Military Drone Innovation in the High North: A Comparative Analysis of Norway, Sweden, and Finland

By

Patrick Steindl

Submitted to:

Central European University

Department of International Relations

In partial fulfilment of the requirements for the degree of Master of Arts in International Relations

Supervisor: Dr. Raluca Csernatoni

Vienna, Austria

2025

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Vienna, 21 May 2025

Patrick Steindl

Abstract

The Russian war against Ukraine has shaped both the security architecture of the European Arctic and the perceived importance of unmanned systems in interstate warfare. However, these two discourses have barely been connected in the academic debate so far, presenting a research puzzle regarding this disconnect. This thesis aims to initiate a broader debate on the impact of military drones in the Arctic security dynamics by assessing the current military innovation process of unmanned systems in the High North.

By using Mahnken's military innovation framework, I assess the current drone innovation process in Norway, Sweden and Finland since February 2022. For the methodology, a mix of qualitative discourse and content analysis is applied. To assess the current drone innovation process, the research draws on official government documents, research papers, media sources and expert interviews. It finds that all three states are currently adapting their military forces to incorporate unmanned systems, however they remain within the experimentation stage of the military innovation process.

Two main implications for the European Arctic emerge: while drones are well suited for Arctic warfare, technical limitations must be addressed to realise their full potential. This thesis contributes to understanding the current shifts in the Arctic security dynamics and offers a basis for further research on unmanned systems in the High North.

Acknowledgments

First, I want to thank my supervisor, Dr. Raluca Csernatoni. Her continuous guidance and deep expertise in security studies have been inspiring throughout the thesis process. I am also deeply grateful for my friends, both longstanding ones as well as the people I have met at CEU and I can now call my friends, who have allowed me to have such a great experience throughout my studies. Further, I would like to thank my whole family, who have supported and enabled me to pursue my goals no matter whether in Vienna or New York, something that would have not been possible without them. Last but not least, I want to say thank you to my wonderful partner Fiona, who always believed in me and pushed me to follow my dreams, no matter the circumstances.

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1. Introduction

"The security in northern Europe has been adversely impacted by this development. A crisis in our region affects us all. Therefore, we must be ready and able to act together in peace, crisis and conflict." ('Joint Statement by Defence Ministers of Finland, Norway and Sweden' 2022) This joined statement was issued in response to Russia's full-scale invasion of Ukraine by the Ministers of Defence of Norway, Sweden and Finland. This perception of threat by Russia has been the dominating narrative leading the debate on Arctic security since then and resulted in major political shifts as both Sweden and Finland abandoned their longstanding neutrality and joined NATO. The enlargement of the alliance in the High North has pushed the Arctic further into the centre of contemporary security debates in Europe, after already seeing an increase in interest in the geopolitical dynamics of the region since the mid-2000s (Morrison and Bennett 2024; Depledge 2020; Heininen and Nicol 2007). This is mostly seen as an answer to Russia's military capability advantage in the High North, the strategic importance of the Kola Peninsula, home of Russia's nuclear second-strike capability, for Moscow combined with their reoccurring use of force to achieve foreign policy goals against neighbouring states. Besides their strategic reorientation, European Arctic states further committed to step up their own military capabilities, which are already visible through rising defense spending, regular international training activities in the High North and personnel increases for the armed forces (Swedish Ministry of Defence 2024a; Edvardsen 2025; Martin 2025). While Russia's invasion has profoundly changed Europe's security in its core another far reaching lesson learned by military strategists from the war comes straight from the battlefield: the impact of emerging technologies such as drones.

How profound the impact of unmanned systems on the conduct of war in the present setting of interstate warfare has been, can be observed through the rupture the conflict created in the scholarly

debate on drone warfare, with the main emerging entity being small scale drones (Kunertova 2023b; Chávez and Swed 2023). However, small scale drones have not replaced larger drone systems but should rather be understood as an addition. Drones in the context of this thesis will predominantly focus on unmanned aerial vehicles (UAVs). However, as unmanned surface vehicles (USVs) and unmanned underwater vehicles are also part of the research scope they will be addressed accordingly. The drone debate has shifted its focus away from large scale military grade and its impact on asymmetric warfare. This change is driven by three factors. Firstly, the potential of tactical (or commercial) drones to balance power asymmetries between states has been demonstrated. Secondly, the close proximity of drone operators to frontlines has been shown to counter the assumption of remote killing. Thirdly, the need for diverse drone forces to leverage the context-specific advantages of different drone types has been recognised. (Chávez and Swed 2023; Kunertova 2023a; 2023b; Calcara, Gilli, Gilli, Marchetti, et al. 2022).

Their strategic effectiveness on the battlefield, while it remains context specific to the war in Ukraine for the moment, has forced an increasing adaptation and procurement of drones. Armed forces in the High North – focusing on Norway, Sweden, and Finland - are thereby no exception, as all three states have increasingly focused on the use of UAVs, USVs and UUVs. Drones in the context of the Arctic could serve as key technology to overcome environmental and geographic challenges of the region, as the harsh climatic conditions are a continuing challenge to the deployment of soldiers in the region, especially in the case of allied forces unfamiliar with the environment, and also potentially aiding the issue of remoteness (Wilson 2025; McKenzie et al. 2024).

However, what remains puzzling is that the growing literature debates on Arctic security dynamics and the use of military drones has been disconnected, while empirical evidence shows

an increasing linkage between the two. Or to state it otherwise, why has a technology reshaping war elsewhere been so unevenly theorised in the Arctic? Simultaneously, the spillover effect of the Russian full-scale invasion of Ukraine into the High North in the context of strategic alignment and the following re-militarization have sparked a growing academic debate. Further, the geographic and environmental conditions in the Arctic such as remoteness, connectivity issues and hostile climatic circumstances seem to point towards the use of unmanned systems in the first place and still the literature barely bridged the gap between drones and the Arctic. However, the adoption of emerging technologies, in this case drones, and their implementation in the tactical and strategic approaches of armed forces have not created a similar effect in the literature. Therefore, the question remains: To what extent have drones been implemented into the armed forces of each case? What are the implications of the rapid diffusion of military drones in Norway, Sweden, and Finland for Arctic security dynamics?

By applying the military innovation framework of Mahnken and drawing on official documents, research publications, media sources and expert interviews, I examine the ongoing drone innovation in Norway, Sweden and Finland since the start of Russia's full-scale invasion of Ukraine in February 2022. Based on the empirical analysis, this thesis finds that all three states are predominantly within the experimentation stage of the drone innovation process. Notable steps towards the implementation phase are visible in specific aspects such as Norway's acquisition of large ISR UAVs, Sweden's drone swarm capability development or Finland's publication of a "National Drone Strategy". Further, the empirical findings allow to distil two main implications from the current drone innovation processes in Norway, Sweden and Finland for the security dynamics in the European Arctic, the likely strong effectiveness of drones in the Arctic context and the technical limitations necessary to overcome before unfolding their potential.

This thesis is structured as follows. The second chapter reviews the existing literature on Arctic security and drones in security studies. In the third chapter the applied framework of military innovation necessary to categorize the drone innovation process is explained. Followed by the fourth chapter where the applied methodology of discourse analysis and qualitative content analysis are displayed. The fifth chapter analysis and compares the individual drone innovation process of Norway, Sweden and Finland along the categories of capability innovation, strategic innovation and organizational innovation. The sixth chapter distils the main implications from the analysed discourses for the security dynamics of the European Arctic, followed by a conclusion.

2. Literature Review

2.1. Arctic security

The Arctic, or also called the High North, has received increasing attention as a research subject, specifically as a geopolitical arena for conflict, within security studies. However, within the framework of Arctic geopolitics we see two differentiating contestations: Contestation as a research subject as well as a strategic issue. The Arctic as a research subject has undergone a transformation over the last decades. This understanding of the Arctic is argued to be closely connected to the previous understanding of the Arctic as a region of unique cooperation (Østhagen 2021). Beginning with Gorbachev's description of the Arctic as "zone of peace", the High North was viewed as a region of cooperation or "distinctive region in international society"(Young quoted in Keskitalo Keskitalo 2007, 195). This led to the establishment of Arctic exceptionalism within the broader public as well as the scholarly world. Four underlying assumptions are often identified as driving forces to portray the Arctic as a zone of cooperation rather than conflict: Lack of disputed interests, unique governance structures in the region, Arctic states explicit will to cooperate with each other, and the lack of opportunities to gain through conflict (Young 2009; Humrich and Wolf 2012; Byers 2013; Hilde 2014a; Käpylä and Mikkola 2019).

