Nordic Innovation

The Nordic AI and data ecosystem 2022

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Foreword

In 2019, the Nordic Prime Ministers agreed on a new vision for the Nordic cooperation, Vision2030, which holds that the Nordics is to be the most sustainable and integrated region in the world by 2030. Following this, the five Trade and Industry Ministers launched eight programmes for the period 2021-2024, whereof AI & Data is one.

Our vision is for the Nordics to become a leading region in digitisation, ethical AI and responsible use of data by 2030. The Nordic countries are all in the global top 10 when it comes to "AI readiness" and private investment in AI. Now is the time to propel the work in this area by leveraging our common Nordic values and AI readiness, paving the way for ethical AI and responsible use of data, and thus setting a precedent for the world on how we envision data protection, privacy and human-wellbeing at the core of any AI development.

On assignment from Nordic Innovation, E&Y has undertaken this extensive mapping of the AI ecosystem in the Nordics as it stands today, with a special focus on public sector actors and national initiatives and programmes within the area.

The purpose of this mapping is not only to identify which national actors, initiatives and programmes exist today in the AI & data innovation ecosystem in the Nordics but also what some of the challenges, best practices and strongholds in each country to be able to build on these on a Nordic level.

We want to thank E&Y and all the interviewees who have contributed with their insight into the field of AI & data. This publication is part of the programme AI & Data by Nordic Innovation. E&Y is responsible for the report's content and the recommendations. We hope this report also will serve Nordic businesses, public actors and decision-makers and other stakeholders in the data value chain, besides being a source of information for us at Nordic Innovation in our continuous work in the AI & Data programme.

The Nordics has a number of prerequisites needed to become a leading region in digitalisation, ethical AI and responsible use of data. With our long history of collecting data resulting in the world's oldest consistent statistical databases, we have a unique possibility of connecting the public sector and brilliant minds with innovative solutions; to create a more integrated, liveable and greener society.

Oslo, 8 June 2022

Svein Berg – Managing Director, Nordic Innovation

Executive Summary

This report presents an overview of the Nordic ecosystem for the responsible use of data and ethical artificial intelligence (AI), both from the perspective of the Nordic region and the individual countries within it. The report has been written by EY on behalf of Nordic Innovation and has been commissioned to include the following information:

1. Mapping of the current state of the Nordic AI and Data ecosystem as a whole.
2. Mapping of the most relevant national actors, initiatives, and best practices in the five Nordic countries.
3. Identification of Nordic strongholds with most potential for Nordic Added Value.
4. A short comparison with relevant EU level activities.
5. Recommendations for Nordic level measures to support capabilities for the responsible use of data and ethical AI.
6. Development of a basis for launching pilot projects as described above.

In order to identify strongholds and recommendations for the ecosystem, the report dives into each individual country to explore several important areas, starting with which actors are relevant. In addition, the report describes the national strategies and policies tied to the responsible use of data and ethical AI as well as which major initiatives exist. For the initiatives, best practices are identified where possible to reveal what the countries are doing particularly well. Finally, each country has their own breakdown of national challenges and strongholds that are particularly relevant for them.

Bringing the scope back to the Nordic level, the national findings are used to describe how the ecosystem for the responsible use of data and ethical AI functions across the whole region. Moreover, the Nordic countries are compared to each other to display where they are similar and where they are different. Furthermore, since the countries are similar in many ways, the report sets out to describe which challenges and strongholds are common across the Nordic region. In order to set the Nordic region in relation to the rest of Europe, a comparison to European level activities is also included. Finally, taking into account all of the findings in the report, a list of recommendations is included in order to set a starting point for potential goals and new initiatives that can be leveraged to strengthen the Nordic responsible use of data and ethical AI.

The report is intended for policy makers and organisations who are interested in strengthening cooperation across the Nordic countries with regard to the responsible use of data and ethical AI. The goal is that the reader will find new and noteworthy information that will help them to understand the Nordic AI and data ecosystem. In turn, this information can be leveraged to pursue new strategies, policies, and initiatives that will continue to build on the existing Nordic strengths while counteracting the current challenges.

Results

Regarding the results of the report, the two most important topics to address are the challenges and the strongholds. Starting with the Nordic level, for each of these topics, the report describes three areas to keep in mind in order to develop the Nordic ecosystem for the responsible use of data and ethical AI.

From the perspective of challenges, the primary areas to address include data management, the ability of organisations to transition from AI pilots to production, and the organisational understanding of regulations and the development of ethical AI solutions. Overall, the theme behind the challenges is that the Nordic countries are struggling with some of the technical aspects that are fundamental to the responsible use of data and ethical AI.

On the side of strongholds, however, the areas with the greatest potential to build on include the Nordic focus on ethics, equality, and fairness; the availability of valuable national datasets; and Nordic capabilities that are relevant to the data and AI ecosystem. Summarising the strongholds, the common thread is that the Nordic countries have a stable foundation for innovation, including across the public and private sectors, as well as the societal values that are required in order to be successful at the responsible utilisation of data and the development of ethical AI.

Switching the focus to the individual countries, Denmark has one challenge and two strongholds that stand out compared to the other countries. Starting with the challenge, Denmark is recognised as having a particularly noteworthy gap in capabilities for the responsible use of data and ethical AI when viewed across the geography of the country due to the heavy influence of Copenhagen in relation to the rest of the country. On the other hand, when it comes to the strongholds, Denmark has an especially strong public sector when it comes to AI development. In addition, the country places a significant emphasis on efforts towards ethical and responsible AI.

From the perspective of Finland, there are two challenges and one stronghold. The first challenge is related to Finland struggling with finding enough resources to effectively work with AI development while the second is about Finnish companies struggling with data management. When it comes to the stronghold, however, the country is especially well positioned with regards to AI education and research in relation to its Nordic peers.

Moving on to Iceland, there is one challenge and one stronghold. The challenge is directly related to the small

size of the country which puts it in a difficult position to access the right competencies to be able to focus on the responsible use of data and ethical AI. However, Iceland recognises this position and is actively working on leveraging its small size to its advantage which is why its stronghold is related to its proactive stance towards innovation through its beneficial policies for attracting international companies and workers.

When it comes to Norway, the country has two noteworthy challenges and one stronghold. The first challenge is related to the lack of commercialisation of AI research and AI pilots by businesses while the second is tied to its shortage of capabilities and competence for AI development. Norway's stronghold, however, is based in its strong position for pursuing twin transitions which is related to the combination of digitalisation with a green transition of industries.

Finally, Sweden has one challenge and one stronghold that stand out compared to its Nordic peers. The challenge is related to the country having a vague national strategy for the responsible use of data and ethical AI which makes it especially difficult to progress as a country due to the high degree of freedom in decision-making given to public organisations. When it comes the to stronghold, however, it is clear that Sweden has a particularly robust private sector that is making significant and frequent investments into innovation.

Recommendations

By combining the insights from each of the Nordic countries together with the findings from the region as a whole, this report lays out five recommendations for potential paths forward. These are meant to guide policy makers and organisations that are interested in strengthening Nordic cooperation related to the responsible use of data and ethical AI by describing how to build on strongholds and counteract challenges. The recommendations are as follows:

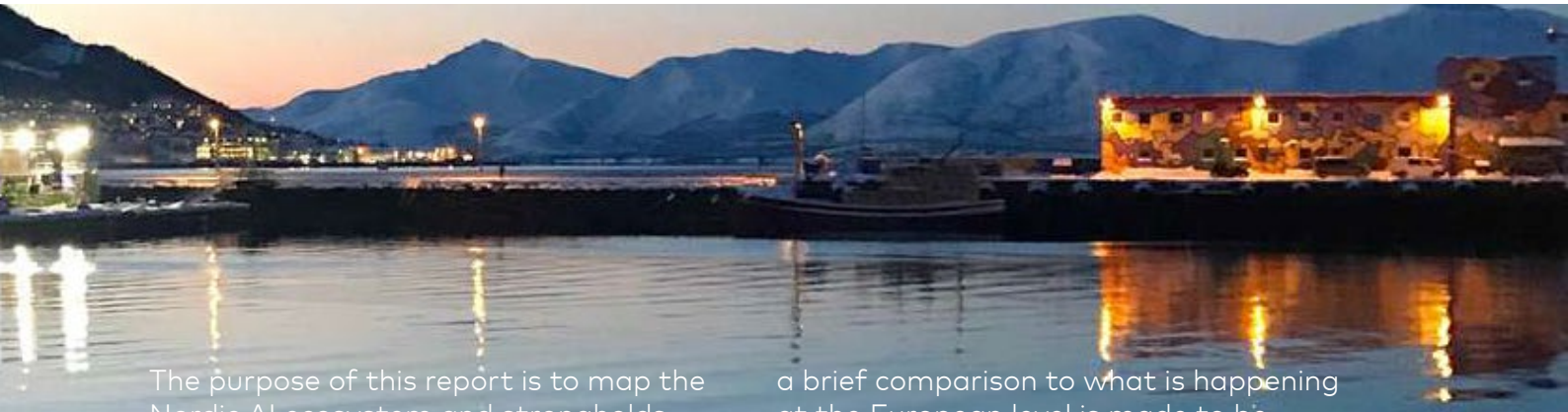
1. The Nordics should pursue increased sharing and utilisation of national datasets
2. The Nordics should build a competitive advantage on the responsible use of data and ethical AI
3. The Nordics should raise the AI and data competency level among organisational leaders
4. The Nordics should support businesses and academic institutions in finding relevant partners for solving AI and data challenges
5. The Nordic countries should share best practices, use-cases, and knowledge with each other related to ethical AI and the responsible use of data

These recommendations are intended to be on a relatively high level in order to encompass the relevant strongholds and challenges while leaving room for the many potential initiatives that are categorised within them and that can be launched in the future. However, in addition to a more detailed breakdown of these recommended paths forward, the report also describes two examples of initiatives that can be pursued in order to make it more clear to the reader which types of approaches that could be of interest.

Introduction

Artificial Intelligence (AI) has been an important topic for businesses and public organisations alike for the past several years. During this time, the public has grown increasingly accustomed to AI-powered services that are delivered by the world's largest tech companies. However, even though other organisations also have the potential to deliver new and improved services through AI, there is still work to be done to succeed in this endeavour. This includes the Nordics where many local assets make the region a potential contender in the development and deployment of ethical AI and the responsible use of data on an international scale.

To explore how the Nordics is progressing with regards to data and the utilisation of AI, this report delivers an in-depth review of the current state of AI and data in each of the countries, as well as recommendations on how to strengthen the capabilities of Nordic businesses within AI and data.



The purpose of this report is to map the Nordic AI ecosystem and strongholds, which includes the following:

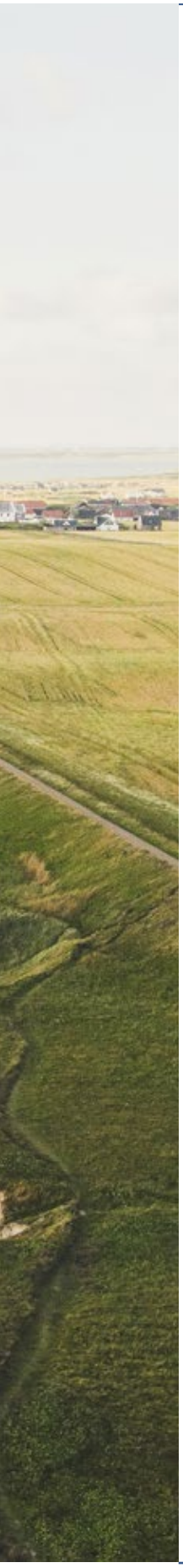
1. Mapping of the current state of the Nordic AI and Data ecosystem as a whole.
2. Mapping of the most relevant national actors, initiatives, and best practices in the five Nordic countries.
3. Identification of Nordic strongholds with most potential for Nordic Added Value.
4. A short comparison with relevant EU level activities.
5. Recommendations for Nordic level measures to support capabilities for the responsible use of data and ethical AI.
6. Development of a basis for launching pilot projects as described above.

The report itself is broken down into two main parts, plus a section for recommendations directed to creating added value for businesses in the Nordic region. The first part constitutes key findings exploring the ecosystem for AI and data within the Nordics as ell as how the countries compare across several parameters, including their national strategies and the best practices we have identified in each Nordic country. In addition, due to the strong similarities between the countries, there are also descriptions of common challenges, strongholds, and capabilities. Finally, a brief comparison to what is happening at the European level is made to be aware of what is happening at an EU level and to showcase what is impacting the Nordic region.

The second part is a longer section on each country that dives into key areas for AI development, including the countries' strategies, most relevant national polices, actors, initiatives, programs, and best practises. While describing positive aspects of the Nordic region is important, the report also highlights some of the challenges that are faced by each of the countries. To round up the country sections, national strongholds have been identified that can be leveraged to support the AI and data ecosystem, both within the individual countries but especially at the Nordic level.

Finally, this report is the result of a Nordic study conducted by EY on behalf of Nordic Innovation. In its development, innovation context analyses of the AI and data field in each of the countries have been complemented with interviews with national experts in order to capture a more complete view of the current stage of AI and data in the Nordic region. The resulting report is meant to provide additional insight into the fast-developing field of AI and data in the Nordics while also recommending concrete actions to support Nordic businesses in their development and deployment of data and ethical AI

Key Findings



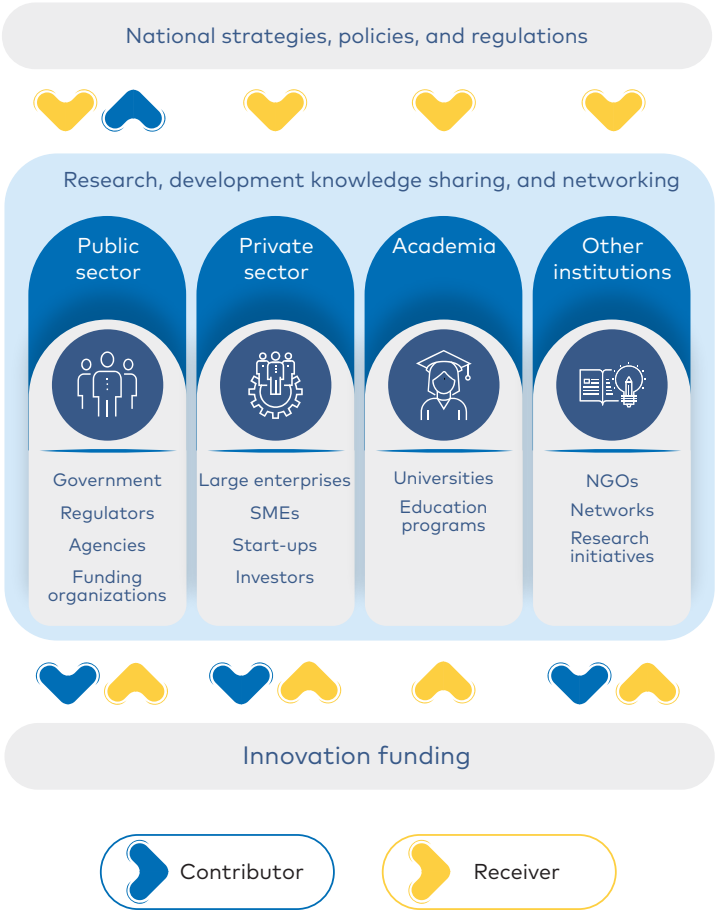
Overview

In this initial section of the report, an overview of the findings from the study is presented, written from the perspective of the entire Nordic region. The overview itself is broken down into three areas, including a visualisation of the Nordic AI and data ecosystem as a whole, a comparison of the Nordic countries on several key parameters, as well as a break-down of important activities on the EU-level that need to be considered at the Nordic level as well as individual country level.

Nordic AI & Data Ecosystem

The overarching structure of the Nordic AI and d ata ecosystem can be broken down into four types of actors that influence and/or are influenced by relevant factors. The actors themselves include those within the public sector, private sector, academia, as well as other institutions such as non-governmental organisations (NGOs). When it comes to the factors, there are national strategies, policies, and regulations; innovation funding; as well as research, development, knowledge sharing, and networking.

While all of the actors have the potential to influence each factor either directly or indirectly, the purpose of the visualisation is to show which actors have an especially important role for any given factor. An example of this is that the public sector is the only type of actor that can set a national strategy, even though the other actors can indirectly participate through activities like lobbying. Similarly, there are some academic institutions that provide innovation funding, but these are generally quite small in relation to the other types of actors. Finally, when it comes to factors that all actors are contributing towards, they include research, development, knowledge sharing, and networking.



Comparison of Nordic Countries

The Government AI Readiness Index by Oxford Insights scores how ready a given government is to implement AI in the delivery of public services to their citizens. The Nordics is highlighted in the introduction of the 2021 report as a leading region due to its governments having high internal capabilities. The Nordic countries have relatively small economies on a global scale but being a small country with a homogenous population also has its advantages when it comes to being agile and being able to adopt new technologies fast. All Nordic countries rank high in the 2021 Government AI Readiness Index. Finland ranks first among the Nordic countries, at 4th place, closely followed by Sweden, Denmark and Norway in 6th, 9th, and 13th place respectively. Iceland lags behind compared to the other four Nordic countries and ranks as number 46 out of the 160 countries in the index[1].

All five Nordic countries have a national AI strategy. Finland was one of the first countries in the world to initiate and publish a national AI strategy in 2017[2]. Sweden followed suit and launched a national AI strategy in early 2018. Denmark followed with its national strategy in March 2019 and Norway in January 2020 and recently, mid-2021, Iceland published its AI strategy. Finland has for a long time been considered the leading AI nation, while Iceland has lagged behind compared to its neighbours in directing national attention to AI specifically. In addition to being the last Nordic country to publish an AI strategy, Iceland's strategy is considered vague, and there is a lack of available skilled labour to work with AI in the country. Among our interviewees, Finland has received positive feedback for having revised its national AI strategy and devising action plans connected to the strategy. Norway and Sweden on the other hand are criticised for not setting a clear direction and not having enough actions to realise the strategies.

Denmark, Finland, Norway, and Sweden all have national AI strategies that emphasise the importance of ethical and trust-based AI. Denmark aims to be a frontrunner in the use and development of responsible AI. In Finland, one of the key actions in the Artificial Intelligence Programme is to steer AI development into a trust-based and human-centric direction. The Norwegian AI strategy launched a separate set of ethical principles for development and use of AI. In Sweden, the government has identified the need for ethical guidelines for AI as an important role in succeeding with AI. This shows that all Nordic countries have responsible use of data and ethical AI on top of their national agendas, and have the region have the possibility to take a leading position and build a competitive advantage within this area.

All five Nordic countries share the same characteristics in terms of being a trust-based society. The inhabitants have a high degree of trust in both each other and the authorities. Therefore, creating trustworthy AI is high on the agenda in the Nordics. This is reflected in the policies related to data and AI in the

Nordics countries. More specific, all five countries have explicit policies related to data protection and privacy implications. In Denmark, the Data Ethics Council has established guidance material and assessments for creating AI solutions with ethical considerations. In Finland, a data protection act that supplements GDPR has been launched to regulate the processing of personal data. Finland has also established an ethical information policy in the age of AI. Furthermore, Finland has a non-discrimination act which also applies to the use of AI, and one of Sitra's focus areas during the period 2021-2024 is Fair Data Economy. Iceland has, in the same way as Finland, a policy on data protection. As mentioned above, Norway's AI strategy launches a set of ethical principles for development and use of AI. In the extension of these principles the Norwegian Data Protection Authority has published a report on the privacy implications of AI and has launched a regulatory sandbox for AI. The Swedish Authority for Privacy Protection (IMY) and AI Sweden are in the period 2021 to 2023 collaborating on offering guidance and support regarding data protection.

