Increasing Public Safety Through Augmented Reality Technology Utilized by Police Officers

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Abstract

Augmented reality (AR) technology presents a promising avenue for enhancing public safety measures within law enforcement, yet its integration into police operations remains largely unexplored. This study addresses the research question: How can police officers in Canada utilize augmented reality technologies to increase public safety? Through an extensive review of literature spanning over two decades, encompassing diverse fields such as security, military, and emerging technologies, this research examines the feasibility and implications of AR adoption within policing agencies. The findings reveal the potential benefits of AR technology in enhancing various aspects of policing, including criminal investigation, training, and situational awareness. Despite the promising prospects, significant challenges, and concerns, such as legal, privacy, and funding constraints, hinder the widespread adoption of AR technology in law enforcement. The discussion underscores the imperative for proactive policy development and comprehensive research initiatives to address these challenges and unlock the transformative potential of AR in revolutionizing policing practices. While the adoption process may be slow and fraught with complexities, the study highlights the necessity for law enforcement agencies and policymakers to embrace emerging technologies like AR to safeguard communities effectively in the digital age.

Keywords: augmented reality, AR, technology, police agencies, law enforcement, public safety, police officers, revolutionizing policing practices

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To maintain effective law enforcement in an ever-changing world, it is crucial to employ creative thinking when implementing emerging technologies into society (Cowper, 2004). The successful integration of such technologies can significantly impact the safety and well-being of citizens, and it is vital to remain forward-thinking in this regard (Cowper, 2004). Adapting to new technologies is especially important in law enforcement, where cutting-edge tools and techniques can significantly enhance the ability to protect and serve communities. As such, it is imperative for law enforcement professionals to stay abreast of emerging technologies and to be able to think critically about their potential impact on society. (Cowper, 2004). Considering that the technological advances of the 21st century are moving at an unprecedented rate (Korinek, 2021), police officers must be well-equipped in understanding and applying these transformative technologies, not only to combat new threats due to technological advances but to enhance the way they police.

Among these advancements is the creation of augmented reality (AR). According to 2023 statistics, augmented reality has a market value of USD 25.1 billion and is expected to grow to USD 71.2 billion in 2028 (Augmented, 2023). It is essential also to note the advancements in virtual reality (VR) training in law enforcement and its effectiveness. This is due to the similarities between VR and AR technologies, such as incorporating virtual elements in a visual display headset. The integration of VR has drastically improved the quality of training programs and has led to numerous benefits for policing agencies (Kleygrewe et al., 2024).

Considering the success and viability of VR within law enforcement training, Augmented Reality is an emerging technology that has implications for public safety and is a potential tool

police officers can utilize. Unlike VR, where the user is completely immersed in a computer-generated world, AR blends the real environment and virtual objects in real time for the user, essentially aligning both the real world and virtual objects. Not only can this technology be used for police training purposes, but AR has the unique ability to be integrated into the fieldwork of police officers.

Statement of Problem

The problem herein is the need for more initiative on behalf of policing agencies in Canada to research, test and implement emerging AR technology. Law enforcement officers must possess a high level of proficiency in using cutting-edge technology to stay ahead of the evolving tactics of criminals. Officers must be well-versed in the latest technological advancements to effectively combat crime in the digital age and be prepared to utilize them to their fullest potential. Failure to do so could result in a significant disadvantage and endanger the lives of both officers and the public (Cowper, 2004). As such, law enforcement agencies must prioritize research on technological tools to increase public safety.

Purpose or Aim of Study

This research paper aims to provide a comprehensive introduction to AR and its potential benefits to law enforcement agencies in Canada. It seeks to explore and discuss the implications of AR on increasing public safety and produce potential applications for its future use as a law enforcement tool. The purpose of this research is to explore and examine the fundamental principles and components of this technology, along with research developments occurring today that have the potential to enhance police performance. This paper will provide policing agencies with insights into the possibilities of AR technology and enable them to make informed decisions on its use**.**

Research Question

The primary research question is, how can police officers in Canada utilize augmented reality technologies to increase public safety?

Worldview

This research study adopts a pragmatic worldview, prioritizing the research problem and question while utilizing all available approaches to understand it (Creswell & Creswell, 2018). Instead of focusing solely on one method, pragmatism allows for various methodologies, worldviews, assumptions, and data collection and analysis (Creswell & Creswell, 2018). Moreover, a pragmatic perspective prioritizes the real-world implications and uses of research (Creswell & Creswell, 2018). By adopting this approach, the study aims to explore practical solutions to increase public safety through AR technology leveraged by police agencies in Canada; therefore, a pragmatic worldview is suitable.

Scope of the Study

This study's scope will focus on increasing public safety in Canada through emerging technology; specifically, Augmented Reality used by police officers, as well as the principles and components of this technology and its implications for police agencies. This scope includes examining and discussing current technological tools and devices used by police agencies as well as augmented reality and virtual reality. This study’s scope will mainly include the discussion of current VR technology utilized by policing agencies due to its similarities in design with AR to illuminate the potential success of AR implementation and provide a comprehensive understanding of how AR can be integrated into policing.