However, is the concept of Arctic exceptionalism still applicable as useful framework or have geopolitical dynamics changed the perception of the region? A first shift towards the Arctic as an upcoming region of geopolitical competition and the first steps towards 're-securitization' of the Arctic were visible during the late 2000's (Chalecki 2007; Huebert 2004). After the annexation of Crimea by Russia the notion of the High North as a security entity started to accelerate but remained relatively stable (Heininen et al. 2020; Rahbek-Clemmensen 2017). One explanation for the continuation of stable relations during this time was brought forward by Østhagen (2018),

pointing out that Arctic states are "mutually dependent" (Østhagen 2021) in the political realm to provide a beneficial economic environment in the region (Østhagen 2018). The Arctic has been associated with the concept of "regional security complex", as multiple authors continued to apply the 'Arctic exceptionalism' also in terms of security (Wilson Rowe 2020; Exner-Pirot and Murray 2017; Käpylä and Mikkola 2019). However, a contradicting strand in the literature showcased that the assumption of a regional security complex in case of the Arctic is flawed due to the difference in security perceptions by Arctic states prior to 2022 (Østhagen 2021). At the same time a growing voice within the literature, especially in grey literature, pointed out the vast increase of military capabilities by Russia in the High North, which have been explained through (Hilde 2014b; Konyshev and Sergunin 2014; Sergunin and Konyshev 2017).

However, this did not raise further concern in the debate as tensions in the region itself remained low and cooperation continued. A turning point in the Arctic geopolitical discussion has become visible after Russia's full-scale invasion of Ukraine, with both the academic literature as well as grey literature pointing towards the importance of military capabilities in the region (Limon and Gürdal Limon 2024; Hilde, Ohnishi, and Petersson 2024; Mikkola, Paukkunen, and Toveri 2023). What became specifically visible is the end of the perceived Arctic exceptionalism from previous literature (Koivurova and Shibata 2023). While scholars were and continue to be right about the low risk of conflict erupting from within the Arctic or spillover effects bringing armed conflict to the region, we can observe increased security concerns by Arctic states, especially in the European Arctic (Raspotnik and Stępień 2025; Østhagen 2024). The transition from Arctic cooperation towards rising conflict can be observed from a comprehensive security perspective as well as from a traditional military security one. Pointing towards an increase of tensions from a broader understanding of security is the continuing absence of Russia from the Arctic Council (Dyck 2024). While some cooperation still exists on the working-level of the Council, the balancing

act between the perceived threat by Russia and need for circumpolar cooperation in the High North has now been tipped towards the threat perception by Western Arctic states. Another contradicting voice to the understanding that conflict does not arise from within the region is the increased use of hybrid warfare measures by Russia, ranging from espionage, to cyber activities and infrastructural interference (Kertysova and Gricius 2023). While remaining below the threshold of war and also few indicators showing that any actor in the region is interested in an escalation of tensions, Stensrud and Østhagen (2024) showcase the potential effects of such actions as "one misplaced fishing trawler might serve as a dangerous trigger if seized by another party" (p.124).

A different perspective to evaluate geopolitical dynamics is the more traditional military security one, for which the most profound change has been Sweden and Finland joining NATO, ending two long lasting periods of (forced) neutrality and uniting all Western-Arctic states as part of the alliance (Hilde, Ohnishi, and Petersson 2024). This creates an interesting dynamic for the idea of the Arctic as a regional security complex, as the raised issue of only loosely connected security concerns between different parts of the Arctic are now very much intertwined. An increasing buildup of military capabilities is also visible, especially by western Arctic states, as a response to the perceived threat posed by Russia (Finnish Ministry of Defence 2024; Swedish Ministry of Defence 2024a). Building on the expansion of NATO, the debate has widened to include the unique environmental circumstances in the Arctic and what challenges military forces face in a potential conflict in the High North (McKenzie et al. 2024; Wilson 2025). Therefore, it seems justified to assume that the Arctic security situation is changing and with it the perception of security by the Arctic states. Exploring how states are adopting their military capabilities to keep up with their changing security environment will allow us to get a glimpse of how Arctic security could develop in the future.

In correlation with the emergence of the Arctic as a security region stands the connection between technology and the Arctic. Technology and its use are not a novel aspect of discussion concerning the High North. Due to its environmental challenges and the perception of the Arctic frontier, technology has been envisioned as a key to the Arctic since the first colonial adventures up North. This socio-technical imaginary of the Arctic has been a connecting continuum since then as is outlined by Johnson (2024) and described as "the Arctic imaginaries of the present echo some aspects of the past" (B. T. Johnson 2024, 204). The range of technologies with implications for the Arctic security environment is broad, ranging from surveillance capabilities, space technology to drones.

Due to the remote and vast nature of the High North, 'situational awareness', defined by Endsley (1988) as ""the perception of the elements in the environment within a volume of time and space, the comprehension of their meaning, and the projection of their status in the near future" (Endsley 1988, 97), has a longstanding importance within the Arctic security framework. Situational awareness can be achieved through multiple capabilities such as satellites, radar sensors or UAS's. Drawing on space-based components and stationary capabilities, the infrastructural base to enable an increased use of drones in the Arctic, mainly satellites and their ground infrastructure, has been part of the debate to a greater extent. Multiple authors showcase the interdependence of Arctic security and space. Besides the similarities in challenges of remoteness, resource-scarcity and hazardous environment, or as Byers (2020) characterizes them as "cold, dark, and dangerous", space technology plays a vital role in Arctic security (Byers 2020). Space based technologies such as satellites allow to collect vast information about military activities both in the Arctic and space due to the near lack of other human activities (Byers 2020). Earth-based space infrastructure as satellite ground stations in the Arctic also receive increased attention, due to their strategic position

to access satellites in the polar orbit and the increased dual-use of commercial infrastructure (Boschetti et al. 2022).

Zooming further into the understanding of the ongoing Arctic geopolitical dynamics is helpful to understand the unique perception of the selected cases. While the broader literature debate focuses on the overarching regional aspects of Arctic geopolitics, a growing amount of literature on the state specific understanding of these considerations allows a more granular view on their strategic approach. The aspect of security is thereby displayed from different perspectives. The importance of case-specific contexts in the Arctic from a broader understanding of security is highlighted by Østhagen (2024) in his analysis of the misconceptions surrounding the geopolitical debate about the Norwegian Svalbard archipelago. Highlighting the generalization of Arctic issues, it enforces the understanding of different regions in the High North. Contrary a more traditional understanding of security has been visible in emerging case studies related to the expansion of NATO accession of Finland and Sweden. It highlights the strong security cooperation between Northern European states, the change in perception of defending their Arctic territories as well as their future role in the alliance to provide their cold weather expertise, as is already visible in the Cold Weather Centre of Excellence in Norway, to other allies (Wegge 2022; Ojanen and Väisänen 2023). Simultaneously, differences between the three states are displayed in terms of their strategic approaches to defense in the region (Bentzen 2023). Despite their different understandings of security, both debates are based on a similar perception of what drives the present changes of security dynamics, namely the perceived threat of Russia. The emergence of this narrower understanding of security in this debate underscores the change of geopolitical dynamics, moving from the perception of cooperation towards greater tensions.

As we have seen, the Arctic as a security region and the rise of military capabilities, are at the centre of wide-ranging debates within the literature, even more so after the rupture that the Russian full-scale invasion of Ukraine created in the European security architecture. A key aspect which has fundamental impacts in Ukraine, but has not transitioned to the Arctic discourse, is the increasing utilization of military drones. This seems puzzling as an increasing amount of evidence showcases the use of military drones in the region, ranging from procurements, drone specific infrastructure and technological developments tailored to the region.

2.2. Drones in security studies

Unmanned Aerial Systems (UAS) or Unmanned Aerial Vehicles (UAV) have been a major subject in the discussion on the relationship between technology and security. There has been a large debate in academia on how drones have contributed to change in military affairs, first from a strategic and since the war in Ukraine from a tactical perspective. To understand the impact drones have on military affairs, it must be clarified what a drone is. While the conceptual understanding is debated, one common definition of drones has been formulated as "aircraft of varying size that do not have a pilot on board and are instead controlled by someone on the ground" (Boyle 2020) or "autonomously or remotely piloted aircrafts that perform different military and nonmilitary tasks" (Gilli and Gilli 2016, 62). Armed drones, as the main focus of this study, are defined as "flying, high-resolution video cameras armed with missiles" (McConnal, as cited in Woodward 2011, 6). The overarching conjunction that connects these definitions is the lack of physical presence within the vehicle or system. Even after exploring some of the conceptual definitions of drones, further differentiation is needed to grasp a broad variety of drone models.

Drawing on the previous classification, the war in Ukraine has not just marked a turning point, or "Zeitwende" in the European security architecture but also changed the academic

approach towards the usage of drones in warfare and its potential implications (Gogua 2023; Kunertova 2023a; 2023b). The military drone debate before the full-scale invasion of Ukraine in 2022 was predominantly focused toward large scale models (Class III) such as Medium Altitude Long Endurance (MALE) and High Altitude Long Endurance (HALE) systems, nearly neglecting the potential implications small- and mini-drones could provide for interstate-warfare (Chávez and Swed 2023). Multiple prominent authors in the field specifically limited their research scope to exclude smaller drones due to reasons such as "limited range and payload" (Calcara, Gilli, Gilli, and Zaccagnini 2022, 792) or the assumption that if sophisticated military drones are not able to yield a change in military affairs cheap and less sophisticated small models will have even less impact (Weiss 2018; Fuhrmann and Horowitz 2017; Joshi and Stein 2013). While this argument seemed to be plausible under the assumption that small drones are not entangled with the strategic level often sought to be understood by the authors, they misjudged the potential mass use of smaller UAVs as has been witnessed during the full-scale Russian invasion of Ukraine and the profound strategic implications they had during this war.