Developing accurate and unbiased AI models requires large amounts of data of high quality. On this background, several of the Nordic countries have launched supporting strategies or policies related to making public data more easily available for both public and private institutions. One of the concrete initiatives related to Denmark's national AI strategy is to make data more easily available. In Sweden the Ministry of Infrastructure published a separate strategy in 2021 to make Sweden the leading country in data sharing. In 2021, Norway published a white paper on Data Driven Economy and Innovation where working towards increased sharing and use of public data is an important aspect. Furthermore, Norway has established national principles for use and sharing of data, as well as guidance material on data sharing. As part of its national AI programme, Finland adopted an open data policy. The country has published an Act on the Secondary Use of Health and Social Data aiming for data to be used in development and innovation activities. Additionally, Finland had an open data programme running from May 2013 to June 2015 which aimed to eliminate obstacles to re-use public data and to create the pre-condition for open data within public administration. Today, Finland has an Open Data and AI policy action plan running until 2023.

In each of the country reports best practices have been identified within data and AI and are described in detail. When comparing the best practices across the countries it becomes apparent that the countries have different strengths when it comes to AI. Starting with Denmark, one of the best practices are related to ethical considerations in organisations' data products, and the other best practice is related to supporting SMEs in their AI journey. Finland has a strong AI landscape and

ecosystem, and therefore their best practices are related to this. One of the two best practices identified, AI Business programme by Business Finland, aims to accelerate the capabilities and business models of Finnish companies. The other best practice identified by us in Finland is related to building knowledge and capabilities in AI within Finnish companies. The First Artificial Intelligence Accelerator (FAIA) is addressing the lack of AI knowledge in Finnish companies by facilitating three-month long AI training programs where organisations learn the basics of AI and what it takes to succeed with AI-driven products. Moving to Norway, their best practices are centred around sharing and building competency and capabilities within AI. First is the regulatory sandbox to support responsible use of AI, and second is the Health Analysis Platform. The goal of the Health Analysis Platform is to ensure better utilisation of health data. Lastly, Sweden, in the way same as Finland, has a strong ecosystem within AI.

One of Sweden's best practices is Vinnova's Start Your AI Journey which is a programme that encourages AI innovation by providing funding to private and public organisations. The other identified best practice in Sweden is the availability of networks for knowledge-sharing and inspiration within AI and data.

Some of these include AI Sweden's networks and workshops for its partners, the network for regions and municipalities run by the Swedish Association of Local Authorities and Regions (SALAR), and the network to promote public administration's ability to use AI that is led by a group of public organisations, including the Swedish Public Employment Service.

Nordic Challenges

When it comes to AI and data challenges within the Nordics, we find that most challenges are common across the region. Among these, we find topics such as a shortage of talent, connecting academic AI research with business implementation, and low adoption rates of AI in businesses. In this section, however, we will drill down on three areas that are of particular importance but that the Nordics also have to possibility to engage with and alleviate, including 1) Data management, 2) Transitioning from pilots to production, and 3) Understanding regulations and developing ethical AI solutions.

Challenge 1

Data management

Data management is an integral part of most successful organisation today, and it is especially important for the responsible use of data and ethical AI. The field is broad, covering areas such as data architecture, data quality, data strategies, operating model, privacy compliance, IT security, and more. However, the overarching purpose of data management is simply to manage data as an organisational resource in order to unlock value. Since this field covers such a wide array of topics, for the purpose of this report, the following section will discuss data management as a whole. In addition, it is worthwhile to note that organisations largely have their own unique challenges within data management, and that these change over time as some issues are solved while new ones arise. In turn, this makes it difficult to narrow down specific areas to concentrate on. Nevertheless, as a whole, data management is an important area to include when discussing the responsible use of data and ethical AI.

To understand why both businesses and public organisations in the Nordics find data management for AI development to be a particularly challenging topic, it is worthwhile to recognise some of the historical changes that have occurred for organisations. To start with, for the past few decades, the concept of digitalisation has been an integral part of how businesses and organisations have developed themselves to stay relevant, retain a competitive edge, and attract new customers. From this perspective, the Nordics are doing well, with a high level of digital services in both the public[3] and private sectors, as well as a high level of digital competitiveness on the global market[4]. However, along with the digitalisation transition, and the improvements that are continually made in the pursuit of it, a significant amount of data has been created. For a relatively small number of companies, this data became the backbone of their enterprises, but for many companies it took years to start using the collected, available data to accurately measure performance, and often even longer to start analysing customer behaviour.

Following in the footsteps of several key innovations such as advancements in deep learning and access to cheaper processing power, AI started gaining traction during the 2010's and was publicly showcased by various global tech companies[5]. This led to a wave of calls and recommendations for businesses and organisations to make use of AI in order to once again stay relevant, retain a competitive edge, and to attract new customers. With this advent of AI, the few companies that had prioritised data management were suddenly in an excellent position to move into AI development due to their organised, high-quality datasets that could be utilised as training data for AI solutions. But for most businesses and organisations, data was still not a priority, and the data that was available

was largely siloed in different solutions with no concrete, overarching strategy for its use nor an IT architecture that was conducive to rapidly pursuing AI development.

We are now several years into the re-emergence of AI, and both businesses and public organisations point to data[6] and data management[7] as among the most significant barriers to developing AI solutions, let alone deploying them. Our expert interviews point to SMEs as especially struggling with adopting AI even though there is high motivation to work with AI. In part, this is due to them being in a grey zone where they are no longer start-ups that can grow with data management in their core function, nor are they large companies with more resources to invest into developing their data management capabilities. This puts many SMEs in the position of not being able to get the large, high-quality datasets that are required for developing AI. On this front, local experts see companies pursuing additional data collection before having decided what the end goal is. In turn, this seemingly proactive decision can end up causing further headache as additional data cleaning and restructuring is likely to be necessary if the formatting is incorrect or if the data cannot easily be utilised in conjunction with other necessary sources.

While the topic of data management is not a simple issue to tackle, there is potential to lift competencies broadly across the Nordics which would be beneficial not just to AI development, but also to the creation of new and improved services. However, our expert interviews indicate that generic strategies are widely available and that organisations would prefer to see more tailored support. This can quickly become an arduous task depending on detail, but by structuring and categorising the strategies based upon common organisational needs, more helpful support can be introduced without the need for company-specific consultations.

Challenge 2

Transitioning from pilots to production

In the Nordics, there is widespread enthusiasm and drive to pursue AI development, both across the public and private sectors. This has, for example, led most Nordic public organisations to already try to create their own AI solutions[8], but unfortunately few of them have successfully deployed their pilot solutions. In fact, for the past few years, organisational leaders in various forums have agreed that they struggle to get past the pilot graveyard. This is the concept where pilots are continually created, but that instead of being put into use in the organisation, they are instead put aside as little more than a learning experience.

While this experimental approach to AI development has its uses, especially for starting to build the right types of skills and competencies, it is not a worthwhile

investment over time unless concrete progress is being made that leads to an eventual return on the investment. However, to succeed with passing through this barrier between pilots and production, there are three topics that need to be addressed.

The first topic is the level of understanding of AI within the leadership team. Today, expert interviews point to many organisations pursuing AI development from a bottom-up approach where developers are the ones leading the campaign to create ethical AI solutions. This approach can work if there is support from the leadership team, but often it quickly falls apart if a serious investment is needed due to unforeseen challenges. Due to this, organisational leaders need to have a better understanding of AI and what its potential is. This will both help them with discerning which types of AI projects have the potential to improve the organisation, as well as when further investment can be worth the risk. Without this knowledge, the safe bet will always be to refrain from increasing the AI development funding which is inevitably going to lead to more pilots being put aside than going forward into deployment in the organisation.

The second topic is the lack of clarity surrounding costs and what is actually needed to bring a pilot AI solution into production. Again, there is some responsibility to place on organisational leaders to stay informed, but the focus here is rather on the knowledge within the operative AI development teams and how they can distil the most important information to be utilised by leadership in decision-making. Similar to one of the challenges related to digitalisation, a common issue here is that the bridge between developers and leadership is missing. In essence, similar to how leadership cannot be expected to understand the details of AI development, the AI developers cannot be expected to be well-versed in corporate strategy and the creation of business cases and project plans. In order to solve this, organisations who are experiencing this disconnect can explore how abridging roles can help with simplifying AI development into use-cases, business cases, and project plans that can be reviewed and understood by organisational leaders.

The third and final topic is tied to data, along with which data that is available and necessary to succeed with putting an AI pilot into production. Data management has already been covered in more detail in the prior challenge, but what is important here is rather what is required of the data. What we have found through expert interviews is that businesses and public organisations are often surprised by the amount of data that is needed when working with AI. Even public organisations with potentially vast amounts of data can struggle here.

Unfortunately, there is no silver bullet available to solve the issue of needing a significant amount of data since it requires a global leap forward in how AI

solutions are built, but organisations can try to measure the amount of data they need by utilising tools like an accuracy learning curve[9]. Since AI solutions have a depreciating return on new data, the accuracy learning curve can be used to estimate how much training data is needed in order to meet a specified level of accuracy. By utilising tools like this, organisations can more easily predict if they will have enough data to reach their AI goals.

In addition to the quantity, there are also challenges tied to the completeness of the data which requires organisations to explore if parts of the available datasets are missing. Furthermore, the overall quality of the data needs to be taken into account by reviewing the datasets for errors and mistakes. And lastly, there is also the challenge of ensuring that the data to be utilised can be joined with other relevant datasets to reach the desired outcome[10]. By utilising a proactive approach to data and considering these factors, organisations can raise their likelihood of success in creating pilot AI-driven solutions that can later be deployed to create value for them and their customers.

Overall, the transition from piloting AI solutions to putting them into production is a challenge with several barriers. And while the amount of data is a difficult topic to provide a resolution for, the remaining topics can be tackled through the right types of initiatives. In particular, our expert interviews point to the need for more effort being put towards bringing organisational leaders into the AI sphere to educate them about what AI actually is, what it can realistically do for their organisations, as well as what will be required to reach AI development goals. By approaching the challenge from this angle, there is also the possibility to showcase the need for a well-functioning organisational structure that enables AI development to be distilled into more realistic business cases and project plans. Finally, by succeeding with these leadership questions, fewer organisations will need to rely on the often-unsuccessful bottom-up approach to AI development while more organisations can be strategically led to the development and utilisation of value-adding AI solutions.

Challenge 3

Understanding regulations and developing ethical AI solutions

The last Nordic challenge that will be covered in-depth is the topic of regulations and the responsible use of data and ethical AI. Both of these areas have been hot topics for the past few years, with the regulation side seeing the introduction of GDPR as well as Schrems II, both of which will be briefly described in the next paragraph, and the ethical AI side growing in popularity after public failures in AI development as well as due to an increased focus on inclusion and equality. While these areas do have their distinct differences, they are brought together by market analyses and expert interviews continually pointing to there

being a lack of understanding amongst organisations with regards to how to handle them.

Starting with the topic of regulations, many of the underlying reasons for why they are a challenge to understand and adhere to are grounded in one of the very first steps of AI development, namely the data. GDPR, as an example, is entirely about data protection and therefore puts in place various limitations on what businesses and public organisations can do with data that is tied to customers and individuals[11]. And since many organisations want to improve their services through the use of AI, customer data quickly becomes a difficult topic. If we look at Schrems II, on the other hand, we find that it is rather about ensuring that personal data transferred to third countries continues to comply with GDPR equivalent limitations on their usage. This is especially important for companies based in the U.S. since the European Commission has deemed the U.S. to have inadequate privacy protections according to GDPR. This means that many of the largest global technology companies can be off-limits for providing services like cloud data storage as a result of the U.S. based companies potentially sending personal data to the country. In addition to these high-level complexities, there are numerous details that are just as important and also need to be understood and adhered to depending on the type of data and use-cases. Due to all of these potential tripwires, it is no surprise why many organisations are worried about making mistakes and are therefore hesitant to take their first steps toward AI development.

Switching over to the ethical side, organisations are faced with how to make sure that the AI solutions they are working on will not be inherently biased and provide erroneous outputs. There are already many public examples of AI solutions going awry, ranging from biased job application filters to social media bots that had to be taken down within a day of launch[12]. Some of these mistakes have been less serious while others have had real-world consequences for the businesses that launched the AI solutions, but they have taught organisations around the world about the importance of ensuring that AI solutions do not provide poor outputs due to either poor inputs or algorithms.

While it may not immediately sound too challenging to create ethical AI solutions, it is worthwhile to note that many of the public failures have been made by companies who are seen as leaders in AI development. Therefore, it is often unclear for organisations how ethics and fairness can be replicated in AI, and it is why it has become increasingly important for AI developers to understand why their solutions provide their outputs. This is because as long as the AI itself is a black box with little to no clarity regarding how conclusions are reached, then developers cannot truly know if the outputs are indeed ethical and unbiased. In turn, this makes putting AI solutions into production particularly difficult, and

as will be described in the Danish country report, this issue is something that the country is struggling with, even with their significant focus on ethics.

Stepping back from the challenges themselves, there is also the important perspective of who gets a head-start when most are struggling with understanding regulations and ethical AI development. In this case, expert interviews indicate that the winners are generally the large, international companies with the resources necessary to rapidly untangle regulations and to tackle the topic of ethical AI. Therefore, while Nordic companies and public organisations are hesitantly taking steps forward, or potentially standing still while trying to learn more, the largest and most well-known AI developers can continue to invest and develop AI solutions to compete in the Nordic market. This is not to say that international companies have no role to play in the Nordic market, but rather that Nordic organisations need to collaborate more to be able to effectively compete.

To conclude this challenge, it is understandable why both businesses and public organisations struggle to understand the current regulatory landscape and how to develop ethical AI solutions. However, there are ways for the Nordic region to collectively improve on both fronts by setting up frameworks, guidelines, and networks for those who require support. In addition, Norway is setting a regional example by having introduced a regulatory sandbox for organisations in the country to learn more about applicable regulations and ethical AI development. This will be described in more detail in the Norwegian country report, but the take-away is that this challenge is largely about disseminating the right information in an easily digestible manner and providing ways for organisations to accustom themselves to both the regulations and ethical AI.

Nordic Strongholds

Similar to the Nordic challenges, our research points to a high degree of commonality across the neighbouring countries with regards to their strongholds. For example, it is clear that the Nordic countries have a strong digital competitiveness and a positive attitude towards technology, including AI, which is an important asset for the region. In addition, the population is generally trustful of the government and authorities which is valuable for data collection and utilisation. However, the areas that will be explored in more detail in this section are the following three topics, 1) The Nordic focus on ethics, equality, and fairness, 2) The availability of valuable national datasets, and 3) Nordic Capabilities.

Prior to describing the strongholds in more detail, it is worthwhile to clarify how the Nordic challenges and Nordic strongholds differ with regards to data and ethics. In the prior section on Nordic challenges, data and ethics were brought up from the perspective of technical challenges that hinder responsible use of data and ethical AI. In the coming section, however, ethics will be described from a societal perspective while data is discussed with the view of its availability on a national level, not regarding the technical capability to fully utilise it.

Stronghold 1

The Nordic focus on ethics, equality, and fairness

The Nordic countries have long been recognised as leading countries when it comes to equality, and recent surveys have even indicated that it is the most gender equal region in the world[13]. Not only has this led the region to be the home of the first country in the world to offer paid parental leave to fathers, namely Sweden[14], but it has also made the Nordics a top performer amongst OECD nations with regards to gender equality in employment[15]. Underlying these surveys and statistics is a culture that emphasises the value of all people, and that places high importance on fairness and equal rights for all. This has historically been a point of pride within the Nordics, but going forward, it can also be a way to attract international investments into the region.

While ethics, equality, and fairness were not initially at the forefront of AI development, the topic has experienced widespread attention for the past several years. And as it was explored in the section on Nordic challenges, much of this attention is due to the public failures of large companies. In addition, the past few years have brought new directives, principles, and regulations that are meant to both guide the way for AI development and to keep organisations in line. An example of this is the ethics guidelines for trustworthy AI put forth by the High-level Expert Group on AI which was appointed by the European Commission[16]. In these guidelines, the group puts forward seven key requirements that AI systems should meet in order to be deemed trustworthy, including human agency and oversight, technical robustness and safety, privacy and data governance, as well as diversity, non-discrimination and fairness.

Overall, these public failures and new guidelines are important as they showcase how mistakes can be costly and what the local authorities require of organisations wishing to deploy AI solutions. But that is only part of the story, because removing bias in data and working with ethical AI is not simply about avoiding mistakes and complying with regulations, it is also about how benefits can be realised. And this is where the recognition of Nordic ethical values becomes a potential selling point for the region.

As many consumers in the world have noticed, various products and sectors have been overtaken by initiatives aimed at customers who want businesses to act in a responsible manner. There are numerous examples of this, but a few of them include fair trade coffee, sustainable fishing, recyclable packaging, net-zero carbon footprints, and responsible water usage. While some of these have more niche markets than others, the point is that businesses are adapting to consumer demands, and this is something that the Nordics can explore utilising from the perspective of AI development. In particular, the

region has the potential to leverage the already strong foundation for ethics, equality, and fairness, in order to attract new investments from abroad and to export AI solutions developed in the region. Similar to how other nations have become known for their cars or wine, the Nordic countries can instead become known for responsible data usage and ethical AI solutions that customers value, and thereby boost the whole region through the influx of investments and competence.

Overall, the topic of ethics is not immediately connected with how additional value can be created in the Nordics, but upon closer inspection there is potential to introduce something that can be both new and appreciated among businesses and consumers. To succeed with this, however, the Nordic countries will likely need to pursue the goal in a collaborative manner and to market themselves internationally as ethical AI developers. Over time, the Nordic status as a leading region for equality can then become synonymous with the development and deployment of AI solutions that are unbiased, fair, and ethical.

Stronghold 2

The availability of valuable national datasets

The Nordic countries are jointly in control of a vast amount of valuable data that can be leveraged by businesses and public organisation alike to create new services and to improve the lives of everyone living in the region. The data itself covers all types of topics, ranging from traffic information to groundwater data, citizens' health, as well as taxes paid by companies[17]. In essence, national datasets contain data on the most important parts of everyday life, and in theory these can be called upon to gain new insights and to make better decisions.

Unfortunately, the countries jointly face the significant barrier of data management not being mature enough in order to easily share data and collaborate across organisations, let alone across countries. However, due to the value of potential improvements that can be made with the data, both businesses and public organisations want to improve access to and utilisation of national datasets[18]. Therefore, it is worthwhile to explore some of the ways that these national datasets can serve as a value-adding asset for the Nordics, including in healthcare and infrastructure.

Starting with healthcare data, which is one of the most popular areas with a significant amount of potential value in both monetary and societal terms, there are many ways in which it can be used. Most of these use-cases involve sensitive patient data and are therefore particularly difficult to work with due to today's regulatory environment, but there are other aspects which are worthwhile to consider. One promising

example which does not require handling of sensitive patient data is related to how to prevent missed doctor appointments. Here, just the region of Stockholm loses an estimated 500 million SEK each year due to about 2% of patients not making their way to doctor appointments[19]. Not only does this have the direct cost related to paying doctors who are simply waiting on their next appointment, but it also increases the length of queues for seeing a doctor since patients who missed one appointment generally need to be booked for another time.

The second promising dataset is related to infrastructure where there is widespread talk about how to predict maintenance needs[20]. Once again, there are many applications that can provide added value in the Nordics through the sharing of knowledge and data, including for bridges, railways, and roads. Here, Denmark already has an example of what is possible when utilising AI and public-private partnerships to predict maintenance needs of one of their large bridges[22]. Since the solution is focused on how to know when concrete bridges need maintenance, this is type of initiative has great potential to be utilised in other Nordic countries.

Overall, the potential to utilise public datasets to create added-value in the Nordics is vast. The few datasets mentioned here have a particularly high value without the need for access to the most sensitive types of data, but there are many other examples as listed in the report on Nordic cooperation on data to boost the development of solutions with AI . And while some datasets are beneficial on a smaller scale, there are larger benefits to be unlocked through cooperation. Not only will the larger combined datasets create more accurate models, but the sharing of competencies in how to develop those models will more rapidly ensure that all Nordic countries can access the benefits unlocked through the use of the datasets.

