me by a representative from the company SED, which is analysed for this final part in the literature review. The study evaluated the performance of the SED system during simulated high-risk scenarios at Václav Havel Airport in Prague, Czech Republic (Smazinka, D., n.d.).

The researchers conducted multiple controlled simulations, involving police officers and actors portraying both victims and perpetrators. In two of the simulations, they played out armed attacks inside the airport. The researchers measured the effectiveness of SED against traditional human-based reporting (emergency phone calls, pushing a “panic button” etc.) by timestamping both automated alerts and tracking the action in real time. In one simulation, the first gunshot occurred at 19:36:20. The SED system issued an alert within 5 seconds (at 19:36:25), whereas the first emergency call was not received until 19:43:10, a delay of nearly 7 minutes. In the other simulation, the SED system again detected gunfire 5 seconds after the first shot (20:58:43), while the first emergency call took 1 minute and 22 seconds longer (at 21:00:05). Although the study did not assess total police response time, they only tested the time until emergency units got the first information about a shooting, it clearly demonstrated that the SED system enabled significantly faster identification of incidents compared to traditional methods.

4 Empirical Context

This chapter presents background data necessary to understand the social relevance, policy implications, and practical challenges of implementing GDT. Drawing from international and national contexts, this section provides a comparative analysis of firearm prevalence, regulation, and violence in three countries: the United States, the Czech Republic, and Norway. The rationale for selecting these countries is threefold. The United States has a long-standing history with GDT deployment, particularly with second generation systems like ShotSpotter, and has produced the majority of existing research on the topic. The Czech Republic offers a more recent perspective, having implemented third generation GDT and providing access to interview data from local stakeholders. Norway, while not currently using GDT, is the primary country of analysis for this thesis, as the potential implementation of such systems is the central research concern.

The chapter also includes focused analyses of key incidents of gun violence: the 2023 mass shooting at Charles University in Prague, the Czech Republic, 2011 Utøya terrorist attack and the 2020 terror attack at the Al-Noor mosque, both in Norway. These cases serve to highlight the societal consequences of extreme gun violence, regardless of a country's overall firearm prevalence. At the end, I analyse the trajectory of ShotSpotter in Chicago, with a focus on why it was ultimately removed, showcasing some of the challenges and criticism the technology has faced.

4.1 Gun ownership in USA, Norway and the Czech Republic

This chapter explores the prevalence of gun ownership and the legality governing firearms in the United States, Norway, and the Czech Republic, as well as homicides and gun homicides. Since GDT is directly linked to firearm use, understanding each country's gun culture and regulatory environment provides important context for evaluating the relevance and necessity of GDT.

4.1.1 USA

Registered firearms

The United States does not maintain a national, centralized registry of firearm ownership. This lack of official data makes it difficult to really know how many Americans own guns. However, according to surveys conducted in 2024 by the Pew Research Center, about one-third of American adults report personally owning a firearm (Pew Research Center, 2024). According to the same study, over 70 % of respondents say that personal protection is a major reason as to why they have a gun. Given the absence of a comprehensive gun registry in the United States, and the existence of unregistered firearms, estimating the total number of privately owned guns is challenging. Estimates vary widely: some sources suggest around 200 million privately owned firearms, while others claim the number mirrors closely the total population, with over 300 million guns in circulation (Cook, P. J & Ludwig, J., n.d.; Krouse, W. J., 2012; Time, 2018).

Gun laws

The United States has a distinctive gun culture, particularly when compared to countries like Norway. A big part of this cultural difference might be rooted in the Second Amendment to the U.S. Constitution, which reads:

> *"A well regulated Militia, being necessary to the security of a free State, the right of the people to keep and bear Arms, shall not be infringed"* (amend. II, n.d.).

Some Americans interpret this amendment as guaranteeing that every individual has the right own firearms, akin to how Norwegians might view the right for freedom of religion. For a substantial portion of the American population, firearm ownership is closely tied to national identity and a belief in the right to self-defence, including protection against government overreach. Gun laws vary significantly between states. Some states, like Texas and Arizona, permit open and concealed carry with minimal restrictions, while others, such as California or New York, have stricter licensing requirements, background checks, and waiting periods (Reeping et al., 2019). Due to the requirements for legally obtaining firearms are different from state to state, it becomes difficult to compare with Norway and Czech Republic, that will not be further discussed in this assignment.

4.1.2 Norway

Registered firearms

In contrast, Norway maintains an official firearm registry. According to the Norwegian Police Directorate, as of 2024, there were 1,403,848 privately owned firearms registered in the country, belonging to 472,660 individual owners (Jensen, I. et al., 2024). This equates to roughly 8.5% of Norway's population owning firearms, with each gun owner possessing an average of three weapons.

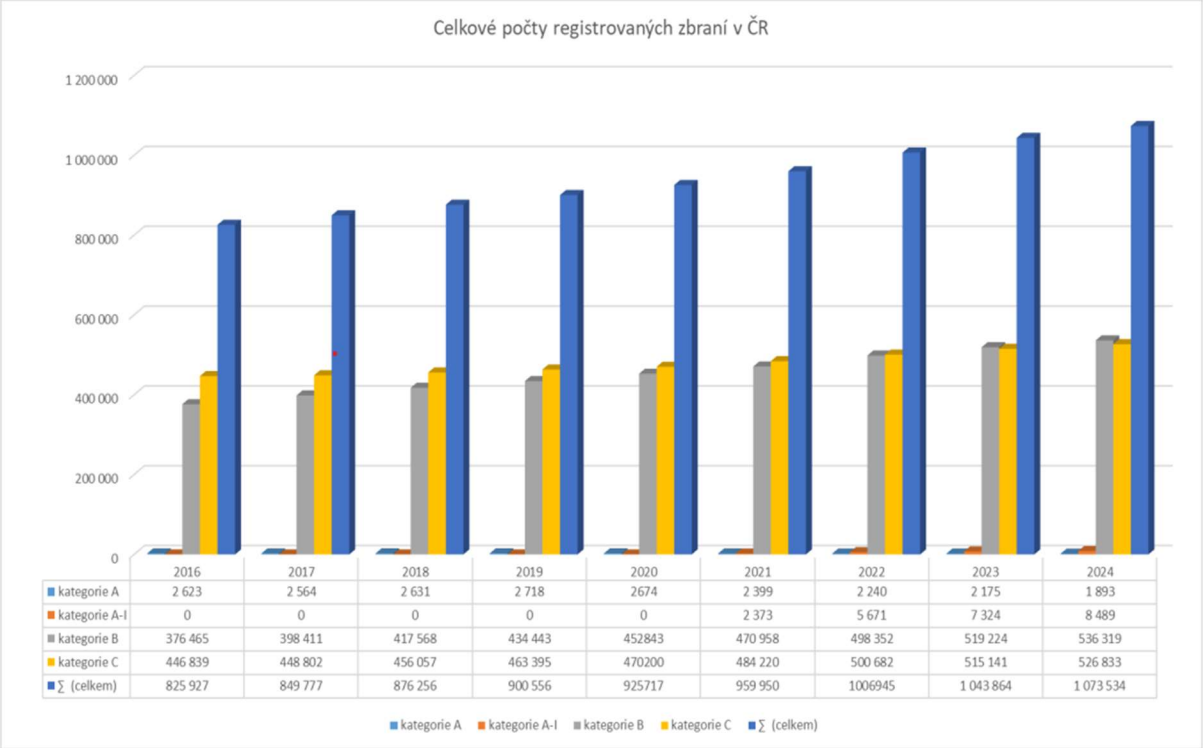
Gun laws

In Norway, firearm ownership is strictly regulated, and self-defence is not recognized as a valid reason to possess a weapon. People trying to own a gun must present a legitimate purpose, typically related to hunting, sport shooting, or in some cases, collecting. The process varies depending on the intended use. For example, for hunting reasons, applicants are required to complete a certified hunting course. Those seeking to own firearms for sport must be active members of a shooting club, with documented participation in regular training and competitions. All prospective gun owners are subject to background checks conducted by the police. Fully automatic weapons and other military-style firearms, such as the AK-47, are explicitly banned, as they are not deemed suitable for civilian use under Norwegian law (Forskrift Om Våpen, Skytevåpen, Våpendelar Og Ammunisjon (Våpenforskrifta), 2021)

4.1.3 Czech Republic

Registered firearms

According to official statistics published by the Czech Police, the number of registered firearms in the Czech Republic has steadily increased in recent years. In 2016, the total number of legally registered firearms stood at 825,927. By 2024, this figure had risen to 1,073,535, representing nearly a 30% increase over an eight-year period, see Figure 4 - 1. This include a wide range of firearm types divided into categories, from basic hunting rifles to more strictly regulated semi-automatic weapons, which require advanced licensing (Policie České republiky, n.d.).



	2016	2017	2018	2019	2020	2021	2022	2023	2024
kategorie A	2 623	2 564	2 631	2 718	2674	2 399	2 240	2 175	1 893
kategorie A-I	0	0	0	0	0	2 373	5 671	7 324	8 489
kategorie B	376 465	398 411	417 568	434 443	452843	470 958	498 352	519 224	536 319
kategorie C	446 839	448 802	456 057	463 395	470200	484 220	500 682	515 141	526 833
∑ (celkem)	825 927	849 777	876 256	900 556	925717	959 950	1006945	1 043 864	1 073 534

Figure 4 - 1: Official statistics published by Czech Republic showing the registered firearms in Czech Republic (Policie České republiky, n.d.).

With a national population of approximately 11 million, this translates to roughly one registered firearm for every 10 to 11 inhabitants. According to numbers from Czech police, in 2020, there were a bit over 300.000 firearms license holders in Czech Policie České republiky, 2021). On average, this means each license holder owns approximately three weapons, comparable to the situation in Norway. However, the proportion of the population holding firearm licenses in the Czech Republic is significantly lower, amounting to less than 3%.

Gun laws

The Czech Republic is one of the few European countries with a constitutional right to bear arms. In a manner similar to the United States, Czech citizens are legally permitted to own firearms for self-defence purposes. The regulatory framework distinguishes between several categories of weapons, each with its own licensing requirements. Most legally owned firearms fall under Category C, see Figure 4 - 1, which includes hunting rifles and other less-restricted weapons. More tightly controlled weapons, such as handguns and semi-automatic rifles are classified under higher categories, which carry stricter licensing conditions (Burga, S., 2023; Policie České republiky, n.d.; Vikarska, Z., 2021).

To obtain any type of firearm license, applicants must undergo a criminal background check and a medical examination to assess their physical and psychological fitness. In addition, candidates are required to pass both a written multiple-choice exam and a practical exam. The level of difficulty and the margin for error allowed in the exam depends on the category of weapon the applicant seeks to obtain. The practical component ensures that the applicant is able to handle and operate firearms safely and responsibly (Burga, S., 2023)

4.1.4 Guns per capita

Gun ownership between the tree countries varies greatly. The United States far surpasses Norway and the Czech Republic, with actually more firearms per 100 people, then people itself. Norway records a significantly lower rate at 28.8 guns per 100 residents, though this is still more than double that of the Czech Republic, which stands at 12.5 per 100 citizens. See Table 4 - Table 4 - 1 for an overview of the statistic.

Table 4 - 1: Gun Ownership per 100 people in the three countries mentioned (Pew Research Center, 2024).(Jensen, I. et al., 2024; Pew Research Center, 2024; Policie České republiky, n.d.; Time, 2018).

Country	Firearms per 100 citizens
Norway	28.8
USA	33-100*
Czech Republic	12.5

**Since USA does not have national data registry of firearm ownership, this number is a based on different estimates and surveys. Taking the together the lowest and highest number (Pew Research Center, 2024; Time, 2018).*

Note that the Norwegian and Czech numbers are based on official government registries, meaning they likely only reflect legal ownership of firearms. In contrast, the U.S. numbers are derived from estimates and may include a portion of unregistered or illegal firearms. If similar estimation methods were applied to Norway and the Czech Republic, their per capita rates might also be somewhat higher.

4.2 Homicides and gun homicide rates

This section explores total homicides and gun-related homicides across the three countries. As GDT is intended to respond to firearm use, understanding the frequency and nature of gun crime in each context is important to evaluating the relevance and potential relevancy of such

systems. Wherever possible, homicide statistics have been drawn from official police records to ensure consistency and reliability. However, due to challenges in accessing certain foreign law enforcement databases and language limitations, this has not always been possible. In some instances, secondary sources have been used. While overall homicide rates offer a general sense of societal safety and criminal violence, they do not always provide clear guidance on the suitability of GDT. This is because total homicide figures include killings by all means, knives, blunt objects, poison, and more, not just firearms. Therefore, this section also considers firearm-specific homicide rates. A limitation with that is that it won't include data like people that have been shot but not killed, meaning it won't include the total number of actual gun violence.

The study will look at the years 2010, 2015, 2020 and 2021. That was the only years the I was able to find official police numbers on homicides in Czech Republic.

4.2.1 USA Homicide Rate

According to the FBI, the national homicide rate in the United States per 100.000 inhabitants was 4.8 per in 2010 and 4.9 in 2015 (Federal Bureau of Investigation, 2011, 2016).

The FBI hasn't published statics like this after 2019. Consequently, data for 2020 and 2021 has been drawn from Statista, although this is not a government source, it closely correlates with previous FBI trends, showing credibility. In 2020, the homicide rate per 100.000 peaked at 6.8, decreasing slightly to 6.5 in 2021 (Statista Research Department, 2024). For an overview of the data, see Table 4 - 2.

Table 4 - 2: Homicides rate per 100,000 in USA

Year	Homicides rate per 100,000 in USA
2010	4.8
2015	4.9
2020	6.8
2021	6.5

4.2.2 Norway Homicide rate

The homicide rate in Norway is low. According to statistics from the Norwegian Police, a total of 277 people were killed in the country between 2014 and 2023 (Voldsseksjonen, Kripos, 2025). Of these, 51% were killed using a knife, while approximately 15% a total of 41 individuals were killed with firearms. This results in an annual average of just over four gun-related homicides per year.

Figure 4 - 2 shows that annual homicide numbers have remained relatively stable, typically ranging between 20 and 40 incidents per year (Voldsseksjonen, Kripos, 2025, p. 5). The sharp spike in 2011 stands out clearly in the data and is directly attributable to the terror attack 22nd of July.

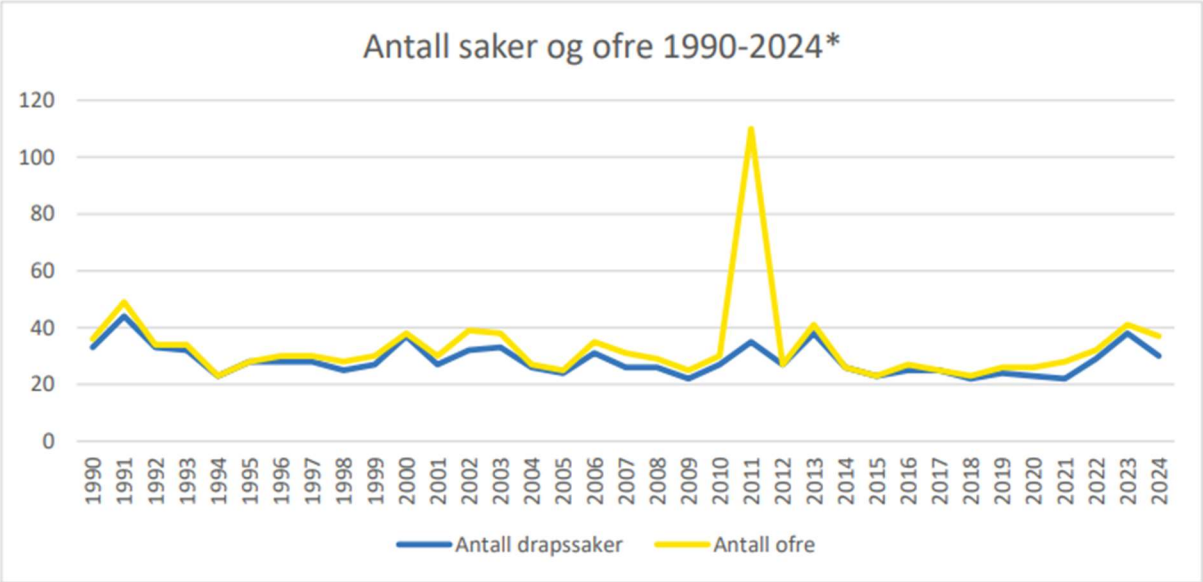


Figure 4 - 2: A statistic showing number of cases and victims in Norway (Voldsseksjonen, Kripos, 2025).