Some authors explored the potential use of small drones by violent non-state actors such as terrorist organizations or rebel groups, with the argument that the proliferation of small drones has broader implications for changing warfare than the dominant research on large drones (J. Rogers 2019; Boyle 2020; Chávez and Swed 2021). However, the academic literature on the actual use of armed small drones by violent non-state actors remained scarce, with the exception of Haugsvedt and Jacobsen (2020) and Haugsvedt (2024) updated study showcasing the methods, actors, and scale by which non-state actors have used armed UAV's to carry out their attacks (Haugstvedt 2024; Haugstvedt and Jacobsen 2020). This lack of engagement with armed small drones within the academic literature can be seen as one of the reasons that shaped the misconception of drones in large-scale and high-intensity conflict before the Russian war of aggression against Ukraine.

Turning away from the subject of the drone itself, UAVs have been closely connected to 'remote warfare' (RW) and combined in the literature to have established a unique mode of warfare (Gross 2015; Kreps and Zenko 2014; P. Rogers 2012; Gregory 2011). While this will not be addressed as a particular focus within this thesis, it is still necessary to understand the broader context of drone proliferation. The literature on RW does go beyond armed drones, including important aspects such as cyber-warfare or the use of local security forces and Special Forces, however military drones will be the focus point in this review (Krieg 2018; Ohlin 2017; Watts and Biegon 2017). One understanding of 'remoteness' in warfare as part of the literature identifies the use of technology to extend force projection. The Arctic region, as most of the territory is covered by sea/sea-ice and therefore having large remote areas and simultaneously providing hostile environmental challenges for military operations to deploy boots-on-the-ground due to extreme cold weather conditions, can be considered as a region with large potential for remote warfare operations (Kennedy and Rogers 2015). Kennedy's and Rogers's assumption about future warfare mostly neglected the aspect of human interaction in the deployment of military drones. This did not reflect the indeed essential close interlinkage and dependencies drones still have towards humans. Therefore a critical lens emerged towards the portrayed 'videogamification' and 'remoteness' of killing for drone pilots and showcased the psychological effects and lived realities drone pilots experience only marginally differ from controlling traditional fighter jets (Gregory 2011; Jeangène Vilmer 2023).

Adding to the human capital notion needed to conduct drone warfare and operations, is the need by militaries to train and educate drone operators in order to manoeuvre and operate sophisticated UAVs. Jackman (2023) highlights the human constraints in place that affect drone proliferation through the lack of available and trained drone operators, an aspect of increasing importance particularly for western militaries. Her study, however, does not account for the large

proliferation of small drones, witnessed in the war in Ukraine. Further, neglecting the assumption of remote warfare is the vast need for humans within conflict zones, as is observed in the ongoing full-scale Russian invasion of Ukraine. Due to their limited operating range, operators of small-scale drones are forced to act in close proximity to the actual frontline and therefore exposed to an increased risk of physical harm (Perdue 2024; Sabbagh and Kochetova 2024). A fitting label to represent this shift of the operating environment for drone operators has been termed by González (2024), describing them as "virtual warriors" (González 2024, 9). Kunertova (2023) adds the element of how drones enable the individual soldier at the frontline by giving them either increased surveillance capabilities or providing them with a "limited precision combat capability"(Kunertova 2023a, 582) through the use of armed commercial drones. What continues to be missing from the debate up to this date is the spillover effects the usage of drones will have for different contexts of conflict, as it is most likely that future wars will be fought differently to the one in Ukraine. The Arctic is no exception to this, with little to no attention being given to the usage of armed UAVs.

Building on the projection of force by technological advancements, autonomous interaction and coordination of multiple weapon systems is seen as a major change in the future of military affairs and have been widely discussed (Scharre 2014; Grimal and Sundaram 2018). Drone swarms are often the key example in the debate regarding what effects autonomous weapon systems (AWS) will bring to the battlefield (J. Johnson 2020; Altmann and Sauer 2017; Horowitz 2019). A 'swarm' is the cooperation of multiple drones or "coordinated use of various drones which might be of different types, 'intelligence', size, and capabilities so they can act in unison" (Lehto and Hutchinson 2021, 38–39). Going beyond, the implementation of new artificial intelligence (AI) capabilities into drone swarms is expected to further accelerate the importance of UAS's. One potential change that is mentioned is their effect on deterrence through threatening the second-strike capabilities of nuclear powers, therefore potentially creating a "use-them-or-lose-them

situation" (J. Johnson 2020, 26). Another proclaimed benefit of autonomous unmanned systems lies in their ability to identify and engage targets by themselves (Konert and Balcerzak 2021). However, one must be cautious in the degree of autonomy attributed to current drone systems. Issues remain in regard to autonomous target identification, which provides an increased risk for civilian casualties (Petrovski and Delchev 2022).

The usage of drones within the Arctic security framework has barely been touched upon in the literature, except for Rogers (2023), who provides a first overview about the recent proliferation of drones in the Arctic (J. Rogers 2023). Rogers sees the use of unarmed military drones as a form of power projection which leads to a security dilemma between Russia and the Western Arctic states. He views the usage of drones in the region as a natural consequence due to the technology's purpose "as a replacement for vulnerable humans in hazardous places" which he discussed in his earlier work on the history of drone warfare (Rogers 2023). However, Rogers's framework lacks the component of armed drones as well as considering the potential of small-scale drones, in line with the majority of literature on drones within security studies prior to the Russian invasion of Ukraine. Further assessing the more regional impacts of developing drone forces within the framework of Norway, Sweden and Finland is helpful to aid the understanding of Arctic as diverse region.

In conclusion this literature review has critically evaluated the discourse surrounding Arctic security dynamics as well as the role of drones in security studies. Showcasing the evolving nature of the perception in the High North, we can see that the Arctic as a whole, and the European Arctic more specifically, remain a region of increased geopolitical tension. While an outright armed conflict or war occurring within the region is highly unlikely, we can see that spillover effects from outside such as the Russian war against Ukraine, have drastically changed the security environment.

The NATO accession of Sweden and Finland serves as a paradigm for the severity of change in the security perception of Arctic states. The second debate that informs this thesis is the perception of drones in security studies and how their impact on warfare is perceived. One can observe a stark difference in the debate prior to the Russia-Ukraine war, with a focus on large scale systems which were seen without any larger significance for the conduct of warfare. Further, the understanding of drones in warfare leading to what is known as 'remote warfare' has also undergone a transition, as drone operators are predominantly operating in close proximity to the frontlines. The debate has since evolved, specifically through the emergence of small-scale drones on the battlefield in Ukraine, which have emerged as a key technology. The profound impact of unmanned systems in multiple domains in the Russian full-scale invasion of Ukraine has sparked a wide-ranging change within military forces to adopt such technologies and the ever-faster R&D circle in the war creates a need for constant adaptation in drone capabilities. Combining the recent change of security dynamics in the Arctic and the drastic effects drones have had on the battlefields of the Russia-Ukraine war, it raises the question to what degree Norway, Sweden and Finland are adopting such a technology in the light of their changing security perception.

3. Theoretical framework

3.1. Military Innovation

This thesis will be guided by the heuristic scope of the military innovation framework, therefore analysing the process of how drones have been adopted into the military forces of Norway, Sweden and Finland.

In the literature debate military innovation is not clearly defined and a broad variety of definitions exist, blurring the conceptual clarity of what actually entails a military innovation. As the recent work of Horowitz and Pindyck (2023) describes, the number of definitions is comparable to the publications on military innovation. To aid the discussion their understanding of military innovation is defined as "changes in the conduct of warfare designed to increase the ability of a military community to generate power" (e.g., p.99). Their understanding highlights one of the few components in the determination where widespread consensus exists within the literature, change (Rosen 1988; Evangelista 1988; Adamsky 2010a). Such change is often informed by new technologies, tactical adaptations and political changes. However, the degree or extent of change necessary does remain disputed in the debate and varies widely.

The main debates within military innovation studies revolve around the following four schools identified by Grissom (Grissom): civil-military model, interservice model, intraservice model and cultural model. The most suited model for the case of drone proliferation in Arctic states is the cultural model, as it views external shocks as one way how military innovation can be driven, which fits the changing security environment in the High North due to Russia's war against Ukraine. Further, military innovation is seen as a process of change which does not occur in sudden rupture but rather includes different stages of innovation. Drawing on the framework of Thomas Mahnken,

military innovation can be categorized into three distinctive, but overlapping, innovation phases: speculation, experimentation and implementation (Mahnken 2011).

Speculation as the initial phase of military innovation, is framed around innovating actors using new approaches to operational issues or potentially applying emerging technologies. Indicators for the initial phase are mostly discourse based and are found in publications or speeches. The main issue in observing the speculation phase is the large degree of uncertainty within the debate. The authority of opinions voiced can hardly be ascertained and it is likely that the debate is scattered with contrary opinions and beliefs. Besides the scrutiny of assigning authoritative weight to opinions, military innovation debates might also occur outside of the public within the structure of military staffs, therefore reducing the opportunity to detect military innovation in its initial phase (Mahnken 2011, 304). Adamsky (Adamsky 2010b) has showcased the impact of intellectual engagement during the first stage of innovation.