Significance of Study

The research on augmented technologies in policing is significant as it enriches the scholarly literature in this area. This technology has yet to be implemented and thoroughly

researched, so the discussion and examination of how this emerging technology can be used will set the wheels in motion for further discussion and exposure to this realm of technology that can transform the way traditional policing is done.

To create a prototype and test it within Canadian police agencies, it is crucial to have a comprehensive understanding of the benefits, challenges, and implications of integrating AR into law enforcement practices. Researching and utilizing this technology can increase public safety and improve policing practices. However, it is essential to note that integrating AR will bring about issues of legality, funding, privacy laws, and police accountability that will significantly affect the public and police. This will have implications for government policy and decision-making in the near future.

Limitations of the Study

Considering the novelty of this area of research, there may be limitations in research specifically conducted in Canada, in addition to a limited number of studies testing the viability of AR within policing organizations. It may be likely that there will be a lack of qualitative data results due to the insufficiency of this technology's utilization by policing agencies; this will result in a limited examination of the perceptions and attitudes of the public, police, and policymakers on the use of AR within policing.

Literature Review

The Benefits and Growth of AR Technology

A prominent theme is AR technology's potential benefits and growth. In the report titled Spanning the Virtual Frontier: Canada's Immersive Technology Ecosystem (2020) by the Information and Communications Technology Council (ICTC), the ICTC commented on the growing field of immersive technology and the significant benefits seen today. According to the ICTC (2020), the growth of immersive technology in Canada has been remarkable, with over

100 new companies specializing in immersive technology products and services established between 2014 and 2017 alone. In retail, AR enhances shopping experience, in healthcare, it trains medical professionals and guides during surgeries, in education, it creates interactive learning materials, and in architecture and construction, it improves project efficiency Information and Communications Technology Council, 2020).

The AR market has been experiencing significant growth globally and is projected to contribute up to USD 1.5 trillion to the global economy by 2030 (ICTC, 2020). A significant portion of Canada's immersive technology companies, approximately 81%, are engaged in sectors vital to national interests and economic development (ICTC, 2020). These sectors include national defense and emergency response (ICTC, 2020). This is concurred by the Department of National Defense and Canadian Armed Forces (DND & CAF) (2019) as they state that recent technological advancements have revolutionized the public safety sector. Although they add there is still much work to be done to fully utilize the value of newer technologies and the high-quality data required for making real-time operational decisions, efforts are already underway to explore the potential of data-driven technologies, such as augmented reality, to enhance the efficiency and effectiveness of Defence programs (National Defense and Canadian Armed Forces, [DND & CAF], 2019).

This is significant in connecting to literature by Bach (2021); Cowper (2004); DND & CAF (2019); RCMP (2021); and Schwab (2019), as they all speak to the viability, growth, and benefits of AR technology. Cowper (2004), Liu (2018), and Schwab (2019) share similarities in relaying the specific functions of AR, such as facial recognition, voice recognition, and spatial mapping in benefiting security and military fields. Interestingly, Cowper (2004) predicted

success and practicality over 20 years ago; such findings are corroborated today by studies conducted by the ICTC (2020), Liu (2018), and Bach (2021).

Legal and Privacy Concerns

Schwab (2019) explores the potential of augmented reality technology in security. However, the author highlights significant limitations that may hinder or delay the adoption of such technology in the fields of security and public safety, notably privacy and legality issues. According to the ICTC (2020), integrating and adopting AR technology into Canadian society raises concerns about privacy and legal compliance. Schwab (2019) expresses that no clear framework exists for integrating AR into security or public safety fields. AR devices can collect sensitive personal data and process biometric data without people's consent, leading to unwarranted surveillance and reduced privacy rights (ICTC, 2020). Schwab (2019) further explains that using AR technology may result in legal data retention, sharing, and access issues. Proper safeguards must be implemented to prevent unauthorized access or misuse of collected data (Schwab, 2019). As per Schwab's (2019) explanation, with the increasing usage of AR in security, it is highly probable that legal concerns will also expand. This may involve governments at every level regulating the AR data's content, usage, and distribution, along with safeguarding and storing it (Schwab, 2019).

Moreover, a significant gap in the literature regarding the use of AR in Canada and the U.S. is the lack of knowledge of legal frameworks governing the use of AR technology by police forces. This can include the admissibility of AR-generated evidence in court proceedings and clear guidelines for legally deploying AR-enhanced surveillance tools (Schwab, 2019). Considering the adoption of somewhat new technology, such as body worn cameras in Canadian

police departments, has had a slow adoption it can be assumed several factors hinder the acceptance of newer technology such as AR.