Table 4 - 3 shows the numbers for the total homicide rate in Norway for last few years.

*Table 4 - 3: The numbers of the total homicide rate in Norway for last few years (*Crimes Recorded - Inentional Homicide and Attempted Intentional Homicide*, n.d.)*

Year	Total homicide rate in Norway
2010	0.60
2015	0.46
2020	0.58
2021	0.54

4.2.3 Czech Republic Homicide rate

According to official government statics, the homicide rate in the Czech Republic has been on a significantly decline in recent years, resulting in a 50 % decrease from 2010 to 2021 (*Crimes Recorded - Inentional Homicide and Attempted Intentional Homicide*, n.d.). The statics show every intentional homicide per every 100.000 inhabitants, giving it a murder rate shown in Table 4 - 4.

Table 4 - 4: Total homocide rate in Czech Republic for last few years

Year	Homicide rate in Czech Republic
2010	1.0
2015	0.84
2020	0.53
2021	0.43

4.2.4 Total homicide rate

Based on the retrieved data, Norway's homicide rate has remained relatively stable over the past decade, fluctuating modestly between 0.46 and 0.60 per 100,000 inhabitants. The Czech Republic has experienced a significant decline in homicides, where its rate was cut by more than half between 2010 and 2021. In contrast, the United States saw an increase in the years 2020 and 2021, see Table 4 - 52 and Figure 4 - 3**Error! Reference source not found.** for overview.

Table 4 - 5: Overview of total homicide rates in three mentioned countries

Country	2010	2015	2020	2021
Norway	0.60	0.46	0.58	0.54
Czech Republic	1.0	0.84	0.53	0.43
USA	4.8	4.9	6.8	6.5

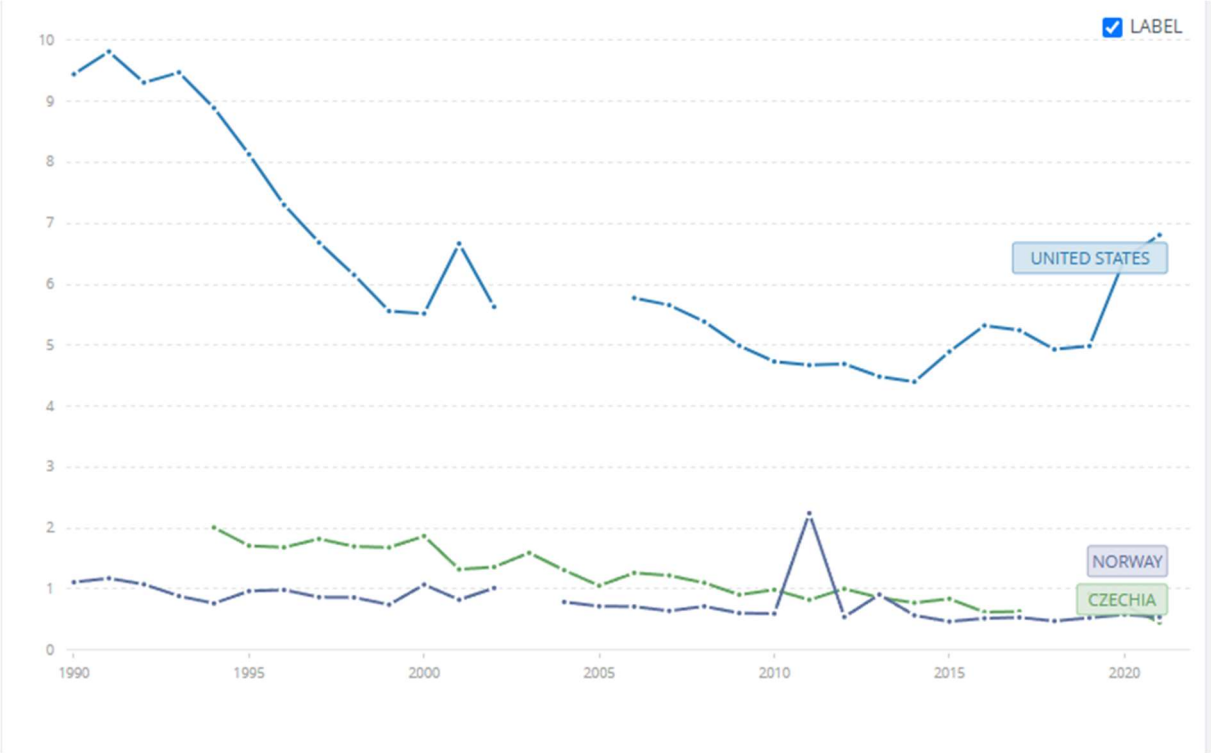


Figure 4 - 3: Homicide rate statistics for the three countries presented

Figure 4 - 3 from UN Office on Drugs and Crime's International Homicide Statistics database has put the United States, Norway and Czech Republic homicides rate together going back to 1990. Note there are some years where is no data, like Czech after 2017 (World Bank Group, n.d.). The comparative trend shows that all three countries have seen a general decrease in homicide rates since 1990, with the United States having started from a much higher baseline. However, USA has homicide rate has increased in recent years. Notably, the Czech Republic, which had nearly double Norway's homicide rate in 2010, recorded a lower rate than Norway by 2020.

4.2.5 Gun homicide rate

This part presents homicide rate by firearm, which refers to homicide where the cause of death is specifically due to a firearm, excluding suicides. Table 4 - 6 shows homicide by firearm rates.

Table 4 - 6: Homicide by firearm rates for the three mentioned countries (Dyvik, E. H, 2025; Our World in Data, 2024; Voldsseksjonen, Kripos, 2025) .

Country	2010	2015	2020	2021

Norway	<0.1	<0.1	<0.1	<0.1
Czech Republic	0.1	<0.1	<0.1	<0.1
USA	2.9	2.8	4.1	5.5

In both Norway and the Czech Republic, the firearm homicide rate has remained 0.1 or below 0.1 per 100,000 inhabitants throughout the period. The numbers are so consistently low that meaningful year-to-year comparisons become difficult. Gun-related homicides are rare in both countries and represent only a small fraction of total murders, which is already a very low number. The United States has significantly higher firearm homicide rates, with a noticeable increase between 2015 and 2021. In 2021 alone, the U.S. reported 5.5 firearm homicides per 100,000 people, over 50 times the rate seen in Norway or the Czech Republic. The proportion of homicides involving firearms differs significantly between the countries. In Norway and the Czech Republic, most murders involve other weapons such as knives or blunt instruments. In the United States, however, firearms are the predominant tool used in homicides.

4.3 Extreme Acts of Gun Violence

Violent gun crime is a relatively rare occurrence in both Norway and the Czech Republic, compared to countries like United States. However, a single incident of a mass shooting, can still create massive harm, even in societies without high levels of gun violence. Grant Duwe (2019) defines mass public shootings as "*incidents that occur in the absence of other criminal activity in which a gun was used to kill four or more victims at a public location within a 24-hour period*" (Duwe, 2020, p. 1). This definition distinguishes mass shootings from more frequent gang related or other criminally motivated gun violence, like robberies.

Although mass public shootings make up only about 0.5% of all homicides in the U.S (Duwe, 2020), they are often described as a uniquely American phenomenon. However, both Norway and the Czech Republic have experienced tragic cases of mass shootings and attempts in recent years. This suggests that such incidents are not limited to high crime societies and can occur even in countries with low overall gun violence. Moreover, they underscore the devastating potential of a single armed individual. As Choi et al. (2014) argue, gun violence is a unique and universal threat to public safety, regardless of its frequency (Choi et al., 2014).

Research has also found that individuals with serious mental illness are disproportionately overrepresented among mass public shooters (Smart, R & Schell, T. L, 2021).

The next section examines three cases of extreme gun violence, two from Norway and one from the Czech Republic. Such real-world examples illustrate how isolated extreme acts of gun violence can cause significant harm, even in societies with otherwise low levels of gun homicides.

4.3.1 22nd of July 2011

On July 22nd, 2011, Norway experienced a deadly act of domestic terrorism. A total of 77 people was killed by a terrorist who acted alone. The attacker, disguised as a police officer, first detonated a bomb near the government quarters in Oslo, killing eight people. Following the explosion, he traveled to Utøya, an island outside of Oslo. Utøya was hosting the annual summer youth camp organized by the Labour Party. There, he opened fire on the camp participants, many of whom were teenagers, killing 69 people before being apprehended by the police. All the weapons used in the attack were legally obtained. At the time, that was the deadliest mass shooting by a lone gunman, the world had seen (Police1 Staff, 2024).

According to official reports, the first shot was fired at 17:21, and the perpetrator was arrested approximately one hour later. During that period, the lone gunman was able to carry out a prolonged and devastating attack at Utøya. Many died in the time right before the perpetrator was apprehended. In the aftermath, Norwegian police experienced considerable criticism for not arriving to the island sooner and apprehending the terrorist faster. Part of the delay stemmed from police being uncertain about the number of attackers involved. Early information, such as phone calls from people at the island, suggested the possibility of multiple gunmen, which led police to delay their engagement while assembling sufficient personnel and equipment. Had it been confirmed earlier that the assailant was acting alone, the response might have been faster, this could potentially have saved lives (22. juli-kommisjonen, 2012; Zondag, M. H. W. et al., 2017).

4.3.2 Al-Noor attack 2019

10 August 2019, a young Norwegian man attempted to carry out a mass shooting at Al-Noor Islamic Center Mosque in Bærum. He was motivated by far-right ideology and inspired by the events of 22 July. He first shot and killed his stepsister, who was adopted from China, before arming himself with two rifles and a shotgun taken from his father. He then drove to the Al-mosque with the intention of killing as many Muslims as possible. Upon entering the mosque during a prayer session, the perpetrator began shooting. However, his plans were hindered by worshippers, who managed to overpower and restrain him until the police arrived. Although several shots were fired, no one inside the mosque got hit, resulting in no one killed or seriously injured. Their swift and courageous intervention of the civilians inside the mosque, likely prevented a mass casualty event. (Lepperød, T, 2020; NRK, 2019)

An official evaluation of the incident later revealed delays and communication breakdowns during the police response (Evalueringsutvalget, 2020). During the altercation, one of the mosque attendees, broke free and made an emergency call but initially dialled the non-emergency police line, 02800, instead of the correct emergency number, 112. This resulted in his call being less prioritized and ended up in queue were police instead answered more emergent calls. The caller also attempted to stop passing vehicles to get assistance, but no one stopped. When he eventually reached the emergency line, a language barrier created further complications; the caller was not fluent in Norwegian, and the operator struggled to understand what was being communicated. As a result, several critical minutes passed before the police understood what the man was trying to tell them, allowing them to send police officers to the correct location (Evalueringsutvalget, 2020; Lepperød, T, 2020; NRK, 2019).

4.3.3 Charles University 2023

On December 21, 2023, a lone gunman opened fire at Charles University in Prague, killing 14 people before committing suicide before police was able to apprehend him. It was one of the deadliest mass shootings in Czech history. The shooter, a student at the university, had legally obtained the weapons used in the attack and was reportedly struggling with mental illness (Burga, S., 2023). The tragedy sent shockwaves through Czech society, with Prague's mayor, Bohuslav Svoboda, noting:

"*We always thought that this was a thing that did not concern us. Now it turns out that, unfortunately, our world is also changing and the problem of the individual shooter is emerging here as well*" (Burga, S., 2023).

The incident prompted legislative responses, including new firearm regulations to take effect in 2026, such as granting doctors access to national databases to see if their patients were registered with firearm (Cameron, R., 2024).

In the aftermath of the tragedy at study was conducted (Hrinko et al., 2025). It identified significant gaps in security infrastructure and licensing protocols, especially regarding monitoring the mental health of firearm license holders. The report advocated for integrated multimodal detection systems—technologies that combine audio sensors for detecting gunshots or screams with visual surveillance. This would be a part of a broader, risk-based public safety strategy. Timely detection and automated alerts, the study emphasized, are important for minimizing response times and improving situational awareness during such high-impact events.

4.4 Shotspotter in Chicago

The city of Chicago first deployed the GDT ShotSpotter in a pilot project in September 2012. Initially covering approximately three-square miles, the system's coverage expanded significantly over the years. By May 2018, the technology had been deployed across more than 136 square miles of the city (City of Chicago, 2024; Connealy et al., 2024). However, the city ultimately chose to terminate its contract with ShotSpotter on February 16, 2024, with decommissioning taking effect on September 22, 2024 (City of Chicago, 2024; Connealy et al., 2024).

The following section will examine the reasons behind the removal of ShotSpotter in Chicago. It begins by exploring public perceptions of ShotSpotter and GDT more broadly. It then considers the socio-political context at the time, particularly the influence of the Black Lives Matter (BLM) movement and its role in shaping attitudes toward policing. The analysis will also focus on the controversial police killing of 13-year-old Adam Toledo, an incident that followed a ShotSpotter alert and became a focal point in public debates. Finally, the section discusses the company's rebranding from ShotSpotter to SoundThinking, a move that some critics have linked to the system's termination in Chicago.

4.4.1 Public perception

Survey data from Chicago concerning public attitudes toward ShotSpotter and GDT reveal both support and complexity. The aforementioned 2022 poll conducted by Fallon Research & Communications found that 84% of Chicago respondents either supported, or somewhat supported, the use of GDT, while only 12% expressed opposition (Fallon Research & Communications Inc., 2022). However, this question referred to GDT in general, without explicitly naming ShotSpotter. When asked specifically about ShotSpotter, awareness was considerably lower, 57% of respondents said they had never heard of the company. Despite this, 63% expressed a favourable view, compared to 22% who viewed it unfavourably. This discrepancy between general support for GDT and specific knowledge of ShotSpotter raises questions about how the technology was introduced to respondents. It is important to note that although the survey was conducted by Fallon Research, it was commissioned by ShotSpotter, the company behind the technology being evaluated. This raises questions about potential bias in how the survey was framed or interpreted. According to the same survey, 51% of Americans said they felt safer knowing GDT systems were in place, while 38% disagreed to some extent. It is possible that respondents who were unfamiliar with ShotSpotter were given a standardized description of the system during the survey. If this description reflected the company's own marketing, such as the following excerpt from SoundThinking's website, it likely framed the technology in a highly positive light, and excluding controversies it has faced:

"Police rely on the community to call 9-1-1 if gunshots are fired, but only 20% of incidents are ever reported on average. This creates a situation where police departments have a large data gap that makes it difficult to be able to effectively "serve and protect" when it comes to gun violence. SoundThinking's ShotSpotter acoustic gunshot detection technology fills the gap with a network of acoustic sensors that can detect, locate, and alert police to nearly all gunshot incidents. The system is in operation in more than 170 cities and is used by police to:

1. *be able to respond to a higher percentage of gunfire incidents.*
2. *improve response times to crime scenes to better aid victims and find witnesses; and*
3. *help police locate key evidence to identify and investigate suspects" (SoundThinking, n.d.)."*

ShotSpotter's own definition does not include critical perspectives and empirical evaluations, some of which suggest mixed results regarding ShotSpotter's accuracy and actual impact on

crime, as detailed in several studies mentioned earlier in this thesis (Doucette et al., 2021; Mares & Blackburn, 2012, 2021; Vovak, H. et al., 2021)

Concerns have also been raised regarding the distribution of ShotSpotter coverage across Chicago. According to the MacArthur Justice Centre, around 80% of Black residents and 35% of Hispanic residents lived in areas covered by ShotSpotter, compared to just 13% of white residents (Manes, J. & Brunt, A. V., n.d.). This disproportionate deployment has led to criticism that the technology reinforces existing patterns of over-policing in communities of colour (Ebrahimji, A., 2024). These patterns are echoed in broader perceptions of gun crime across demographic groups. While 47% of all respondents in the Fallon survey described gun crime in Chicago as a "very big problem," only 33% of white respondents agreed, compared to much higher concern among Black and Hispanic respondents (Fallon Research & Communications Inc., 2022).