Stronghold 3

Nordic capabilities

The Nordic countries have several important capabilities that are relevant for the responsible use of data and ethical AI. As a starting point, the Nordic countries are well-versed in digitalisation and rank highly in digital competitiveness, both of which are valuable for data and AI. For example, in the IMD World Digital Competitiveness Ranking from 2021, Sweden ranked 3rd behind USA and Hong Kong SAR, while Denmark, Norway and Finland ranked 4th, 9th, and 11th respectively. In last place in the Nordics was Iceland with a rank of 21, but that is still a commendable placement considering it placed ahead of much larger economies such as France, Spain, and Japan[23].

From the perspective of AI readiness, the Oxford Insights' AI Readiness Index placed most Nordic countries in the top 10 in 2021, as mentioned in the Nordic Comparison chapter. The only missing country was Iceland with a rank of 46 out of 160. In particular, the Nordic countries are considered to be

especially strong from the perspectives of government AI readiness and in data and infrastructure[24].
This means that the Nordic countries are seen as having governments with strategic visions for how to develop and manage AI, supported by appropriate regulation and attention to ethical challenges. In addition, with regards to data and infrastructure, the Nordic countries are seen as having the necessary infrastructure to power AI tools as well as high-quality data which is representative of the citizens in each country in order to avoid bias in data and erroneous results.

Another valuable asset is the Nordic region's capability for cooperation on complex topics such as cross-border digital services and cross-border data exchanges[25]. In this case, the mindset to establish joint goals with neighbouring countries and to collaborate on reaching them is an essential part of further strengthening the region. In addition, the established lines of communication between the various innovation departments and organisations helps the Nordics with more quickly progressing as there is already a history of cooperation to build on that partially removes the need for finding relevant stakeholders and ensuring buy-in from each of the parties with regard to the goals to be set.

While it is difficult to find specific numbers on the number of AI start-ups, there is a high degree of entrepreneurial spirit to build upon within the Nordics where all countries, with the exclusion of Iceland, place well above the European average for start-ups per capita. In fact, in 2020, Denmark and Finland placed 3rd and 4th behind Estonia and Ireland, while Sweden and Norway placed 6th and 11th, respectively[26].

In addition to the number of start-ups, it is also difficult to find the amount of private capital being invested in AI based businesses, but it is clear that Nordic tech-companies are seeing significant investments. As of 2021, the European average for capital invested per capita was $269, but all of the Nordic companies were well above that threshold, with Sweden leading the way in Europe at $1,567 invested per capita. For the rest of the Nordics, Finland, Iceland, Denmark, and Norway placed in 7th, 8th, 9th, and 11th, respectively[27].

Finally, besides the private capital being invested, each of the countries also know how to publicly fund both public and private initiatives related to AI and data. All of the countries, with the exception of Iceland, have organisations that invest directly into innovation initiatives, including AI and data. And even without a dedicated innovation funding organisation, Iceland is also backing various initiatives that utilise AI and data. This support, coming from both the public and private sectors is particularly important since many organisations struggle with securing enough internal funding to pursue projects related to the responsible use of data and ethical AI.

A Nordic Comparison to EU Level Activities

While the Nordic countries have already made significant strides forward in the fields of AI and data, there is also important progress being made at the European level. In this section, some of these topics will be explored in greater detail, including the particular attention that is being paid to ensuring the AI solutions are safe and ethical, and that the required data is available when possible.

Starting with the topic of ethics, the Nordic countries are all aligned on the need to ensure that AI and data are utilised in an ethical and responsible manner that takes into account national regulations and human rights. While the region has yet to adopt a unified regulatory framework to approach this subject, there is some movement on the European level that is worthwhile to keep in mind when deliberating future regulation of AI. For example, in December 2018 EU's High-Level Expert Group on AI presented a first draft of Ethics Guidelines for Trustworthy AI, and the guidelines were revised and published in April 2019[28].

Later, in October 2020, the European Parliament adopted resolutions related to AI, including on copyright[29], liability[30], and ethics[31] . Then in 2021, additional resolutions were added, including on AI in criminal matter[32], as well as in education, culture, and the audio-visual sector[33].

In addition to already adopted resolutions, in 2020 the European Commission drafted various proposals, including on policies to ensure a common European approach to AI[34]. In this case, the White Paper presents policy options that are meant to enable a trustworthy and secure development of AI in Europe that is in alignment with the values and rights of EU citizens.

Moreover, in 2021 the European Commission drafted the AI Act which is a proposal for legislative action that is meant to harness the opportunities and benefits of AI, but to also ensure the protection of ethical principles[35]. This step made Europe the first major regulator to draft a proposed law on AI which is widely seen as a significant milestone for AI governance[36]. The proposed law assigns applications of AI to three categories of risk. Due to the potential for misuse of AI, the highest risk category would contain applications which would be explicitly banned in the EU, such as government-run social scoring. In the middle tier, high-risk applications would be regulated and subject to specific legal requirements in order to be used. And finally, the applications that fit neither category would be left largely unregulated[37].

Besides the risk categorisation, the AI Act also puts forward four objectives. The first one is to ensure that AI systems placed on the Union market and used are safe and respect existing law on fundamental rights and Union values. The second is to ensure legal certainty to facilitate investment and innovation in AI. The third is to enhance governance and effective enforcement of existing law on fundamental rights

and safety requirements applicable to AI systems. And finally, the fourth is to facilitate the development of a single market for lawful, safe, and trustworthy AI applications and prevent market fragmentation.

While the drafted proposal is a clear step in the right direction to ensure the ethical and responsible use of AI, there are suggested improvements to the proposal. Among these are updates to account for the full and future risk of AI by, for example, requiring companies to disclose all potential uses for an AI solution, even if they are not intended use-cases by the business itself. Moreover, additional protections of human rights could be added to shore up vague terminology that leaves room for loopholes. And lastly, there are also proposals to boost AI innovation in Europe by including areas like regulatory sandboxes that can be used to test new services without fear of penalties[38].

Besides the AI related activities, there are also EU actions being taken with regards to data. Already in 2003, the European Commission and the Council of the European Union adopted a directive on the re-use of Public Sector Information (PSI)[39]. In 2013, this PSI directive was revisd, and in 2018 there was another proposed amendment. Finally, in 2019 the latest directive was introduced which address the barriers to the re-use of publicly funded information across the EU while also bringing the legislation up to date with the advances in digital technologies. Under the new rules there are various improvements, including that all public sector content that is already easily available is principally freely available for reuse. In addition, a particular focus was placed on high-value datasets, including statistical and geospatial data[40].

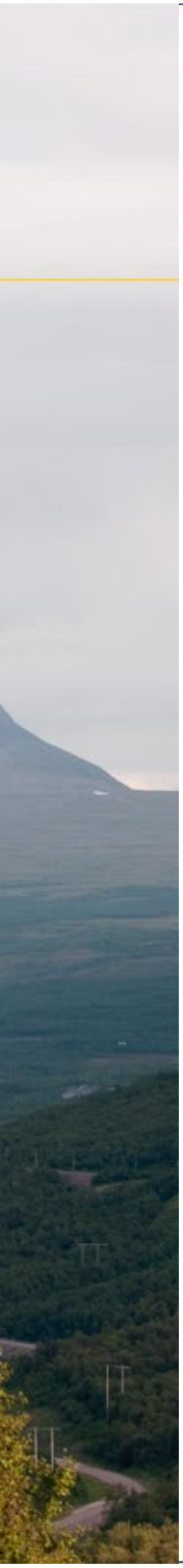
While these proposals and directives are an important part of Europe's approach to AI and data, they are not a complete list of everything that is being done at the European level. Besides these examples, there are also numerous strategies, policies, and best practices that reside within each of the member states. This already large amount of information is then further multiplied due to the fluid and rapidly evolving nature of AI which continually changes the European landscape and makes it particularly difficult for any person or organisation to keep a comprehensive view of all ongoing activities. Nevertheless, these European initiatives are an integral part of how the whole region will work with responsible utilisation of data and ethical AI during the years to come.

Country Reports

This section of the report goes into a deeper exploration of each of the countries in order to create a more detailed understanding of ongoing activities within each part of the Nordics. Within each country, the most important local actors are listed and described, primarily focusing on the public sector but also with some key private sector and academic institutions introduced. In addition, the local strategies and policies are summarised to set the stage for how each government views AI and data, as well as to see how much of a priority the areas are. Afterwards, an overview of the most important ongoing initiatives tied to AI and data are described which is then used as a basis for picking out best practices to highlight. Finally, each country faces several challenges in the fields of AI and data, but since many of these are common across the Nordics, this section covers the issues that are most pressing for each nation. In a similar fashion, the local strongholds are presented as the concluding part of each country analysis, focusing on what each nation is particularly good at in relation to each other.

Country Reports

DENMARK



Introduction to Country

Denmark has multiple times been recognised worldwide as a digital frontrunner and is known for being a leading country within digitisation of business, the use of digital public systems, technology readiness[41], as well as there is a long tradition of utilising data within the public sector, healthcare, the financial sector, food, and production[42].

When it comes to setting the stage for AI development and application, Denmark provides a great foundation. This is thanks to the country's nationwide 5G network coverage, the digital skills of citizens due to their high adoption of technologies and utilisation of the internet[43], and a good research environment with a focus on computer science and particularly within AI sub-disciplines such as Natural Language Processing, cognitive systems and Algorithms and Complexity[44].

Denmark is also a leader within eGovernment with a maturity score of 85% and praised for its holistic approach to digitising citizen services by putting humans at the centre and focusing on their needs[45]. From the perspective of the Danish government, it has identified the importance of the role that Denmark can play for AI development as well as how AI can benefit the nation. For example, in the Danish national strategy for AI, Denmark envisions itself to be a front-runner in responsible development and fair use of AI. The European Commission also appointed Denmark to lead the common work to create standards for the responsible use and development of AI[46].

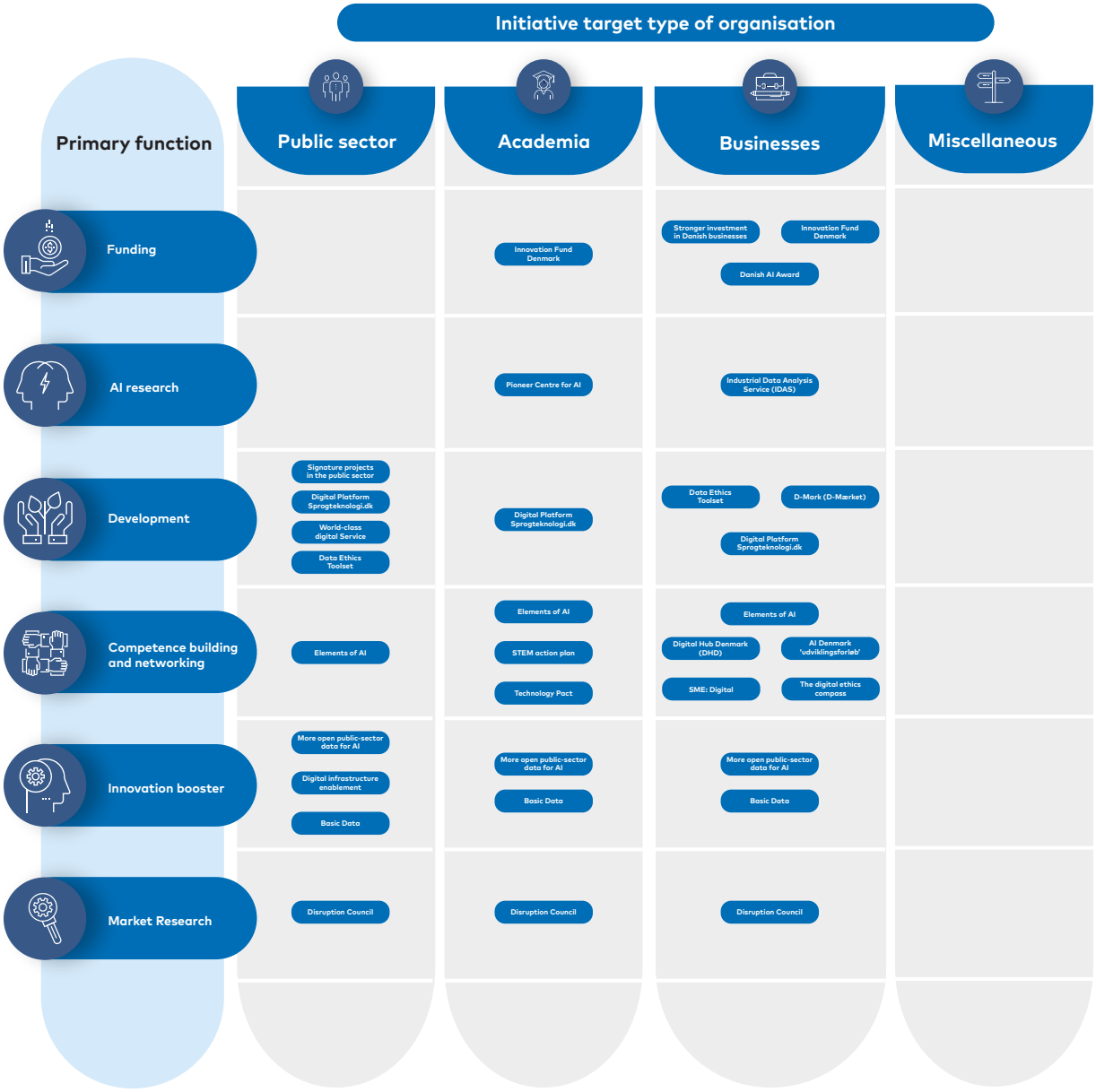
The Danish AI strategy is built upon four overarching objectives, which includes the development of a common ethical and human centred basis for AI, a strengthened research field within theoretical and applied AI. Furthermore, there is a goal for Danish businesses to grow through developing or using AI, and finally, the public sector should use AI to a larger degree to offer citizens outstanding services .

Through a common national AI strategy as guideline, multiple public and private sector initiatives, and advances in research within the field of AI, Denmark has seen many great developments within the field. According to the 2021 OECD Survey Data, the estimated VC investments in AI start-ups in Denmark increased by 200% from USD 27 million in 2015 to USD 82 million in 2020.

In addition, our research and interviews show that there are many start-ups developing or utilizing AI, while Danish SMEs are starting to gain some traction when it comes to digitalisation and AI adoption through support of public initiatives. Moreover, incumbent industries are making sense of their data as well as starting centres of excellence or putting Proof of Concepts (PoCs) into production. Furthermore, they are also emphasising bringing fairness and transparency into the development and use of AI.

While these are positive steps for Denmark, there are also challenges which need to be addressed, including the issue of regional divides of AI readiness and adoption.

Visualization of National AI & Data Ecosystem



National Actors

AI Denmark

AI Denmark is an organisation with the goal to support SMEs to utilise AI solutions. To achieve this, AI Denmark takes in about 40 SMEs each year on a six-month long development journey where the companies are helped with making use of data to unlock a competitive edge. In addition, the organisation also contributes to the development of a national AI ecosystem, including best practices, an online learning platform, an AI community, and a Danish AI prize[48].

Agency for Digitisation (Digitaliseringsstyrelsen)

The Agency for Digitisation lies within the Ministry of Finance and was established in 2011 with the purpose of leading the government's digitisation policies. The overarching aim is to renew the Danish welfare and the agency is thereby responsible for the implementation of the government's digital ambitions and the use of digital technology in the public sector[49].

Invest in Denmark

Invest in Denmark is an organisation under the Ministry of Foreign Affairs that helps foreign companies establish business and research activities in Denmark free of change and in full confidentiality. Copenhagen Capacity works closely with Invest in Denmark[50]. Within AI, Invest in Denmark published a whitepaper "All you need to know to start your AI adventure in Denmark".

Danish Centre for Big Data Analytics driven Innovation (DABAI)

The centre with its research initiative aims to make Denmark a forerunner in exploiting big data's potential. The centre was launched by Innovation Fund Denmark and is a partnership between three Danish universities, Danish companies with the right data competence, government institutions and computer science researchers. It focuses on seizing opportunities within Big Data analysis research and innovation with as special focus on the Danish Business ecosystem and the society. DABAI brings newsletters, annual conferences, consultations, workshops, prototypes to invested companies and also gives the possibility of researchers such as PhDs or Post-docs. DABAI actively contributes on reports such as "Artificial Intelligence in Practice (Kunstig intelligens i praksis)"[51].

Danish Data Ethics Council (Dataetisk Råd)

Danish Data Ethics Council was founded in 2019 as an independent council. The purpose of the council is to increase awareness about ethical dilemmas, partly through public debate. Keeping up with constant digital advancements, the council continuously provides their perspective on how to use data responsibly and shed light in the opportunities for new innovative solutions that benefit society[52].

Danish Industry Foundation (Industriens Fond)

The Danish Industry Foundation focuses on three specific drivers to develop and support initiatives, activities, and projects – primarily in Denmark, but also abroad. These include knowledge, competences, and innovation. The Danish Industry Foundation has more than 100 active projects in its project portfolio. Besides financing programs such as AI Denmark, the Danish Industry Foundation supports further key initiatives which directly or indirectly aim making Denmark stronger within AI such as the "Big Data Business Academy" and "Industrial Data Analysis Service"[53].

Danish Life Science Cluster

The Danish Life Science Cluster is a national cluster, working on translating Danish life science and welfare technology research and knowledge into new and better commercial solutions. Those should benefit public institutions and private institutions as well as citizen across the country. In its "Care AI" program, the cluster recognizes seizes the opportunities of digitalisation and AI to create new opportunities within the home care sector. This is a joint effort between German and Danish partners[54].

National Centre for Research in Digital Technologies

The aim of the centre is to develop and support the digital field through research in AI, Big Data, Internet-of-Things (IoT), and IT Security. When relevant, the research may include ethical and moral aspects of the new technological development and use of AI and Big Data in a Danish context.

Ministry of Industry, Business and Financial Affairs (Erhvervsministeriet)

The Ministry of Industry, Business and Financial Affairs of Denmark's main mission is to create competitive and innovative conditions for growth. The ministry is responsible for policy areas that are of importance to the general business environment, including business regulation, intellectual property rights, competition and consumer policy, the financial sector and shipping. Furthermore, the ministry published the Danish National Strategy for AI together with the Ministry of Finance in 2019[55].

Danish Business Authorities (Erhvervsstyrelsen)

The Danish Business Authority endeavours to create the best conditions for growth in Europe, and to make it easy and attractive to run a business in Denmark. The Danish Business Authorities are part of the Ministry of Industry, Business and Financial Affairs[56].

National Centre for Public Sector Innovation

The National Centre for Public Sector Innovation (COI) is a publicly owned organisation that supports more effective deployment and use of new technologies, such as AI, in the public sector. In order to achieve its goal, COI collaborates with other entities across the national, regional, and municipal levels in Denmark. From 2022 the former COI became part of a new National Centre for Public-Private Innovation (CO-PI) established by the Danish government, the regions, and the municipalities.

The overall purpose of CO-PI will be to support innovation procurement and public-private innovation based on challenges in the public sector. Focus areas are technology that improves welfare services, green transition, and sustainable construction[57].

National Strategies and Policies

In 2019 the Danish National Strategy for AI was launched. The program's initial initiatives were set for three years and several organisations were responsible to realise those initiatives such as the Ministry of Industry, Business and Financial Affairs, Ministry of Employment, Ministry of Finance, Ministry of Transportation, Agency for Digitalisation, Danish Agency for Institutions and Educational Grants, and the Danish Business Authority.