Implementing new technologies, such as body-worn cameras in Canadian police departments, has been slow due to various factors (Erick, 2019). These include concerns regarding privacy and legality (Erick, 2019), lack of funding, and the reluctance of officers and unions to adopt them (Better Canada Institute, 2021; Smoot, n.d.). It can be assumed that the acceptance of newer technologies like AR is also hindered by similar factors, including the public's privacy concerns and delays in adopting laws.

Additionally, there may be pushback from officers and their unions, who argue that advanced technologies like AR and body-worn cameras violate their privacy rights and increase their stress due to constant surveillance (Better Canada Institute, 2021; Smoot, n.d.). They also worry that such technologies could be used to target them in disciplinary proceedings (Better Canada Institute, 2021; Smoot, n.d.). This is significant to understanding the resistance that augmented reality may face. It also highlights a broader issue of a lack of legal and privacy knowledge when it comes to adopting new technology, as well as a resistant police subculture that Canadian law enforcement agencies and the government must address.

Lack of Funding

According to the ICTC (2020), Canadian investors have yet to provide substantial funding for AR technology due to various factors, including challenges within the AR industry and broader investment trends. One of the reasons for this is that AR technology is considered a high-risk investment, as there is uncertainty surrounding its market viability and potential returns (ICTC, 2020). Although AR holds promise for various sectors like gaming, education, healthcare, and manufacturing, its widespread adoption and revenue-generating potential still

need to be proven (ICTC, 2020). This uncertainty discourages investors from investing in AR start-ups without evidence of market demand and sustainable business models (ICTC, 2020).

Schwab (2019) agrees with this discovery and warns that the lack of a clear vision for integrating augmented reality into security programs and public safety fields could result in their rejection. AR is already widely used for gaming and shopping, but without a clear vision, security programs may not receive necessary funding approval from key decision-makers due to budget constraints (Schwab 2019). Additionally, Schwab (2019) adds that problems like privacy and legal concerns will need to be addressed and will come at a high cost. This theme provides a significant outlook on one of the many factors as to why AR has yet to be utilized by police agencies.

The need for testing and adoption of AR within Law Enforcement

A recurring theme within all the literature expresses the urgency to grab a hold of this emerging technology and utilize it for the overall betterment of society. This major theme additionally serves as a significant gap in the literature due to the novelty of this area of research and the lack of available information in addressing the research question. This is only further illuminated by Cowper (2004), Bach (2021), Schwab (2019), LeBeuf (2000), and the National Defense and Canadian Armed Forces (2019), as these authors implore the need to stay abreast of emerging technologies to stay relevant and ahead of evolving criminal tactics and threats.

Moreover, these authors all similarly provide insights into how the police, military and security can use AR technology to revolutionize these industries. The insights provided by Cowper (2004), Bach (2021), and Schwab (2019) are crucial instructions to municipal and federal police departments on how to test and develop AR technology. According to the RCMP's Specialized Policing Services (2021), this technology is under the radar of the government, and there is a discussion on its potential use as a law enforcement tool; however, this discussion

within the RCMP is in its infancy and may take several years to develop. As a testament to the inability for police departments to adapt side by side with emerging technology is the findings provided by LeBeuf in 2000. LeBeuf (2000) reveals that Law enforcement decision makers have long understood the usefulness of technology in their work ranging from earlier technological advancements within policing such as AFIS—Automated Fingerprint Identification System or crime mapping systems. However, the technology sector has rapidly outpaced the decision-making processes of public police departments (LeBeuf, 2000). As a result, police are left vulnerable in an age of technology-based criminal activity (Cowper, 2004; LeBeuf, 2000).

Methodology

Search Methodology

The search methodology for this study focused on searching for secondary data due to time constraints and the lack of resources to collect primary data. A comprehensive search was conducted using strategies such as keywords (See Table 1), and inclusion and exclusion criteria to optimize relevant resources. The following databases were utilized for the search; Criminal Justice Abstracts with Full Text (CJA), Canadian Commons, and Google Scholar. The initial and revised searches yielded various sources of credible literature and a number of search results (See Tables 2,3,4,5 and 6).

Table 1

Key Search Terms

"Law Enforcement" "Police" "Policing" "Police Officer" "Public Safety"	*AND*	"Augmented Reality" "Virtual Reality" "AR" "VR" "Technology" "Mixed Reality" "MR" "XR" "Extended Reality"	*AND*	"Canada" "North America" "United States" "America" "U.S."

Note. This Table illustrates the key terms used to identify relevant literature for the article selection.

Table 2

Results from the initial search.

Database 1	Search Term(s)	Search Results
Criminal Justice Abstracts with Full Text (CJA)	augmented reality AND policing	58

Note. This Table illustrates the search database used, search terms, and number of hits returned from the initial search.

Table 3

Results from the revised search.