Following on the speculation phase, military innovations can enter the stage of experimentation if the ideational progress has gained sufficient support within an affected military organization. Indicators for innovation reaching this stage can be experimentation within the organizational or doctrinal approach of militaries (Mahnken 2011, 305). This can either be through the adoption of foreign technology, organization or doctrine but such experimentation can also lead to domestic innovation. Armed forces can further use exercises to test and assess the potential of a military innovation, comparing traditional approaches/technologies to emerging ones. Such exercises do not only have to be conducted empirically but can also occur in more theoretical framework, through the usage of wargaming scenarios. Such experimental pursuits serve as a clear indication for deepened interest in a new conduct of warfare. Still, uncertainty remains as "without a clear understanding of the objectives of foreign manoeuvres, it is easy to misinterpret their results"

(Mahnken 2011, 306). It is therefore important to consider broader bureaucratic support to understand if the experimental phase will lead to the further adoption of a new mode of warfare.

Sufficient success during the experimentation phase of a military innovation might lead to the incorporation of suitable doctrines and organizational changes to suit the needs of the individual military forces. Publishing a doctrine for an emerging technology or mode of warfare is one example of implementation. In turn this might inform the curriculum of a military organization in order to implement the changes from a new doctrine. In similar sense, the founding of new units, branches or career opportunities linked to the capability of the innovation are an indicator for an implementation of a military innovation (Mahnken 2011, 307). Challenging in this stage is to evaluate the practical impact of an innovation, as in the case of drones. While unmanned systems have been used extensively in the Russia-Ukraine war and also in other theatres of war, their practical usage in the environment of the High North has not been explored in conflict. The actual effect of drones might therefore vary from their theoretical expectations.

After displaying the different phases of innovation according to Mahnken, it is necessary to understand them not as separate entities but to understand them as distinct but overlapping. Therefore, doctrinal changes can very much be informed and adopted according to experimental experiences and one actor can therefore be in different stages of innovation at the same time.

Mahnken framework further provides key advantages to analyse the drone innovation process in the High North compared to other frameworks such as diffusion models of military technology, based on Roger's 'Diffusion of Innovations' (DoI) framework. For example Gilli and Gilli (2016) developed a framework to assess the diffusion of drone warfare, focusing on two main aspects determining the speed and scale of diffusion of military technology, platform and adoption challenges. While this would also allow to assess to what degree drones have been implemented

by Norway, Sweden and Finland to a certain degree, the diversity of drone systems emerging and used does not allow to effectively categorize them under one framework due to vast differences in adoption and platform costs. Further the innovation framework, does not allow to assess the multifaceted nature of the drone innovation process, with the simultaneous existence of multiple stages of innovation progress. To operationalize the outlined theoretical framework, I will now turn to my methodological approach to showcase at which stage in the drone innovation process each case has reached up to this point.

4. Methodology

The following chapter will outline the methodology applied to research the process of military innovation regarding military drones within the armed forces of Norway, Sweden and Finland. The research specifically engages with the potential changes in capability development, strategic adaptations and organizational changes, while applying the findings to the Arctic context. This thesis will draw on a qualitative approach, using discourse analysis to identify and portray the processes.

The analysis draws on a triangulation of three main sources: official government documents from all three states, publications of the defense research agencies from each state and media reports. In order to identify the assumed changes in military affairs in each of the selected cases, this thesis will utilize discourse analysis in order to identify change and map its development. The analysis of official documents will facilitate an understanding of the current and planned direction that each selected state intends to take with regard to the use of drones in the context of the Arctic. The selected documents will include defense and security strategies, Arctic strategy and military procurement documents. In order to achieve a more profound analysis of the assumed change in military affairs, it seems interesting to compare the official direction proclaimed by the governments with the publications of their national defense research institutes (Forsvarets forskningsinstitutt (Norway), Totalförsvarets forskningsinstitut (Sweden), Puolustusvoimat (Finland)). Given the fast-paced nature of change of drone developments, media reports from established national and international news outlets will also be monitored to identify possible indicators in regard to the military innovation phases. They will serve as a complementary source of information to the information gained from official documents and publications, in order to capture more recent developments not yet incorporated in official documents. The media sources

will be critically evaluated and cross referenced with other sources. To further strengthen the analytic corpus, three semi-structured interviews with experts from Norway, Sweden and Finland have been conducted.

A mix between Discourse Analysis and Qualitative Content Analysis (QCA) was chosen as the methodological approach for this thesis in order access the defense related discourse in Norway, Sweden and Finland in regard to military drones which are represented in in official documents, research publications and media sources (Alejandro and Zhao 2024). Specifically, QCA was employed to provide systematic, deductive coding of the selected data, according to the predefined innovation categories, therefore providing a structured overview. Discourse Analysis techniques were then used to achieve more nuanced understanding of the specific framing, language, and underlying assumptions within the policy documents, research publications, and interview responses, allowing for an interpretive perspective of the coded data. For the coding of the data, a deductive approach has been applied based on the understanding of necessary components of military innovation:

- Discourse on technological innovation
- Discourse on strategic innovation
- Discourse on organizational innovation

The selection of Norway, Sweden and Finland as case studies to analyse drone proliferation in the Arctic was due to various reasons. First, the recent accession of Sweden and Finland to NATO compared to the longstanding membership of Norway creates a clear variable to compare the three states. At the same time their proximity to Russia has led to a deteriorating security situation for all three states since the Russian war against Ukraine in 2022, while this development already started with the Russian occupation of Crimea in 2014. While the wide-scale usage of

military drones in interstate conflict starting to increase since 2014, an unprecedented exponential rise was introduced by the Russian war against Ukraine, therefore my analytical time frame will focus on the discourse after 2022. A specific focus will be to analyse if any specific rupture is visible in the publications since 2022 in terms of the relevance of drones for military affairs in the Arctic. In line with these changes are an increased amount of media reports on issues related to military drones in all three countries such as the repurposing of Andøya Air station as drone base, a recent unveiling of a drone-swarm project in Sweden or the proposal by Finland to host a new NATO drone base in Pirkkala (The Baltic Sentinel 2024; Gosselin-Malo 2025; Jonassen 2024).

Nevertheless, there are several obstacles within the methodology of this thesis. Initially, the existing language barrier precludes access to policy documents and secondary literature in the native languages of the selected case studies. While the majority of documents are published in English by all selected states and institutions, a certain amount is only published in Norwegian, Swedish and Finnish. In order to overcome this problem and to be able to include a wider range of documents, I will use the translation software deepL Pro, to gain access to native language documents. While it is acknowledged that this will compromise the analysis to a certain degree due to a loss of meaning during the translation process, it will nevertheless facilitate the creation of a more compelling picture of the discourse. The second obstacle of this thesis lies in the nature of information restriction in terms of military affairs. The incorporation of expert interviews will serve to supplement the available information with insights into ongoing discussions from interviewees. Despite the constraints imposed by data availability due to classification restrictions, the incorporation of expert interviews can facilitate a more profound comprehension of the subject matter and stimulate the emergence of further discussions. This is of particular importance in the study of emerging technologies such as drones, as the ever-faster research and development cycle

creates short-lasting debates and the need for rapid adaptation, both from a capability as well as a strategic standpoint.

5. Military drone innovation process in Norway, Sweden and Finland

In the following chapter I am going to apply the military innovation framework to the usage of drones in the armed forces of Norway, Sweden and Finland. For the timeframe, the start of Russia's full-scale invasion of Ukraine serves as the starting point of the analysis until April 2025. This will allow us to get a better understanding of the usage of unmanned systems in the High North and aid the ongoing Arctic security debate. First, each case will be observed individually and categorized within the framework of military innovation and in a subsequent step three cases will be compared.

5.1. Norway

For a military innovation process to occur, a specific strategic or operational challenge often serves as an initiating factor. In the case of Norway such a driving aspect exists, namely the perceived security threat by Russia. As is mentioned continuously throughout various strategy papers regarding the security situation of Norway, Oslo feels the need to adapt its capabilities for a potential military conflict with Russia. Drawing lessons from the Russian war against Ukraine the Norwegian Armed Forces state "…there is a need for high-tech weapons…" (Norwegian Ministry of Defense 2024, 19) and specifically mention drone capabilities as one such weapon system. In a similar approach this is also highlighted in the defence analysis report 2025 by FFI (FFI 2025). While drones have been in sporadic use within the Norwegian Armed Forces before, this indicates a new process of broader innovation regarding unmanned systems for multiple domains.

5.1.1. Discourse on capability innovation

The discourse on capability innovation consists of two main discourses, on the one hand the acquisition of current drone systems such as long-range reconnaissance models or small-scale

drones. On the other hand, the discourse includes planned development of new unmanned systems and capabilities, including the upscaling of drones in terms of quantity. There exists the expectation that drones in the Norwegian Armed Forces will be as common as machine guns currently are (Interview #1 2025). What has been confirmed by the Norwegian ministry of defence is the acquisition of long-range UAVs for the purpose of intelligence, surveillance and reconnaissance (ISR), which will enter service between 2029-2032 (Norwegian Ministry of Defense 2024, 59). The substitution of previously manned aircraft through long range drones indicates that, regarding surveillance drones Norway is reaching the implementation phase for the first time. However, the innovation process for other drone capabilities remains much less clear at this point.