The strategy aims to make Denmark a frontrunner in the use and development of responsible AI. AI should factor for better decision making but the technology should not replace people or make decisions for us. This vision is supported by 4 key objectives as depicted below including examples of initiatives supporting the objectives.

(1) There should be a common ethical and human cantered basis for AI,

focusing on incorporating ethical principles and making Denmark attractive for being the best in EU. As an example, the Disruption Council (Distuptionrådet) brought forward impacts on jobs through the introduction of AI as well as highlighted data ethics in as a cornerstone in AI development. Moreover, a Data Ethics Council (Dataetisk Råd) has been established creating guiding material and assessments for creating new technology such as AI with ethical considerations.

(2) The research environment should be strengthened for both theoretical and applied research,

where better access to high quality data for research is the base as well as a way forward to attract and retain AI researchers in Denmark. The research and innovation policy strategy "Denmark – ready for the future" should strengthen the research in digital technologies such as AI. The STEM, action plan initiative aims to enhance competences within the field and Teknologipagten aims to introduce the understanding of technology in the earliest school years.

(3) The development and usage of AI should lead to growth for Danish Businesses,

through attracting investments as well as enabling the right resourcing for companies, thus making Denmark an attractive growth environment. E.g., a freely available Common Danish language resource for natural language processing is in focus which should enable developers to extend the usage and create new solution with language understanding and voice recognition. Moreover, a DKK 20 million investment pool managed by the Danish Growth Fund was made available which targets organisations with a business model where AI is at its core. 50% of the financing is private sector based and the other 50% need to be funded by the private sector leading to a total fund size of DKK 40 million.

(4) Outstanding citizen services should be offered by the Public Sector,

where public services should be citizen focused, faster and more efficient such as case processing. The Danish Public sector launched several signature projects which are developed in an incubator style, taking highest positive impact for citizen and best scalability across the public sector as key consideration for what AI use-cases to develop.

Other initiatives such as making public data more easily available for both public and private institution affect all 4 objectives.

National Initiatives and Programs

The most relevant Danish initiatives and programmes related to AI and data are presented in the below table. It is important to note that the list is not exhaustive due to the dynamic nature of the AI ecosystem.

Initiative	Responsible entity	Description
AI Denmark 'udviklingsforløb'	AI Denmark	The development program runs from 2021 to 2023 and is made for 120 selected companies which get support from experts from the Danish Technological Institute, DTU, the Alexandra Institute, AAU and the University of Copenhagen. AI Denmark offers the AI Explorer program tailored to companies starting to work more with data driven or informed decision making. A second part of the program is the AI Accelerator which is an intensive program sparring SMEs with experts input around developing proof of concepts and scaling towards productionised systems.
Basic Data	Agency for Digitisation	Since 2012 the Basic Data program has made data available from real estate, addresses, roads and areas, water and climate, geography, persons, and businesses.
Danish AI Award	AI Denmark and Danish Industry Foundation	The award is intended to promote the use of AI in the Danish business community. The participants for the award are the selected companies for AI Denmark 'udviklingsforløb'.

Data Ethics Toolset	Danish Data Ethics Council (Dataetisk Råd)	The Data Ethics Council created several initiatives supporting responsible and sustainable data use in business and public sector. "Dataetik - Sådan gør du!" is a tool including a 5-step guide how one can prepare before getting started working with data ethics. "Samkøring af data" supporting public authorities to make the necessary considerations prior to decisions on the interconnection of data using new technologies such as AI. Sharing data in the public sector has become a cornerstone for a well-functioning institution. Acknowledging that authorities will increasingly utilise and connect citizen's data, it is crucial to address the data ethical aspects. "Samkøring af data" includes a data ethics assessment form that clarifies the scope of data ethical issues in projects as well as an impact assessment, which should be completed if the interconnection of public sector data involves possible data ethical risks.

Digital Hub Denmark (DHD)	Digital Hub Denmark (a public-private partnership between the Ministry of Business Affairs, the Ministry of Foreign Affairs, the Ministry of Education and Research, as well as The Confederation of Danish Industry, Danish Chamber of Commerce, and Finance Denmark)	The vision of DHD is to make Denmark a leading digital country in Europe. To do so Digital Hub Denmark brands home-grown digital solutions to attract talent, investments and international customers to new scalable tech products and services that are shaping future industries worldwide. Focus areas include but are not limited to IoT, Big Data, and AI.
Digital infrastructure enablement	Danish Government	A shared digital infrastructure that is safe and sufficiently robust to meet future requirements among others the develop of Artificial Intelligence.

Digital Platform Sprogteknologi.dk	Agency for Digitisation	The website, sprogteknologi.dk, was created in 2020 and is used for gathering and displaying metadata about existing language resources. Future actions include the development of further Danish language resources, e.g., a central word register and the development of a Danish speech recognition resource. The initiative runs from 2019-2026. The purpose is to support Danish technology companies developing AI solutions utilising the Danish language. Sprogteknologi.dk aims to gather existing language resources and make them freely available to all, as well as develop and give access to new language resources that can reduce barriers and strengthen the development of language technology solutions in Danish. Moreover, other focus points are to create a Central Word Register and the development of a Danish Speech Recognition resource, both in Collaboration with private companies, research, and public sector actors.

Disruption Council	Established by the Danish Government	Disruption Council is a partnership between businesses, governmental institutions, and job market experts to anticipate the challenges and opportunities that new technology developments bring along on the labour market. The partnership was formed in 2019 and it aims to provide suggestions and recommendations about future skills and labour demand. As part of the national AI strategy, the Disruption Council brought forward impacts on jobs through the introduction of AI as well as highlighted data ethics in as a cornerstone in AI development
D-Mark (D-Mærket)	Independent private organisation started and supported by the Danish Industry Foundation (Dansk Industri), Confederation of Danish Industry (Dansk Erhverv), SMEdenmark (SMVdanmark), Danish Consumer Council (Forbrugerrådet Tænk).	The D-Mark is Denmark's new labelling scheme for IT security and responsible data use. It shows an organisation's digital responsibility. It is relevant for all types of organisations and guides them through an overview of what they must live up to. The criteria are based on recognised international frameworks from European and national councils, committees and working groups.

Elements of AI	Confederation of Danish Industry (Dansk Industri), European Commission and the Finnish Government	A series of free online courses in AI aiming to encourage as broad a group of people as possible to learn what AI is, what can (and can't) be done with AI, and how to start creating AI methods. Elements of AI was developed by the University of Helsinki together with the Finnish consulting firm Reaktor. In connection with Finland's EU Presidency in 2019, the Finnish Government and the European Commission decided to make the course available in all European languages in order to give all Europeans the opportunity to gain basic knowledge of AI.
Industrial Data Analysis Service (IDAS)	Danish Industry Foundation (Industriens Fond)	IDAS is a project funded by the Department of Computer Science, the University of Copenhagen (DIKU) and the Danish Industry Foundation. The goal of the project is to transfer the latest big data knowledge and technology to Danish industry as well as to identify and solve the key barriers and obstacles that Danish industry faces when applying big data methods.

Innovation Fund Denmark	Innovation Fund Denmark (Innovationsfonden)	Innovation Fund Denmark is the main public fund for soft financing of research and innovation projects among private companies and public knowledge institutions. The fund was established in 2017 and the aim is to support the development of knowledge and technology, including advanced technology, to strengthen research and innovative solutions that benefit growth and employment in Denmark. Projects supported by the Innovation Fund Denmark are directly or indirectly within the field of AI such as the support of the Danish health-tech star-tup, Radiobotics, to develop algorithms that can decipher and understand X-rays quickly and accurately. The Innovation Fund Denmark is also co-publishing reports specifically within AI such as "An AI Nation? Harnessing the opportunity of artificial intelligence in Denmark"
More open public-sector data for AI	Ministry of Industry, Business and Financial Affairs	In 2019, the Ministry of Finance – Agency for Digitisation established a collaboration with businesses and research communities. The initiative was one of the key proposals in the national AI strategy and had the goal to identify five public-sector datasets during 2020 and 2021, which could be made available for businesses, researchers and public authorities and contribute to the development of AI.

Pioneer Centre for AI	Centre will be rooted in the Department of Computer Science (DIKU) at the University of Copenhagen but will include researchers from IT University Copenhagen (ITU), Technical University of Denmark (DTU), Aarhus University (AU), and Aalborg University (AAU)	The first Danish pioneer centre for AI, located at the University of Copenhagen observatory, will focus on Artificial Intelligence research within computer vision, natural language processing, and machine learning. The researchers will also work in conjunction with governmental institutions and companies to work on a range of societal challenges ranging from climate and conservation to crisis response and many more. will conduct world-class artificial intelligence research also looking into societal challenges, people and design while putting Denmark at the international forefront.
Signature projects in the public sector	Ministry of Finance – Agency for Digitisation	Within the Danish public sector there is a lack of experience in use of AI. In response to this, the Ministry of Finance – Agency for Digitisation launched a funding package for 2019-2022 of EUR 27 million backing 40 projects for testing the uptake of AI in the public sector with a particular focus on healthcare, public administration, and the green transition. The funding package is a result of a cross-sectoral collaboration and co-funding between municipalities, regions, and the central government.
SME:Digital	The Danish Business Authority	SME:Digital is a coordinated scheme to support the digital transformation which can benefit the companies' ability to innovate with AI.

STEM action plan	Research and innovation policy	The STEM action plan was launched together with Technology Pact in response to the importance that more young individuals are encouraged to take digital and technological education programs focusing on AI.
Stronger investment in Danish businesses	Ministry of Finance – Agency for Digitisation	It is proposed to launch a pilot project in the form of an investment pool of DKK 20 million (EUR 3.1 million) over four years targeting companies with a business model based on artificial intelligence. The prerequisite for this is a 50 percent financing from the private sector amounting to a total investment pool of DKK 40 million (EUR 6.2 million). The fund will be managed by the Danish Growth Fund.
Technology Pact	Ministry of Industry, Business and Financial Affairs Ministry of Higher Education and Science Ministry of Children and Education	The Technology Pact was launched in 2018 by the Danish Government and involved more than 80 partners from companies, educational and research institutions, business organisations and private foundations. With the Pact, the Danish government commits to a joint mission that more Danes obtain technical and digital skills. Especially with the focus on Science, Technology, Engineering, and Mathematics (STEM) profiles, this greatly supports the needed skills for Artificial Intelligence as well as areas important for the development of AI such as cyber security.
The digital ethics compass	Danish Design Center	The digital ethics compass supports SMEs by educating them in working with data and digital design in a responsible and ethical way.

World-class digital Service	Ministry of Finance	The Ministry of Finance has paved the way for how the public sector is to provide better and more cohesive digital services for citizens, including through increased use and dissemination of new technology such as Artificial Intelligence. The Reform will ensure that people have access to services based on their needs by accelerating e-government efforts and contributing to better and more cohesive welfare.

Altogether, the Danish initiatives and programs cover important topics to develop the countries Data and AI capabilities, ranging from supporting the up skilling of people within Data and AI, making investment funds available, making higher quality public data available, as well as educating about AI and piloting solutions especially for those who do not have enough experience within the field such as SMEs.

Moreover, we can see multiple initiatives which support bringing the concept of responsible and fair AI towards institutions and their employees.

These initiatives and programs showcase that the Danish Data and AI ecosystem is broad and support public and private institutions as well as brings research further. Two initiatives are to highlight as best practices.

Best practices in Denmark

Two best practices to advance the field of AI have been identified in Denmark. First, there are established toolsets which enable public and private organisation to engrain ethical considerations in their data products. Second, there is availability of support for SMEs in their AI journey and a platform to share best practices and lessons learned.

Best practice 1

Toolsets which enable public and private organisation engraining ethical considerations in their data products

Ethics has been an important topic for the past several years since many AI developments see poor outcomes due to reasons like bias introduced across the AI development cycle from bias within selecting data, introduced bias from potential data or model shift to poorly or not monitored models.

In 2019, the Danish government launched an independent Data Ethics Council which was tasked to define data ethics as well as investigate the ethical dimensions of data combination in the public sector. The Council made available a general introduction to data ethics, "Dataetik - Sådan gør du" as well as prepared a Date Ethics Canvas (Dataetisk Canvas) which companies can use to go through their proposed five-step guide to data ethics. This includes, identifying of the data usage purpose and how data will be handled, analysing which considerations speak for and against the respective data processing, weighing opposing considerations, deciding which of the considerations weigh heaviest, and evaluating implications on an ongoing basis. The method is further motivated and described in a 272 pages theory and method report. The mentioned Canvas and Guides are part of a larger toolset which also incorporates tools (Samkøring af data) to support the ethical dimension of linking data in the public sector. Sharing data in the public sector has become a cornerstone for a well-functioning institution. Acknowledging that authorities will increasingly utilise and connect citizen's data, it is crucial to address the data ethical aspects. The toolset supports public authorities to make the necessary considerations prior to deciding on connecting different data points when using new technologies such as AI. "Samkøring af data" includes a data ethics assessment form that clarifies the scope of data ethical issues in projects as well as an impact assessment, which should be completed if the interconnection of public sector data involves possible data ethical risks.[58] This ethical toolbox demystifies data ethics and gives the public the opportunity to operationalise and think differently around their data which directly affects also their AI initiatives.

Another best practice within Ethical AI is the D-label (D-mærket), instantiated by Industriens Fond, Dansk Industry, Dansk Erhverv, SMVdanmark and Forbrugerrådet Tænk. The D-label is an

independent private organisation which introduced a new labelling scheme for IT security and responsible data use. It ultimately shows companies digital responsibility and provide transparency for both, organisations, and consumers. The D-label gives companies an overview of what they have to live up to in regards to data ethics, data protection and data security. The label itself is based on frameworks from European and national working groups and committees. It offers a free self-evaluation based on questions with public access whereafter an organisation can decide to apply for the D-label and after payment and supervision and control the D-label will be awarded.[59] A certified label like the D-label makes companies comparable on how they use and secure data eventually giving consumers, both private and business the power to decide with which organisation to do interact or do business with.

Best practice 2

Supporting SMEs in their AI journey and sharing best practices and lessons learned

In our research conducted it was eminent that especially many SMEs struggle already in their digital transformation as well as leveraging their available data right. This is due to multiple factors, available resources and skills as one of them which directly links to making it more difficult to bring forward a business case for AI and hence the low prioritisation.

AI Denmark, a development program which is made for 120 selected companies, supports SMEs with two different distinct offerings, AI Explorer program for companies which just start working more with data and more informed decision making and a second program which is the AI Accelerator, an intensive program sparring SMEs with experts around developing proof of concepts and next steps to make it production ready. Partnering up with IT University, University of Copenhagen, Technical University of Denmark, Aalborg University, Alexandra Institute, and Technological Institute

(Teknologisk Institut)[60] this initiative can be seen as a best practice bringing the private sector and research closer together and enabling knowledge exchange to bring Danish SMEs. Most of the companies take a quick PoC approach especially with non-digital born companies. Understanding the need of SMEs to demystify data and AI also for organisations not participating in the program, AI Denmark regularly delivers webinars, podcast episodes, and website content. Moreover, AI Denmark is working on a small board game for a workshop creating AI business cases. It further aims to train people's minds to understand AI key concepts. Realising the challenge for many SMEs to understand the deployment and post deployment implications to successfully productionise an AI system, AI Denmark educates SMEs on, for example, how fast you can deploy an AI solution into production with API and code snippets.

National AI Development Challenges

Denmark has a strong digital foundation; however, the country still faces several challenges hindering it from becoming a frontrunner within AI. Many of these challenges are common across the Nordics, but when it comes to the more country-specific topics, we find challenges such as a shortage of resources with technical capabilities necessary for the development and implementation of AI. The ability for companies to turn a PoC into an actual AI product which requires extensive investment and maintenance of data. Lastly, there is a divide between AI capabilities and adaptation in cities versus rural areas of the country.

Challenge 1

Regional divides in Denmark and demystifying AI

Early research from the Aalborg University Business School indicates that there are strong regional divides in Denmark when it comes to AI. The most advanced AI clusters are the four largest cities (Copenhagen, Aarhus, Odense, and Aalborg) as well as some municipalities that benefit from spill-over effects of being located close to larger metropolitan areas. There are multiple explanations for these regional divides: i) The industrial specialisation in the municipalities with certain industries being more likely to locate in certain areas. The likelihood of some industries then specialize in AI will be higher because e.g., high-knowledge intensity industries often already have the existing capabilities and the jump to AI will be less resource-demanding compared to less-knowledge intensive industries. ii) The sheer number of AI-users in the municipality, which then can inspire other firms. iii) There is also the possibility that these areas might benefit from universities situated in their cities that produce research that is then made available to the local private sector, which in turn could become more knowledgeable on ways to utilise data and benefit from AI. In addition, alumni AI professionals are more likely to stay in the larger cities where the job pool is larger, and the field of AI can be seen as more interesting. This dynamic would further reinforce the regional divides as cities both create new AI talent and retain the new workers graduating from local universities.

On the other hand, regions which used to have a strong manufacturing background and now resemble the old industrial areas have a harder time to keep up with the speed of digitalisation and are thus left behind when it comes to AI adoption. To that end, one can fear that AI will be further enhancing those regional divides because some regions get more efficient and continue to move further ahead of those who are struggling to simply place the foundation for AI adoption.

The early quantitative research being conducted within the Aalborg University Business School also reveals that the access and consumption of information depicting AI differ within the mentioned urban, sub-urban, rural and old manufacturing regions. In urban areas, the quantity, quality, and consumption of AI related information are significantly higher than in others. The information gain is one of many factors in a big mechanism for companies in urban areas advancing more within the space of AI.

The tone of how AI is presented in the consumed media also plays a role in how it is perceived by individuals and companies, eventually likely to affect the business decisions of going forward in the AI journey or not.

Especially SMEs and non-digitally born companies sometimes struggle turning the ambition and motivation of using AI into reality. There is generally work to be done when it comes to demystifying the concept of AI and moving away from the 'hype' to helping companies understand what AI is and what it is not. Furthermore, helping companies plan for AI and making it more actionable so they understand what is required of their organisations in terms of resources and investments to develop and maintain AI solutions.

National Strongholds

Despite the challenges Denmark needs to overcome, there are areas where Denmark has a strong position within AI. The progressing usage of AI across the public sector as well as the push towards ethical AI with several initiatives are two distinct strongholds to elaborate on.

Stronghold 1

AI in the public sector

The National Strategy for Artificial Intelligence in 2019 outlines the government's vision for the public sector to use AI to offer world-class services. More specifically, improve public services through faster and more efficient case handling as well as creating a good framework to utilise data to develop AI across the public sector.

In terms of development, AI in the public sector follows an incubator style, where failing fast and learning fast is accepted. Ideas are implemented quickly and the learnings from failures are taken into account. Development is focused on what works for scalability in other municipalities or regions. However, despite being one of the world's most digitised countries, there are varying maturity levels across different regions. To address this, the government aims to utilise use cases with greatest impact on citizen as well as easily scalable solutions to municipalities that are lagging. In the Municipality of Jammerbugt, a forecast tool used for decision support for planning, mapping, and warning of floods in rural and urban areas has been developed. In the Norddjurs Municipality, a solution for automatically routing mails to the right person was implemented which was then scaled to ten other municipalities.

The government has successfully forged partnerships with the private sector and educational institutions. For example, the Ministry of Higher Education and Science initiated the establishment of the Danish Pioneer Centre for AI, a collaboration between Danish universities aimed at solving some of society's problems through AI. The Danish Business Authority provides analysis of Danish companies, the technology they use, and how AI and Machine Learning (ML) can be used in their organisations. Key players in the field, such as AI Denmark, are already initiating mapping of companies supplying and using AI.