Database 1	Search Terms(s)	Search Results	Reason for Revision
Criminal Justice Abstracts with Full Text (CJA)	augmented reality AND (policing OR police officers)	1	Added synonym for policing
Criminal Justice Abstracts with Full Text (CJA)	augmented reality AND (police OR law enforcement)	11	Removed ‘policing’ Replaced with ‘police’ and added a synonym for police
Criminal Justice Abstracts with Full Text (CJA)	augmented reality AND (police OR law enforcement) AND public safety	181	Added keyword ‘public safety’
Criminal Justice Abstracts with Full Text (CJA)	augmented reality AND (police OR law enforcement) AND public safety AND use	2	Added keyword ‘use’

Note. This Table illustrates the search database used, search terms, and number of hits returned with revisions applied to the search

Table 4

Results from the initial search.

Database 2	Search Terms(s)	Search Results
Canada Commons	augmented reality AND policing	3,647

Note. This Table illustrates the search database used, search terms, and number of hits returned from the initial search.

Table 5

Results from the revised search.

Database 2	Search Term(s)	Search Results	Reason for Revision
Canada Commons	augmented reality AND (policing OR police officers)	3,647	Added synonym for policing
Canada Commons	augmented reality AND (police OR law enforcement)	5,052	Removed 'policing' Replaced with 'police' and added a synonym for police
Canada Commons	augmented reality AND (police OR law enforcement) AND public safety	3,475	Added keyword 'public safety'
Canada Commons	augmented reality AND (police OR law enforcement) AND public safety AND use	3,449	Added keyword 'use'
Canada Commons	Augmented reality	10,000	Removed 'AND (police OR law

			enforcement) AND public safety AND use'

Note. This Table illustrates the search database used, search terms, and number of hits returned with revisions applied to the search

Table 6

Results from the initial search.

Database 3	Search Term(s)	Search Results
Google Scholar	augmented AND policing	61,300

Note. This Table illustrates the search database used, search terms, and number of hits returned from the initial search.

Results from the revised search.

Database 3	Search Term(s)	Search Results	Reason for Revision
Google Scholar	augmented reality AND (policing OR police officers)	87,200	Added synonym for policing
	augmented reality AND (police OR law enforcement)	135,000	Removed 'policing' Replaced with 'police' and added a synonym for police
	augmented reality AND (police OR law enforcement) AND public safety	89,000	Added keyword 'public safety'
	augmented reality AND (police OR law enforcement) AND public safety AND use	89,700	Added keyword 'use'

Note. This Table illustrates the search database used, search terms, and number of hits returned with revisions applied to the search.

Inclusion and Exclusion Criteria

In order to focus on relevant information for this capstone paper, specific criteria have been established for the inclusion and exclusion of sources. To be included, sources must be scholarly, written in English, full-text, and peer-reviewed. Reports, books, and viewpoint papers published in accredited journals and by credible authors, and institutions from 2000 to 2024 are acceptable. This ensures that the research meets high academic standards. The sources studied are not limited to discussions taken through a policing lens. Literature that speaks to the use of AR in any related field, such as security and military will be included. Studies conducted in military and security fields are also considered relevant given the shared similarities between these fields and law enforcement. This allows us to visualize the potential for AR within a police setting.

Although this broad timeline resulted in many search hits, it was necessary to ensure that we covered all relevant information since AR technology has been discussed for over 20 years. By examining past findings and emerging data, we can establish meaningful connections and develop a comprehensive understanding of the topic. In the purpose to better understand the emergence of new technology within law enforcement, literature that discusses other emerging technologies other than augmented and virtual reality will be accepted.

Initially, the inclusion criteria were limited to Canadian literature. However, due to the limited number of Canadian sources available, literature from outside the United States was included in this study. Canada and the United States share many similarities in culture, socioeconomic conditions, and legal systems. Therefore, research findings in the U.S. may be applicable and transferable to this study. The study's focus group includes law enforcement agencies and police officers, which are relevant to maintaining public safety. Exclusion criteria

include sources that are news articles, blogs, and sources not in English. Studies conducted before 2000 are excluded to ensure relevant and viable studies will be reviewed. Additionally, studies conducted outside of Canada and the U.S. are excluded to ensure that the findings and discussions regarding AR technology are applicable in a Canadian setting.

Abstract Review

The initial and revised searches yielded many sources related to the keywords and inclusion and exclusion criteria. The sources were inspected first based on each title, examining their relevance to the research question and whether the identified keywords (refer to Table 1) were used. If an article and its respective title seemed feasible at first glance, it was further inspected, and the abstract was reviewed. In reviewing each abstract, the inclusion and exclusion criteria were at the forefront in determining if the study would be selected. Ultimately, 29 article abstracts were examined. Each source identified two or more key terms, such as "augmented reality," "police," "policing," and "Canada." U.S.," "AR," and "VR." The articles were selected based on three main criteria: they were either conducted in Canada or the U.S., the literature was scholarly or peer-reviewed, and the article mentioned AR in the field of law enforcement, security, or military.