Chicago's political leadership eventually responded to such public concerns. Brandon Johnson, elected as mayor in 2023, campaigned in part on a promise to end the city's contract with the company. He cited the system's unreliability and its connection to high-profile incidents of police violence, including the 2021 killing of 13-year-old Adam Toledo, in which a ShotSpotter alert played a role in initiating the police response (Connealy et al., 2024; Pena, M. et al., 2023). Mayor Johnson characterized the system as a "walkie-talkie on a pole," emphasizing its limitations and calling it "clear evidence that ShotSpotter is unreliable and overly susceptible to human error" (Cherone, H., 2024). Johnson further emphasized that instead of spending resources on GDT, the city would redirect funding to "communities that have been historically underserved" (Haeberle, B., 2024), a clear reference to marginalized neighbourhoods, particularly Black communities

4.4.2 Black Lives Matter

To understand better understand some of the critique of ShotSpotter that Mayor Johnson said, it's important to have some background on the sociopolitical climate in which this occurred. The Black Lives Matter (BLM) movement got renewed and widespread attention following the killing of George Floyd in May 2020. Floyd, an unarmed black man, died after a white Minneapolis police officer, Derek Chauvin, knelt on his neck for nearly nine minutes during an arrest. Chauvin was later convicted of murder. The event triggered widespread protests police brutality and systemic racism, focusing especially on the disproportionate use of force

by law enforcement against black Americans, claiming police would have dealt the situation differently if George Floyd had been white.

The BLM movement has been an outspoken critic of structural inequalities in the U.S. criminal justice system. Advocates argue that repeated instances of police violence highlight enduring racial biases in American policing. Among the movement's central demands have been calls to defund or reduce police budgets, instead priotizing spending resources toward mental health services and social workers. Many within the movement view law enforcement as an institution historically shaped by systemic racism (Campell, A., 2021; The Guardian, 2022; University Archives, n.d.)



Figure 4 - 4: High ranking politicians kneeling in silence to honour George Floyd (Blow, C. H., 2020).

Figure 4 - 4 shows high-ranking politicians, such as former Speaker of the House Nancy Pelosi, kneeling in silence to honour George Floyd (Blow, C. H., 2020). The incident brough policing, race and police brutality to the forefront of American political discourse (Vitro, C. et al., 2022). The gesture symbolized how deeply issues of race and policing had permeated American mainstream politics.

4.4.3 Trust in law enforcement and background

The killing of George Floyd in May 2020 and the rise of BLM movement had a significant and measurable impact on public perceptions of law enforcement in the United States. Research conducted during and after the protests documented a sharp decline in trust toward the police, particularly among Black Americans (Vitro, C. et al., 2022). 51 % of the overall population in USA reported to have confidence in the police (Ozimek, T., 2024). When compared for only Blac Americans, the figure declines to 27 % (Jones, J. M., 2021). By comparison, trust in law enforcement is substantially higher in other countries. In Norway, 70% of respondents expressed confidence in the police (Horvei, M. & Karterud, T., 2024), while in the Czech Republic, surveys reported trust levels around 72% (Siska, M., 2019). This trust gap may help explain differing attitudes toward technologies like GDT. Perceived legitimacy of law enforcement might potentially influence whether such tools are seen as protective or intrusive. Relatedly, public perception of safety differs considerably across the three countries.

In 2024, 87% of Norwegians reported feeling safe in their local communities (Horvei, M. & Karterud, T., 2024). In the Czech Republic, a 2021 survey found 85% of citizens felt safe in general (*Feeling of Safety in the Czech Republic in General*, 2022). In contrast, public perceptions of safety in the United States are notably more different. For example, 40 % of Americans survey in a Gallup poll from 2023 reports they feel unsafe when walking alone at night near their home(Saad, L., 2023). Or more spesifically in Chicago, a 2024 Harris Poll showed that 64% of residents expressed concern about public safety, while only 36% reported feeling unconcerned (*Chicagoans Reflect on the Last Year*, 2024)

Demographic differences between these countries also differs between the countries. The United States is notably more ethnically diverse, with 75.3% of the population identifying as white and 13.7% as black or African American (U.S. Census Bureau, n.d.). In contrast, both Norway and the Czech Republic are historically more ethnically homogenous, and neither collects racial data in their national censuses. Moreover, the United States history with slavery differ from Norway and the Czech Republic. In USA, many black Americans trace their ancestry to enslaved people, this continues to shape deep racial disparities in public trust and interactions with the justice system and between different ethnicities (HISTORY.com Editors, 2024).

The National Association for the Advancement of Coloured People (NAACP), a influential civil rights organizations in the U.S., emphasizes that racial disparities still remain deeply embedded in the criminal justice system today. According to the NAACP, these inequalities "directly obstruct and deconstruct our minority communities" and are shaped by the legacy of police practices that originated during the era of slavery (NAACP, n.d.).

The organization traces the origins of modern-day policing to the so-called "*Slave Patrols*" established in the early 1700s in the Carolinas. These patrols were created as a system of social control designed to instil fear, suppress slave uprisings, and catch slaves who managed to escape. They had legal authority to enter homes without warrants and use violence to enforce obedience. Although these patrols formally ended after the Civil War, the NAACP argues that their influence has persisted, shaping the "mentality" of modern day policing institutions and contributing to ongoing racial biases in law enforcement (NAACP, n.d.). The organization reports that Black individuals are five times more likely than white individuals to be stopped by police without just cause. Additionally, 65% of Black adults have reported feeling racially targeted by law enforcement, and 84% believe that white people are treated more favourably by police. Furthermore, 87% of Black adults belive the U.S. criminal justice system is more unjust toward black individuals. Moreover, they claim that there is similar drug use among the white and black population, however black Americans are six times as likely to be imprisoned for drug-related offenses (NAACP, n.d.). Also even though black Americans only make up about 13 % of the US population, they make up 48 % of people serving live in prison without parole (Prison Policy Initiative, n.d.). Statics like this underscore why policing and race remain a particularly sensitive and politically charged issues in the U.S. The BLM gained huge traction by drawing attention to such issues.

4.4.4 The Death of Adam Toledo

Adam Toledo, a 13-year-old boy, was fatally shot by a Chicago police officer on the March 29, 2021. The police response was triggered by a ShotSpotter alert that had detected gunfire in a neighborhood in the Little Village area. Officers responding to the alert encountered Adam Toledo and another individual, Ruben Roman, in an alley. When approached, both individuals fled from the police on foot. One of the officers, Eric Stillman, pursued Toledo and saw that he was armed with a gun. After repeated commands to drop the weapon, Toledo stopped near a gap in a wooden fence and began to turn toward the officer, discarding the firearm behind

the fence. Officer Stillman did not see Toledo drop the weapon, and thought he was still armed. When Toledo moved, he perceived an imminent threat, fired one shot, which hit Toledo in the chest. Toledo was pronounced dead at the scene. The firearm recovered at the scene, was later matched to the earlier gunfire detected by ShotSpotter. A subsequent investigation concluded that the officer's actions were legally justified. The State Attorney determined that the use of deadly force was warranted under the circumstances, since Officer Stillman had valid reasons to believe Toledo still was armed, and no charges were filed against the officer Eric Stillman (Foxxy, K. M., 2024).

The death of Adam Toledo, especially due to his and the fact that he was unarmed and young, sparked widespread protests and intense public backlash across Chicago and beyond (Walter-Warner, H., 2021). Demonstrators gathered in large numbers, expressing outrage not only at the police officer's use of deadly force, but also at the broader system they believed enabled it. Many protesters directly linked the incident to the deployment of ShotSpotter technology, arguing that it had drawn law enforcement into a volatile situation that ended in the death of a child. The technology was widely criticized in protest slogans and public statements, see Figure 4 - 5Figure 4 - 5 (Daley, J., 2021).



Figure 4 - 5: A woman holds a photo of Adam Tolerado with the text ""Say no to programs like Shot Spotter they steal lives & they steal tax dollars" (Daley, J., 2021)

In the aftermath, then-candidate and later elected Mayor Brandon Johnson commented on the need for reform. He stated that the city should pursue alternative strategies to reduce gun violence, which wouldn't rely on physically stopping people on the street (Mohtasham, D., 2024).

4.4.5 ShotSpotter changing name to Soundthink

In April 2023, the company ShotSpotter underwent a corporate rebranding and changed their name to SoundThinking Inc. According to the company's official statement, this change was made to better reflect its broader mission and expanded portfolio of law enforcement technologies, beyond GDT. The rebranding coincided with the launch of its SafetySmartPlatform, which integrates multiple products such as, Crime Tracer, a search engine for law enforcement databases, Case Builder, an investigation management tool (SoundThinking, 2023). CEO of ShotSpotter, Ralph Clark said that "*ShotSpotter established the acoustic gunshot detection category more than 25 years ago. As the public safety landscape has evolved, we have evolved with it*" – CEO Ralph Clark. (SoundThinking, 2023).

However, the timing of the rebrand sparked speculation among critics and analysts. Some have claimed that the company sought to distance itself from negative publicity and political backlash, particularly following the 2023 Chicago mayoral election. After Johnson's election, the city's decision to discontinue the system was seen by many as a political below to the company. Notably, following these developments, ShotSpotter's stock value reportedly declined by nearly 1/3 (Hing, G., 2023; Noonan, K., 2023).

It's important to note the despite the criticism, the company has explicitly denied that the rebranding had anything to with controversies related to Chicago. On their website they address this question directly:

"*Did ShotSpotter rebrand itself as 'SoundThinking' to distance itself from the surveillance product following Chicago's 2023 mayoral election?"* Which they answer *"Absolutely not. This is a patently false claim. The rebranding of the company was driven by the extension of other products and services beyond ShotSpotter*." (SoundThinking, n.d.a).

5 Research Design and Methodology

Since quantitative methods have been addressed throughout the thesis, this chapter will focus on presenting the methodology used in the qualitative research. The reasons for this research design will also be explained. In addition, this chapter will describe the process of data collection, how the interviews were structured, selection of interviewees, development of the interview guide, the ethical guidelines followed, and the main considerations, limitations, and challenges faced during the study.

5.1 Methodology and research design

According to social scientist William Lawrence Neuman, research is a way to gain knowledge, and is "*highly relevant for understanding social life generally and to the decisions you make each day*" (Neuman, 2014, p. 1). It is an ongoing process of searching and trying to work towards the truth and understand the world. Neuman identifies three main types of research based on their underlying goals: *exploratory, descriptive, and explanatory*. Each serves a different purpose depending on the maturity of the topic and the questions being asked (Neuman, 2014). A research design is the structured plan guiding the choices a researcher makes throughout the process. It serves to connect the research question to the data collection and analysis. Some have suggested that research design can be likened to the blueprint used by an architect, meticulously crafted , detail-oriented, and practical (Blaikie & Priest, 2019). Furthermore, a design is essential for addressing the research problem as clearly and effectively as possible (Dewey, J., 2020). In this thesis, the research design includes both qualitative and quantitative components. The qualitative aspect primarily relies on semi-structured interviews, while the quantitative component draws from national and international statistics.

This project blends exploratory and descriptive elements. It is exploratory in that it seeks to open new discussions around the implementation of GDT in Norway, an aspect relatively unstudied. It is descriptive in its effort to document and present detailed accounts of how stakeholders perceive this technology. As Neuman explains, exploratory research is often used when little prior knowledge exists, whereas descriptive research seeks to develop a well-rounded picture of a specific phenomenon or setting (Neuman, 2014).

In terms of methodological orientation, the project combines both qualitative and quantitative approaches. Quantitative data, such as firearm-related homicide rates and gun ownership statistics, offers a wider perspective. This helps establish how Norway compares to countries like the U.S. and the Czech Republic, where GDT is already in use. Meanwhile, the qualitative part focuses on the experiences and opinions of stakeholders collected through interviews. This approach attempts to provides enough breadth and depth, making sure the topic is approached from multiple angles. While Neuman notes that surveys remain one of the most widely used methods in the social sciences, they are grounded in a quantitative and deductive paradigm (Neuman, 2014). They typically start with predefined variables that are tested through standardized questions. This study, however, leans more toward the qualitative side when it comes to its primary research component, the interviews. The goal was not to test a hypothesis, but rather to explore perceptions, beliefs, and institutional realities. The interviews conducted for this thesis varied in format, depending on the preferences and availability of the participants. They are different in length, number of questions, audio recorded/not record, in person or in writing. Using different formats allowed flexibility, which made it easier to accommodate the participants. At the same time, it gave me useful insight into how the format itself can influence the tone, depth, and clarity of the conversation.

5.1.1 Selection of interviews

Number of interviews

A key question to consider was: *How many interviews are enough to serve the study's purpose effectively?* This is a common dilemma in qualitative research, where the goal is not necessarily to generalize findings statistically, but to explore perspectives in depth. For example, the AI-ethic expert interviewee, is based in Oslo. Had the participant been based in a more rural and less densely populated area, such as Finnmark, his perspectives on the implementation or relevance of GDT might have differed. Similarly, interviewing a different AI expert altogether could have resulted in an entirely different interview. Even though the AI expert provided valuable information, no single interviewee can fully represent an entire professional or geographic group. As Neuman points out, "*When we sample, we select some cases to examine in detail, and then we use what we learn from them to understand a much larger set of cases*."(Neuman, 2014, p. 246). In that sense, the interviews conducted are not

intended to cover every possible perspective, rather they are strategically selected to provide relevant and diverse takeaways.

Ultimately, a balance must be struck between depth and manageability. As Edwards and Holland elegantly put it, when answering on how many qualitative interviews are enough, *"It depends."* (Edwards, R. & Holland, J., 2013, p. 67). At some point, the researcher must move from data collection to analysis and writing. Therefore, the number of interviewees for the this research was 5, by that time I decided that further interviews were unlikely to give significantly new information, and practical limitations such as time management for the thesis had to be considered.

Selection criteria

To answer the research questions, participants with in-depth knowledge and expertise related to GDT were interviewed. Given the limited time and resources available, a purposive sampling strategy was chosen. This approach is commonly used in qualitative research to identify and select information-rich cases that are especially relevant to the study's objectives (Patton, 2002). The goal was to include participants with diverse insights, both from within the GDT industry and from relevant public sectors, while ensuring relevance to the Norwegian context. It has been used considerable amount of time on researching different companies and people associated with GDT. As well as using my personal network of friends, family and colleagues to explore potential candidates. Most outreach were conducted either via mail or LinkedIn.

As Triangula is a Norwegian GDT company based in Oslo, where I reside, they were identified as an ideal starting point for interviews. They were able to give useful information into the national context: Why is GDT not currently in use in Norway? Has there been dialogue with Norwegian law enforcement? What are their views on the future of GDT in the country? To gain a comparative perspective from a country where third generation GDT is already operational within law enforcement, I turned to the Czech Republic and SED product. Interviews with SED representatives offered important information about how technology functions in real-world policing, what hurdles they have encountered, and how their system is integrated into daily police work. In addition, I interviewed an IT advisor from the Norwegian police to gain perspectives on the legal and institutional understanding of GDT and AI use in policing. An expert in AI ethics was also included to provide critical reflection on the

potential social consequences of introducing such surveillance technologies in a Norwegian context. Finally, I conducted interviews with officers from the Czech police who actively use SED. These conversations provided essential information into how third generation GDT is experienced in practice: Was it effective? What criticisms had they encountered from the public? As Norway and the Czech Republic share some socio-political similarities, I considered this comparison valuable in understanding how Norwegian citizens might respond to the introduction of GDT — whether with concern, acceptance, or something in between.