One such emerging aspect of future drone capabilities relates to the debate around autonomy. Autonomy for drone systems is framed to provide advantages in three main categories: target acquisition, navigation, coordination between individual systems ('swarm' technology) (FFI 2025b, 74). Swarms are being discussed as an extension of manned aircraft systems, supporting them during their operations. At the same time the research on UAV swarms is progressing as well and the 'Valkyrie' project has reached the level of surveillance and attack UAVs cooperating to identify a target and destroy it on command of a human operator several kilometres away, according to a recent FFI report (FFI 2025a). As stated by the project leader Rikke Amilde Seehuus "The last mile of the marathon is to make this an operational system that the soldiers in the operational departments can carry with them."(FFI 2025a), Norway has not yet reached a wide scale deployment of UAVs. Therefore, we can see a reoccurring theme in the current discourse from the drone innovation process in Norway, highlighting the large progress made in recent years while the operationalization of the systems has not yet been achieved.

Furthermore, there is an emphasis within the Norwegian Armed Forces to test emerging drone capabilities such as swarm technology "…under Norwegian conditions, with Norwegian forces." (FFI 2025, 91). The exploration of innovation and change is also present within the Norwegian Military Academy, but no clear procedures have been established, stating that Norway remains in a "testing stage" in regards to drones (Interview #1 2025). The importance of context for drone capabilities is a key factor in their effective use, however so far little public evidence has been available to the extent of testing taking place, indicating the experimental nature unmanned systems still have within the armed forces of Norway. A further aspect that indicates the experimental phase, is the perception of experts within the Norwegian Armed Forces in regard to drones.

5.1.2. Discourse on strategic innovation

In regard to the use of drones by the Norwegian armed forces from a strategic point of view three indicators can be used to determine the innovation phase of unmanned systems in the Norwegian Armed forces. First the use of drones in training exercises has been rising. The character of the usage of drones in these exercises can best be described as experimental as was visible during the previously mentioned Arctic Joint Viking exercise in 2025. Using tennis balls to explore the effectiveness of UAVs against armoured vehicles showcases that innovative modes of warfare are being tested, drawing on lessons learned from UAV usage in the Russia-Ukraine war (Gosselin-Malo 2025). However, the absence of particular training ammunition and having to substitute such with sporting goods, very much indicates the experimental characteristics.

In a similar vein increasing cooperation for unmanned systems, specifically tailored to the environmental challenges in the High North, are part of Norway's agenda according to Major General Lervik, stating that technology will have to be adopted (Edvardsen 2024a). Drones are part

of this discussion as Leivik highlights Norway possesses "…a strong professional environment within unmanned systems. This is important to the Norwegian defence but also attracts major interest from our allies." (Edvardsen 2024b). How concrete steps towards an increased technological development cooperation between Arctic states could look like was not specified. A first step towards materializing such cooperation regarding drone capabilities has been taken by the five MoDs of the NORDEFCO member states, initiating interaction on cooperative development and procurement of drones in November 2024 (Edvardsen 2024b). Further, international cooperation in regards to unmanned systems has been strengthened by Norway's recent decision to join the international drone coalition in support of Ukraine (Norwegian Ministry of Foreign Affairs 2025).

The importance of drone innovation in regard to the strategic approach can be observed in the FFI publication on the Norwegian defence situation in 2025. Here, the question of how drones should be implemented into the Norwegian Armed Forces is the first aspect mentioned in regard to what lessons Norway can draw from the Russian war against Ukraine. Potential usages mentioned are as sensors, weaponized systems or communication capability, however further operational opportunities are to be explored (FFI 2025b). In regards to Norways strategic innovation multiple aspect indicate the experimental phase, such as improvised means to test drone systems, adapting unmanned systems to the specific operational conditions of Norway and initiating a planned cooperation with allies. While such more concrete actions go beyond the theoretical engagement of the speculation phase, they fall short of a concise strategy with developed steps to resemble the implementation phase.

5.1.3. Discourse on organizational innovation

While organizational changes so far have been rather scarce in terms of the innovation process of unmanned systems within the Norwegian Armed Forces, there are still indicators for the innovation process. One such indicator is the repurposing of the former, briefly closed air base at Andøya, announced in April 2024. It will host the planned long-range drone capabilities which will function as a key aspect of Norway's aim to improve its situational awareness in the northern part of its territory (Norwegian Ministry of Defense 2024). By the use of military facilities for the specific purpose of drone operation Norway showcases a clear intent in implementing drone capabilities, which is further strengthened by the clear timeline for the operational use in place. Further, Norway aims to distribute drone systems across the different branches of the Norwegian Armed Forces, in line with the normalization mentioned previously, similar to machine guns. However, at the moment the distribution is still very much limited to only a handful of units carrying out weapon tests (Interview #1 2025). This falls in line with the experimental phase due to the emergence of limited units pushing forward the innovation process through a testing phase, rather than large scale distribution.

5.1.4. Findings

Overall, we can observe that drones are seen as a key capability within the Norwegian armed forces to prepare itself for future conflict scenarios. However, the military innovation process is still very much in flux and mostly resembles the experimentation phase, with a degree of speculation and implementation occurring at the same time. This can be seen in the increased use of drones in military exercises or the prominent role unmanned systems have in current defense documents. At the same time some aspects still rather resemble that of the speculative phase, as is specifically visible in FFI's 'defence analysis report 2025', where it is outlined how unmanned systems might

be used in the Norwegian context but no specific organizations are being mentioned to be tasked with developing the capability yet.

A divergence in the innovation process can be identified in the different purposes of drones for the armed forces. Reconnaissance UAVs seem to be in a later stage of the innovation process, with specific infrastructure for drone operations, signed procurement contracts and a specific timeline for entering long range surveillance drones into service. Weaponized drones at the same time are also prominent in the debate, however no explicit procurements or organizational adaptations have taken place yet. This difference in innovation progress can be explained through the longstanding use of large-scale drone models for reconnaissance purposes, allowing the Norwegian Armed Forces to rely on a greater set of previous experiences by other militaries, while small scale drones, especially as a weaponized system, much less experience exists.

5.2. Sweden

In a similar fashion to Norway, the initiating factor for the current military innovation process in regard to unmanned systems in Sweden is based on the changing security threat Russia is perceived as. In order to sufficiently prepare its military forces for a potential conflict with Russia, Stockholm is taking notice of lessons learned from the Russian war against Ukraine, specifically in regard to drones. This is not the first time the Swedish Armed Forces (SAF) are using drones, as tactical UAVs had been deployed to Afghanistan and Mali as part of the international operations participated in. However, the development of UAV capabilities decreased with the changing focus of the SAF on national defense rather than international operations (Borg 2020). The extent to which drones were previously neglected as capability for SAF is visible in the "Totalförsvaret 2021–2025" (Total defence 2021-2025) document, a comprehensive outline of Sweden's security situation which is published every five years, where drones are not mentioned at any point and

unmanned systems are only once in the context of the US long range strike capabilities (Swedish Ministry of Defence 2020).

5.2.1. Discourse on capability innovation

However, this perception has drastically shifted, with UAVs and other unmanned systems now prominent in Swedish defence discourse. In terms of the capability innovation, the acquisition of various types of drones is seen as a priority as well as the need to implement greater autonomous capabilities in unmanned systems. At the forefront of Sweden's innovation goals for UAVs is the ability to operate them in swarms. In January 2025, the Swedish Defence Minister announced the development of a new drone swarming technology, enabling drones with different capabilities and of different models to operate collaboratively, controlled by a single operator (Saballa 2025). When the swarm capability can be used on the battlefield remains unknown, a first trial of the swarming capability was tested during this year's Arctic Strike NATO exercise (Pool 2025). While this not unique in the current defence landscape, Sweden has been able to present a key step in the innovation process by demonstrating advancing drone swarming capabilities through domestic research, actively pushing forward drone innovation.

The quantity in which Sweden wants to acquire unmanned systems (most likely UAVs will make up the largest part of these systems) is not defined in numerical terms yet, however (Swedish Ministry of Defence 2024a). An indicator for the likely upscaling of drone production, is the assessment of such systems as ammunition, therefore, needs to be produced in large quantities and serves as a key resource to uphold any military capability, moving beyond a mere capability innovation. One such example of using drones as a sort of ammunition have been so called 'kamikaze drones', which Sweden expects to be operational in 2027-28 (Norén and Granlund 2025). While the acquisition of drones is consistently present in the total defence 2025-2030 document,

barely any procurements of unmanned systems have been made public. One exception is the acquisition of small scale reconnaissance drones for the Swedish Home Guard units, Sweden's military reserve force, with an estimated 130 Anafi UAVs procured (Shepard News 2024; Myrlander 2024). However, the small quantity procured indicates that Sweden has not yet decided on small scale reconnaissance drone system, but this procurement should rather be seen as a testing patch. The Arctic as an operating theatre is also part of the capability innovation, specifically adapting current systems to operate in subzero conditions. This is visible through the testing carried out under the 'Demo UCAV' project, which recently assessed the current ability of UAVs to operate above the 68th parallel north in cooperation with the Norrland Jagerbataljon K4 (FOI 2025). Such testing indicates the experimentation phase as it currently remains with a relatively small sample size of units involved and will need to be expanded to different unit types.