Article Selection

The articles selected for this capstone paper were chosen from the initial 29. These articles were selected based on their potential to address the research question, relevance to the capstone's scope, and ability to contribute meaningfully to the discussion. The chosen articles were impactful in providing a comprehensive understanding of AR and its potential utilization by police, including its technical functionalities and limitations. Canadian sources were prioritized over U.S. literature to narrow down the article selection. All six articles underwent a critical analysis to determine their suitability in answering the research question. The final

review process involved a meticulous evaluation of the articles' introduction, methodology, results, recommendations, and conclusions, following the guidelines of Creswell and Creswell (2018).

Results

AR Viability Within Policing and the Need to Adopt Emerging Technology

According to the literature discussed by Cowper (2004), Liu et al. (2018), Schwab (2019), and Bach (2021) the benefits of using AR in the public safety sector are numerous. AR tools can be used in various aspects of policing, including criminal investigation, training, and patrol (Cowper, 2004), as well as related fields in military and security (Bach, 2021; Schwab, 2019). Although the findings by Schwab (2019) and Bach (2021) provide similar insights into the applications and use of AR they only speak to its components in a military and security field. However, Cowper uniquely has discussed this, specifically as a tool to benefit police officers.

According to Cowper (2004) AR can provide real-time data on crime scenes, suspects, and other critical information, enabling officers to make better-informed decisions and act more quickly. AR tools can also be used to identify and track individuals based on their voice patterns and enhance an officer's ability to read lips, especially in noisy or crowded environments (Cowper, 2004). Moreover, AR technology can be used to create 3D visualizations of crime scenes and other forensic data, allowing officers to better understand the scene and identify potential evidence (Cowper, 2004). The technology can also translate languages in real-time, identify individuals based on biometric data, and integrate sensors that detect chemical, biological, and explosive threats, providing officers with immediate notification of any contamination (Cowper, 2004).

Additionally, AR technology can provide officers with maps, heads-up displays, and other data that can improve situational awareness and help officers make better decisions,

ultimately leading to enhanced public safety (Cowper, 2004). This study adds immense strength in answering the research question, since it focuses solely on AR's applications in a policing realm. At its strength base, the authors of this paper gathered information from many different engineering and government resources, scientific and academic research papers, and projects, as well as examining the field research conducted on the Battlefield Augmented Reality System (BARS) that was developed at the Naval Research Lab in Washington, D.C.

The results provided by Cowper (2004) suggest the feasibility and positive application of AR to enhance public safety. They also provide insights into a comprehensive picture of AR technology, various AR initiatives, and how they might impact the law enforcement profession over the coming years. This is only a handful of the potential applications of AR, which has been predicted in literature by Cowper (2004) and similarly by Schwab (2019). The technology's feasibility is evident in the implementations and testing carried out by researchers like Bach (2021), Cowper (2004), and Liu et al. (2018). Their main findings help in answering the research questions as well as serving as a source document for police officers and agencies, providing a starting point for developing practical and beneficial policing applications.

Notably, the U.S military proposals to increase situational awareness and the enhancement of soldiers' capabilities through the use of AR underscores the potential success of this technology in enhancing public safety. To successfully achieve their objectives and address this problem the U.S. military invited Microsoft engineers to carry out their vision (Bach, 2021). The literature concluded that Microsoft's HoloLens technology has significance in increasing a soldier's personal safety, and situational awareness through providing features such as thermal imaging, holographic imagery, and 3D terrain maps projected onto their field of vision (Bach, 2021). It is significant to mention the success of the porotypes has been significant in the U.S.

military's decision to form a new contract with Microsoft which is an estimated $21.88 billion dollars (Bach, 2021). This information is crucial and adds strength to the evidence as it uncovers that Microsoft's HoloLens technology is dependable and highlights the promising prospects of AR technology in the military sector. This, in turn, suggests that there is potential for its adoption within the law enforcement agencies in Canada.

To further solidify the ambiguity of whether this technology works Liu et al. (2018) conducted a research project to evaluate Microsoft HoloLens' AR technology. They wanted to explore its capabilities and limitations in "head localization, real environment reconstruction, spatial mapping, hologram visualization, and speech recognition" (Liu et al., 2018, p.2). The study's findings revealed high accuracy regarding the functionalities and components of Microsoft's HoloLens technology (Liu et al., 2018). This is mentionable since the findings reveal the tangible success of AR as well these evaluative findings can be useful references for future studies and other companies looking to develop HoloLens software to utilize AR in their respective fields of work (Liu et al., 2018).