5.1.2 Structuration of interview

This section will present and reflect on each interview conducted, in chronological order. It includes my own reflections, on what went well, what could have been done differently, and how my role as a researcher developed throughout the process. This reflective practice was crucial for improving both my development as an interviewer and my broader understanding of the topic

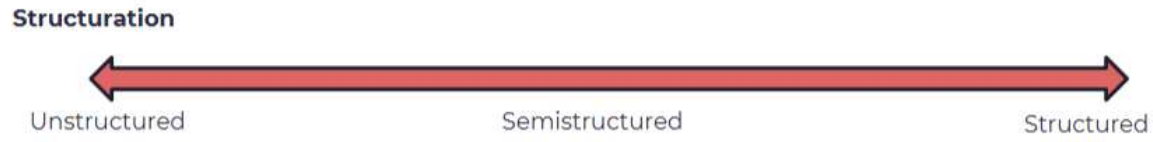


Figure 5 - 1: An illustration of how the structure of interviews can be viewed along as a spectrum (Fisker, J. K., 2024, p. 8).

Figure 5 - 1 was taken from one of Jens Kaae Fisker lectures at the University of Stavanger, MEN185 course, illustrates how the structure of interviews can be viewed along as a spectrum, ranging from unstructured, through semi-structured, to fully structured formats (Fisker, J. K., 2024, p. 8) As Fisker explained in the lecture, interviews are rarely found at the extreme ends of this spectrum. In practice, most interviews fall somewhere in the middle, typically semi-structured, and may lean slightly toward either the structured or unstructured side depending on the context and purpose.

According to Edwards and Holland (2013), structured and semi-structured interviews are the two most commonly used forms of qualitative interviews. In a standard semi-structured interview, the researcher prepares an interview guide. The interview guide is a set of guiding questions or topics, but there is flexibility in how these questions are asked and in what order. This format allows interviewees to respond in their own words which provides depth and

understanding, while also maintaining enough structure to enable comparisons across participants by ensuring that key themes or questions are consistently covered.

On the other end, unstructured interviews offer more flexibility. Although the researcher begins with a clear topic and an overall aim, the direction of the conversation is largely guided by the interviewee. The goal is to allow the participant to speak from their own perspective, using language and ideas that feel natural to them. Burgess describes, that this approach creates a conversation with a purpose, where the researcher follows the participant's lead, exploring new themes and adjusting both the content and even the focus of the research based on what being spoken during the dialogue. (Burgess, 1984). Both semi-structured and unstructured interviews are widely used across the social sciences, and while the form of the interview might appear similar, the theoretical orientation and analytical approach taken by the researcher often differs.

In this research, semi-structured interviews were chosen as the primary method of data collection, therefore this is highlighted here. This format allowed participants to speak freely and openly, giving the interviews a more conversational feel, while still being guided by key questions. It provided the flexibility needed to discuss complex or sensitive topics, while also offering enough structure for me to keep the conversation focused and ensure that essential themes were addressed.

However, as will be discussed later, both the interview guides differed between interviews, and so did the settings in which they were conducted. For instance, the written interview did not allow for any follow-up questions. In contrast, the first interview with Triangula followed the guide only loosely, which allowed for a more open-ended and spontaneous discussion. This shows how different interviews varied along the spectrum Jens Kae Fisker spoke of (Fisker, J. K., 2024), however they still maintained their core as semi-structured.

5.1.3 Semi-structured interview

A main characteristic of semi-structured interviews, is that it lets the interviewer and the interviewee both engage. The interviewer prepares and uses an 'interview guide,' which is a list of questions and topics that should be covered during the conversation, usually in a specific order. While the interviewer follows the guide, they can also explore new topics that come up during the interview if it seems relevant and appropriate. The questions asked, are

typically open-ended, which allows for allows for up-follow up questions, and longer answers (Cohen D, Crabtree B., 2006). A main reason why it was chosen to conduct the interviews this way, is that it allowed for the conversations in interviews to have a natural form. The interview guide I developed, kept on developing throughout the interviewing process. The interview guide was divided into themes, which had several under-topics which questions. The under topic again, had some questions, which could be less open answering, sometimes just yes/no. The following sections will present how the different interviews and interview guide was conducted.

Face-to-face interview

One of the interviews for this study was conducted face-to-face, a method that offers several key strengths in qualitative research. Face-to-face interviews often resemble natural conversations, which allows the interviewer to be more responsive, adapting questions in real time based on the participant's answers. This kind of setting also creates space for observing non-verbal cues, such as body language, tone, and facial expressions, which can add layers of meaning to what is being said (Neuman, 2014). In my case, this was the first interview I conducted, and it proved to be especially insightful. It took place early in the process, at a stage when I was still developing my understanding of GDT. The participant was a representative from Triangula, naturally he had a verry good understanding on how this technology functioned, and his explanation really made me understand the topic much more, which allowed me to better understand the literature which helped me with the writing as well. However, the interview also came with challenges. It was conducted in Norwegian; the interview guide was English, the notes I took was in Norwegian, and my summary of the conversation had to be done in English. This created some confusion, and it took time ensuring I had translated things correctly. Since the interview was not recorded, I relied heavily on rapid notetaking throughout the 1.5-hour conversation. To keep the flow of the discussion natural, I scribbled quickly, sometimes so fast that parts of my notes became nearly unreadable (being left-handed and writing with a pen, certainly did not help). Later, when trying to reconstruct the full sentences from keywords, I found myself questioning whether I was faithfully capturing the participant's words or simply filling in gaps based on my memory. This experience taught me a valuable lesson: recording interviews significantly eases the work of transcription and ensures greater accuracy.

The open-ended and conversational style of the interview led to many follow-up questions, which provided good insights but also meant I didn't get through my full list of questions. This less structured format allowed for depth but lacked the time efficiency that more structured interviews might offer.

Moreover, it is worth acknowledging a known limitation of face-to-face interviews: the risk of interviewer bias. Factors like the interviewer's tone, appearance, and phrasing can influence the responses. There are six types of interview bias that can affect the quality of data collected (Neuman, 2014):

1. Errors made by the respondent
2. Unintentional mistakes or sloppiness by the interviewer
3. Intentional manipulation by the interviewer
4. Bias introduced through the interviewer's own expectations
5. Failure to probe effectively, and
6. Influence stemming from the interviewer's appearance.

In the Traingula interview, failure to probe effectively was my biggest learning point. There were several follow-up questions I could have asked, which I only realized later when writing the summary. I had high expectations for the interview, which made me nervous, which affected my focus in the conversation. However, it was a good experience, and allowed me to be more relaxed and sharper for the next interviews.

Video interview

Communication through video-conferencing platforms such as Microsoft Teams or Skype has become increasingly common, especially after the COVID-19 pandemic. This shift toward digital interaction has also extended to qualitative research, where online interviews are now seen as a practical and accepted alternative to face-to-face meetings. One clear advantage of this method is that it overcomes geographical barriers, allowing interviews to be conducted without the need for travel. Both the interviewer and the interviewee have the flexibility to choose their location, whether it's their home or office, which can help participants feel more relaxed and open during the conversation. Additionally, video makes it possible to observe non-verbal, sensory, and emotional cues, such as facial expressions, body language, and tone, similar to what can be picked up during face-to-face interviews (Hai-Jew, 2015).

It’s also important to note a significant limitation of video interviews when compared to face-to-face interactions. These interviews depend on a stable internet connection and access to compatible devices, which can be a barrier for some participants. Not everyone has the same level of access to technology, and for certain groups—particularly older participants or those less familiar with digital tools—navigating video-conferencing platforms can be challenging. This technical requirement can limit who is able or willing to take part in a video interview, potentially affecting the diversity or inclusiveness of the sample (Hai-Jew, 2015)

The interview was with a representative from SED, and since he was based in the Czech Republic, conducting the interview via Microsoft Teams was a very practical solution. It saved me the time and cost of traveling there and offered different possibilities than a phone call or written exchange by email or post would have. The participant, who works in the tech field, was actually more familiar with Teams than I was, which made the process smooth. At several points during the conversation, when he mentioned company names, I wasn’t sure how to spell, he simply typed them into the chat. This helped maintain the flow of the conversation without unnecessary interruptions. Being on the computer also allowed him to share his screen, which made it possible to show me video demonstrations, PowerPoint slides, and other material explaining SED technology. At one point, when he referenced a study on how SED don’t conflict with GDPR regulations, he immediately sent me the document through the chat, giving me a chance to look it over later. These kinds of interactive elements made the video interview particularly rich and dynamic, in a way that wouldn't have been possible through phone or written formats.

Telephone interview

One of the interviews conducted for this thesis was over the telephone. Telephone interviews offer certain advantages, particularly in terms of logistics. Like video interviews, they make it easier to reach participants across geographical distances and can be more accommodating for individuals with tight schedules. In this instance, the participant suggested the telephone format due to time constraints, and it allowed for a more flexible arrangement that suited both of us. However, telephone interviews also come with limitations. The lack of visual cues means there is no access to the interviewee’s facial expressions, gestures, or body language (Edwards, R. & Holland, J., 2013). In my case, this limitation became evident when the participant at one point made an ironic remark that I did not initially understand. Had the

interview been conducted via video or in person, it's likely the seeing the body language, could made me understand the irony better.

That said, I personally found the telephone format to be more comfortable than video interviews. I tend to move around when speaking on the phone, which made the interaction feel more natural. Unlike in a video setting, I didn't have to be conscious of my appearance, eye contact, or background distractions. While the medium has its drawbacks, especially for capturing non-verbal communication, it proved to be an efficient and effective solution in this particular case.

Written interview

The last two interviews for this research were done in writing digital format. Written interviews have certain limitations, like the inability to observe participants body language, and limited possibilities to ask follow-up questions, they also offer advantages. As Handy and Ross (2005) explain, written interviews allow participants to respond thoughtfully at their own pace, and they eliminate the need for scheduling a time when both the interviewer and interviewee can do it. I intentionally aimed to include at least one written interview in this study to gain experience with the method. This flexibility proved especially valuable. One interviewee had a demanding work schedule, making it difficult to arrange a live meeting. Instead, I sent the interview questions digitally, and he responded when he was free to do so. The other written interview was conducted with a representative from the Czech police. In addition to flexibility, this format offered another benefit: due to limited confidence in his English-speaking capabilities, he feared potential misunderstanding and therefore wanted it to be written. This allowed us both to translate the interview guide and questions from English to Czech, and back to English, so we minimized the language barriers.

5.1.4 Interview guide

An interview guide is a prepared list of questions or topics that the interviewer intends to cover during the interview. It can vary in detail, some guides are very specific, outlining not only the types of questions to be asked but also suggestions for how they should be phrased or introduced (Edwards, R. & Holland, J., 2013). For this thesis, I chose to work with thematically structured interview guides. Each guide was organized by topic, under which I

listed the relevant questions I planned to ask. However, I adopted a more flexible approach during the actual interviews. Participants would occasionally raise new and unexpected themes while responding to a question, and rather than interrupting their flow, I would allow the conversation to deviate from the original guide. In such cases, I asked follow-up questions based on the new topic. Sometimes topic changed from AI to legal concerns. I then made note of the questions related to AI we had skipped and made sure to remember to ask them towards the end of the interview.

The interview guides also evolved with my research, as my understanding of GDT evolved. For instance, my early interview with Triangula was conducted when my technical knowledge of GDT was still very limited. Consequently, that conversation focused heavily on the product's technical features, with less emphasis on ethical or societal aspects. As I gained more knowledge through interviews and reading, I updated my guide, accordingly, adding new questions and themes for future interviewees. One challenged I faced for every interview, was managing the numbers of questions I wanted to ask. I often found myself to curios, writing long interview guider with questions that wouldn't get answered because we run out of time. I therefore had to make sure that I planned what topics and questions I would start with first, to make sure we had time to talk about them. If we had time, I made sure to ask the rest of the questions. Not all questions the participants were asked exactly the same questions; this made it more difficult to directly compare their answers when doing the analysis. However, given the diversity of participants, ranging from different backgrounds and countries, this variability was also a natural consequence. The interview guides reflect both my development as a researcher and the differences in participants who volunteered for the study.

5.2 Methodological Limitations and Ethical Considerations

This part highlights some of the limitations with this research data, as well as ethical considerations I made sure to be aware of during the process.

5.2.1 Data selection

This study acknowledges several limitations, particularly in terms of data selection and access to key stakeholder perspectives. One of the most significant is the absence of direct input

from the general public in Norway. No quantitative survey was conducted to assess how familiar Norwegian citizens are with GDT, whether they would support its implementation, or how they perceive its potential implications, particularly in relation to privacy, surveillance, and public safety. Such viewpoints would have been valuable for evaluating the societal relevance and acceptability of GDT in a Norwegian context. Initially I wanted to conduct a survey to complement the qualitative interviews. However, due to time constraints, I had to prioritize other data collections. Additionally, the study lacs input from additional relevant stakeholders. This could be interviews with Norwegian politicians, legal professionals specializing in AI and digital governance, or high-ranking police officials in Norway, such as the Chief of Police in Oslo. This could have contributed more directly to understanding the regulatory, political, and operational frameworks relevant to a potential Norwegian implementation of GDT. Unfortunately, my limited contact network wasn't enough to get in touch with them.

Several attempts were also made to schedule an interview with the American company ShotSpotter. Much of thesis revolves around the technology of SED, Triangula and ShotSpotter, so interviewing representatives from each one, could be insightful. Gaining ShotSpotter's perspectives on the rise of third generation GDT, the European marked, Chicago and the future of GDT, would be interesting. Although a date for interview was initially confirmed and the interview guide sent to a representative at their request, the interview did not materialize.

5.2.2 Language

Much of the desk-based researched revolved around gathering data from officials and government. As much of the thesis revolved around foreign countries, like USA and Czech Republic, they used different language then Norwegian. With English, this was not that much of a problem, with Czech however, this was more of a issue. I had to rely on translation, by google translate or ChatGPT to understand parts of what was written in publications written in Czech, by the Czech government. The same language barrier occurred during one of the interviews. The interview with a representative of the Czech City police, originally intended as a live video interview, was in written due to language concerns. The interview guide was translated into Czech, and the responses were then translated back into English using the ChatGPT. While the translated content appeared coherent and contextually sound, the possibility of minor mistranslations or lost nuance cannot be fully ruled out. However, this

might have been a better solution for the issue then conducting the interview with such language barriers at place.

5.2.3 Overall research

The broader research scope of this thesis is also subject to limitations. Third generation GDT remains a relatively new and underexplored technology in law enforcement contexts. As such, there is a limited body of literature evaluating its long-term effects on crime reduction, public safety, or community wellbeing. Ideally, the research would have examined GDT implementation in a country socio-politically and demographically similar to Norway, such as Denmark, to draw more contextually relevant findings. However, in the absence of such case studies, the research relied on examples from the United States, where second generation GDT has been in use for years, and the Czech Republic, which has only recently adopted third generation systems. ShotSpotter's removal from Chicago was also included to explore some of the controversies and criticism the technology has faced, especially in a diverse community.
Therefore while this study offers exploratory insights, its conclusions should be viewed as a preliminary contribution to the emerging discourse on GDT in Norway.