In addition, Sweden does not only want to expand its drone capabilities in the aerial domain but also in other domains of warfare. Recently Saab announced that Sweden will procure autonomous UUVs for the purpose of mine countermeasures, further emphasising the Swedish approach to not only obtain unmanned capabilities but develop them further through the implementation of increased autonomous capabilities. While the development of drone swarm capabilities by Sweden is indicator for a more developed innovation, resembling the implementation phase, the current testing of drone swarms, the assessment that kamikaze drones will be operational in the years ahead as well as the initial testing to adapt drone systems to Arctic conditions remain in the experimental phase. Similarly the small procurement of UAV systems should be seen as a testing run rather than an implementation.

5.2.2. Discourse on strategic innovation

Sweden leverages both domestic innovation as well as international cooperation to advance its drone capabilities. Stockholm decided to join the drone cooperation for Ukraine in 2024, supporting Kyiv in terms of procurement and training capabilities (Swedish Ministry of Defence 2024b). Besides the support Sweden demonstrates for Ukraine through the cooperation, this allows Sweden to gain firsthand experience and insight for its own development of drone capabilities, building on the ever-faster R&D circle of drone systems in Ukraine (Swedish Ministry of Defence 2024b). This further allows Sweden to grasp the broader drone ecosystem necessary to implement unmanned systems in their full effectiveness and integrate the lessons learned from Ukraine (Matlack, Schwartz, and Gill 2025).

In the strategic approach to the use of unmanned systems we can observe that Sweden has transitioned from drones in international operations to portraying drones as a key future capability for their territorial defence, according to a senior Swedish scholar (Interview #2 2025). Stockholm has also joined the British and Belgium led 'MQ-9 International Cooperation (MIC) Support Partnership (SP)' as an observer, which aims to enhance cooperation between allied states interested in procuring the MQ-9B drone system (RAF 2024; Gosselin-Malo 2025). With the status of an observer Sweden showcases an initial interest in procuring the HALE system but no further indications in such systems have been stated. Therefore, this should be seen as a transitional aspect between the speculative and the experimental phase in the innovation process. That large scale drone models are of interest in the Swedish context, is further visible through a recent wargaming report from FOI, assessing the impact of armed medium altitude, long endurance (MALE) models in low-density battlefields. One of the scenarios specifically evaluates the value of such systems in the Finnish Arctic of Lapland, with information superiority and limited precision strikes seen as

the main contribution by MALE systems (Hörnedal 2024). The use of wargaming is an indication for the experimental phase of the innovation process and further underscores the diversity of unmanned systems that are of interest in the Swedish debate.

However, Sweden's previous experience of using UAVs in a limited scale should provide them with an effective blueprint of implementing drones in a larger scale, armed or unarmed, likely decreasing the needed time to reach the implementation stage. Overall, the strategic innovation is multifaceted, showcasing a speculative aspect through the study of foreign innovation as part of the drone cooperation for Ukraine and the observer status in the MQ-9B reaper cooperation, experimental in the case of using drones in wargaming scenarios and moving into the implementation phase by the planned adoption of Sweden's defence doctrine to view drones as key capability for its territorial defence.

5.2.3. Discourse on organizational innovation

The most prominent example of organizational innovation taking place in regard to unmanned systems is the "Demo Ucav", a combined effort of the Swedish Defence Materiel Administration (FMV), Swedish Armed Forces and the Swedish Defence Research Agency (FOI), which was founded in 2023. The project aims to "build knowledge, test new technologies and pave the way for next-generation systems and new capabilities" (FMV 2025) of drones as well as counter-drone measures. It is emphasised that the project is not designed to create operational ready systems but rather serves as knowledge and testing hub for future capabilities. However, the drone innovation process seems to be expanding as it is stated that "trials are underway at several units in the country" (FMV 2025). The founding of a multi domain project with a clear emphasis on testing emerging drone capabilities falls under the experimentation phase of the military innovation process. The argument can be made that the expansion of testing moves it closer to the implementation phase;

however, this seems less likely due to the stated focus on knowledge production rather than present ready operational systems.

So far there have been no significant infrastructural changes announced to be used specifically for drone operations. Sweden's approach to implementing drones can be described as comprehensive, as it plans to implement unmanned systems "in all branches of defence" (Swedish Ministry of Defence 2024a, 74). This planned expansion of unmanned systems signals across a variety of units within the SAF moves the innovation process towards the implementation phase, however as it is still in the planning phase and has not materialized yet it remains in the category of experimentation. One exception to the integration of unmanned systems across the different branches, is planned creation of specialised logistics units to provide supplies through the use of "autonomous and unmanned systems", indicating a further development of current unmanned systems to add an additional autonomous capability (Swedish Ministry of Defence 2024a, 84).

In regard to the organizational innovation, we can observe that both the 'Demo Ucav' project and the approach to implement drones fit the experimental phase. As an organization exists with the clear purpose to drive innovation and testing this clearly falls under the experimentation phase. While one can argue that the commitment to implement drone systems across all military branches, and even the discussion to establish specific drone units, indicate the implementation phase, the uncertainty to when such implementation should take place and in what specific form is more suited to the experimentation phase.

5.2.4. Findings

Drawing on the previous findings, Sweden views drones as a key capability to ensure their readiness for future combat scenarios. The specific details and scale of the implementation and procurement of drones remain to be finalized, and the matter is still largely unresolved, although a

preliminary outline is beginning to take shape. A clear focus in the Swedish discourse in regard to the capability innovation is automation of drone systems. By developing swarm capabilities to combine different UAV systems through domestic research, Sweden is indicating a first step towards the implementation phase in the innovation process.

At the same time, indicating the need for a large volume of drones while not defining any quantity of needed unmanned systems, on the rare occasion of procurement only a very limited number of drones are acquired, and the planned expansion to different domains of unmanned systems very much showcases the current uncertainty in the innovation process, which very much is in a testing stage. A similar situation is evident in the discourse surrounding Sweden's strategic innovation process, which is currently experiencing an unstable phase. While the coalition in support of Ukraine has characteristics of experimentation, participating as an observer in regard to the HALE system cooperation should be seen as a speculative aspect. While testing MALE models through a wargaming approach in the Swedish Defense Research Agency should be considered as an experimental aspect.

In regard to the operational approach, Sweden has created the dedicated ‘UCAV demo’ program to develop and test its drone capabilities, with a clear emphasis on future capabilities, which can therefore be assessed as part of the experimentation phase. In addition, Sweden's current intent is to implement a comprehensive plan for the provision of drone systems across all military domains, with the exception of the planned establishment of specialised drone units for logistical purposes. While this provides a clearer understanding of how unmanned systems should be integrated, the lack of materialized progress indicates the experimental nature of the innovation process.

5.3. Finland

Finland, in a similar fashion to its Nordic allies, is concerned by aggressive posture of its eastern neighbour Russia. While Finland has considered Russia as a threat for most of its history, based on the previous invasion during the 'Winter War', the full-scale invasion of Ukraine still raised the threat perception. As a strong advocate for supporting Ukraine, Helsinki is taking notice of the ongoing change in how interstate warfare is conducted in Ukraine, specifically in regard to unmanned systems. The extent of change visible in Ukraine was described as "The whole concept of warfare." (Interview #3 2025).

5.3.1. Discourse on capability innovation

To move the drone innovation forward, Finland is increasingly relying on international cooperation. One example is the joint development between the Finnish company Insta in cooperation with an undisclosed Ukrainian partner (Bernacchi 2025). In addition 'Summa Defence', another Finnish defence company, has launched a drone production facility in Finland, to supply unmanned systems to Ukraine, further strengthening Finland's future domestic drone production and its cooperation with Ukraine (Bisht 2024). Further, the Finnish Armed Forces also announced to have opened a call to procure portable UAV capabilities, based on previous research the technological requirements had been determined (Finnish Army 2022). This indicates one aspect of the implementation phase due to the apparent research and testing process conducted previously.

Further, the discourse on unmanned systems is expanding across multiple domains. In a recent report by the Finnish National Defence University both Unmanned Ground Vehicles (UGVs) and USVs are research subjects, however the study on UGVs is based on simulation training while the USV report remains in a preliminary stage of the research (Saastamoinen and Rissanen 2025). In regard to the capability development and procurement UGVs have not gone

beyond the prototype phase in regard to Finland, with a recent display of the THeMIS (UGV) at the SecD-Day 2025 in Helsinki, a key exhibition for the Finnish defence sector (Defence Industry Europe 2025).