The study conducted by Liu et al. (2018) has great value for law enforcement agencies looking towards the first steps in developing a prototype. The findings reveal the major functionalities of HoloLens to be accurate (Liu et al., 2018). Considering the U.S military have already began testing, this displays the potential for AR to enhance public safety and be implemented and adopted by policing agencies. The strengths of evidence provided by Liu et al., (2018) can be corroborated by the U.S military's decision to utilize Microsoft's HoloLens technology to carry out their objectives. However, the study has a weakness and limitations. The experiments only focus on one or two specific technical aspects of a given functional component of the HoloLens system (Liu et al., 2018). This study neglects to evaluate every single technical

design and use of this technology, which calls for further testing and research on the viability of AR technology such as the HoloLens.

Furthermore, the RCMP is leading the discussion on how policing in Canada can adapt to emerging technology. Investigation into literature to understand where policing in Canada falls in their attentiveness to new technology reveals that the RCMP is at the forefront of this discussion. In the 2021 report published by the government of Canada, titled, “2021-26 strategic plan: RCMP Specialized Policing Services” The RCMP Specialized Policing Services developed a departmental plan for the 2021-26 fiscal year to modernize the RCMP. The RCMP's Specialized Policing Services (SPS) has identified the need for federal policing to keep pace with the rapidly evolving technological world, especially since contemporary criminal activity is underpinned by technology (RCMP, 2021). In this strategic plan, the SPS mainly speaks to supporting the evolution of the RCMP with efforts focused on implementing cutting-edge science and technology, delivering modern training, and innovative tools (RCMP, 2021).

According to the report's main findings, there are six major trends that the organization need to consider while developing its strategies and plans. The report highlights "The 4th Industrial Revolution" (RCMP, 2021, p. 3) as the top trend, which includes the importance of augmented reality applications. The report examines the implications of the use of such AR technology in training or during real-time crisis resolution (RCMP, 2021). This report has immense significance and adds strength to the answering the research question since it is published by a reliable source, it has roots in Canada and points towards the potential future and success of AR adoption within the RCMP.

Legal and Privacy Considerations

The implementation of AR technology in police work raises privacy and legal issues that need to be addressed (ICTC, 2020; Schwab, 2019). With AR devices, sensitive personal data can be collected, and biometric data can be processed without people's consent, leading to unwarranted surveillance and reduced privacy rights (Schwab, 2019). There is no clear framework for integrating AR into security or public safety fields, and concerns have been raised about the lack of guidelines for legally deploying AR-enhanced surveillance tools (Schwab, 2019; ICTC, 2020).

Moreover, the admissibility of AR-generated evidence in court proceedings is not well understood, and legal data retention, sharing, and access issues may arise with the use of AR technology (Schwab, 2019; ICTC, 2020). The government may need to regulate the content, usage, and distribution of AR data, and proper safeguards must be implemented to prevent unauthorized access or misuse of collected data (Schwab, 2019; ICTC, 2020). The theme of privacy and legal concerns is crucial in addressing the research question related to the implementation of AR technology in police work and highlights the limitations and gaps that are in place such as legal and privacy concerns. These concerns have a significant impact on the reluctance to adopt such technology. Therefore, it is necessary to establish proper safeguards and regulations that can address these issues and protect the privacy rights of citizens.

Funding Considerations

The increasing costs of policing have become a major issue in Canada, affecting all levels of government (CCA, 2014). According to the Federation of Canadian Municipalities, nearly 20% of municipal operating budgets are currently allocated towards security, with police service expenditures identified as among the most rapidly growing expenses for municipalities. Although modern technology and resources can be useful in preventing and solving crimes, it remains uncertain whether the handling of this data adds and unforeseen costs cause extra

demands or undue burdens on departmental resources and time (Deloitte, 2008, as cited in CCA, 2014).

There are various factors that impact the overall cost of implementing technology for law enforcement agencies. The cost is not limited to the price paid to the vendor (National Public Safety Partnership, n.d). It includes the initial expenses for acquisition, such as labor, hardware, warranties, software, and licenses (National Public Safety Partnership, n.d). After that, the departments must compute the deployment costs, operating costs for regular use, maintenance costs for repairs or upgrades, and disposal costs for removal or end of ownership (National Public Safety Partnership, n.d). Additionally, Schwab (2019) suggests that the absence of a distinct plan for integrating augmented reality into public safety and security programs could lead to their rejection, and the lack of a clear plan may result in budget constraints that prevent key decision-makers from approving necessary funding for security programs. Although Schwab (2019) speaks to its use in a security field, his findings are still applicable in the policing world. Since there is a lack of data and literature available on the definitive successes of AR technology within law enforcement, it is highly probable that the potential risk of investing will discourage police and government decision-makers from initiating any prototypes and testing. Additionally, Schwab (2019) notes that addressing concerns related to privacy and legal matters will be expensive.

Furthermore, the Information and Communications Technology Council (ICTC) states that Canadian companies are facing challenges in securing funding from investors, which is hindering the adoption of AR technology by Canadian companies (ICTC, 2020). The reluctance among investors to invest in emerging tech like AR is also contributing to the lack of financing

available for Canadian companies (ICTC, 2020). In addition, reduced spending by clients may negatively impact the demand for immersive tech products and services (ICTC, 2020).