5.2.4 Ethical considerations

Qualitative interviewing involves ethical considerations, which includes the importance of protecting participants information and ensuring they are fully informed about the nature and purpose of the research (DiCicco-Bloom & Crabtree, 2006). In order to ensure that these principles were followed in this study, I anonymized all participant by giving them a different name, I also removed the name of the city in Czech Republic that installed SED, as some of the information provided by the local police, could be sensitive. Further on, all interview participants were clearly informed that their participation was voluntary, and that withdraw at any point without providing any explanation. I naturally followed the guidelines from sikt.no.

Also, a significant proportion of the research involved conducting interviews with representatives from the companies Triangula and SED. Due to limited research conducted on third generation GDT, it was necessary to gather information on the technology from the company websites. It has to be acknowledged that such sources might have a positively bias,

which could lead to information highlighting benefits, while minimizing limitations or risk associated with the technology and product.

Although not yet formally published, it has been received their permission to reference it in this thesis, as no similar studies could be found.

Furthermore, during the interview representative from SED shared a brand new unpublished study regarding the systems performance (Smazinka, D., n.d.). As the study had not yet been published, it had not undergone peer review. However, I checked the author's academic background via Google Scholar and found that he had previously published several peer-reviewed studies. This gave the study a degree of credibility, even though it had not yet been formally evaluated. Given that the document was very recent, it is likely that it had simply not yet completed the peer-review process. That's why I choose to include for the thesis.

6 Results

This chapter presents findings from the five interviews conducted for this thesis. The aim has been to explore how GDT is perceived and understood by both Norwegian stakeholders and those with first-hand experience using the technology elsewhere, particularly in the Czech Republic. The selection of interviewees spans a range of roles. Among them are a Norwegian police IT advisor, an AI ethics expert, a Czech police officer using the SED system, and representatives from both companies Triangula and SED.

6.1 Overview of the interview participants

The Table below provides an overview of the interview participants, detailing their roles, national context, method of interview, their relevance to the study and where to find their interview guides. For the rest of this research, only the participants' names will be used to refer to them. I therefore recommended to keep the table easily accessible, as a point of reference, should the different names become difficult to keep track of during reading.

Table 6 - 1: Overview of Interview Participants and Relevant Information

Participant	Role	Country	Type of interview	Relevance	Date	Interview guide Appendix
"Ola"	Triangula representative	Norway	Face to face. Unstructured. Not recorded	Norwegian GDT developer, Norwegian market perspective	05.02.2025	A
"Jakub"	SED representative	Czech Republic	Video. Semi-structured. Recorded	Developer of SEDl GDPR, technical design,	19.03.2025	B

				adaptation barriers		
"Kari"	IT-advisor in Norwegian police	Norway	Telephone. Semi-structured. Recorded.	Law enforcement innovation, institutional readiness,	05.04.2025	C
"Lars"	AI-developer	Norway	Written structured interview	Expert in AI ethics, data governance	08.04.2025	D
"Jan"	Czech City Police Officer	Czech Republic	Written structured interview (translated)	Operational use of GDT in daily police work	10.04.2025	E

6.2 Interview data

To structure the empirical findings clearly, the interview material has been organized thematically into three parts. The first theme focuses on the Czech context and the deployment of the SED system, based on interviews with Jakub and Jan, who is directly involved in its development and everyday use. The second theme centres on Norwegian stakeholders Ola and Kari, with particular attention to perspectives on law enforcement, technological innovation, and the GDT company Triangula. The third theme addresses the ethics GDT. While this part primarily draw on the interview with Lars, ethics and AI were a recurring concern across all interviews, and therefore include reflections from multiple participants.

6.2.1 Czech City and SED deployment

The Czech Republic offers a concrete example of GDT actively used in European law enforcement. According to Jan, (anonymous) city in Czech launched a half-year pilot of the

SED system in late 2022. Initially, around ten sensors were installed. By 2024, the deployment had expanded to approximately 60 sensors. These devices were integrated into the city's existing surveillance network, which includes roughly 300 CCTV cameras. Jakub, from SED, hints that the implementation was motivated partly by concerns of perceived higher gun violence and a major shooting at Charles University in late 2023, where 14 people were killed. This event heightened political and operational interest in detection tools like SED.

According to Jan, SED has notably improved police response times:

"*Alerts reach operator within seconds, reducing reaction time from minutes to tens of seconds compared to emergency calls*".

6.2.1.1 System functionality

Jakub explains how the SED system is integrated with CCTV, allowing police operators to assess situations in real time and determine whether a patrol unit should be dispatched. This integration helps reduce the number of unnecessary deployments triggered by false alarms. During the interview, he provided an example illustrating this functionality. He explained that if the SED system detects what it identifies as a gunshot, nearby CCTV cameras automatically turn toward the location of the sound. If, for example, the area is crowded and there is no visible reaction, such as people fleeing, it may indicate that the sound was not in fact a gunshot. To demonstrate this, Jakub shared a specific incident where the SED system had flagged a sound later determined to be a tram shifting tracks. To my untrained ears, the recording did sound very similar to a gunshot. However, by reviewing the CCTV footage in real time, the operator could see a tram changing tracks at the exact moment the sound occurred. Based on this visual confirmation, the operator manually corrected the system classification, and no officers were dispatched to the scene, instead marking it a false positive. The SED system incorporates a machine learning mechanism, allowing it to improve accuracy over time based on such corrections.

According to Jan, police operators received approximately three hours of training to become proficient in using the system. He also noted that there were no big issues in integrating SED with the police force's existing IT infrastructure.

Detection Capabilities and Performance

Jakub said the SED system is capable of detecting a range of acoustic events, including gunshots, aggression, glass breaking, shouting, and the sound of spray cans used in illegal graffiti. According to Jakub the technology is being explored for use in other settings, such as hospitals, where it could notify security staff of escalating aggression among patients.

Jan shared statistical information from December 2024 that law enforcement using SED has gathered:

In the gunshot category, SED registered 125 alerts classified as gunshot related. Of those, only four were false alarms, just over 3 %. In 99 cases, police operators checked the situation via CCTV and found no need to send law enforcement. Only 16 of 125 incidents lead to a police response.

Legal and privacy concerns

Jakub emphasized how the SED system was specifically designed with GDPR compliance in mind from its inception. It does not record continuous audio or capture private conversations. Instead, it transmits a one-second anonymized sound sample when an event is detected. JALUD Embedded invested more than €20,000 in legal assessments to prove its GDPR compliant. Despite these safeguards, some cities, including Amsterdam, suspended implementation over privacy concerns. Local authorities conducted their own legal reviews before granting conditional approval. This delayed deployment by approximately one year. Both Jakub and Jan said during their interviews that SED had not been involved in any legal disputes.

Public Perception and Reception

According to Jan, reactions from the public towards SED, has been positive. He reported no major concerns about surveillance or stigmatization. SED has primarily been installed in the city centrum, where disturbances are more likely, especially during the nighttime at weekends. Citizens, especially older residents, have expressed feeling safer. Among police staff, initial some police officers were sceptic, think the system would lead to many false positives. However, this turned out to be over-exaggerated, after deployment the system proved to be highly accurate. Jakub mentioned that the technology was very unknown to the people in

Czech. SED were sometimes criticized, regarding the technology is some form of “Big Brother” surveillance. However, after direct engagement with critiques, much of that perception has changed. When the people better understood the how the technology functioned, that it didn’t record, and was GDPR complaint, the sceptisim declined, and it was perceived as less invasive.

Market for SED

Jakub noted that SED is currently used in the Czech Republic, Slovakia, Poland, the UK, the Netherlands, and Brazil. The company has not had any discussion of implementation of it, but says they are very open for it. They have had some talks with Sweden, but it didn’t materialize. Cities that have adopted the system tend to be either densely populated urban areas or smaller municipalities – being smaller often entails less bureaucracy and easier to implement new technologies. According to Jakub, rich countries with active “*smart city*” programs and sufficient budgets are ideal markets for the technology.

Jakub compared the cost of SED to that of ShotSpotter. He estimated that ShotSpotter costs around $80,000 per square mile per year, while SED could cover the same area with six sensors priced at €1,500 each.

Notable incidents and future of the technology

When asked to share SED biggest success story on how the system has helped law enforcement. Jakub shared a story on how SED has saved the life of a human being. The system detected aggressive shouting during a fight between to people in a public area. Police were dispatched and arrived to find one individual experiencing a heart attack. Officers used a defibrillator and saved the person’s life. Later, medical staff estimated that the person would have died if he hadn’t gotten help that fast.

Looking forward, both Jakub and "Jan " that while the future is difficult to predict, they think AI capabilities will increase, and its role in public safety. Jakub suggested that audio recognition is a cheaper and potentially more scalable alternative to mass CCTV deployment, especially as AI capabilities improve.

6.2.2 Traingula and Norwegian law enforcement

Both Kari and Ola confirmed that there has been contact between the Norwegian police and the company Triangula, with signs of interests in the technology. However, the dialogue did not result in any form of pilot project or implementation. Ola noted that the final decision to decline the technology came from the police, though he could only speculate as to the reasons, he thought that restricted budgets and the low incidence of public gun violence in Norway likely played a role. Interestingly, Ola confirmed that Triangula's technology is currently operational in Norway, though not under the of law enforcement. The system is installed at Akershus Fortress in Oslo, where it is used by the Norwegian military.

Kari, for the most part, said the same thing. She speculated that low rates of gun violence in Norway and bureaucratic might be reasons for no deployment. She explains how the police is a large public institution. They might be structured in ways that make innovation difficult. The risk of making a mistake when trying something new can outweigh the perceived benefit, which can lead to less innovation (Interestingly, Jakub mentioned the same thing in his experience when dealing with governmental sector, sometimes the people working in governmental sector can have the perception that its better to do nothing and don't face the consequences, or potentially try something new and fail).

Legality in Norway

Neither Kari nor Ola was aware of any specific law in Norway that would prohibit the implementation of GDT systems like Triangula. Kari emphasized that the police must adhere to both national laws and European regulations, including the Politiregisterloven (Police Register Act). She pointed out that the technology is still relatively new, and the legal framework surrounding the use of AI in policing is complex and not yet fully developed. Building legal competence in this area will take time, and the uncertainty around what is legally allowed can create hesitation among decision-makers in law enforcement.

Benefits of GDT

Both interviewees saw potential advantages in the adoption of GDT for Norwegian policing. Kari described the technology as promising and likely to improve police efficiency. She noted that it could help confirm whether shots had actually been fired in response to calls from the

public, reducing unnecessary dispatches. She also pointed out its potential value in investigations, by narrowing down the location of a shooting, police might recover physical evidence such as shell casings or blood traces. This could help reconstruct events more accurately. For police units dispatching to a gun shooting, this could give them better situation awareness, providing information of numbers of shooters and localisation.

Ola agreed with much of what Kari said, but he also reflected on the police response during the 22 July 2011 terror attacks. One thing that complicated the situation for the police, was the overwhelming volume of emergency calls that flooded the police command centre. Many citizens, scared and anxious, called the police to report what they believed were gunshots in various locations. For the most part, the calls turned out not be true, but each one had to be taken seriously. This means police had to use resources to verify if it actually was shooting in various places or not. This drained police resources. He suggested that if a system like Triangula had been in place at the time, it could have helped verify where gunshots were actually occurring and rule out the false alarms, making police use their resources more effectively at that critical time. At the same time, the police received conflicting reports from people at Utøya—some saying there was more than one shooter. Faced with the possibility of meeting multiple gunmen at the island, the police had to wait for enough personnel and equipment to engage with an unknown number of terrorists. This delayed their response. If Triangula had been in use, it could potentially have provided law enforcement with reliable data on the numbers of shooters at Utøya (e.g. by examining the data and seeing that only one weapon was in use). Ola thinks this could have meant that police could have gotten to Utøya island faster. In a scenario like that, where every minute counts, this could potentially have saved lives.

Future of Traingula in Norway

Kari expressed cautious optimism that Norwegian law enforcement may eventually adopt GDT. She believed the technology could prove effective but stressed that implementation would need to align with both legal frameworks and public expectations regarding surveillance. Kari also emphasized the need to build legal and institutional understanding around AI and its applications before such tools can be deployed.

Ola was similarly hopeful about the future of GDT in Norway. He speculated that the technology might first be introduced to specialized police units, such as the Delta force (Norway's anti-terror police unit), who are trained to handle high-risk incidents. These units could use mobile applications linked to Triangula to receive real time data on the amount and position of shooters, as well as the types of weapons used. Ola stated he would be surprised if, within the next ten years, technologies like Triangula were not more widely adopted across European law enforcement, particularly if gun violence continues to rise in parts of the continent. However, both stressed that they hoped there would be no need for the technology in the future, and there be less gun shooting.

Norwegian police and AI innovation

Kari also described an interesting ongoing AI-related project within that Norwegian police are currently pursuing. One current project focuses on automating the transcription of police interviews. All police interviews in Norway are audio recorded, and when children are involved, the recordings must be fully transcribed. Kari explained that this task is both time-consuming and emotionally draining, especially in cases involving child abuse. AI could potentially alleviate this burden by automating much of the transcription process, saving resources and reducing psychological strain on investigators. In addition, Kari discussed the potential for AI to assist with data structuring in complex investigations. In large-scale cases, there is often an overwhelming amount of data to process and its difficult and time consuming to structure it. She mentioned that AI could help investigators sort information chronologically, grouping witness statements, surveillance footage, and financial records in a way that makes the case easier to understand and manage

6.2.3 AI concerns

Transparency and black box issues

A common theme among multiple of the participants, was how difficult it is to understand how the AI functions and reach conclusion, sometimes referred to as "*black box*" problems.

Lars emphasized that while the public may not need to understand the all technicalities of the algorithm, however they did need a clear understand of what the technology does, and what it doesn't do. The public needs to understand that the algorithm detects gunshot and notifies

police, however it may not be correct 100 % of the time. He described this as forming a "mental model", and he thinks this could create bigger trust towards the people using the technology.

Jakub cited the same concerns. He noted how programmers of AI, feeds the system with data, but how the algorithm interprets it, can become unclear. He noted that even system developers themselves don't always know what patterns the algorithm is using to make decisions, and stated:

"*Because you never know what is actually inside. Even we don't know*."

Kari shared similar worries. She expressed concern over how algorithms might be misused, particularly when their decision-making logic is not fully understood. As an example she mentioned how social mediums, like Facebook, needs peoples attention and thus can promote content that generates the most engagement for the users. She notes how the content, at times, has been racist or fake news. Spreading harmful or ill-intended content online has surely never been the developers intention, however that's what it at times did. Its therefore important to know what drives the algorithm, and they can have a potential downside that can be unknown in the beginning. This ambiguity makes it difficult to hold systems accountable.

Public trust and stigmatization

Ola and I also discussed a closely related issue, stigmatization and GDT. Ola said that some critqs of Shotspotter claims it created stigmatization for certain demographics because the sensor were put up in public places were gun violence is more frequent, which happened to be areas with more minorities. He contrasted this with Triangula, which functions as a mobile application primarily installed on police officers' smartphones, and is therefore not fixed to specific geographic areas. However, he acknowledged that this form of critique could still be applied to Triangula. Since police officers are typically more present in high-crime areas, the concentration of mobile detection in such zones might still be perceived as reinforcing stigma or over-policing in those communities.

Larsalso talked on the issue of uneven deployment of GDT. He acknowledged that concentrating such technologies in higher crime areas, and those areas happened to me minority communities, this could lead to stigmatization or bias of the inhabitants. However, he said that this concern should not automatically disqualify the technology. As he stated:

"Let's measure and monitor bias, but don't let fear of it stop us from solving real problems."

Lars further problematized the idea that technology like GDT inherently reinforce social or racial inequalities. He suggested how this argument could be challenged: If this technology is concentrated in those areas, this could lead to more police presence in the area and this could actually reduce inequalities. He explained that the police would catch more criminals, creating a community with less crime. According to Lars, this would benefit the majority of law-abiding people living there.