The public sector in Denmark utilises AI beyond the signature projects formulated in the AI strategy, e.g. the Machine Learning Lab uses AI to detect fraud e.g. in tax reports and helps collaborate with other ministries and authorities for knowledge exchange and on driving the development of AI. Danish business authorities also work with AI by promoting how public data can be used to create AI products. An example is a hackathon with geographical data, where they reached companies that does not have experience of utilising the data. The agency responsible for the geographical data was available to improve the data for the companies to use. The Danish Business Authority then acts as a facilitator of the dialogue between the user and the data owner. With the availability of talent and digital infrastructure already in place, it only takes time for the country to exploit the full potential of AI.

Stronghold 2

Efforts towards ethical and responsible AI

Denmark has a society built on trust and there is very high acceptance in the usage of digital technologies which gives Denmark a great base for the development AI but also the need for it to be responsible and safe.

Denmark has best practices within giving organisations toolsets to incorporate ethics and fairness considerations in their AI development. Moreover, the D-label gives companies the opportunity to look at what is expected with regards to how to treat data. In the Danish national strategy for AI, Denmark emphasises that it is crucial that the use of AI is centred on the society's shared values of freedom, liberty, security, and equality. Therefore, responsible, and ethical use of AI must be ensured.

With this, the government aims to lead and promote the use of AI as a supplement to human knowledge to exploit its benefits without compromising the society's values[61]. To this end, the government launched the independent Danish Data Ethics Council that aims to ensure the responsible use of data for innovation. Within the public sector, The Danish Business Authority also has a Data Ethics Team working on how Danish companies can work with AI in a responsible manner.

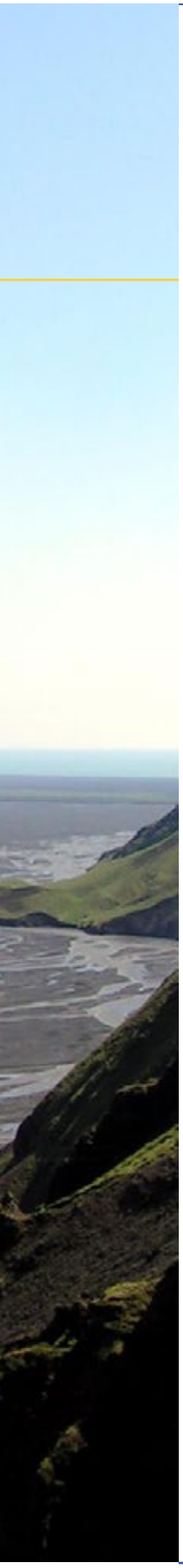
Within research and specifically for AI, the Danish Technical University (DTU) has developed principles for safe AI, namely (1) Security, where the AI system should be robust and secured against attacks. Moreover, it should have passed testing and verification processes. (2) Open Source, where overall methods used, code written, and results of test should be accessible for the public. (3) Privacy by Design, where AI design considerations respect privacy of the many. (4) Calibrated Values, where it is ensured that the AI system is corrected from bias. (5) Accountable, ensuring transparency in how decisions are made. (6) Understand Social Relations, plus the relation to knowledge and competences of users. (7) Understand Power, where context, data, and consequences of actions from AI systems are understood[62]

The available toolkits mentioned in best practices as well as other efforts such as the Danish Design Center's publicly available package of information and exercises for workshops to as the right ethical questions to overcome common pitfalls as well as spotting ethical challenges with within products and services tackles the ethical standpoint from an even broader perspective.

The national AI strategy and its launched initiatives as well as the collaborative move from public and private institutions to make ethical and fair AI more transparent and understandable for organisation, makes it a stronghold for Denmark. The work needs to continue converging from ethical frameworks to also concrete legal implications as well as concrete methods to be implemented to overcome ethical and fairness challenges.

Country Reports

FINLAND



Introduction to Country

Finland has long been one of the frontrunners in AI especially in relation to its size.

Finland is only the 41st largest economy in the world when measured by GDP but in many AI indexes it is ahead of larger economies such as Germany, Japan, and its Nordic peers. During the past five years, Finland has been among the top 10 countries in the Global AI Vibrancy Ranking by Stanford University when AI efforts in research & development and economy are measured per capita.[63] Finland reached the 6th place in the 2017-2020 rankings but fell on the 8th place in 2021 ranking with the UK and South Korea bypassing it. However, even on the 8th place, Finland outperformed all other Nordic countries when measured per capita. Moreover, Accenture assessed the impact of AI to annual economic growth rate by 2035 in 12 developed economies and the impact in Finland was the 2nd highest, only after the US.[64] The research compared the size of each country's economy in 2035 in a baseline scenario, which shows expected economic growth under current assumptions, and an AI scenario, which shows expected growth once the impact of AI has been absorbed into the economy.

In addition, Finland ranked 4th in Oxford Insight's Government AI Readiness Index 2021 which measures globally the preparedness of countries for responsible use of AI.[65] Only the US, Singapore, and the UK ranked better than Finland. However, in 2020 Finland ranked 3rd in the same index so there has been a small decline in the ranking. Finland as a country has also been a notable contributor to the overall development of AI. For example, the researchers in Finnish Universities have been able to get their academic papers to the globally awarded AI publications more often than their peers. [66]

On the business side, Finland has promising networks and ecosystems around AI such as Finnish Artificial Intelligence Society, CleverHealth network, One Sea, and Smart Otaniemi which exploit public and private collaboration. In Finland, there are also public funding instruments, such as Growth Engines

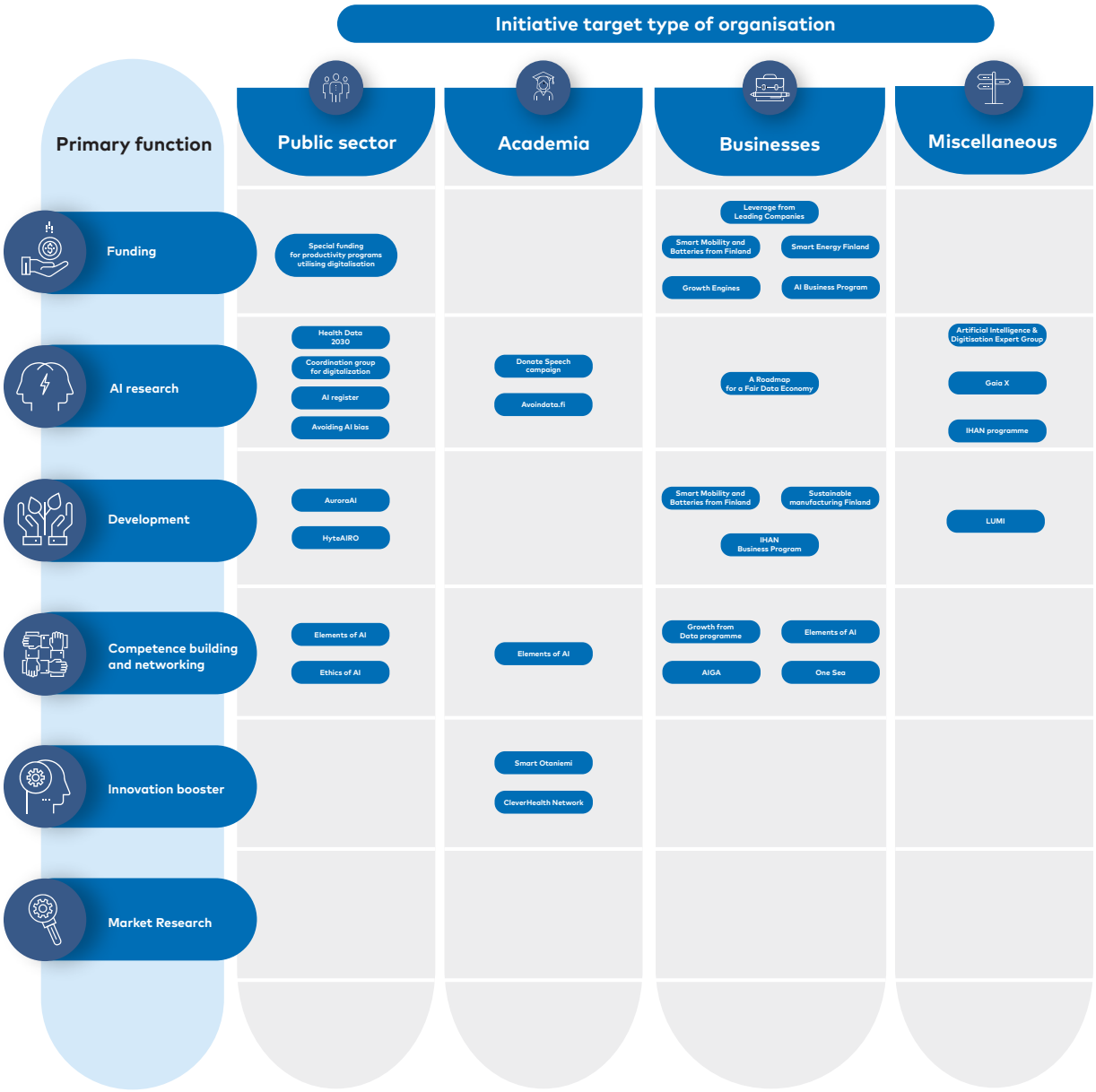
programme by Business Finland, which have largely supported the AI-driven companies and projects in AI ecosystem. In addition to these larger ecosystems, a few private companies have also been developing their own ecosystems with either a more general AI agenda or targeted use cases. Examples of such companies are Silo.AI as well as Nokia and Kone, respectively. These ecosystems have been able to create notable business value, yet there seems to be little co-operation between the ecosystems that would in turn enable them to grow even further.

Strong academic performance combined with promising ecosystems and overall positive attitude towards AI and digitalisation lays a strong basis for AI adaptation and implementation in Finland. Furthermore, according to OECD, Finns have a high trust in public institutions which creates a favourable basis for implementing Finnish AI strategy initiatives. However, according to interviewed Finnish experts, Finland might not be fully utilising its AI potential as the link between basic academia research and practical implementation could be stronger. Finland might be missing applied research, business capabilities, and capital to take full advantage of its strong academic performance.

According to Finnish experts the lack of market size and resources are also clear challenges for Finland. Even though Finland, being slightly behind Denmark and Ireland, has invested into AI the 3rd most per capita among all EU countries[67], Finland´s investment focus is quite narrow in comparison to the other EU countries. For example, Finland has emphasised its investments to ICT specialist compensation whereas Denmark has invested even more heavily on academic teachers' compensation and computer hardware and Sweden, on the other hand, especially on research & development and design. This narrow focus of investments can become a weakness in the long run for Finland.

As is evident from the different indexes and the state of the Finnish AI ecosystem and research, Finland is globally well positioned in AI development, especially when considered per capita. However, other countries are stepping up in the AI competition and approaching to bypass Finland and there is some national challenges Finland is facing regarding AI development. Thus, actions that maintain and grow Finland's high-ranking position in global AI development need to be initiated by both the public and private sector. This has already been addressed in the national AI strategy which aims to identify a handful of focused AI initiatives by the end of 2022. In the following chapters a more thorough overview of the Finnish AI actors, initiatives, and programmes as well as the national challenges and strongholds related to AI development is given.

Visualisation of National AI & Data Ecosystem



National actors

The most important Finnish AI actors with the biggest relevance to the Finnish AI landscape and ecosystem are presented below. These actors have been selected based on expert interviews and mentions in other publications in the Finnish AI field. The focus has been on public actors and actors who are either owned by the government or otherwise largely contribute to AI ecosystem in terms of public interest. All of the actors have AI work in their core focus, or they largely support AI and data-related initiatives or policies.

Business Finland

Business Finland is a government organisation for innovation funding, programs, trade, internationalisation, promotion of export, and ecosystem building. It was founded in 2018 by merging its predecessors Tekes and Finpro Oy. It provides funding to start-ups, SMEs, large corporations, and public sector and runs programs in selected areas. During the last pre-COVID year of 2019, Business Finland granted a total of 571M EUR in funding for companies. The purpose of program activities is to prompt businesses to benefit from market transitions and to increase understanding of themes affecting the future of business. This enables Finland to increase international business operations and to renew Finnish society. In addition, the programs enable the participants to resolve common challenges and learn from their peers. The programs provide a unique way for bringing together various operators: companies of different size seeking growth, renewal and internationalisation as well as research and other organisations working in cooperation with the companies. The programs mobilise a critical mass of actors and build joint offerings from Finland in strategically selected sectors and markets. The typical duration of the programs is 4–6 years. Recently ended AI related programs include AI Business and Smart Energy Finland, and on-going programs include Sustainable Manufacturing Finland, Smart Mobility Finland, Personalised Health Finland, and Smart Life Finland.

CSC – IT Center for Science

CSC is a Finnish center of expertise in information technology owned by the Finnish state and higher education institutions. CSC provides ICT expert services for higher education institutions, research institutes, culture, public administration, and enterprises. The services are provided to CSC's owners for no profit. CSC operates the data center where LUMI supercomputer is located and has created the free online course Elements of supercomputing.

Data Protection Ombudsman (Tietosuojavaltuutettu)

The Data Protection Ombudsman is a national supervisory authority which supervises the compliance with data protection legislation. The Office of the

Data Protection Ombudsman employs approximately 40 specialists, including Data Protection Ombudsman and two Deputy Data Protection Ombudsmen.

ELLIS Unit Helsinki (European Laboratory for Learning and Intelligent Systems)

European Laboratory for Learning and Intelligent Systems (ELLIS) is a network of excellence that gathers the top machine learning researchers together, with a mission to make Europe more attractive to talent. The network operates through ELLIS Units and joint programs. ELLIS Unit Helsinki contributes to a concerted European effort in machine learning, especially in probabilistic modelling and Bayesian inference, simulator-based inference, data-efficient deep learning, privacy-preserving machine learning and interactive AI. ELLIS Unit Helsinki is hosted by FCAI and it coordinates ELISE, one of the four European Network of Artificial Intelligence Excellence Centers spreading its knowledge and methods in academia, industry, and society.

Finnish Artificial Intelligence Society (FAIS)

Finnish Artificial Intelligence Society (FAIS) was founded in 1986 and it is the official member society of the European Association for Artificial Intelligence (EurAI) in Finland. FAIS supports and promotes the advancement of public knowledge, education, research, and applications of AI in Finland. FAIS invites AI researchers, practitioners, and enthusiasts at large in Finland to join the society as members.

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Finnish Center for Artificial Intelligence (FCAI)

Finnish Center for Artificial Intelligence (FCAI) is a community of AI experts in Finland, initiated by Aalto University, University of Helsinki, and VTT (the Technical Research Center of Finland). FCAI is one of the Academy of Finland's flagships, which are hubs of top-level research where the research is combined with economic and societal impact. FCAI will play an integral role in Finland's AI Strategy to realise the potential for AI-led economic growth by connecting pioneering academic expertise and top talents within industry and the public sector. FCAI aims to attract top talent to Finland to create new types of AI, which can operate with humans in the complex

world, and to renew the Finnish industry with this new AI. FCAI has three goals in AI research: data efficiency, trust and ethics, and interaction between AI and humans. FCAI has a 250M EUR budget for its flagship term (2019 – 2026) and it comprises 60 professors and 300 researchers.

First Artificial Intelligence Accelerator (FAIA)

First Artificial Intelligence Accelerator (FAIA) fosters the Finnish AI ecosystem by working in the intersection of organisations applying AI and service providers offering AI solutions. The accelerator was established as a joint effort by the Ministry of Economic Affairs and Employment, Technology Industries of Finland and Silo.AI. The objective behind establishing FAIA was to ensure AI knowledge is passed onto and applied in industry. Currently FAIA is run by Silo.AI and it facilitates 2–3-month long AI training programmes where organisations learn the basics of AI and what it takes to succeed with AI-driven products. In addition, FAIA has conducted a market research in 2020 regarding the state of AI and the AI landscape in Finland to offer a comprehensive outlook of the Finnish AI market.

Ministry of Economic Affairs and Employment (MEAE)

MEAE is an important national actor in AI since it is responsible for industrial policy, innovation and technology policy, and internationalisation of companies. MEAE is leading the national AI strategy work. It also plays a crucial role by steering organisations such as VTT (the Technical Research Center of Finland) and Business Finland.

MyData Global

MyData Global is an international non-profit founded in Finland. It has over 100 organisational members and close to 400 individual members. Its purpose is to empower people by improving their right to self-determination regarding their personal data. Even though the organisation is now international with quite independent local hubs, the MyData Conference is still held yearly in Helsinki. The values of MyData are written to the MyData Declaration that anyone can sign online. In addition, they have produced whitepapers which contain more detailed and technical descriptions on how personal data should be used in the future.

Sitra

Sitra is a fund operating under the supervision of the Finnish Parliament. At the end of 2021, the market value of its investment assets was 1 107M EUR. Sitra can be seen both as a think tank and as an investment company. It has three main themes for the years 2021-2024: Sustainability Solutions, Fair Data Economy, and Democracy and Participation. With these themes, Sitra has two functions: to produce studies on future developments and to offer trainings for Finnish decision makers. Multiple projects and initiatives are and

have been carried out under the theme of Fair Data Economy, including A Roadmap for a Fair Data Economy, Health data 2030, Digipower investigation, Gaia-X, and IHAN business programme.

The Finnish Tax Administration

The Finnish Tax Administration has been willing to pilot new technologies when it comes to digitalisation and AI. It is using Robotic Process Automation to reduce some of the routine work from its employees. Tax Administration launched chatbot Virtanen in 2019 and is continuously updating its capabilities to cover more and more tax-related conversations. It is also experimenting with speech recognition by converting received phone calls to text in order to better understand customers in tax-related matters and to further develop its operations.

Universities

Aalto University and University of Helsinki are the top two universities in Finland for AI research. Both universities are in the Helsinki capital region and have extensive collaboration, for instance, they have founded together the Finnish Center for Artificial Intelligence (FCAI) and ELLIS Unit Helsinki. The universities also have joint research through Helsinki Institute for Information Technology (HIIT) and Helsinki Centre for Data Science (HiDATA). Aalto was founded in 2010 by merging the Helsinki School of Economics, Helsinki University of Technology, and the University of Art and Design Helsinki. Through Helsinki University of Technology, Aalto has a long history in AI research with for example famous neural network pioneers. University of Helsinki, in turn, is the oldest and largest university in Finland. It has created together with the Finnish technology company Reaktor the hugely popular Elements of AI online course which was later published and received acclaim also globally.

VTT (Technical Research Centre of Finland)

VTT is the largest research and technology company and the largest applied research centre in Finland. VTT is fully owned by the Finnish state and operates under the ownership steering of MEAE. It was founded in 1942 and has currently 2000 employees out of which 33% have a doctorate or licentiate degree. Its goal is to "advance the utilisation and commercialisation of research and technology in commerce and society". The three main business areas are (1) Carbon neutral solutions, (2) Sustainable products and materials, and (3) Digital technologies. Related to AI, VTT has research and development projects on Automated driving and smart mobility services, Smart health and wellness, Smart buildings, AI for industry, and Ethics and future of AI. In addition, VTT has developed an online tool that organisations can use to test their AI maturity.

National Strategies and Policies

Finland launched a national AI programme – the Artificial Intelligence Programme – in 2017 as one of the first countries in the world and an updated version with a vision for Finland in the age of AI in 2025 was presented in 2019. The aim of the programme was to make an operative guide through which Finland could become one of the world's leading countries in the application of AI. [68]

As part of the programme, Finland has adopted an open data policy and aimed to create adequate conditions for a prosperous development of AI. The overall aim has been to increase the competitiveness of business and industry, provide high-quality public services and improve the efficiency of the public sector, and ensure a well-functioning society and wellbeing for the citizens. Achieving the programme's aim – making Finland one of the leaders in the application of AI – has been done through the following 11 key actions: (1) enhance business competitiveness through the use of AI, (2) effectively utilise data in all sectors, (3) ensure that AI can be adopted more quickly and easily, (4) ensure top-level expertise and attract top experts, (5) make bold decisions and investments, (6) build the world's best public services, (7) establish new models for collaboration, (8) make Finland a forerunner in the age of AI, (9) prepare for AI to change the nature of work, (10) steer AI development into a trust-based, humancentric direction, and (11) prepare for security challenges.