This raises questions about whether the general lack of funding from Canadian investors is causing the government and policing authorities to hesitate in adopting AR technology in policing. Overall, this theme was significant and shows depth in answering the research question since it displays the obstacle of funding and costs which curtail the utilization of AR by police officers. However, this theme reveals the limitations that exist due to the minimal and incomplete data available for Canada's immersive technology industry. The existing data in Canada is vague due to the novelty of this area of research and due to this, much of the data regarding AR technology is in aggregation with data from the U.S. (ICTC, 2020).

Discussion

A Virtual World

It has been thoroughly established in the literature that there is a new virtual world where criminal tactics have evolved, and as such police represent an important market for technology companies that needs to be developed quickly. To keep up with the changing world police organizations need to utilize the technological tools that are available to them. The key is not for police agencies only to adopt new technology but also to adapt with it. This will ultimately ensure that law enforcement agencies do not fall short in leveraging tools that will significantly enhance the way they police and contribute to public safety.

Moreover, it has become starkly apparent through reviewing the available literature that almost every progressive field of work and industry has already taken advantage of AR technology in some capacity and have transformed their traditional practices. The ICTC (2020) explains that AR is revolutionizing various industries, as it is increasingly used in retail for virtual try-ons, in healthcare for surgical planning and training, in education for interactive

learning experiences, in architecture for visualizing designs, and many more. However, as AR is being utilized by many fields and industries in Canada, it has not yet been leveraged by police agencies, which acts to its detriment.

Lack of Adoption

When it comes to public safety fields, there seems to be a lack of initiative in testing and implementing AR prototypes. Despite numerous discussions on the benefits and implications of AR technology in fields such as the military and security, there are no concrete examples of development or implementation within any police agency in Canada. As an outlier, the RCMP has briefly discussed AR technology's promise however, there is yet to be a plan in place to test and develop. This can be seen in the lack of available literature, which suggests that police organizations have yet to take a proactive approach towards exploring the potential of AR technology.

The U.S. military alone has shown potential in being one of the first in North America to utilize AR technology to develop software and a headset tailored to meet their objectives of increasing situational awareness and soldier. However, it is still in progress, and no definitive data is available on its findings and feasibility. The military and police have similar objectives as both are primarily responsible for ensuring public safety. According to Bach's (2021) research, AR technology so far has proved to be beneficial for the military, and it is likely that law enforcement agencies can also leverage this technology in a positive way. While most industries have successfully adapted to emerging technologies, police agencies are lagging. It is evident that they are still struggling with the challenges that come with much simpler technologies, such as body-worn cameras. The discussion surrounding AR impact on policing practices has been wildly positive, which raises the question of why law enforcement agencies fall staggeringly behind.

Challenges and Concerns

The novelty of AR technology poses as a significant drawback in its adoption on behalf of government and policing agencies. Although there are numerous benefits as outlined by Bach (2021), Cowper (2004), Liu et.al (2018), RCMP (2021), Schwab (2019), and the National Defense and Canadian Armed Forces (2019), there are barriers which inhibit police officers from utilizing this technology. Firstly, there is a general lack of research and literature in this technology being leveraged by policing agencies. This ultimately means that there is an unknowingness in how to approach and implement AR. Police and government policy makers will need to consider the costs of AR, the legal implications and most importantly the privacy concerns that will come with such invasive yet beneficial technology.

There are risks that will inevitably come with the implementation of AR, such as there are with any new technology, however it should not be the cause of its hindrance. Policing organizations need to realize the importance of staying ahead of emerging technology, not only to combat evolving criminal tactics, but to alleviate and revolutionize their policing practices. In comparison if we look to the debate surrounding body-worn cameras we can see similar considerations in its adoption such as funding, legal and privacy concerns, however, at its forefront body-worn cameras provide added layers of protection and accountability for officers (Better Canada Institute, 2021). They protect officers from false claims when the alleged behavior is captured avoiding millions of dollars in lawsuits (Better Canada Institute, 2021). There seems to be a trade-off between the benefits new technology can provide and the risks associated with it. As the Council of Canadian Academies (2014) mentions, technology offers potential cost savings but creates new resource demands.

Revolutionizing Police Practices

The use of technology has transformed the traditional methods of policing. The adoption of computers, fingerprinting, crime mapping systems, body-worn cameras, and predictive policing has revolutionized day-to-day policing (Government of Canada, 2023; LeBeuf, 2000) These technologies utilize algorithms, data analysis, and emerging software technology to the benefit of law enforcement agencies. However, the slow adoption of emerging technology can be attributed to legal, funding, and privacy implications, which need to be discussed and researched widely before they can be utilized.