As mentioned previously, Jan and Jakub reported of no major concerns regarding over-surveillance or stigmatization after deployment in Czech Republic.

AI evidence in court rooms

The issue of potentially using AI as evidence in a court room, was questioned to multiple interviewees .Lars noted that he didn't have good understandings off Norwegian law and court, however he was sceptical if it should be valid to use. He recommended that while raw data, like the sound of a gunshot, might be used in court, the algorithm's interpretation of that data should not be treated as direct evidence. Lars noted that if the algorithm couldn't be understood, there would involve a risk of convicting innocent people to jail if used.

As mentioned by the Czechs, there hadn't been any issues regarding usage of SED AI-based evidence in court. However, Jakub acknowledged potential challenges if algorithmic outputs become a theme in court. He indicated that the company might be reluctant to disclose the inner workings of the algorithm, citing concerns about protecting proprietary information and intellectual property (if competitors get knowledge on how their algorithm functions, they might steal it).

AI and the future

Participants were also conflicted on whether or not they were positive regarding AI and the future. Kari said she was both optimistc and not at ease. She specifically mentioned China, and their social credit score program. Kari also said she had read a report from Europol regarding ChatGPT, and how criminals can misuse it. For example, by grooming children. Criminals can have the AI talk to children for them, and make it seem like they are a little boy, instead of a grown man. She found it troubling how law enforcement had to operate within a

strict legal framework, while criminals could freely use new technology as they pleased. This would potentially place the police to always be one step ahead of criminals. At the same time, Kari also saw much potential in how AI could help the police, especially in terms of effectivization.

Lars turned out be quite hopeful for AI and the future. He argued that to many people look at a potential downside, not acknowledging the benefits:

"Im optimisitic (...) Most people focus on what could go wrong if we deploy an AI system. But very few consider the cost of not deploying it. If this could save taxpayers money, make the streets safer, or help catch violent criminals, then we have a strong moral imperative to act—and it would be unethical not to"

7 Discussion

The purpose of this chapter is to interpret and critically reflect on the key findings of the study in light of the four central research questions.

The chapter first explores how GDT has evolved over time, with a specific focus on the shift from second- to third generation systems. It evaluates their respective strengths and weaknesses, addressing technical accuracy, AI integration, and ethical concerns such as transparency and bias. Next the discussion turns to the experience of ShotSpotter in Chicago, exploring how public perception, racial and social dynamics can shape public acceptance for GDT. The third section evaluates how GDT may affect social sustainability, using Felce and Perry's (1995) quality of life framework. Finally, the discussion turns to the implications of introducing GDT in Norway

7.1 Technological evolution of GDT

7.1.1 Development through three generations

This research divides the evolution of GDT into three distinct generations, each with increased improvements in accuracy and utility.

The origins of GDT can be traced back to World War I, where first generation systems used acoustic triangulation to locate enemy artillery. These systems relied on strategically placed microphones on the battlefield to determine the origin of sound waves, a technique that laid the foundation for modern day GDT (Nobel Prize Outreach, n.d.; Van Der Kloot, 2005).

Second generation GDT emerged during Yugoslav wars in the 1990s, initially in a military context, and later in civilian US law enforcement. This generation was sophisticated enough to detect lower-calibre weapons, such as pistols and rifles, making it especially relevant for urban policing (Aguilar, 2013). It was introduced to civilian police to combat the increased gun violence that surged in U.S. cities at time, (Mazerolle et al., 1998). ShotSpotter become an industry leader, with deployments in over 170 American cities, as well as in countries like Brazil and South Africa (Piza, E. L. et al., 2024; SoundThinking, 2025).

Third generation GDT represents a shift towards more advanced technology by incorporating AI and machine learning, while also being fully GDPR compliant. Unlike previous

generations, which were primarily limited to detecting gunshots and typically installed statically in strategic locations, often in countries/communities with high rates of gun violence, the newest generation can detect a broader range of sounds, such as screams demonstrated by SED. Furthermore, it is available as a mobile application, as shown in the Triangula case, meaning it can operate on standard smartphones without the need for additional microphones or sensors, while also allowing high mobility. Notably, third generation GDT has gained momentum within European law enforcement where gun violences is rarer, with deployments in countries such as the Czech Republic, Slovakia, Poland, Netherland and the United Kingdom. (AmberBox, n.d.; JALUD Embedded, n.d.b; Triangula, n.d.).

7.1.2 Second generation Accuracy

Studies evaluating the technical accuracy of second generation systems revealed considerable variability. Reported location precision ranged from 7 to 25 meters in some studies (Aguilar, 2015; Mazerolle et al., 2000), while other analyses identified average errors of 132 meters, with discrepancies significant enough to misplace the incident onto a completely different street Such inaccuracies can pose a real risk in police settings. In active shooter scenarios, and gunfire in general, accurate location of the event is essential to enable rapid police response, in order to apprehend the perpetrator and deliver medical aid to victims. Bullet cases from the suspect are rather small and can easily disappear. When GDT systems provide incorrect data on the location, this can delay emergency response time, and lead to fewer important evidence being collected.

7.1.3 Third generation Accuracy

In contrast, third generation GDT, although significantly less researched than its predecessor, appears to offer a significantly improved performance. Unlike second generation GDT, which have been deployed and evaluated in multiple cities over time, third generation technology has not yet been thoroughly assessed in a real world, long-term urban policing contexts. However, experimental research provides promising indicators on its accuracy. In studies, third generation systems demonstrated remarkably high accuracy rates of approximately 99 % in correctly identifying gunshots, and location gunfire position of a distance of 5 meters

(Djeddou & Touhami, 2013; Galangque & Guirnaldo, 2019; Lojka et al., 2016; Navrátil, M. et al., 2011).

While more research is needed, these early findings indicates that third generation GDT systems can provide improvements in precision and reliability over previous generations. The more accurate the GDT system is, the lower the likelihood of false alarms and misdirected police action, reducing strain on police resources.

7.1.3.1 Third generation Ethics

Although third generation GDT systems seem to provide considerable technological improvements, it also introduces new ethical challenges. The implementation of AI and algorithms creates difficulties in understanding of and scrutinize the system. A recurring theme across the interview, was the so called "black box" problem. Multiple participants highlighted this, the difficulty of understanding how an algorithm actually arrive at their conclusion. Jakub who developed the SED addressed this issue:

"*Because you never know what is actually inside. Even we don't know*."

As he explained, while the company develops the algorithm and provides training data, the way the system interprets and responds to input can become unclear, even to the people who designed it. This lack of transparency can create ethical and legal dilemmas. Consider a scenario in which two people are involved in a shootout, both claim self defence and claiming the other person fired first. A GDT notification may provide reliable data on what weapon fired first and where it was fired from. If other evidence, like eye witnesses, is absent, data from GDT systems might be the only way of asserting who fired the first shot, and who was acting in self defence. However, if not even the developer can explain how the GDT decided that person A was the perpetrator and person B was in self defence, can such evidence responsibly be used in court? If the evidence is admitted without understanding its basis, it may undermine the defendant's right to a fair trial. If dismissed, it may result in both individuals being acquitted, potentially allowing someone who attempted murder to avoid accountability. During the interview, Lars was sceptical of using direct AI evidence in court, claiming that if it can really be understood or explained, using it would potentially send innocent people to jail.

Kari voiced similar concerns. She warned that AI systems may be vulnerable to misuse, especially when the logic behind their decisions is not fully understood. As an example, she drew a parallel to social media platforms, noting how their algorithms are designed to maximize engagement by prioritizing content that generates clicks and likes. While this may be profitable from a business perspective by increasing user attention and advertising revenue, it can also have unintended consequences. She noted that these algorithms, though not designed with bad intentions, have in some cases amplified divisive or harmful content, fuelling polarization and even hatred. The problem, she argued, lies in not fully understanding or anticipating the broader social effects of the algorithm's behaviour. Her point was that even well-intentioned technology can create problematic outcomes if the underlying logic is neither transparent nor critically examined or understood. If no one is able to verify how the GDT algorithm functions, confidence in its reliability and accuracy can become difficult to establish. This concern becomes certainly more apparent when comparing SED to traditional GDT systems, since SED also incorporates additional sound classification, such as human screams (JALUD Embedded, n.d.b). This type of addition can certainly in some cases contribute to creating a safer society. During the interview with Jakub, he shared an incident where the SED system detected distressing human screams during a physical altercation between two men. The alert allowed for a quick police response to the scene. Upon arrival, officers discovered that one of the individuals had suffered a heart attack. They were used a defibrillator on the man, this rapid intervention, according to medical personnel, likely saved his life. Another example, hypothetical, might involve a woman being attacked while walking home alone at night. Since she is being attacked, she can’t call the police, and if no one is around, no one can hear her screams. SED can allow for police response in such scenarios. However, this addition also introduces a higher risk of misclassification, especially if the underlying training data is demographically skewed. For instance, if the AI system is trained primarily on vocal samples from white Europeans, it may be less accurate in interpreting distress or aggression in minority populations. In a worst-case scenario, a Black male voice expressing fear might be misclassified as hostile, reinforcing harmful stereotypes and potentially contributing to the over-policing of already marginalized communities. These risks points to broader concerns about deploying advanced technologies, leveraging AI, in diverse societies. AI systems are often viewed as neutral and objective, but their design and implementation can conceal implicit biases. The black box issue makes it difficult to detect and correct potentially discriminatory outcomes. As a way of mitigating this, Lars highlighted the importance of algorithmic transparency and was favourable for open-source coding if the

technology was implemented in Norway. Lars meant that transparency around the technology could circumvent possible concerns and criticism, creating more legitimacy towards the technology and law enforcement using it. However, this ideal of transparency may be difficult to realize in practice. As Jakub pointed out, companies that develop these technologies may be hesitant to disclose how the algorithms function, by citing intellectual property concerns.

Lars also offered a nuanced perspective on the ethics of this. While he acknowledged the risks associated with algorithmic bias, he emphasized that failing to deploy new technologies could itself entail relatively ethical costs. In his view, given that GDT has the potential to deter crime and save lives, then choosing not to implement it, despite its imperfections, could also lead to negative societal consequences. The ethical challenge, he suggested, lies in balancing the risks of misuse with the possible advantages of increased safety and crime prevention.

7.2 ShotSpotter in Chicago

The case of ShotSpotter in Chicago illustrates how the public reception of a technology like GDT can vary significantly depending on sociopolitical context, particularly in regard to public trust in law enforcement, historical inequalities, and patterns of marginalization. It serves as a valuable contrast point when considering how GDT might be received in other countries.

ShotSpotter was first introduced in Chicago in 2012 and terminated in February 2024 (City of Chicago, 2024; Connealy et al., 2024). While the system aimed to improve police responsiveness to gun violence by detecting and localizing gunfire, its implementation became deeply controversial, specially following the fatal police shooting of 13-year-old Adam Toledo in March 2021 (Daley, J., 2021).

In that incident, ShotSpotter detected gunfire in a neighbourhood and notified law enforcement, which prompted their response. Officers arriving in the area encountered Toledo. Officers saw that he was armed with a gun, and Toledo tried to flee, hid the firearm, and was subsequently shot by an officer who perceived him as an armed imminent threat, not realizing he had dropped the weapon. After a thorough, year-long investigation that included reviews of body camera footage and eyewitness testimony, it was concluded that the officer involved, would not be charged (Foxxy, K. M., 2024). Nevertheless, the incident ignited widespread public outcry in Chicago (Walter-Warner, H., 2021). This backlash cannot be

understood in isolation. It occurred in the broader context of the BLM movement, revitalized after the 2020 murder of George Floyd, which caused greater public discourse focused on systemic racial disparities in policing (Campell, A., 2021; The Guardian, 2022; University Archives, n.d.). Critics questioned whether GDT technologies escalate further risk in marginalized communities by increasing armed police responses in already tense environments (Mohtasham, D., 2024).

Concerns about racial equity in ShotSpotter's deployment also contributed significantly to the controversy. According to the MacArthur Justice Centre, in Chicago 80% of Black residents and 35% of Hispanic residents lived in ShotSpotter covered neighbourhoods, compared to only 13% of white residents(Manes, J. & Brunt, A. V., n.d.). This connected ShotSpotter to existing perceptions of over-policing and surveillance in minority communities. The NAACP claim that black Americans and white Americans use drugs at similar rates, yet black Americans are six times more likely to be incarcerated for drug related offenses (NAACP, n.d.). When GDT increases police presence in marginalized areas, the fear is that it leads to disproportionate scrutiny from law enforcement. This can result in more arrests of black individuals, while residents in less policed white areas may commit similar offenses with less risk of detection. This dynamic can create a downward spiral: increased arrests make it harder for individuals to secure employment, which may lead some to commit further crimes out of necessity, resulting in more police presence in the area, more arrests and further destabilizing the community. These issues become especially troubling when considering the false positive rate of second generation GDT systems (Mazerolle et al., 1998; Ratcliffe et al., 2019). False alerts may lead to officers wrongfully stopping, detaining, or even arresting innocent people, which can further undermine public trust, especially in communities already extra wary of police interactions. If officers respond to a false alert, expecting a dangerous and armed suspect, but instead confront someone completely unrelated, such as a person walking to work, tensions may escalate quickly. The individual, knowing they’ve done nothing wrong, might be scared and hesitate to comply when ordered at gunpoint to lie on the cold, wet pavement, potentially ruining his clothes and humiliating him. Their resistance, or confusion, could be interpreted as threatening, especially by stressed officers primed for danger. Research shows that high-stress environments impair decision-making (George, A. L., 1986). In such scenarios, a single misjudgement, on either side, could have deadly consequences.

However, it is worth noting that some interviewees offered a counterpoint, arguing that GDT technologies could, in fact, help reduce racial and social inequality by increasing police

presence in areas with high crime rates. Lars, noted that concentrating GDT systems in such areas could risk increase of stigmatization of certain communities; however, he argued that it should be possible to monitor for such biases without overcorrecting (e.g. not deploying the technology). He argued that if higher crime rates are indeed concentrated in areas predominantly populated by certain demographic groups, then using technology to target and apprehend offenders in those areas could ultimately enhance safety in these communities. In his view, this would allow the vast majority of law-abiding residents in those communities to live safer, more stable, and more prosperous lives.

Trust in law enforcement plays a critical role in shaping perceptions of such technologies. Only 27 % of black Americans report to have confidence to the police, compared to 51 % for the total population (Jones, J. M., 2021; Ozimek, T., 2024). In contrast, trust levels are significantly higher in Norway with 70%, and the Czech Republic with 72% (Horvei, M. & Karterud, T., 2024; Siska, M., 2019). This disparity in trust is further reflected in perceptions of public safety: in 2024, 87% of Norwegians and in 2022, 85% of Czechs report feeling safe in their communities, compared to 64% of Chicago residents who expressed concern about public safety in 2024 (*Chicagoans Reflect on the Last Year*, 2024; *Feeling of Safety in the Czech Republic in General*, 2022; Horvei, M. & Karterud, T., 2024). These gaps in trust and safety perceptions might be deeply rooted from America's racial history. The NAACP traces modern policing back to the "Slave Patrols" of the 1700s, arguing that the legacy of racial control continues to influence modern law enforcement (NAACP, n.d.). Black Americans are five times more likely than whites to be stopped without cause. They represent 13% of the U.S. population, but 48% of those serving life sentences without parole (NAACP, n.d.; Prison Policy Initiative, n.d.). In this context, policing, and by extension, technologies like GDT might have been perceived not only as tools for safety, but also for systemic racism, surveillance and control in Chicago. Therefore its important to note that ShotSpotter functioned as intended in the Toledo case: it correctly detected and located gunfire and notified police. The pistol Toledo carried just prior to being shot, was in fact the one that triggered the alert. Assigning blame solely to the technology, risks oversimplifying a tragedy shaped by systemic and human factors. Had police been dispatched based on a citizen's call rather than ShotSpotter, the outcome might have been the same.