Further, Finland aims to increase its domestic drone production, as it is mentioned in its recent drone strategy paper. One example of how this can be achieved is through international cooperation, as the development of a new version of the 'Steel Eagle' drone by the Finnish technology company Insta in cooperation with Ukraine, has shown (Insta 2025). The research and development of domestic, although in cooperation with international partners in some cases, unmanned systems indicate the implementation phase, especially in regard to the development of an adapted version of 'Steel Eagle' UAV for the specific use in Ukraine. A key emphasis throughout the defence report is the implementation of autonomy in regards to drones, however it is not specified how and in which form autonomy should be achieved (Finnish Ministry of Defence 2024).

A first glimpse into the current development of autonomous capabilities of unmanned systems by Finland is the development of swarm capabilities, however no specifications have been made public (Interview #3 2025). In the current stage the research and development of autonomous capabilities still seems to remain in the experimental phase as no public testing or demonstration has taken place. Overall, we can observe that Finland is moving towards the implementation phase in regards to capability innovation, emphasising domestic drone development and has moved to the implementation phase in that regard. While these developments still rely on cooperation with Ukraine and adapting based on their experience, the development of prototypes allows Finland to strengthen its own drone industrial base. The Finnish Defence Forces also initiated a call to procure portable UAVs, with the goal to procure between 1000-2000 systems (Finnish Army 2022).

At the same time, autonomous capability are emphasized in the discourse but remain in the experimentation phase as the official documents remain unclear on what autonomous capabilities are of interest and no public testing has taken place so far. Additionally, experimentational aspects such as land- and sea-based unmanned systems as research subject at the Finnish Defense University and the presentation of a Finnish UGV prototype, remain.

5.3.2. Discourse on strategic innovation

How profound Finland views the future impact of unmanned systems in military affairs is visible in the recent Defence Report stating that "They will change the future of war, operations and the battlefield." (Finnish Ministry of Defence 2024, 25) and further emphasized during an interview as "The whole concept of warfare." [will change] (Interview #3 2025), therefore indicating a change across all three levels of warfare, the strategic, operational and tactical. While the impact is seen as profound the forward-looking approach indicates more towards the experimental phase as it is not defined in what way the impact will occur yet. Further, within the defence report Finland commits to the advancing unmanned systems, emphasising the need for increased autonomy of such systems. (Finnish Ministry of Defence 2024). In addition, drones are seen as a one of five focus areas for Finland's future research and development priorities (Finnish Ministry of Defence 2024, 45).

However, "new technology" remains at the forefront of the discourse showcasing the remaining ambiguity existing within the innovation process. A profound milestone in the strategic adoption of drone systems has been the recently published "National Drone Strategy" (PIA 2025). Initiated by the Finnish parliament the strategy is a comprehensive approach to develop Finland into a leading player in drone development. In terms of military perspective of unmanned systems, the strategy labels the benefits of drones as "… reduces human casualties and enhances operational efficiency." (PIA 2025, 6). Further, it highlights the need for drone systems to be adopted to Finland

"cold and extreme conditions" (PIA 2025, 6) and "Testing in Arctic conditions" as a research focus, showcasing the importance of the Arctic as an operating theatre for Finland. This was also emphasized during the interview, as Finland's cold-climate expertise allows them to adapt systems to their specific needs. While the adoption of the strategy is a step towards the implementation phase, the first two areas identified by the strategy to push forward Finland's drone innovation are: "Building and Strengthening of Expertise" and "Advancing Drone Concept Development and Experimentation" (PIA 2025, 7). This is an initial step in moving towards the implementation phase and provides a fundamental framework to the development, procurement and implementation of unmanned systems as well as providing an overview of related technologies supporting and enabling drones in the future. However, in terms of military use of drones the strategy remains vague. Therefore, this should be seen as an experimentational aspect, as where some exercises are conducted to gain experience but has not reached a critical point to adapt the previous strategic approach to training. Overall, the strategic innovation discourse recognizes the transformative nature of unmanned systems and has initiated first steps to implement drones, notably through the publication of the first "National Drone Strategy", however the emphasis on testing and capability development, continuous to indicate the experimentation stage as dominant.

5.3.3. Discourse on organizational innovation

Finnish defence forces are also adapting their military training in regard to unmanned systems, allowing conscripts to fulfil their service through research on drone systems (YLE 2025). However, it remains unclear to what extent this opportunity is available or if it remains as a niche opportunity for only a handful of conscripts. This also aligns with that drones have been implemented into the training programme of Finnish Armed Forces to some extent, training concepts have not been adopted to the use of drones but drones are rather used within existing concepts (Interview #3 2025).

By adapting the military training of future soldiers Finland showcases an aspect of implementation in their drone innovation process, although the limited availability does not align with the implementation phase.

Finland's recent NATO accession has also influenced its drone innovation process, namely in the proposition to host a drone base for the alliance's large reconnaissance drones in southern Finland, however the planning is still in the early stages (Stenroos 2024). While dedicating specific infrastructure to unmanned systems should be considered as an indicator for the implementation phase, the acknowledgement of preliminary stage of the decision-making process brings it back to experimentation phase.

So far Finland has not founded a specialized drone branch or specialized units, as has been the case in Ukraine, which would be "mandatory" (Interview #3 2025) to achieve the full potential of unmanned systems according to a former senior Finnish officer (Interview #3 2025). However, the common conservative approach to technological change is described as an obstacle to the establishment of such specialized units. This lack of organizational change further emphasizes the experimental nature of the drone innovation process in Finland. Therefore, the organizational process of Finland shows first steps towards reaching the implementation phase but remains within the experimental stage due to the lack of doctrinal change and absence of specialised drone units.

5.3.4. Findings

Overall, Finland perceives unmanned systems as a critical component for its future defence capabilities, spurred by the threat perception towards Russia and the lessons learned from Ukraine. Its drone innovation process currently resides within the experimentation phase for the most part, though a clear development towards the implementation phase is visible, specifically in the discourse on capability innovation. Capability innovation in Finland highlights aspects of the

implementation phase in the development of domestic drone systems, such as the 'Steel Eagle ER', in cooperation with Ukraine. Thereby strengthening its industrial base for future drone procurements. However, autonomy capabilities such as drone swarming remain in the experimentation phase, which have not yet undergone public testing. A comparable situation exists for the exploration of UGV/USV systems which remain as prototypes or as a research subject.

For the strategic innovation process Finland's approach can be categorized as experimental, however the transformative nature of drones in warfare is acknowledged. The national drone strategy is a first step towards the implementation phase, indicating a fundamental change in the Finnish doctrine. However, its current emphasis on future capabilities and experimentation, as well as the military aspect of the strategy remaining vague and general, keeps it within the experimentation phase. The Arctic is highlighted as a key operating area for drone systems, with specific testing and development necessary to provide reliable capabilities in subzero conditions.

Organizational innovation is inherently experimental. The addition of drones to conscript training remains limited and no conceptual change has taken place but rather drones are used with previous concepts. While Finland has offered to host a NATO drone base, the proposal remains in its initial stage and therefore also affirms the experimentation phase. The lack of specialized units, described as crucial during the interview process, further emphasises the experimentational nature of Finland's organizational innovation process. In sum, Finland is moving forward in its drone innovation process but so far has failed to move to the implementation phase. While its capability development showcases increased aspects of implementation, it is evident that the broader strategic and organisational frameworks are still in a state of experimentation, with a strong emphasis placed on foundational development.

5.4. Comparison

The military drone innovation process of Norway, Sweden and Finland, driven by the common threat perception towards Russia, displays distinct national characteristics and progress varies in regard to Mahnken's speculation, experimentation, and implementation spectrum. Overall, all three nations can be situated within the experimentation phase in the broader innovation process of advanced drone capabilities, yet in specific areas initial steps are taken towards implementation, and ongoing speculation about future capabilities is part of the discourses as well.

In terms of capability innovation, a common thread across all cases can be identified to develop or acquire unmanned systems with increased autonomy such drone swarms, indicating a shared understanding of desired future capabilities. Both Norway and Sweden have presented domestic research projects demonstrating drone swarm prototypes, while Finland is working on swarm capabilities of its own, but they have not yet been revealed. While these developments indicate progress towards implementation, their operational deployment remain largely experimental. Finland, however, is pushing forwards its domestic industrial base through international cooperation, such as through the joint development of the 'Steel Eagle ER' UAV, which indicates a step towards reaching the implementation phase. In terms of large scale ISR UAVs, Norway is the leading actor, with confirmed procurement plans and an established implementation timeline. Sweden's procurement of small reconnaissance drones for its Home Guard is characterized as a testing patch, therefore experimental, and Finland's call for procurement of portable UAVs falls under an initial implementation step as they seem to be acquired for further familiarization and testing. The adaptation of drone systems for Arctic conditions is a shared concern, with Norway and Sweden explicitly testing under such conditions, and Finland's National Drone Strategy highlighting this need, placing these efforts within the

experimentation phase. The expansion to different domains of unmanned systems (UUVs and UGVs) remains in a prototype or experimental stage at this point.