In Canada, there is a significant gap in understanding the role that AR technology plays in the policing realm. Due to this lack of understanding, law enforcement agencies are significantly delaying in reaping the benefits that come with such technology. Policymakers need to take the initiative to visualize the potential of AR technology and begin creating and testing a prototype. However, this is only possible if government and police policy makers can understand the immense potential despite its challenges. From the research and insights conducted for this paper, it is suggested that AR technology will likely be adopted by policing agencies and enhance public safety, altering the way police will look and work. However, this will be a very slow adoption process, as it may take several years before policing policy makers will be able to realize the full potential of AR technology.

The full realization of AR's potential in law enforcement requires significant research to ultimately configure and work around the challenges presented. Police agencies must proactively engage in research and testing to harness the transformative capabilities of AR. The literature analyzed in this paper underscores the widespread adoption of AR across diverse industries, signaling its capacity to modernize and enhance traditional methods of work. Moreover, discussions regarding the applicability of AR in policing have permeated scholarly discourse for

over two decades, with tangible precedents established by the U.S. military's utilization of AR to equip soldiers. These findings should serve as compelling evidence for law enforcement officials to recognize the inherent value of AR in increasing public safety initiatives, despite the associated obstacles, and to take decisive action in this regard.

Failure to expedite research and testing, and to address the challenges associated with AR, results in a significant missed opportunity for police departments to capitalize on its potential benefits. By embracing AR technology, law enforcement agencies stand to accelerate substantial advancements in enhancing public safety measures. The insights produced from this paper not only lays groundwork for subsequent research initiatives but also reveals the potential AR has in optimizing public safety through its many operational abilities. AR technology not only can increase efficiency within policing, but it can do so effectively.

Recommendations

Based on the findings of the research conducted on AR technology and its potential use by policing agencies in Canada, several gaps and future research areas have been identified. Policymakers and law enforcement leaders need to take the following actions to bridge these gaps and fully realize the potential of AR technology in policing.

Increasing Awareness and Understanding

Policymakers need to take the initiative to increase awareness and understanding of AR technology in policing. This can be achieved through training programs, workshops, and seminars for law enforcement personnel, policymakers, and the public.

Addressing Funding Concerns

Funding is a significant issue in the adoption of emerging technologies, including AR. Policymakers need to identify and allocate sufficient funds to research, develop, test, and implement AR technology in policing.

Addressing Privacy Concerns

Policymakers need to carefully consider the privacy implications of using AR technology and develop policies and guidelines that ensure the protection of citizens' rights.

Addressing Legal Issues

Policymakers need to review the existing laws and regulations to ensure that they are compatible with the use of AR technology in policing. Policymakers also need to develop new laws and regulations that address the unique aspects of AR technology in policing.

Conducting Further Research

There is a significant gap in available literature on AR technology and its potential use by policing agencies in Canada. Policymakers need to invest in further research to gain a deeper understanding of the potential benefits and challenges of using AR technology in policing.

In conclusion, the adoption of AR technology by policing agencies in Canada has the potential to revolutionize the way law enforcement is conducted. Policymakers need to take the necessary actions to address the gaps and challenges identified in this research and work toward a future where AR technology is fully utilized in policing.

Conclusion

Augmented reality technology has significant potential benefits for various sectors, including national defence, emergency response military, security, and police to enhance public safety (Bach, 2021; Cowper, 2004; ICTC, 2020; DND & CAF, 2019; Schwab, 2019). However, integrating AR into society raises concerns about funding, privacy, and legal compliance (ICTC, 2020; Schwab, 2019). The lack of established guidelines for deploying AR-enhanced surveillance tools poses challenges for law enforcement agencies (Schwab, 2019). Researchers and scholars emphasize the need for clear frameworks to address data privacy, legal issues, and

regulatory oversight (Schwab, 2019). Without a clear vision for integrating AR into industries such as law enforcement budget constraints may hinder its testing and adoption (Schwab, 2019).

Moreover, researchers have a consensus regarding the urgent need to explore and adopt AR technology within public safety fields (Cowper, 2004; Bach, 2021; DND & CAF, 2019; Schwab, 2019). AR has the potential to revolutionize policing practices and help stay ahead of evolving threats and criminal tactics (Cowper, 2004). Ultimately, addressing privacy and legal concerns, securing funding, and promoting testing and adoption within law enforcement are crucial steps toward realizing the full potential of AR technology for enhancing public safety and security**.** In this paper the necessity to utilize new technology has been profusely discussed, and it serves as crucial instruction to police departments and government officials in Canada to initiate research and testing. Inevitability, risks are expected with the adoption of advanced technology where little information exists on the laws the govern it. The unknown territory that comes with adopting AR is enough to sway police officials from meaningfully discussing the positive benefits of its implementation, however it should not warrant the lack of its adoption. In embracing augmented reality technology, policing agencies in Canada not only pioneer the advancement of public safety measures but also contribute to proactive adaptation to emerging technology thus affirming their commitment to safeguarding communities in the digital age and beyond (RCMP, 2021).

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