7.3 Sustainability

Sustainability is often narrowly associated with only environmental concerns. This could entail reducing greenhouse gas emissions, increase production of renewable energy or combat climate change. However, sustainability encompasses much more then environmental concerns (European Environment Agency, 2024). The “Brundtland Report”, highlighted that sustainable development also includes a social aspect (World Commission on Environment and Development, 1987). The social aspect refers to a society’s ability to maintain and promote human wellbeing, social cohesion, and democratic governance over the long term. Social sustainability involves principles such as equity and justice, citizen safety social trust and the protection of human rights (Shaw et al., 2022). Several researches have highlighted that quality of life is a core component of social sustainability (Colantonio, 2011; Shaw et al., 2022; Szalkowski & Johansen, 2024). In this sense, a society cannot be considered truly sustainable if its population does not feel safe, live fulfilling lives, or enjoy basic human rights. Even a country that achieves net-zero carbon emissions would fall short of meaningful sustainability if its citizens lack public safety, civil liberties, or social trust.

The next part will discuss how social sustainability is affected by GDT, using the Felce and Perry (1995) framework for quality of life.

7.3.1 Quality of life

Within the framework of social sustainability, quality of life can serve as a key indicator. Although there is no universally agreed upon definition, Felce and Perry (1995) offer an interesting conceptual model. They define quality of life as a multidimensional construct composed of objective life conditions, subjective feelings of wellbeing, and personal values and aspirations.

7.3.2 Objective life conditions

Objective life conditions refer to measurable and observable aspects of living, such as physical safety, income, housing, and access to services (Felce & Perry, 1995). When evaluating the implementation of GDT, it is essential to ask whether it contributes positively

to such conditions, particularly in terms of enhancing physical safety in society by reducing gun violence.

One of the widely argued benefits of GDT, is its potential to uncover the "dark figure" of crime, e.g. incidents involving gunfire and gun violence that goes unreported to the police (Carr & Doleac, J. L., 2016). Several studies indicate that a large proportion of gun related incidents go unreported, and that GDT may play a critical role in closing this gap. For example, Police Chief Ed Flynn in Milwaukee stated that following GDT installation in 2015, they discovered that 86% of gunfire incidents detected by the system, had not been reported by citizens citizens ("The 'Crime Gun Intelligence Center' Model: Case Studies of the Denver, Milwaukee, and Chicago Approaches to Investigating Gun Crime," 2017). This matches other findings that estimated that roughly 80 % of gunfire incidents typically go unreported (Mares, D., 2022). Similarly, Irvin-Erickson et al. (2017) found that in Washington, D.C., GDT detected between 1.5 and 2.3 gunfire events for every single citizen-initiated 911 call. Furthermore, Carr and Doleac's (2016) found that in both Washington, D.C. and Oakland, only about 12% of GDT detected events corresponded with emergency calls.

These studies suggest that GDT may significantly increase law enforcement's awareness by revealing previously undetected firearm activity. There are several factors that might explain underreporting of gunshots to the police. Ranging from people simply not hearing it, mistaking it for something else or the bystander syndrome, where they assume that someone else will call (Ai et al., 2024). This underreporting can be particularly prevalent in high-crime or marginalized communities, where underreporting may be exacerbated by distrust in police or fear of retaliation (Kirk & Matsuda, 2011).

However, increased detection does not necessarily lead to improved outcomes for society. For instance, studies by Mares and Blackburn (2012, 2021) in St. Louis found that GDT did not correspond with any measurable reduction in gun crime. Furthermore, only about 2% of GDT alerts led to the recovery of ballistic evidence, substantially lower than the 17 % recovery rate for citizen-reported incidents. Similarly, Vovak et al. (2021), examining Wilmington, Delaware, found that GDT expansion did not reduce crime. In fact, rates of shootings and homicides increased, while case clearing rates for gun violence actually declined. Supporting this, Doucette et al. (2021), in their analysis of 68 large U.S. counties, found no statistically significant impact of GDT on firearm homicides, weapons charges, or murder arrests.

These findings have led critics to argue that GDT may generate more noise than usable intelligence, particularly when false positives stretch police resources or lead to responses with little evidentiary outcome (Mazerolle et al., 1998; Cherone, 2024; Haeberle, 2024). Some scholars question whether the costs and operational burden of GDT are justified given its limited impact on gun violence reduction.

Nevertheless, for law enforcement, increased visibility into gunfire prevalence, even if it does not immediately translate into arrests, may offer strategic benefits. Improved detection can enable police departments to better prioritize deployment in areas disproportionately affected by shootings. Additionally, clear data on the scope of underreported gun violence may be leveraged to advocate for increased funding, staffing, or new and better equipment. In this light, even false positives, while problematic, can potentially serve as evidence of increased workload. This can enable departments to argue for bigger budgets to manage the rising number of alerts, or else they would risk compromising their capacity to conduct their other essential duties.

However, drawing a definite conclusion that GDT does not affect gun violence and overall safety in society, would be premature. Gun violence is shaped by a complex web of social, legal, and policy factors. For instance, gun-related homicide rates in the U.S. increased from 2.9 per 100,000 in 2020 to 5.5 in 2021 (Dyvik, 2025), despite widespread GDT use. Yet, Doucette et al. (2021) found that policy context had a strong influence: counties with permit-to-purchase laws saw a 15% decline in homicides, while those with right-to-carry laws experienced a 21% increase. This suggests that GDT is best viewed not as a standalone solution, but as a potential supplement within a broader policy framework.

Although GDT is often associated with countries with high gun rates violence, such as USA, South Africa and Brazil, it may also hold value in relatively less violence countries as well, like Norway and the Czech Republic (World Bank Group, n.d.). No society is immune to gun violence, rare but extreme acts of gun violence, such as the 22 July 2011 terrorist attacks in Norway or the 2023 Charles University shooting in Prague, demonstrate how even isolated acts of gun violence, can have devastating consequences for citizens safety. Such events highlight how uniquely dangerous firearms are compared to other weapons: unlike knives or blunt instruments, guns require little physical strength and can be used from a distance. They also are capable of inflicting mass harm rapidly – making faster police response time extra important. Moreover, legal firearm ownership remains relatively high in both Norway and the

Czech Republic, despite their stricter regulations (Burga, S., 2023; Forskrift Om Våpen, Skytevåpen, Våpendelar Og Ammunisjon (Våpenforskrifta), 2021; Reeping et al., 2019).

In the interview with Ola, he reflected on how GDT might have impacted the 22 July 2011 attacks in Norway. He highlighted how GDT could help police verify the calls from concerned citizens calling about perceived gunshots, which drained police resources, because police had to verify if the shooting were real or not. Also, at Utøya GDT could have provided data on shooting pattern which could potentially revealed that there only was one shooter. This could have influenced a faster police response. In an event like this, where every minute mattered, he believed, such technology could have saved lives

Another case from Norway that highlights the potential value of GDT, is the 2019 attempted mass shooting at the Al-Noor mosque in Bærum. After firing a few shots inside the mosque, the far-right extremist attacker was quickly overpowered by worshippers before anyone was killed or seriously injured. Some might argue that because the attacker was stopped and thus not being able to carry out the mass shooting, in this instance GDT would not have made a difference. In that light, public resources might be better spent on increasing police presence or investing in preventive measures against right-wing extremism.

However, the incident also exposed systemic vulnerabilities where GDT could have made a difference. One of the individuals who subdued the attacker attempted to contact the police immediately, but mistakenly he dialed the police non-emergency number, 02800, instead of 112. This placed him in a call queue, as operators prioritized emergency lines (Evalueringsutvalget, 2020; Lepperød, T, 2020). The person was under extreme stress after the incident, which might explain why he called the wrong number, as this (George, A. L., 1986). After a while he dialled the right emergency line, however his lack of Norwegian language skills caused miscommunications and created confusion with the operator. Several minutes passed before the situation was understood and police were dispatched. Note that as this was going on, people were still struggling to physically keep control of the perpetrator (Evalueringsutvalget, 2020).

This case illustrates a core weakness of relying solely on citizen-initiated emergency calls: they can be delayed, misdirected, or unclear (Klinger & Badger, 1997). A GDT system could have offered an automatic, objective alert, helping authorities respond more quickly. This shows how it is far from ideal to have to call the police in a life or death situations, which one can argue that many situations involving guns, are. It also shows how as Norway continues to

become a more diverse society, language barriers during emergency calls may also become a growing challenge.

It's also important to note that this thesis did not identify any large-scale, longitudinal studies evaluating the real-world effects of third generation GDT on crime or public safety. Given that studies show third generation systems are considerably more accurate than previous generations, and that its starting to be deployed in outside the USA, like Czech Republic, which is more similar to Norway in regards to gun homicides (Dyvik, E. H, 2025; Voldsseksjonen, Kripos, 2025), future research should explore whether this improved technical precision also translates into measurable safety outcomes in practice.

7.3.3 Subjective feelings of wellbeing

This dimension concerns how individuals actually experience and interpret their objective life conditions in life (Felce & Perry, 1995). Even if the objective impact of GDT on safety in regard to crime reduction remains contested, it is equally important to consider the technology's influence on subjective wellbeing, that is how safe and secure citizens feel, regardless of whether measurable crime rates actually have declined. Within the framework of social sustainability and quality of life, this perceived sense of safety and satisfaction represents a meaningful outcome in its own right (Felce & Perry, 1995). A technology that improves public confidence and reduces fear may thus be considered valuable, even if its direct impact on crime statistics is limited. This means that perceptions of safety are not merely byproducts of crime statistics but are shaped by broader psychological and social factors. The presence of technologies like GDT can influence these perceptions in both positive and negative ways, depending on the context and individual experience.

A perceived sense of security can come from various psychological mechanisms. Residents may be unaware of the actual crime levels in their neighbourhoods. In such cases, the presence of GDT may foster the belief that criminal activity, particularly gun violence, is being actively monitored and deterred, and that law enforcement will respond more rapidly if an incident occurs, even if GDT hasn't affected crime. However, this reassurance is not universally felt. For individuals with low levels of trust in the police, or those who associate GDT with systemic issues such as racial profiling or technological inaccuracy, the presence of such systems may lead to heightened anxiety. The Chicago case exemplifies this, where GDT was perceived by some community members not as a protective measure but as a tool of

further marginalization and systemic bias. In these cases, false alarms that result in increased armed police presence may escalate tensions and contribute to a sense of insecurity. This can potentially affect even people with high trust in police. Some residents may interpret the increased visibility of law enforcement as an indication that their neighbourhood has become more dangerous. This perception, regardless of whether actual crime levels have changed, could diminish their subjective sense of safety and well-being, as they now feel less safe.

Survey data from the United States concerning second generation GDT reflects these mixed perceptions. In one poll, 51% of respondents reported feeling safer knowing GDT systems were in place, while 38% did not (Fallon Research & Communications Inc., 2022). Similarly, in a study conducted in Redwood City, California, following ShotSpotter's implementation, 56% of police officers believed it would increase residents' sense of safety, while 44% did not (Mazerolle et al., 2000).

While no formal survey data is available regarding the effects of GDT on subjective well-being in the Czech Republic, interviews conducted for this thesis offer useful insights. According to Jan, public reactions following its implementation have been positive. He noted that older residents in particular have reported feeling safer and that no significant concerns related to surveillance or stigmatization have been raised. Jakub, shared a similar perspective. He explained that initial public scepticism primarily stemmed from unfamiliarity with the technology. Once residents were informed that the system does not record conversations and complies fully with GDPR regulations, concerns reportedly diminished. Its has to be acknowledged that these observations have some limitations. While Jan works directly with SED in the police, it is unclear whether his views are based on systematic public feedback or more anecdotal impressions from his own cases, where citizens may already have had positive interactions with the technology. Similarly, Jakub, as a representative of the SED company, may have an inherently favourable perspective. Nevertheless, the interviews suggest that in the Czech context, the implementation of third generation GDT systems such as SED appears to play role for an increased sense of safety.

In contrast, the U.S. case presents more divided public sentiment. This divergence may be explained by broader societal differences, perhaps the varying levels of trust in law enforcement. As discussed earlier in the thesis, trust in the police is significantly higher in both the Czech Republic and Norway compared to the United States (Horvei & Karterud, 2024; CZ Defence, 2024; Jones, 2021). This points to a broader argument: in countries like Norway, where public confidence in law enforcement is relatively strong, the implementation

of GDT may have a more uniformly positive effect on citizens' perceived safety, even if its objective effects on crime remain uncertain.

7.3.4 Personal values and aspirations

The final part of Felce and Perry's (1995) multidimensional framework for understanding quality of life, is personal values and aspirations. This refers to how much weight individuals place on different aspects of their lives, such as privacy, safety or freedom. In this context, people's acceptance of technologies like GDT, depends not only on measurable outcomes like crime reduction but also on how such technologies align with their personal values. For instance, individuals who strongly care about personal privacy and freedom from surveillance may view the deployment of GDT as a downgrade to their life quality, even if the system contributes to an overall safer society. Conversely, those who place a high value on security and crime prevention, may welcome GDT, accepting some reduction in privacy.

In the United States, where gun violence is more widespread and many citizens report feeling unsafe (*Chicagoans Reflect on the Last Year*, 2024; Dyvik, E. H, 2025; Saad, L., 2023), it can be argued to there appears is a broader tolerance for surveillance technologies like GDT. Here, the public may view GDT as a necessary response to daily threats, even if it comes at the cost of privacy. This context might help explain why the U.S. has become the largest market for GDT (MarketsandMarkets., 2023). By contrast, in countries like Norway, where general population feel more safe, there is less perceived need for such technologies. In these contexts, concerns about civil liberties and surveillance may carry more weight, potentially limiting public support for GDT. These dynamics were echoed in the qualitative interviews conducted for this thesis. Some interviewees welcomed GDT's potential to improve safety, while others cautioned against its impact on democratic rights and transparency. Importantly, values are not fixed: both Kari and Ola noted that in the event of increased gun violence or public fear, Norwegian society could shift toward broader acceptance of GDT. Thus, attitudes toward GDT are shaped not only by its technical performance but also by evolving cultural and ethical priorities.

8 Conclusion

This research set out to examine the implications of implementing GDT in Norway, particularly through a social sustainability perspective. By combining quantitative data, qualitative interviews, and comparative analysis of second and third generation GDT systems, the study aimed to critically assess both the opportunities and risks associated with such technologies.

8.1 Technological Evolution and Ethical Complexity

The historical development of GDT reveals significant technological advancement across three distinct generations. Originating in military sound-ranging techniques during World War 1, GDT evolved again in the 1990s with second generation systems, like ShotSpotter, able to detect gunfire in urban environment, making it applicable for civilian law enforcement. Today's third generation systems, such as Triangula and SED, incorporate AI and machine learning to achieve far greater accuracy and broader sound classification. While these technical improvements enhance detection and responsiveness, they introduce new ethical concerns. Interview data highlighted worries about the AI "black box" effect, where even developers cannot fully explain how decisions are made, raising questions about accountability, fairness, and transparency. Thus, while GDT becomes more precise, it simultaneously becomes less explainable, complicating democratic oversight.

8.2 Lessons from ShotSpotter and the Case of Chicago

The case of ShotSpotter in Chicago demonstrates that the success or failure of GDT cannot only be based on technical accuracy. Even when GDT performs as intended, such as in the Adam Toledo case, public acceptance may still falter. This is because implementation outcomes are deeply influenced by sociopolitical factors, including systemic racism, historical marginalization, and levels of trust in law enforcement. In communities where these issues are prominent, technologies like GDT may be viewed less as tools for safety and more as instruments of control. The controversy surrounding ShotSpotter shows that public legitimacy depends not just on how well the technology works, but on the broader societal context in which it is used.