Finland updated the national AI strategy in November 2020 by launching the Artificial Intelligence 4.0 programme which aims to make Finland a pioneer in the dual transition i.e., the digital and green transition.[69] The programme's objective is that by 2030 Finnish industry's assets will be sustainability, capacity for renewal, technological leadership, and solutions that enable increasing the carbon handprint. In addition, the programme promotes the development and introduction of AI and other digital technologies in companies with a special focus on manufacturing SMEs and considers seamless collaboration between high-speed telecommunications networks, cloud computing, and AI central to digital transformation. In 2021 Finland was only 19th in the European DESI Index when ranked by how many companies utilise at least two AI technologies[70] and the Artificial Intelligence 4.0 programme has a goal to get Finland in the top 6.

In its interim report from December 2021 the programme compiles four concrete objectives and proposed measures for achieving the 2030 AI vision:

- Finland must invest in the development and introduction of leading technologies
- Nature smartness and digital technology are key to triple victory of sustainable development
- Finnish companies are at the forefront of digitalisation internationally
- Finland is actively involved in creating the EU's AI, data, and industrial strategies

Currently the program focuses to formalise joint understanding of goals between public and private sector. Based on the joint understanding handful of prioritised initiatives will be launched in 2022 and 2023.

In addition to the national AI strategies, Finland has several AI and data related policies, which are introduced in more detail in the below table.

National policies	Description
Act on the Secondary Use of Health and Social Data	The Act on the Secondary Use of Health and Social Data was created in 2019 and is currently under a transition period to become fully applied. The Act allows to use health and social data not only in research and compilation of statistics but also in development and innovation activities. A new data permit authority, Findata, was established for the implementation of the Act to ensure that the data is used in an ethical way. Companies and research organisations can apply for data in a centralised manner since Findata approves and combines the data even when data is needed from several different keepers of registers. However, there has been some challenges with increasingly long queues for permits.

Assessment memorandum on the need to regulate automated decision-making within public administration in general legislation	This memorandum was published by the Ministries of Justice and Finance in 2020. According to the memorandum automated decision-making within public administration should be limited to situations with no element of discretion involved. It could only be based on deduction rules pre-determined by the relevant authority in accordance with the legislation. Authorities should be obliged to ensure that the use of an automated decision-making system does not jeopardise the realisation of good governance, legal protection, and fundamental rights.
Data Protection Act (Tietosuojalaki)	The Data Protection Act specifies and supplements GDPR on the protection of natural persons regarding the processing of personal data and on the free movement of such data. The Data Protection Act regulates the processing of personal data, such as the processing of personal identity number and sensitive data, as well as the processing of personal data in specific contexts, for example in connection with scientific research, statistics, archiving, and the exercise of freedom of expression. In addition, the Data Protection Act regulates e.g., the imposition of administrative penalties, the powers of the Data Protection Authority and the age limit for information society services for children. In addition, under the new law, all those involved in the processing of personal data have a direct duty of confidentiality under the law on matters related to the processing of personal data.

Ethical information policy in the age of artificial intelligence	The report Ethical information policy in the age of artificial intelligence was written in 2018 and discusses information policy, how to make extensive use of AI, AI competence needs, and the platform and data economy. Information policy guidelines are detailed from the perspectives of information management, conditions for the use of information, value basis, ethical principles, and financial impacts. The report laid the groundwork for new laws and regulations.
Non-discrimination Act (Yhdenvertaisuuslaki)	Non-discrimination Act obliges public authorities, private actors in the public administration, employers, and training providers to promote non-discrimination. The obligation also applies to the use of AI. In practice, therefore, an impact assessment must be carried out from the point of view of equality when planning the use of AI. The obligation to promote non-discrimination also applies to cooperation and the outsourcing of activities to private actors. For example, a public authority must ensure that it does not acquire and exploit a discriminatory algorithm developed by a private individual.

Open data and AI policy

In Finland, information resources have been opened diversely, from geodata to weather, climate, sea, transport, financial, statistical, and cultural data. Led by the Ministry of Finance, the Open data programme (May 2013 – June 2015) was eliminating obstacles to the re-use of public data as well as creating the preconditions for open data within the public administration. The open data policy covered the proposals of the programme for the key goals and actions in the field of open data in the public administration in Finland.

Currently the public sector is promoting government openness under Open data and AI policy action plan running until 2023. Public interfaces are opened if there are no specific reasons to keep them restricted and data resources are made available through easy-to-use, developer-friendly interfaces whilst considering data protection and data confidentiality regulation. The objective is that the benefits of open data will spread within the society, and even more so when companies join to become producers of open data. In addition, a general set of guidelines on the ethical use of AI will be prepared to ensure that discriminatory operational models will not be utilised directly or indirectly in the AI systems. The measures to open public sector data will promote a data and AI policy that is ethically, financially, and socially sustainable. Meta data that contributes to data resources management of high quality will also contribute to the creation of unified resources required by machine learning in the Finnish linguistic area.

National Initiatives and Programs

The most relevant Finnish initiatives and programmes related to AI and data are presented in the below table. It is important to note that the list is not exhaustive due to the dynamic nature of the AI ecosystem.

Initiative	Responsible entity	Description
AI Business programme	Business Finland	The AI Business programme was active from 2018 to 2021 and aimed to make Finland the best place to research and develop AI and platform economy. Finnish companies and research organisations could apply for funding for their own development project or a joint project. In addition, companies were aided by providing information on suitable EU funding calls, services, and partners as well as by offering start-ups and SMEs free computing resources from the IT Centre for Science.
Growth Engines	Business Finland	Growth Engines is a funding initiative of Business Finland aiming at new business activities amounting to more than one billion euros. Growth Engines are cooperation networks between companies, research organisations and public actors, which strives to find solutions to global market disruption and create new growth sectors in Finland. Even though Growth Engines has no industry focus, it has funded some key AI related companies such as Awake.AI, Silo.AI, Unikie, and ICEYE. The Growth Engine funding has required these companies to pursue larger goals than only private business value - The companies need to also e.g., drive the whole ecosystem toward achieving a common goal.

Leverage from Leading Companies	Business Finland	Business Finland offers partnership funding for research, development, and innovation projects in which leading companies with international operations have agreed to resolve significant future challenges and increase their research, development, and innovation investments in Finland. Funding is intended in particular for joint projects between companies and joint projects between companies and research organisations. Since it was launched in 2020, several AI focused innovation projects have been initiated under the programme.
AI Register	City of Helsinki	In 2020 the City of Helsinki launched together with Amsterdam an AI register. The AI register is a standardised way to document the decisions and assumptions that were made in the process of developing, implementing, managing, and ultimately dismantling an algorithm. The register contains information on AI use cases of Helsinki, which currently include Parking chatbot, Oodi's book recommendation service, Intelligent material management system for libraries, Health center chatbot, and Maternity clinic chatbot. The register is based on the ethical principle that "everyone should have access to understandable and up-to-date information about how algorithms affect their lives".

Avoindata.fi	Digital and Population Data Services Agency	Avoindata.fi is a service that collects all Finnish open data in one place and allows everyone to publish and utilise open data. The service is provided by Digital and Population Data Services Agency.
CleverHealth Network	HUS Helsinki University Hospital	CleverHealth Network, established in 2017, is a health technology ecosystem in which companies and health care experts develop better treatment solutions for Finns and successful export products for companies. Product and service innovations are based on HUS's extensive health data and the leading expertise of clinicians. Vision is to be an internationally renowned ecosystem, which processes and cultivates health and welfare data, a forerunner in the health care revolution, and to create dozens of world-class solutions related to the cultivation of healthcare data.
Artificial Intelligence and Digitisation Expert Group	Ministry of Finance	The task of the National Expert Group on Artificial Intelligence and Digitalisation Research is to examine the future of intelligent technologies, and in particular AI research, and to assess the impact of technologies on different sectors of society. The expert group examines e.g., the development of smart technologies from a climate perspective, the development of know-how in Finland, and the impact of technology on democracy issues. The term of office for the group of experts appointed by the Ministry of Finance is from 1 February 2020 to 31 December 2022.

AuroraAI	Ministry of Finance	The National Artificial Intelligence Programme AuroraAI is ongoing from 2020 to 2022 with the objective to offer citizens personalised and timely public services, reducing the need to be in contact with several different authorities and providers to access services whilst promoting cost-effectiveness. The purpose of the AuroraAI network is to create the technical conditions that will enable information exchange and interoperability between different services and platforms. AuroraAI will help break down silos in the current service provision and ameliorate the mismatch between public services and service users while tackling the waste and underuse of resources.
Special funding for productivity programs utilising digitalisation	Ministry of Finance	Ministry of Finance has conducted three rounds of funding for productivity projects in public organisations. The projects utilise emerging technologies such as AI and RPA. The latest round in the autumn of 2020 accepted a total funding of 5.7M EUR for 23 projects. The projects with highest funding include automating proposed solutions for debt recovery procedures and AI-assisted handling of manually processed purchase invoices.

Hyteairo	Ministry of Social Affairs and Health	The Well-being and Health Sector AI and Robotics Programme (Hyteairo) was active from 2018 to 2020 and supported and sped up the utilisation of AI and robotics in the well-being sectors' services and operating processes. The programme aimed to determine and eliminate obstacles and create the prerequisites for the development and use of AI and robotics in the well-being sector.
Coordination group for digitalization (Digitoimisto)	Ministry of Transport and Communications, Ministry of Finance, Ministry of Economic Affairs and Employment	The coordination group for digitalisation is a permanent inter-ministerial working group for strengthening inter-ministerial cooperation in the digital transformation and the data economy. It is responsible for creating the Finnish digital compass, which consists of a national vision and targets for digital transformation and the data economy for 2030. In addition, the coordination group serves as a single point of contact for citizens and stakeholders in matters related to the data, digital and information policy sector.

One Sea Autonomous Maritime Ecosystem	No leader, several members	One Sea is a high-profile ecosystem with a primary aim to lead the way towards an operating autonomous maritime ecosystem by 2025. The work began in 2016 with the aim to create an environment suitable for autonomous ships by 2025. The collaboration gathers leading marine experts to work together and is a strategic combination of top research, state-of-the-art information technology, and business. An important component in developing autonomy related maritime technology is Jaakonmeri on the coast of Finland, the first internationally open maritime test area for autonomous vessels.
Smart Otaniemi	No leader, several members incl. Aalto University, VTT, and City of Espoo	Smart Otaniemi is an innovation environment for smart and sustainable urban solutions. It connects start-ups, SMEs, large enterprises, research institutes, universities, and public sector agencies across the globe to collaborate on world changing ideas and innovations. Smart Otaniemi offers a real city platform for cutting-edge research, development, and innovation work, topped with a community of bright-minded professionals.

Avoiding AI bias: a Finnish evaluation framework for non-discriminatory AI applications	Prime Minister's Office	The Avoiding AI bias: a Finnish evaluation framework for non-discriminatory AI applications research project is active from 2021 to 2022 with the goal to extensively map out the risks to fundamental rights and discrimination contained in the AI applications based on machine learning used and planned in Finland. The project assesses the impacts of learning-based algorithms in different areas and stages of an individual's life, such as social and health care. The main goal of the project is to develop an evaluation framework to ensure the non-discrimination of AI applications in different usage contexts.
A Roadmap for a Fair Data Economy	Sitra	Sitra has identified a need for A Roadmap for a Fair Data Economy since Finland needs to find ways to accelerate building a data economy to strengthen national competitiveness and enable data economy to generate prosperity. In project preparation, Finland's strengths and bottlenecks in the data economy have been analysed and identified. In addition, the outlook for Finland's data economy has been compared to that of key competitor countries. The creation of a national roadmap started in early 2022.

Digipower investigation	Sitra	Digipower investigation is a two-year initiative ending in 2022 that aims to find out how decision-makers can be influenced by the data collected about them. The decision-maker participants will be using test phones customised for the project with a monitoring app, revealing the parties that collect data about one when using online services. The objective is to identify new mechanisms of influence and develop solutions to make the data economy fairer and more sustainable as well as to examine this knowledge from the perspective of democracy. For individuals, this can mean increased opportunities to benefit from data collected about them in the form of better and better knowledge how and where the collected data is used.
Health data 2030	Sitra	The Health data 2030 project is active from 2020 to 2030 and is meant to implement the strategic objectives of Sitra's Fair Data Economy theme from the perspective of the use of health data. The aim of the project is to ensure Finland's active role in sustainable digitalisation development. Sustainable digitalisation is associated with the development of a European single market for data as defined in the European data strategy and the ethical use of AI as a driver of data-based services.

IHAN project	Sitra	From 2018 to 2020, the IHAN® project laid the foundation for a fair data economy, in which successful digital services are based on trust and create value for everyone. A technical document, IHAN Blueprint, describes a method for data exchange and can be used to implement the IHAN operating model in practice. IHAN project included pilot projects where partnering companies built technical solutions based on the principles of the IHAN operating model. For example, these principles consider data sharing that is based on trust and the individual's consent as a competitive advantage.
IHAN business programme	Sitra	From 2020 to 2021, the IHAN business programme helped SMEs to create new business and services with data which comply with the principles of the fair data economy. The results of the programme included a business model and a viable plan for creating new business for each participating company. The training materials developed during the programme are publicly available in Finnish. The concept will further evolve and continue when new parties conduct similar business programmes using and enhancing the programme materials.

Growth from Data programme	TIEKE	Growth from Data is a coaching programme for companies for harnessing data to serve the development of their business. Companies particularly in the travel and restaurant industry are offered an opportunity to renew their business in accordance with the principles of a fair data economy by creating value and building trust. During the coaching companies develop a new data-based product or service and hear from experts of various fields how they can improve utilising data.
Elements of AI online course	University of Helsinki, Reaktor Education	The free online course Elements of AI was launched in 2018 with the goal of educating 1% of the Finnish population with the basics of AI and what it can do. Later it was made available also worldwide with a variety of translations, educating 750 000 people from over 170 countries to this day.
Building AI online course	University of Helsinki, Reaktor Education	The free online course Building AI is a continuation to Elements of AI, and it focuses on AI algorithms. The course provides a solid introduction to for example machine learning and neural networks as well as introduces where and how AI methods are applied in real life.

Ethics of AI online course	University of Helsinki	The Ethics of AI is a free online course for anyone who is interested in the ethical aspects of AI. It gives background on why AI raises concerns of its ethical use, introduces the main ethical questions and concepts related to AI, and teaches how to start thinking about AI from ethical point of view.
Donate Speech campaign (Lahjoita puhetta)	University of Helsinki, Yle (national public broadcasting company)	The Donate Speech campaign aims to collect 10 000 hours of Finnish speech on different topics and in various dialects. The data will be used in AI research and development and in language research. One of the main goals is improving Finnish language speech recognition. So far Finns have donated more than 4000 hours during 2020 and 2021.
AI Governance and Auditing (AIGA)	University of Turku	The AI Governance and Auditing (AIGA) project explores how to execute responsible AI in practice. The purpose and mission of the AIGA program is to enable executing responsible AI in practice through laying out best-in-class governance mechanisms and auditing principles for algorithmic decision-making as well as building a commercialisation roadmap for AI governance and auditing.

Gaia-X Finland	Gaia-X European Association for Data and Cloud AISBL Finnish coordination by Sitra	From 2021 to 2024, the Gaia-X project strengthens Europe's digital self-sufficiency and right of self-determination regarding data, free access to the market and new value creation, modularity, interoperability, and user-friendliness. The initiative has grown quickly and already involves seven different EU member states and hundreds of businesses. The aim of Gaia-X Finland is to promote Finnish business competitiveness in European data markets by increasing Finland's presence and influence in creating European data spaces as well as in related decision-making.
LUMI (Large Unified Modern Infrastructure)	The European High Performance Computing Joint Undertaking (EuroHPC JU)	When fully operational in 2022, LUMI will be seven times as powerful as the fastest supercomputers in Europe and faster than the current global leader Fugaku in Japan. The huge computational power of LUMI (550 petaFLOPS) is mainly based on graphics processing units (GPUs) which are well-suited for different AI applications, and especially deep learning. The supercomputer is being built in Finland and hosted by the LUMI consortium, which includes Finland, Belgium, Czech Republic, Denmark, Estonia, Iceland, Norway, Poland, Sweden, and Switzerland.

Best Practices

All in all, there are multiple different AI and data related initiatives and programmes ongoing in Finland driven forward by both public and private actors as well as collaboration networks between public and private organisations together with academia. In particular two of the introduced national initiatives and programmes can be nominated as best practices in Finland due to their significant impact on the Finnish AI landscape and ecosystem. Both programmes have addressed the areas with which Finnish companies are struggling the most when it comes to developing and utilising AI, including 1) the general lack of understanding of what AI can do and how it can be applied to business, 2) the lack of skills in the workforce, and 3) the lack of appropriate training data. [71]

Best Practice 1

AI Business programme by Business Finland

In 2017, Finland had a little over 10 AI start-ups, and bigger companies were only starting to build their AI teams. To accelerate the AI capabilities and business models of Finnish companies, Business Finland launched the AI Business programme. The programme funded around 100 PoC projects during 2017-2021, making it the biggest AI funding initiative in Finland so far and contributing significantly to developing the critical mass for the Finnish AI ecosystem.

Business Finland was strict on the selection criteria, since only companies with a solid business plan, existing products, sufficient funding, and satisfactory financials were selected for the programme. The available grant was 50% of the total cost of PoC and, in addition, the participating companies could get free computing resources from CSC (IT Centre for Science) between 20k EUR and 80k EUR. This AI Computing Grant has been successfully utilised by, for instance, the Finnish AI start-up Speechly to develop speech recognition technology comparable to Google. To further support SMEs in developing more data-driven business, Business Finland collaborated with Futurice to provide a series of coaching workshops. The workshops and freely available webinars covered topics including creating a data-driven business model, clarifying competitive advantage, and finding ways to execute a cultural transformation to become more data-driven.

The goal of the PoC projects was not to develop a market-ready product or service but to research if the problem is solvable, and there was a possibility to have a low-interest rate loan after the PoC for product development. During the years 2016-2020, both the headcount and turnover of participating SMEs doubled, which most likely speaks both for the successful selection of promising companies and for the effectiveness of the programme. Similarly, the export of

these SMEs more than doubled with an increase of 159%. Internationalisation and exports are always a key focus area in Business Finland's initiatives. To further increase the internationalisation potential, Business Finland created the Artificial Intelligence from Finland material, which is still being updated, to showcase the Finnish AI knowledge and companies.

During the programme, Business Finland actively organised meetups called AI Breakfasts between the companies involved. These meetups were co-learning events where people networked and shared know-how about technology and their business openly, building long lasting relationships. One key reason these meetups and the whole programme was successful is that the participants were able to trust each other as they were not direct competitors. The networking and knowledge sharing continues in the form of Regional AI Hubs located in e.g., Tampere and Turku. In addition, the annual AI Finland event was launched during AI Business programme, gathering 1200 participants from 50+ countries and further facilitating the creation of an AI ecosystem.

Through this successful programme, Business Finland assisted participating companies to overcome the challenges of understanding business use cases for AI and employees having sufficient AI skills. In fact, the real-life examples of successful AI utilisation set during the AI Business programme have most likely had a positive impact on AI development in the private sector in Finland as many Finnish companies have been waiting for "industry specific use cases and success stories before advancing" their investments on AI development.[72] Having had such a notable impact on AI utilisation of Finnish companies, Business Finland's AI Business programme can be deemed as an AI best practice in Finland.