In all three cases the transformative impact drones have on warfare is acknowledged and they are actively learning from Ukraine's experience, driving the experimentational nature of their strategic approach. This is visible in Norway's use of improvised means in exercises and Sweden's use of wargaming to assess the impact of MALE systems. International cooperation, such as the NORDEFCO initiatives or Norway and Sweden's participation in the international drone coalition for Ukraine, also reflects an experimental aspect to understand and develop improved strategic approaches.

A notable difference is Finland's publication of a 'National Drone Strategy'. While the strategy is focused on initial expertise building and experimentation, its mere existence signals a more formalized step towards implementation compared to Norway and Sweden. Both seem to integrate drone considerations within the broader strategic defense plans without a specific drone strategy approach document like Finland. However, in all three cases, the development of a comprehensive and field-tested defence doctrine for wide-scale implementation of unmanned systems, specifically in the context of the Arctic region, remains ongoing and has not achieved an implemented strategic shift. This is also visible in the case of Sweden, were the planned doctrinal adoption of drones as a key capability signals a move towards implementation, but specific outlines remain unknown and therefore in the experimentation phase.

The least prevalent innovation process in within the discourse of each state so far is the organizational aspect, with predominant aspects of experimentation. Still, within the organizational innovation three themes emerged with drone infrastructure, establishment of drone units or the lack of such and the adaptation of military education. One exception to this is Norway's repurposing of

the former closed air base at Andøya to function as a dedicated drone base, showcasing a clear step of implementation. Sweden's 'Demo Ucav' project has an explicit knowledge and testing focus, characteristic for the experimentation phase. Finland's consideration of hosting a NATO drone base remains prospective and preliminary, indicating the experimental stage. While all three states are incorporating drones into their training and education programmes, this occurs within existing frameworks and lacks the needed adaption and changes in the curriculum to achieve the implementation phase. Further, each state currently lacks the establishment of specialized drone units or even an independent drone branch, which was highlighted as a necessary step by a former high-ranking Finnish officer during an interview. The aspiration to distribute drones across all branches, as stated by Norway and Sweden, remains limited and experimental at this point.

6. Implications for security dynamics in the European Arctic

After displaying the current state of military innovation process in regard to unmanned systems in Norway, Sweden and Finland, the question remains what does this mean in the context of Arctic security? From the assessment, two main implications from the military use of drones can be distilled for the Arctic security context: Drone are well suited to Arctic warfare and technological restraints remain as a key obstacle.

Drones are well suited for the European Arctic

An emerging theme that was mentioned during the interview process, was the assumed similarities in a potential use of drones in the Arctic compared to Ukraine if a conflict erupted in the near future (Interview #1 2025; Interview #3 2025). The plausibility of such a scenario is unknown, however some experts have been raising concerns that Russia's could use its planned large scale military exercise "Zapad-25" as a front for a potential attack against another European state (Burilkov and Wolff 2025; Kixmüller 2025). The effectiveness of drones could even be enhanced through the predominant environmental features of some parts of the European Arctic. The European Arctic is characterized through a continuous decline of vegetation towards the North Pole, such as in the Norwegian Finnmark region (Callaghan, Cazzolla Gatti, and Phoenix 2022).

In addition, the difficult terrain and relative lack of infrastructure complicate the manoeuvrability of traditional forces, which further favours the use of drone systems to compensate for manned systems (Interview #2 2025). Also, the reduced detectability of (small) drone systems in terms of their heat signature compared to large manned models (Interview #3 2025). As the usage of UAVs in the Russian war against Ukraine has shown, drones have devastating effects in open space with no obstacles interfering their routes and are currently responsible for an estimated

two thirds of Russia's losses (Watling and Reynolds 2025). As the discourse shows, Norway, Sweden, and Finland are specifically adopting drones based on the lessons learned from Ukraine. With significantly less vegetation available to provide cover to soldiers operating in the European Arctic, drones will likely be even more lethal capability as they already are in Ukraine. Or as was mentioned during one interview, "That is the optimal place to put unmanned systems. Dull. Dirty. Dangerous." (Interview #3 2025).

Technical limitations remain

However, key technical obstacles remain for unmanned systems to operate successfully in Arctic conditions, more specifically during the Arctic winter. The main obstacle aerial drones face currently is icing, a phenomenon where ice attaches to rotary blades or other parts of an UAV and interferes in the aerodynamic properties of drones, potentially leading to malfunctions and loss of the affected systems (Interview #1 2025; Gronholt-Pedersen et al. 2025). A further technical challenge is the influence of temperature on battery capacities, with sub-zero temperatures significantly reducing the operating radius of current drone systems, with small scale drones specifically affected. In a test by the Greenlandic start up "Arctic Unmanned, conducted in 2023 with temperatures of minus 43 degrees Celsius, the battery of a small drones only lasted for a few minutes (Gronholt-Pedersen et al. 2025). However, more recent studies with lithium metal batteries have shown promising results of increased resilience against extreme cold, offering a possible solution to operate drones in the Arctic (AUVSI 2025).

A further issue remains in terms of autonomous assisting target recognition systems, which will likely struggle with the lack of contrast in the Arctic landscape with snow covered ground and trees as well as a similar grey sky (Interview #3 2025). As such systems are specifically critical in the "last mile targeting" (Cook 2025), meaning the final stretch before a drone hits its target,

adapting such systems is of critical importance. While the previous issues are predominantly a seasonal issue during the Arctic winter, one technical hurdle remains throughout the year, satellite navigation issues. On the one hand the traditional broadband telecommunication from the geosynchronous orbit does not cover the Arctic, therefore satellites in the polar orbit or highly elliptical orbit are necessary (Andersen and Johansen 2013; ESA 2025). However, they remain scarce and predominantly provide narrowband frequencies which are not suitable for the use of drones (Berge and Bergmann 2024; Interview #3 2025). While Norway has successfully launched two satellites through the Arctic Satellite Broadband Mission (ASBM) to provide the necessary broadband to the Arctic, navigation systems remain vulnerable to damage or attacks on space infrastructure due to the small number of satellites (Space Norway 2025). The successful implementation of drone technology on a large scale in the Arctic is dependent on the ability to overcome the demonstrated environmental and technical challenges.

Conclusion

This thesis displayed the ongoing military innovation process in regard to unmanned systems in Norway, Sweden and Finland, assessing the extent of the implementation and evaluating why an Arctic-specific security debate on drones has been slow to materialize. Through employing Mahnken's military innovation framework, the qualitative analysis of official documents, defence research publications, media sources, and expert interviews, reveals a complex and evolving landscape.

The central finding of this thesis has been that all three Nordic states are currently situated in the experimentation phase of drone capabilities, although there are initial steps towards implementation in specific areas. This innovation is primarily driven by the deteriorating European security architecture following Russia's full-scale invasion of Ukraine and the lessons learned from this war.

To answer my first research question on the extent of drone implementation, this study found varying degree of progress. Norway leads in implementing large ISR UAVs with dedicated infrastructure in place. Sweden displays a more advanced innovation process in regard to domestic R&D of drone swarm capabilities. Finland, while also largely experimental, is advancing its domestic drone production ('Steel Eagle ER') through international cooperation predominantly with Ukraine and has published a "National Drone Strategy" as a foundational step, although its current version continues to emphasize building expertise and experimentation. Across all three cases, organizational innovation, such as establishing specialised drone units, lags and remains predominantly in the experimental phase.

Coming back to the second question set out to answer through this thesis, regarding how drones have impacted Arctic security affairs. And the brief answer is, they have not. Yet. The Arctic as an operating environment is a key concern for each state, which is represented in the official strategy documents, media discourse as well as confirmed by experts from each country during the interview process. All states address the development of drones to function within Arctic conditions, although the Arctic is not explicitly mentioned as concern consistently, the emphasis on testing unmanned systems in domestic conditions allows to include the Arctic as key part of defence planning in Norway, Sweden and Finland. The reasoning for this can be found in the experimental nature of innovation process and the technical limitations regarding unmanned systems operating in cold weather conditions, such as icing, battery life or navigation issues. But the interview process has shown that unmanned systems will likely play a key role in the future of the European Arctic security dynamics, as their inherent characteristics were highlighted as an ideal capability for the High North.

This study contributes to the ongoing Arctic security debate and how specific technological innovations are being implemented. By assessing the current drone innovation process in the European Arctic through the comparison of Norway, Sweden and Finland, this thesis aims to lay the groundwork for further exploration of unmanned systems in the context of the Arctic. While this thesis does not delve deeper into the question of why national differences exist, it provides a first overview of an apparent emerging debate which seems likely to gain relevance in the near future. However, limitations exist on the assessment of discourse in the respective national languages, which would likely allow for a more nuanced understanding of the debate.

Future research should focus on creating additional bridges between the previously predominantly isolated studies of Arctic security and drone studies, unmanned systems are a well-

suited for the High North and will serve as key capability for armed forces in the Arctic region of the future. To enhance the current understanding of multiple Arctic's, research into the specific operating environments of each case and how drones will be adopted in each individual circumstance would be an interesting angle to further engage with drones in the Arctic context. Further, the reasoning of why differences in the national context exist invites further research. As security challenges in the Arctic evolve alongside rapid technological developments, understanding how emerging systems like drones are integrated into national strategies will remain a vital part of security discourses.

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