8.3 Social Sustainability and Quality of Life

To evaluate GDT's broader societal impact, this thesis applied Felce and Perry's (1995) framework for quality of life, focusing on objective life conditions, subjective wellbeing, and personal values.

- Objective conditions: GDT may improve law enforcement's situational awareness by detecting unreported gunfire. However, current evidence shows limited or inconclusive effect on crime reduction or arrest rates.
- Subjective wellbeing: Perceptions of safety depend on context. In countries with high trust in authorities, like the Czech Republic and potentially Norway, GDT may foster a greater sense of security. In low-trust environments, it may instead create resentment or fear.
- Personal values: Attitudes toward GDT are shaped by how individuals balance values like privacy, safety, and freedom. Interviews revealed support and concern, underscoring that values are fluid and shaped by context, experience, and public discourse.

Together, these dimensions suggest that GDT's contribution to social sustainability cannot be assumed, it must be earned through ethical, transparent, and culturally sensitive implementation.

8.4 Should Norway implement GDT?

The question of whether Norway should implement GDT cannot be answered with a simple yes or no. Instead, it requires a nuanced evaluation of the technology's compatibility with democratic values, legal frameworks, and public expectations. While Norway experiences relatively low levels of gun violence, rare but devastating tragedies, like the 22 July attacks and the attempted shooting at Al-Noor Mosque, have exposed weaknesses in emergency response systems, where GDT could potentially altered the outcome of the situations, and provided life-saving support.

However, the core issue is not simply whether GDT works, but whether its use aligns with Norwegian principles of transparency, proportionality, and the protection of civil liberties.

This thesis concludes that GDT may be appropriate for Norway, but only under strict conditions. Its deployment must be transparent and clearly communicated to the public, subject to democratic oversight, and ethically grounded in respect for privacy and human rights. It must also be proportionate to actual security needs, avoiding unnecessary surveillance or the stigmatization of specific communities, in order to enhance quality of life for all Norwegians.

If introduced responsibly, third generation GDT could strengthen Norway's emergency infrastructure and contribute positively to social sustainability. If not, it risks undermining public trust and eroding democratic norms.

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10 Appendix

A – Interview Guide “Ola”- Triangula representative

B – Interview Guide “Jakub” - SED representative

C - Interview Guide “Kari” - IT-advisor in Norwegian police

D – Interview Guide “Lars” - AI-developer

E – Interview Guide “Jan” - Czech City Police Officer

Appendix A

Visit with Triangula 05.02.25

Discussion Points for the Meeting

1. Potential and Limitations of the Technology

- What do you see as the primary benefits of gunshot detection technology in a Norwegian context? (Combating crime, helping police, emergency/war/terror, anti-pouching?)

- What are the biggest challenges preventing this technology from reaching its full potential? (e.g., cost-benefit concerns, technical barriers, regulatory hurdles)

- Is the technology feasible for nationwide implementation, or is it more suitable for select high-risk areas? (which areas)

2. Public and Political Perception

- Have Norwegian citizens or politicians expressed concerns or skepticism about this technology?

- Are there political parties, movements, or civil rights organizations that oppose its implementation? (surveillance, not-effective, increasing marginalizing)

- Are there political parties, movements, or civil rights organizations that propose its implementation?

- What steps has Triangula taken to address privacy and ethical considerations?

3. International Perspectives and Lessons for Norway

- How has gunshot detection technology been successfully implemented in other countries? EU-countries (why/why not?)

- Are there particular case studies or best practices Norway could learn from?

- Are there significant differences in regulations abroad compared to Norwegian or EU policies?

4. Regulations and Policy Considerations

- How does Norwegian law currently regulate the use of acoustic surveillance technologies?

- What are the main regulatory challenges in Norway and the EU regarding this type of technology?

- Have there been any discussions with Norwegian government agencies or law enforcement about broader adoption?

5. Research and Public Studies

- Have any studies been conducted on how citizens perceive gunshot detection technology?

- Are there independent evaluations or research on the system's effectiveness in reducing crime?

- What data is available on false positives or potential limitations in different environments?

6. Future Outlook and Industry Trends

- How does Triangula see this technology evolving in the next 5-10 years? (implemented with other technologies?)

- Are there any upcoming innovations or new features being developed?

- Could AI and machine learning play a greater role in improving the system's accuracy and adaptability?

7. Additional Contacts & Further Research

- Can you recommend other experts, policymakers, or law enforcement officials who would be valuable to interview for this research?

- Are there reports, ongoing projects, or additional sources I should look into to gain a deeper understanding of this field?

Appendix B

Questions to SED/Sound Event Detector – 19.03.2025

International Adoption and Expansion

1. Which countries have implemented SED, and are there ongoing discussions about expansion?
2. What patterns do you see among countries considering SED adoption(e.g., crime rates, firearm prevalence, economic status, political systems, population density)? Conversely, what common reasons do countries cite for declining implementation?
3. What are the biggest challenges SED has faced in expanding internationally, and how do these compare to challenges within the Czech Republic?
4. Has there been any discussion about implementing SED in Norway or other Northern European countries? If so, what was the outcome? If not, what factors might explain the lack of discussions?
5. What are the primary motivations for cities or governments interested in SED? Are they responding to an actual increase in gun violence, or is it more about addressing public fear and perceived insecurity?
6. What was the public perception of SED in the Czech Republic before its implementation, and how has it changed since deployment?

AI-Technology and System Performance

7. How does SED work with police and security forces? Do law enforcement agencies trust AI-based gunshot detection, or is there skepticism?
8. How does SED's AI-driven system distinguish between actual threats and background noise, and what measures are in place to reduce false positives and missed detections?
9. What happens if the system fails to detect a gunshot? How does it improve from such mistakes, and does the AI continuously learn?
10. Why has SED chosen to rely on AI for gunshot detection? What are the advantages of this approach, and what potential risks or drawbacks does AI reliance introduce?
11. How does SED compare to competitors like Norwegian AI-based Triangula and American non-AI ShotSpotter? What differentiates SED from these systems?

Legal, Privacy, and Intellectual Property Concerns

12. Has SED data been used as legal evidence by law enforcement or in court?

13. Since SED does not store recordings due to GDPR compliance, does this create challenges in verifying gunshot detections for legal proceedings?
14. Are there concerns that intellectual property protections could make it difficult for legal experts to verify and cross-examine the AI's decision-making process in court?

Costs and Value

15. What is the general price range for implementing SED, and what are the estimated yearly costs for maintaining the system?
16. Has a cost-benefit analysis been conducted on SED's impact on law enforcement efficiency or broader societal benefits? If so, what were the key findings?

Impact and Future of Gunshot Detection

17. Can you share a case where SED directly helped prevent a crime or led to an arrest? What has been the company's biggest success story so far?
18. How do you see the gunshot detection market evolving over the next 5, 10, and 20 years? Will AI-based solutions like SED dominate, or do you foresee continued demand for non-AI alternatives?

Intervjuguide – Akustisk skuddeteksjon og innovasjon i politiet

Intervju over telefon: 5. april 2025

OM INTERVJUOBJEKTET

1. Kan du kort beskrive din nåværende stilling, og hvordan du arbeider med IT i politiet?
2. Har du tidligere erfaring med teknologiprosjekter eller digitalisering innen politiet?

INNOVASJON I POLITIET GENERELT

3. Hvorfor er innovasjon viktig for politiarbeidet i dag – og hvordan påvirker det trygghet og effektivitet?
4. Er det økt fokus på innovasjon i politiet de siste årene? Hva driver den utviklingen?
5. Hvilke innovasjonstyper prioriteres: teknologi, prosessforbedring, kompetanse, eller annet?
6. Ser politiet til andre land for inspirasjon? I så fall, hvilke land og hvorfor?
7. Hva skiller norsk politi fra politiet i f.eks. USA, Storbritannia eller Tsjekkia når det gjelder innovasjonsvillighet?

AKUSTISK SKUDDETEKSJON

8. Hva er ditt kjennskap til akustisk skuddeteksjonssystemer som SED, ShotSpotter eller Triangula?
9. Har slike systemer vært vurdert i norsk sammenheng? Hva var i så fall konklusjonen?
10. Hva er de vanligste årsakene til at slike teknologier ikke tas i bruk her – handler det om kostnader, personvern, tillit, behov eller noe annet?
11. Skytinger i Oslo har fått økt medieoppmerksomhet – hva er politiets vurdering av omfanget? Og hvordan vurderes behovet for teknologi som kan forkorte responstid?
12. Vet du omtrent hvor mange skyteepisoder politiet registrerer årlig i Oslo – og hvordan har dette utviklet seg de siste årene?
13. Hvor mye ressurser brukes i dag på å følge opp meldinger om skudd – og hvor ofte viser de seg å være falske alarmer?
14. I hvilken grad spiller publikums varsling en rolle i dagens responsrutiner – og kan et system som skuddeteksjon redusere avhengigheten av innringer?
15. Hvor kjent tror du slik teknologi, og mulighetene den kan ha, er for den norske befolkningen?
16. Tanker om innbyggere der slik teknologi hadde blitt utplassert, kunne det bidratt til en opplevelse av overvåking eller bidratt til økt stigmatisering?

AI OG ALGORITMER

17. AI-baserte skuddeteksjonssystemer gjør vurderinger i sanntid. Hvordan ser politiet på at beslutningsgrunnlaget er algoritmebasert og til dels uforståelig?
18. Hvordan påvirker det rettssikkerhet og tillit dersom avgjørelser tas av systemer man ikke fullt ut kan etterprøve?

19. Har det vært diskusjoner internt i politiet om faren for falske positiver eller uteblitt deteksjon – og hvordan veier man disse risikoene?
20. Er det en risiko for funksjonsglidning – at et system utviklet for skudddeteksjon senere brukes til bredere overvåkning eller annen kontroll?
21. Hvordan vurderer dere det etiske aspektet ved bruk av AI i offentlige sikkerhetstjenester?

JURIDISK OG PERSONVERN

22. Tror du det juridiske rammeverket i Norge per i dag tillater (eller hindrer) bruk av denne typen teknologi?
23. Kan det oppstå utfordringer med bruk av data fra slike systemer som bevis i rettssaker?
24. Er det behov for mer åpenhet rundt hvordan algoritmene fungerer, f.eks. i form av ekstern etterprøving?

KOSTNADER OG VERDI

25. Hvordan vurderer politiet teknologiske investeringer opp mot kost-nytte?
26. Tror du teknologier som dette kan føre til innsparing i politiressurser på sikt, eller er det primært en investering i trygghet og tillit?
27. Hva er terskelen for at en ny teknologi skal vurderes som «verdt det» i etaten?

FREMTID OG HOLDNINGER

28. Tror du norsk politi vil investere i akustisk skudd deteksjon i fremtiden? Isåfall, hvor lenge til?
29. Hva må være på plass – politisk, juridisk, økonomisk – for at slike systemer skal bli aktuelle?
30. Hvilke risikoer ser du ved at Norge enten ikke tar i bruk ny teknologi, eller at man tar det i bruk for raskt?
31. Hvordan tror du norsk politi sin teknologiske utvikling vil bli de neste 5, 10 eller 15 årene?
32. Hva ser du som den mest lovende teknologiske utviklingen for politiet fremover?

Written Interview – AI, Ethics & Society

Dear participant,

Thank you for agreeing to share your reflections on the role of AI in society. This written interview includes a set of open-ended questions. You may respond to as many as you like, in as much detail as you prefer.

• BACKGROUND & ROLE

1. Can you briefly describe your background and experience with AI systems?

• GUNSHOT DETECTION TECHNOLOGY

2. I have briefly talked with you beforehand the interview what acoustic gunshot detection technology is, and how it can rely on AI. Before this, had you any knowledge of this technology?

3. What are your initial thoughts on this type of technology? (Positive/negative)

• AI TRANSPARENCY & BLACK BOX ISSUES

4. How important is it for AI systems to be understandable or explainable to non-experts?

5. Do you see risks in using AI systems where the decision-making process isn't transparent?

6. Should some AI systems or algorithms be publicly owned to avoid giving too much control to private companies?

7. What risks do you see if privately-owned algorithms are either too secret — or too publicly accessible?

• TRUST & ERRORS

8. What do you think builds or breaks public trust in AI systems?

9. How should we handle the risks of false positives or errors in public-facing AI systems?

• SOCIAL IMPACT & STIGMATIZATION

10. Could deploying AI-based detection systems more heavily in certain areas lead to stigmatization or bias?

11. How can developers avoid reinforcing social or racial inequalities through technology?

• LEGAL EVIDENCE & ACCOUNTABILITY

12. What concerns might arise if AI-based decisions or alerts (such as those from detection systems) are used as evidence in court?

13. On the other hand, what might be the risks or missed opportunities if such AI-generated evidence is not allowed or considered in court?

• REGULATION & FUTURE

14. Do you think current laws are keeping up with how fast AI is developing?

15. What kind of regulation or oversight would you like to see for AI used in society?

16. Are you personally optimistic or cautious about how AI will shape our future?

• CLOSING REFLECTION

17. Is there any aspect of AI's impact on society that you feel is often overlooked or not discussed enough?
18. Are there any ethical concerns related to AI that we haven't touched on, which you think are particularly relevant for technologies like gunshot detection?

Written Interview – XX Police on Use of SED (Sound Event Detector)

Dear participant,
Thank you for taking the time to share your experiences with the use of Sound Event Detector (SED) technology in XX.

I am currently writing my master's thesis on acoustic gunshot detection systems, focusing on whether this technology could or should be implemented in Norway. As part of this research, insights from police departments with hands-on experience using such technology are incredibly valuable and would be greatly appreciated.

Below you will find a series of open-ended questions. Please feel free to respond to as many as you are comfortable with, and in as much detail as you prefer. If desired, your participation can be anonymous.

• BACKGROUND

1. Briefly describe your position and role within the XX Police Department, and how you are involved with the SED system.

2. When and why was the SED system implemented in the police?
   – How was that process? Did local police have experience with similar technology beforehand?

Where did the initiative for implementation come from? (E.g. the police, politicians, local community)

3. Was there any countries looked at for experience with this type of technology?

4. Before implementation, what was the biggest concern regarding the technology? (e.g. too expensive, not efficient, training requirements, resource drain, surveillance fears)

• CRIME RESPONSE

4. How has police response time to gun-related or violent incidents been affected by SED?

5. How do officers typically feel about responding to alerts triggered by technology rather than public calls?

• COST, RESOURCES & EVALUATION

6. Was the financial investment in SED considered high, moderate, or reasonable from a policing perspective?

- How would you describe the yearly costs, high, moderate or reasonable?

7. Has the system helped with more efficient use of police resources?

• TRAINING & OPERATIONS

8. What kind of training did officers undergo to effectively use the SED system?
   – How much time did it require, and what was the feedback they gave on the training? (Yearly training?)

9. Was there complications implementing SED to function within police IT-systems?

• PUBLIC TRUST & ETHICAL CONSIDERATIONS

9. How has the public responded to SED — do they feel safer or more monitored?
   – Were there any privacy or ethical concerns raised by the community, and how were they addressed?

10. Do you see risks of over-policing or stigmatization in neighborhoods where SED is concentrated?

• LEGAL, DATA & ACCOUNTABILITY

11. Has SED data ever been used as part of an investigation or legal case in XX?

12. Are there concerns or discussions about using AI-generated alerts as reliable evidence in court?

• FUTURE OUTLOOK

13. Would you recommend this type of technology to police departments in other cities/countries?
    – If so, what's the main argument (saving money, solving crime, saving lives, etc.)?

14. To your knowledge, are there plans to expand the use of SED within XX, or in more cities in the Czech Republic?

15. How do you see the role of AI-based detection evolving in policing over the next 5, 10 and 20 years?

• **END**

If available, I would greatly appreciate any statistics or internal data related to the use of SED in XX. This could include, for example:

- The number of alerts received over a given period
- How often the police responded to those alerts
- The proportion of alerts that were verified incidents versus false alarms