Best Practice 2

The Basics of AI training programme by First Artificial Intelligence Accelerator (FAIA)

The First Artificial Intelligence Accelerator (FAIA) is addressing the lack of AI knowledge in Finnish companies by organising two to three-months long Basics of AI training programmes for companies to learn the basics of AI and what it takes to succeed with AI-driven products. The programme is targeted at companies which are taking their first steps in identifying and adopting AI technologies and it aims to tackle the two clear barriers in utilising AI and machine learning – understanding the business opportunities of AI and machine learning and deploying AI and machine learning solutions.

The programme consists of 5 interactive workshops which are all conducted by seasoned experts with over 10-20 years of experience with AI. The topics of the workshops include basics of AI, AI technologies, data as an asset, identifying AI use cases, and successful AI projects. Between the workshops, the organisation can book individual sparring sessions with different experts and there is a possibility to arranged monthly webinars with external speakers on any subject that have come up during the workshops.

Through these events, participating companies increase their understanding of how to better utilise data, machine learning, and AI to create business value. In addition, they also gain a strong foundational knowledge and understanding of AI, the ability to identify opportunities for AI and machine learning solutions, experience with how to develop a roadmap for integrating AI solutions into their business, and the capability to pilot AI solutions. Furthermore, an optional part of the programme is to start building the company's first AI PoC. FAIA has also published three playbooks (Basics of AI, Your guide to speech processing, and A guide to continuous AI development) which scale the lessons learned from each accelerator training batch including the pitfalls, must-haves, and guidelines.

The main focus in FAIA's trainee programmes is to enhance the AI and machine learning knowledge in Finnish companies and to give the companies capabilities to continue employee's personal learning and company level development also after the programme has concluded. As the programme is also providing participants a possibility to start building an AI PoC, FAIA is supporting the creation of AI business use cases in Finland and through that increasing the industry knowledge of what AI can do and how it can be applied to business.

National AI Development Challenges

Finland has a few country-specific challenges that the other Nordic countries are not struggling with as much as Finland. These are the challenges of how to effectively channel the nation's scarce materials and human resources as well as the data management know-how of Finnish companies.

Challenge 1

Channelling scarce resources effectively

Finland has the third smallest population within Nordics, Iceland and Norway being smaller, and the lowest GDP per capita. This challenge impacts especially AI implementation since the development of AI is resource-intensive requiring data, computational power, and specialists from various fields. Even though the Finnish society has a solid technical foundation, high-quality research, and both the public and private sector are collecting plenty of data, countries with more extensive resources and the traditional players of the technology field are waking up to AI development and catching Finland up.

There is no company in Finland, or in the Nordics, that can achieve the implementation scale of for example Amazon. In fact, investments to emerging technologies like AI are not being prioritised by Finnish companies as the possibilities for investment are lower than for global giants, and companies aim to optimise their return on investment. In an industry survey conducted by FAIA in 2019, companies' main reason for holding back investments in AI was the general lack of understanding of what AI can do and how it can be applied to business.[73] Finland is also lacking investments in AI start-ups. When compared to other OECD countries in 2020 Finland ranked 19th and was the second last Nordic country with only Iceland having less VC investments to AI start-ups. [74] Moreover, the amount of VC investments to Finnish AI start-ups has increased only tenfold during 2012-2020 from 7.6M EUR to 76M EUR whereas for example Swedish AI start-up investments have increased from 0.9M EUR to 183M EUR in the same period.

The challenge of scarce resources has been identified by the Finnish government and actions are taken to address it as part of the Artificial Intelligence 4.0 programme. During the programme the national AI strategy is updated to achieve Finland's 2030 AI vision including enhancing cooperation between different sectors, increasing investments to digitalisation, and enhancing the digital skills of companies, especially SMEs. A major part of updating the national AI strategy is to find certain focus initiatives to enhance channelling the scarce resources Finland has to meaningful areas of development. Digitalisation has been nominated as one of the central tools for creating new economic growth in the national

AI strategy. Finding the focus areas has also been emphasised by the interviewed Finnish experts – as a small country, both demographically and economically, Finland benefits from focusing on specific AI topics, but at the same time the focus areas should not be too narrow to avoid the problem of not having a diverse set of capabilities.

Finland also needs to make sure that the large Finnish companies can leverage their capabilities at a global scale. To achieve this, "fearless champions", who can get the whole Finnish industry to follow their example, are needed to emerge from the Finnish business field. Business Finland is addressing this through different initiatives. In Business Finland's challenge competition Leverage from Leading Companies [75] companies with international operations have agreed to resolve significant future challenges and increase their research, development, and innovation (R&D&I) investments in Finland. In addition, the leading companies are to boost R&D&I cooperation with research organisations and SMEs. If successful, these projects will lead to additional investments of several billion euros in Finland.

Growth Engines, in turn, are cooperation networks i.e., ecosystems between companies, research organisations, and public actors, which strive to find solutions to global market disruption and create new growth sectors in Finland. [76]

Challenge 2

Data management know-how in Finnish companies

Finnish AI development is also facing a challenge in data management know-how. Finnish experts have recognised that increased data know-how and utilisation of data marketplaces is needed in Finland. There are statistics which show that Finnish companies have utilised data less than companies in peer countries and that the current investments in data marketplaces are smaller in Finland than elsewhere. In fact, the interviewed experts pointed out that in Finland data is a larger problem for companies than AI as a technology; Finnish companies are struggling with what data is needed, what is done with the data, and how the data is stored and maintained to ensure sufficient data quality.

The three main challenges regarding data and its management in Finnish companies were identified by the Finnish Government in a 2019 report called Overall state of AI and national competency survey.[77] Almost all companies interviewed for the report raised handling data as a challenge. Regardless of the maturity of data analytics or AI in the companies, internal data consolidation was seen problematic. This is a disadvantage to Finnish companies as internal data consolidation enables, for instance, the unity of meta data which in turn is a prerequisite for

data to be available centrally for AI and data analytics development and utilisation.

The second challenge highlighted by the interviewed companies was the availability of up-to-date data. AI can be utilised to gain benefits from new and vast data sources that were earlier difficult to process with traditional analytics methods. However, if the used data is not providing current and accurate information, the benefits of using AI are undermined by poor or even wrong insights. The third challenge identified in the report was preparing and transforming data to be used, for example, to train machine learning models. This challenge was present especially in companies with highly developed analytics solutions. Hence, it can be concluded that accessing data is not enough, but data quality and usability play a major role in utilising analytics and AI, and sufficient time and resources need to be allocated also to pre-processing data.

Data management know-how is a complex issue for companies as every member of the organisation is involved in data management and holism is required from the entire company's perspective. This is a pain point in Finnish companies according to the experts – individual employees of a company may have extensive data analytics expertise, but the company can have issues with data management. The reliance of companies on the data management skills of their employees is connected also to data content. As already established, the content and quality of data are as critical to companies as the accessibility of data. Hence, companies need all employees to understand the importance of data quality and the know-how to ensure and preserve it.

Finally, another aspect of data management Finnish companies must consider is the amount of data. The interviewed experts highlighted that nowadays the abundance of data is not a solution to everything. With the increasing concern to environmental aspects, the electricity consumption of AI is becoming more and more relevant, and more focus is needed from companies to ensure sustainable data management and AI utilisation. As computation might get exceedingly expensive or energy intensive in the future, companies are facing diminishing returns when increasing the amount of handled data.

National Strongholds

Finland has many of the strongholds also seen in the other Nordic countries when looking at the global perspective, such as governmental support for utilising and developing AI and extensive national datasets, but there is especially one stronghold that sets Finland apart from its Nordics peers – the state of AI research and education.

Stronghold 1

AI research and education

starting from the 1960s and its success hasn't slowed down over the years. In fact, it was established in the 2019 report Overall state of AI and national competency survey by the Finnish Government[78] that in relation to its size in population Finland has had more expertise and resources than other countries to be utilised in AI research over the years. Finland is recognised as a leader in AI research also in the Nordics and globally. In FAIA's 2020 report State of AI in Finland[79] it is stated that there is state-of-the-art Finnish machine learning research published regularly in the academic media and that Finland is "punching way above its weight in terms of AI". Moreover, when compared to other European countries by the average amount of citations Finland ranks as 5th after Switzerland, the UK, Belgium, and the Netherlands. Among the 50 countries with most published papers in 2013-2017 Finland is globally 17th and within EU 5th with Finnish AI papers published on average 10 per cent more often in top journals.[80] There is also emphasis put on the collaboration between academia and business in Finland.

Finland has achieved its internationally recognised position in AI research by making beneficial decisions regarding AI education. For instance, in the past AI education focused on machine learning which is currently the mainstream technology of AI. As a result, Finnish

research on machine learning is extensive and of high quality which offers the opportunity to focus next on emerging AI technologies such as signal processing, edge computing, and 6G. This gives Finland an advantage compared to countries that are still catching up with AI related topics Finnish academia has already mastered for years.

Finland's investments on AI education haven't decreased over the years. Alongside Denmark, Finland offers the largest number of AI specialised educational programmes per capita on all degree levels in the Nordics.[81] Increasing the Finnish AI knowledge has been a government level objective since the introduction of the national AI strategy in 2017. This important goal of the government to educate people about the basics of AI has also been noticed internationally, including in the US. [82] An example of such governmental initiative has been the support given for the creation of the Finnish Centre for Artificial Intelligence (FCAI). [83] FCAI has a major scientific, societal, and economic impact but also a crucial educational role in increasing the competence of both Finland's workforce and the public. FCAI is fulfilling its educational role through, for example, Master's and doctoral programmes and various large, open online courses for the wider public as well as through collaboration with industries and other stakeholders in the society.

Another investment in Finland's AI education is the free, open for everyone, online course Elements of AI which was created as a joint effort between University of Helsinki and the technology company Reaktor in 2018. [84] The aim of the course was to help people to be empowered, instead of threatened, by AI through teaching them the basic of AI and what can and cannot be done with it. The course was later made available worldwide with a variety of translations and it has aroused great interest educating 750 000 people from over 170 countries to this day. Nowadays, there is also a continuation course called Building

AI which focuses on AI algorithms and introduces where and how AI methods are applied in real life. Finland was also the first Nordic country to publish an industry-specific AI course, AI for Built Environment, in late 2021. [85]

In addition to wide offering of AI education, Finland also has high interest to it. For example, in Coursera, a US-based open online course provider founded by Stanford University, Finland ranked 1st globally in terms of taken Data Science courses in 2021. [86] Overall, Finns are well educated in AI and in the global ranking of AI skill penetration among population Finland is on the 10th place with none of the other Nordic countries reaching the top 15 [87]. A noteworthy fact is also that in Finland the AI skill penetration rate is higher among females than males.

The next step on Finnish AI education could, according to the experts, be establishing an open university for the whole Finland in which anyone could study courses or micro degrees. By pooling together the resources of the Finnish universities instead of each of them making their own online courses, Finland could have a high-quality course offering available to all. Further investments in educating the public about AI also supports cutting-edge AI research as when connecting the best researchers with the best companies it is highly beneficial that all parties involved have some basic understanding of AI.

Country Reports

ICELAND

Introduction to Country

Iceland is a country that shares many similarities with its Nordic neighbours, ranging from having a relatively homogenous population that is largely interested in digitalisation to having a government that is fairly well-trusted and that places importance on equality and ethics.

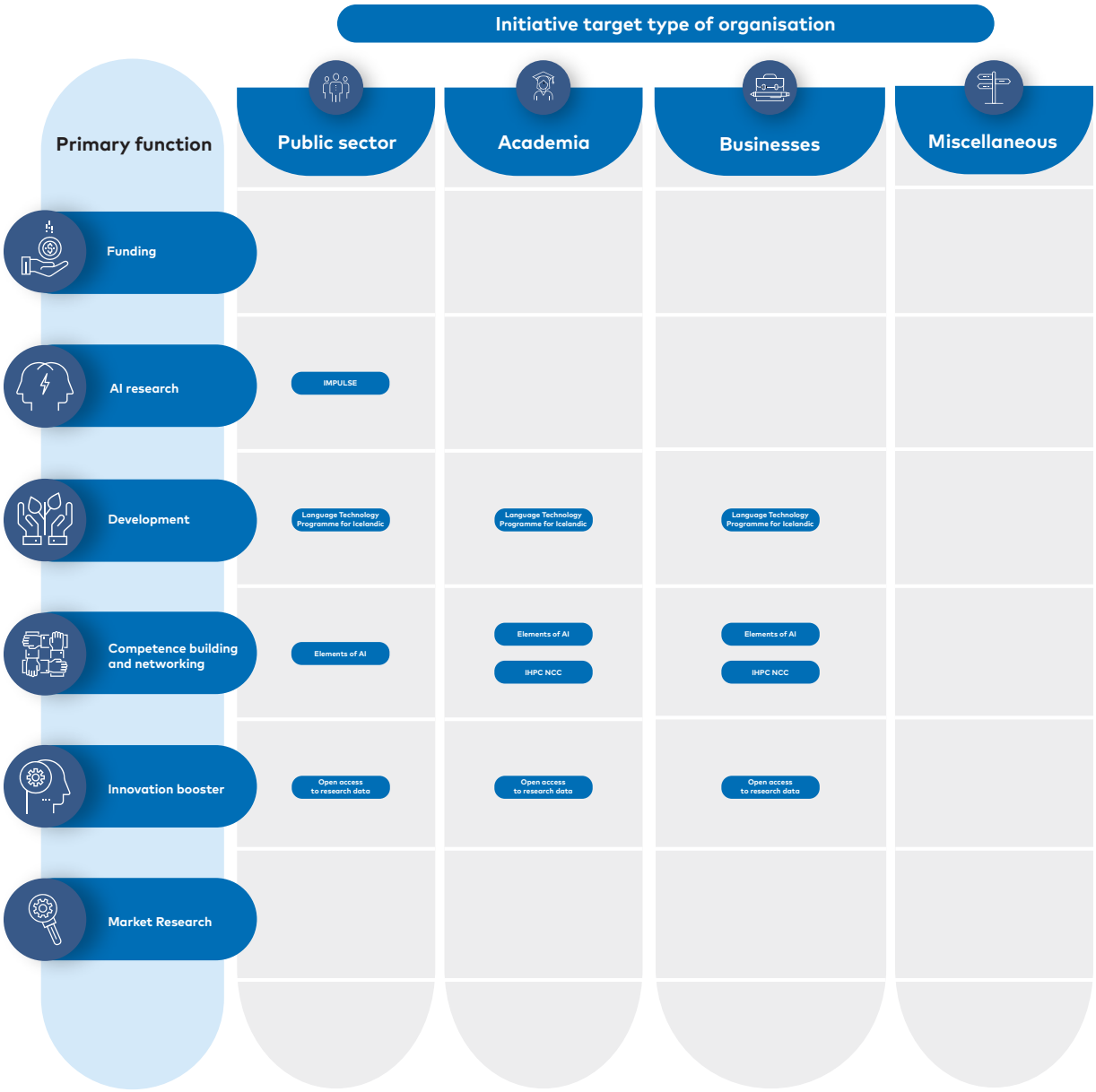
On the other hand, Iceland is the smallest country within the region by a large margin when it comes to population, and the government is planning to use this as a strength due to the potential for rapid adaptation for innovation.

Regarding the national AI strategy, Iceland published theirs from the Office of the Prime Minister in mid-2021 which made them the last country in the Nordics to publish an AI strategy. The strategy itself is known by the Office of the Prime Minister to be vague and in need of further development, it is therefore viewed as a first step on the road to more strategic actions related to AI development. However, prior to further development of the AI strategy, Iceland has decided focus more on its data strategy and management in order to eventually proceed with AI development. In addition, the local government is going through a significant reorganisation which is delaying topics like AI, data, and digitalisation. Going forward, however, the goal is that this reorganisation will support the public sector to work more strategically and to be able to connect more with the rest of the EU through initiatives like research programs. Looking at the AI

development that is currently ongoing in Iceland, most of it can be attributed to the private sector where both start-ups and more established companies are leading the way, particularly within the med-tech and health-tech sectors which are both important industries for Iceland. One of the strengths for the country that is supporting this innovation is the availability of medical records and other health data that aids businesses in developing new services for the industry, including how AI can save on resources and support in preventative care. Besides the private sector, there is also some academic research ongoing at the country's largest universities, but when it comes to the public sector there is a lack of available competency to get any real traction as of yet. However, due to the perceived value that can be created through the utilisation of AI, there is some public funding that has been allocated towards AI development, again particularly within the healthcare sector.

Overall, Iceland is a country that has recognised its small population size as an asset that can be leveraged to rapidly change as necessary in order to pursue digitalisation and innovation, including through the use of AI. However, the national AI strategy is vague and there is a lack of available skilled labour to work with AI which together have a dampening effect on Iceland's pace of AI innovation. This is caused by public organisations being unsure of how to support AI development both internally and externally, and that the few available resources are spread too thin to prioritise AI development. While these drawbacks do exist, Iceland is still working on positioning itself as a future contender in the AI market. This is planned to be accomplished through the use of beneficial policies for businesses that are meant to attract investments and skilled labour from abroad that can be leveraged to quickly grow the local AI development capabilities.
In addition, Iceland has over several decades been collecting and storing healthcare data for the population which can now be used for training AI. Moreover, this data in combination with the homogenous nature of the country can be advantageous for some AI development due to lowered variability. However, the lack of variability can also be a risk if businesses try to extrapolate Icelandic AI solutions to other countries without utilising additional datasets as the AI may not be representative for other populations. Nevertheless, AI development for the healthcare industry can be particularly beneficial and provide a significant boost to the Iceland's AI innovation and status.

Visualisation of National AI & Data Ecosystem



National actors

Almannarómur

Almannarómur is an Icelandic centre for language technology that is publicly funded and that is responsible for implementing the Icelandic Language Technology Programme. This is a five-year programme that began in late 2019. The centre has three objectives that are supported through AI and data, including ensuring the equal states of Icelandic in digital language technology, protecting the Icelandic language, and ensuring individual and organisation have access to language technology.

Center for Analysis and Design of Intelligent Agents (CADIA)

CADIA is an AI lab in Reykjavik University with an interdisciplinary research centre in AI spanning multiple departments at the School of Technology and School of Social Sciences. As a part of its research, the centre is working with a language and voice lab, artificial general intelligence, general gameplaying, socially expressive computing, cognitive signals, and interactive narrative and game design.

Digital Iceland

Digital Iceland is a digitalisation organisation operated by the Ministry of Finance and Economic Affairs with the aim to make digital services the main means of communication between the Icelandic government's agencies and the Icelandic people. As a part of this purpose, the organisation has various objectives and emphases, including increased Icelandic competitiveness which partially aims to make public sector data accessible and exploitable, while taking into account data protection considerations and individual consent. In addition, increased competitiveness is also supported by ensuing that the Icelandic population has knowledge of potential new technologies, such as AI.

Innovation Center Iceland (ICI)

ICI worked on applied research projects together with companies. It had a few AI-related projects in automation and computer vision, such as "Automating drone-based aerial imaging". However, as of July 2021, the organisation was dissolved as a result of a shift in priorities by the Icelandic government. Since then, some tasks performed by ICI have been moved to a different operational form while other tasks have been discontinued entirely or been opened up for continuation by the private sector.

The Icelandic Centre for Research (RANNIS)

RANNIS supports research, innovation, education, and culture in Iceland. RANNIS coordinates and promotes Icelandic participation in European programmes such as Horizon 2020, Erasmus+ and Creative Europe. RANNIS administers competitive funds in the fields of research, innovation, education, and culture, as well as strategic research programmes. Related to AI development, the most significant funds are "Technology Development Fund", "Icelandic Language Technology Fund", and "Icelandic Research Fund (IRF)".

Icelandic Institute for Intelligent Machines (IIIM)

IIIM is the only non-profit research institute in Iceland focusing on AI and advanced automation. It was founded by CADIA, Reykjavik University School of Computer Science and CCP (a virtual reality and game company). Its mission is to accelerate the rate of innovation in Iceland by connecting academic research and industrial engineering needs.

Ministry of Finance and Economic Affairs

The primary role of the Ministry is to direct public finances and economic affairs, but it also manages the state's human resources and leads initiatives aimed at digitalisation and innovation within the Icelandic government. As a part of this purpose, AI is a subject of the Ministry as it works with how to utilise the technology in order to improve efficiency and public services.

Ministry of Higher Education, Science, and Innovation

The purpose of the Ministry is to enhance Icelandic prosperity and to create knowledge-based jobs by breaking down walls between universities, science, industry, and innovation. The vision of the Ministry is for Iceland's main export to be knowledge and intelligence. As a part of this goal, the Ministry works with boosting public confidence in IT by increasing cybersecurity and electronic communications security.

The Prime Minister's Office

The Prime Minister's Office is responsible for the subject of AI in Iceland and is therefore the lead Ministry in producing the AI strategy for Iceland. In addition, the Ministry commissioned a report that was published in 2019 about Iceland and the fourth industrial revolution which included information about AI and how it can impact the country.

Science and Technology Policy Council

The Science and Technology Policy Council is responsible for setting public policy in matters of science and technology in Iceland. The Council sets the official science and technology policy for a three-year period. RANNIS cooperates closely with the Science and Technology Policy Council and provides professional assistance regarding the preparation and implementation of science and technology policy in Iceland.

University of Iceland and Reykjavik University

University of Iceland and Reykjavik University are the main universities in Iceland with academic research on AI. University of Iceland and Reykjavik University are the country's largest public and private universities respectively.

National Strategies and Policies

During 2021, Iceland launched its national AI strategy through the Office of the Prime Minister. The strategy itself is quite general, covering the typical topics found in other Nordic AI strategies, including background to where Iceland is positioned today with regards to AI and how the technology can be used for the local language. In addition, the strategy also specifically addresses ethics and the societal challenges and opportunities related to AI. While the strategy is generic, Iceland recognises it as a first step in the country's AI development journey, and due to this, the public sector in Iceland has yet to take any actions based on the strategy itself. Instead, Iceland is planning to work more on its data strategy in order to set the foundation for AI. This is something it was inspired to do after looking at its Nordic neighbours and seeing the negative impact that a poorly formed data strategy had on the public sector's ability to facilitate AI development in the local countries.

In addition to the AI strategy, the Office of the Prime Minister has laid out an action plan for Iceland in the fourth industrial revolution[88]. This is a prioritized list of actions for Iceland to meet the societal and economic changes brought by new technology, especially AI. The actions include formulating Iceland's policy on AI, strengthening the public's basic understanding of AI, creating a policy and action plan on open data, facilitating the application process of work permits for foreign experts, linking better lifelong learning and formal education systems, strengthening entrepreneurship culture through education in all schools, and strengthening funding for RANNIS.

Finally, the Ministry of Finance and Economic Affairs has published a digital strategy as of 2019 which focuses on creating efficient digital public services, but also emphasises that society in general should have knowledge of technology, such as digital service platforms and AI[89]. The strategy emphasises that digitalisation is a big topic for Iceland today and that it can be seen as a precursor to AI. The main objectives for the digital strategy are increased competitiveness, better public services, safer infrastructure, and a more modern work environment.

Besides the AI and digitalisation strategies, Iceland has also published three policies related to data protection and preparing the country for the future of work, including AI, which are described in the table below.

National policies	Description
Data Protection	Data protection is an important topic for Iceland, and the country has implemented GDPR through the local Data Protection Authority. However, as a part of the adoption of GDPR, certain derogations and exemptions from GDPR are permitted in some areas[90], albeit with safeguard procedures in place. These areas include for scientific or historical research purposes, statistical purposes, and archiving purposes in the public interest[91].
Innovation Policy	In 2019, Iceland published an innovation strategy that lays out a plan for how Iceland can become a country for innovation through the leveraging of individual ingenuity[92]. As a part of this strategy, the fourth industrial revolution is a key aspect.
Science and Technology policy	As a part of its overarching policies for science and technology, the Ministry of Education, Science and Culture is responding to how AI will impact the future of work in Iceland. The policy underlying this states that Iceland needs to boost skills in the labour market in order to ensure that the country has access to qualified employees who can strengthen business competitiveness and boost productivity.

National Initiatives and Programs

In prior sections, Iceland's relatively small footprint in the AI development sphere has already been established. However, this reality becomes clearer in the following part of this report where the few ongoing Icelandic AI initiatives are listed, excluding those that are run within private companies.

Initiative	Responsible entity	Description
IMPULSE	City of Reykjavik	Identity Management in Public Services (IMPULSE) is a project with funding from the European Union's Horizon 2020 research and innovation programme. The project runs from 2021 to 2024 and will conduct a user-centric and multidisciplinary impact analysis on the integration of blockchain and AI on electronic ID (eID) in public services. As a part of this initiative, the City of Reykjavik is trialling eID solutions that will enable citizens with physical impairments to authenticate on Reykjavik's participatory democracy platform Better Reykjavik.
Elements of AI	Digital Iceland	Following Finland's launch of the course known as Elements of AI, Iceland has made an Icelandic version for its own population. Similar to the other countries who have adopted the course, the goal is to teach more people about AI and what it can be used for.

Language Technology Programme for Icelandic	ICLT	The Language Technology Programme for Icelandic is a 14 million EUR initiative that was started in 2019 with the goal to ensure that Icelandic can be used in communication with and through digital devices and computers. The initiative has five core tasks, including speech recognition, speech synthesis, machine translation, language and style checking, and language resources. In order to add to the available database of Icelandic, the people who live in Iceland can donate samples of their speech to help with the initiative.
Open access to research data	Ministry of Education, Science and Culture	In response to neighbouring countries placing an emphasis on increasing the societal benefits from public investments in data through opened access, Iceland has started an initiative to provide access to public data from universities and research institutes. In addition, an increasing demand has been seen for access to data generated through public competitive funds, and therefore this type of data has also been included in the initiative.

Iceland High Performing Computing (IHPC) National Competence Centre (NCC)	University of Iceland	IHPC NCC is a collection of researchers and experts in AI from various academic and industry organisations. Together, they have built up a community of stakeholders and researchers that meet regularly to discuss ongoing research and applications based on HPC, AI, and quantum computing.

While the ongoing Icelandic initiatives that are related to AI and data are beneficial for the country, there are no compelling best practices to describe in further detail. However, the Office of the Prime Minister has made a laudable decision to shift focus towards data and how to work more strategically with it in order to set the foundation for later tackling the topic of AI. After all, data management is an important precursor to succeeding with AI development, and it is also one of the most common hurdles for both private and public organisation to overcome when attempting to develop new AI solutions.

National AI Development Challenges

In Iceland, there is one challenge that surmounts all of the others when it comes to AI development. Even though the country faces many of the same challenges that can be found among its Nordic neighbours, the issue of access to skilled labour with a background in AI is particularly pressing for Iceland, and it is therefore the focus for the country's challenges in this report.

Challenge 1

A lack of skilled labour for AI development

The Icelandic challenge of a lack of skilled labour for AI development starts off with the common issue of simply not having enough availability of the right competencies. This issue can be found in many other countries and organisations, and in Iceland it has resulted in the country needing to catch up with its neighbours with regards to the development of an AI strategy. In addition, the lack of relevant experience has also made working with other AI topics in the public sector into a particularly tough challenge, including for supporting the private sector through financing of relevant projects and the creation of networks for joint AI development. This is why much of the ongoing progress that is being made is tied to academia and a select few areas of the private sector, such as within medtech, healthtech, and fintech.

The other aspect of the skilled labour shortage that impacts Iceland more acutely than the other Nordic countries is in the amount of knowledge sharing and joint AI-development networks that it can pursue. In the neighbouring countries, many networks are already established, and more are continuously being created. This creates an environment where the most impactful networks rise to the top, and where organisations can more easily find the network that is just right for them based on current skill level and ambition. In the case of Iceland, however, there are fewer available resources which means that a more ad-hoc approach to setting up cooperative networks becomes less feasible since there will be fewer variations to create. This leads to the challenge of ensuring that the networks that are established in Iceland, and extend to the rest of the Nordics, are just right for the country based upon what local organisations need support with. Without this well-planned approach to creating AI knowledge sharing networks within the Nordics, Iceland risks not getting as much out of the partnerships as the neighbouring countries.

While the challenge of a lack of relevant experience is a significant hurdle, there is a positive aspect that is important to mention. Since Iceland is such a small country, an increased focus on Nordic cooperation can have an outsized effect on their AI development. This becomes particularly true if Nordic countries turn to Iceland for some of their AI development, which is something that will be mentioned in the next section, and it is therefore worthwhile to explore how Iceland can be brought closer to its neighbours and how targeted cooperation can be pursued.

National Strongholds

Stronghold 1

An invitation to innovation

Similar to the other Nordic countries, Iceland's population is also strongly in favour of digitalisation and innovation. But unlike its neighbours, Iceland faces a tougher challenge related to the availability of workers who have experience working with AI. This combination of attributes has led the country to implement policies that are beneficial for innovation, including for AI, and for attracting foreign workers.

Starting with the policies for innovation, Iceland is aiming to become a testbed for innovation by betting on more open data, especially within the field of healthcare. While the country is still grappling with exactly how open their data should be, this field is particularly interesting since Iceland has a long history of collecting and storing healthcare data about the population, which can now be used to boost innovation and potentially provide a multitude of benefits to the country and population. Moreover, the availability of data and potential to innovate has the capacity to reach an audience of companies well beyond Iceland's own borders, or even the Nordics, who are interested in creating new and innovative ways to improve their healthcare services. However, as mentioned in the country introduction, it is important to recognise that the local data potentially does not have enough variability on its own to support international utilisation of locally developed AIs. Nevertheless, Iceland can be a starting point to test and launch new ideas. In the short term, this potential for innovation can bring new investments to Iceland that can augment the ongoing AI development, and in the longer term it can help the country attract some of the much-needed talent that is currently missing.

When it comes to the skilled labour shortage for AI development that Iceland is facing, the Office of the Prime Minister recognises that innovation can be boosted if foreign workers with the right experience can be enticed to move to the country. This has led Iceland to enact government policies that make it easier for foreigners to move their families to Iceland. These pro-worker policies, taken together with pro-innovation policies have the potential to give Iceland a strong boost as both businesses and experienced workers are attracted to the country. In turn, this stronghold can be further leveraged within the Nordics by pursuing cross-border investments into Iceland when other Nordic countries may be deemed as too restrictive. Thereby raising the overall pace of innovation in the Nordic region while simultaneously strengthening Iceland's position as a regional hub for important innovation, such as within the healthcare and fintech sectors.

Country Reports

NORWAY

Introduction to Country

Norway is known for being at top of UN's Human Development Index[93], and for being one of the richest countries in the world in terms of GDP.

The wealth has, among other things, been obtained through the great access to energy sources such as hydro power and oil and gas[94]. When it comes to industries, Norway is world-leading in petroleum activities, green shipping, aquaculture, and process industry[95]. Across several sectors, Norway has an advantage when it comes to achieving what the European Commission has defined as "Twin Transition"[96], the ability to achieve green and digital transition simultaneously.

Regarding the national AI strategy, it was established in 2020 and it deals with the basic prerequisites for being able to develop and adopt AI, including how Norway must develop competence within AI and how the public and private sector should be able to utilise the potential inherent in AI within an ethical framework. According to the digitalisation minister at that time, Nikolai Astrup, Norway has a good foundation to succeed with AI through a population that is positive towards adopting new technology, a business sector that is technologically advanced and a highly digitised public sector[97]. Compared to the other Nordic countries, Norway ranks as number 13 in Oxford Insight Artificial Intelligence Readiness Index from 2021[98], which is below its neighbouring countries Finland, Sweden, and Denmark.

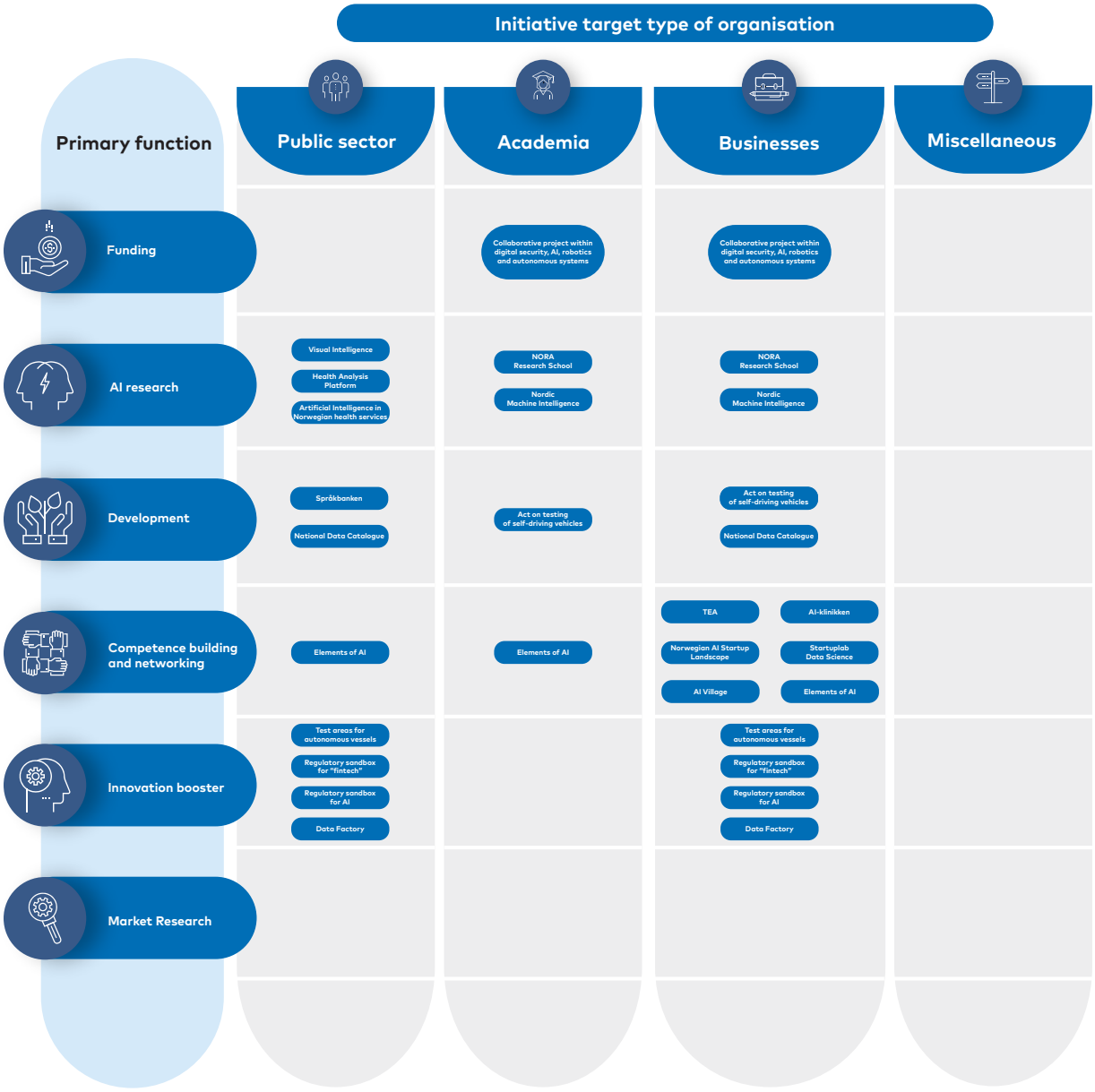
Furthermore, Norway, like the other Nordic countries, has a trust-based society where there is a high degree of trust in each other, in organisations and in the authorities. The Norwegian government wants to maintain this trust when AI is adopted in the society through the AI strategy. In the Oxford Insight Artificial Intelligence Readiness Index from 2020 Norway was ranked as second best in the world in terms of responsible use of AI[99].

With the strategy, several concrete actions to bring it to realisation were launched. The actions are related to making data more widely available, establishing an AI-friendly regulatory framework and increase the focus on AI in higher education programs. The actions are described in more detail in the section "National Strategies and Policies". However, the AI strategy has not been revised since it was launched in 2020, and the general perception is that the political interest in the field has been declining since then. On the positive side, the perception is that there are good financing lines in Norway within research on AI.

In the recent years, Norway has seen an emergence of AI clusters and networks that maintain the relationship between academia and business. Looking at the participants and partners in the clusters and networks, there is a high participation of major players in both the public and private sectors, and there are also SMEs represented in some of the clusters.

Desk research and interviews show that both fundamental and applied research within AI takes place in several universities, networks, clusters and even within some organisations, but that the transition from research projects to large scale adoption in businesses is often missing. In addition, we learnt through the interviews that a large proportion of companies in Norway have launched AI pilots in the last five years, but a low proportion of these pilots has been implemented in large-scale in the businesses. This is described in more detail later.

Visualization of National AI & Data Ecosystem



National Actors

Cluster for Applied AI

Cluster for Applied AI was Norway's first business cluster for applied AI. The purpose of the cluster is to contribute to profitable and sustainable use of AI in a business context. The cluster's vision is for the businesses to become leading, data-driven, effective and customer-centric through the development and use of AI. The cluster holds more than 60 members and close collaborating partners which represents the entire value chain of AI. The cluster aims to create new jobs based on rapid development and application of AI. Cluster for Applied AI was established in 2019 and is hosted by Smart Innovation Norway[100].

Some of the main members of Cluster for Applied AI are eSmart Systems, IFE Invest, Statsbygg and Østfold Energi. Kongsberg Innovasjon, Kjeller Innovasjon, IKT Norge and NHO are some of the partners.

DigitalNorway

DigitalNorway is a non-profit organisation financed by 15 enterprises to facilitate digitalisation of Norwegian industry founded in 2017. Telenor, Equinor, Statens Vegvesen, Sintef and Kongsberg are some of the members. DigitalNorway focuses on reaching out to SMEs. DigitalNorway offers free courses, webinars, and meetups to help the SMEs succeed on their digital journey. One of the focus areas for DigitalNorway is to establish a collaboration project in the field of data sharing that contribute to the digitalisation of the Norwegian business sector[101].

Innovation Norway

Innovation Norway is the Norwegian Government's agency for supporting businesses throughout the country to work with innovation and development across industries. This is the main soft funding agency for businesses, organisations, and the public sector in Norway. Innovation Norway supports in terms of financial means, as well as with competence, advisory services, and networking.

They assist Norwegian businesses to grow and find new markets . Innovation Norway has a dedicated accelerator for international scaling for companies utilising AI, which is described in more detail under "National Initiatives".

Furthermore, Innovation Norway is, together with the Research Council of Norway and Siva, responsible for administering the national programme for Norwegian business clusters. The Norwegian Innovation Clusters is funded by the Ministry of Trade, Industry and Fisheries and the Ministry of Local Government and Modernisation. The budget for the cluster programme for 2021 was NOK 217 million, and at the turn of the year 2020/2021 the programme had 39 clusters. The clusters in the programme include established businesses, entrepreneurs, investors, knowledge communities and public-sector developers, and the members from the business sector take the lead.

Examples of business clusters that have better use of data as a key component in their collaboration are Proptech Innovation and the Cluster for Applied AI[103].

Ministry of Local Government and Regional Development

The Ministry of Local Government and Regional Development was responsible for developing the Norwegian national AI strategy in 2020 and is currently working on a strategy related to value creation from data, which was published as a white paper in 2021. The Ministry of Local Government and Regional Development currently consists of eight specialised departments, and one of the departments is the Department of National IT Policy and Public Governance. The responsibility includes work on digitalisation and innovation in the public sector, the Personal Data Regulations and administrative responsibility for the Norwegian Data Protection Authority and the Privacy Appeals Board[104].

Norwegian Artificial Intelligence Network for Europe (NAINE)

The main purpose of NAINE is to contribute to increased number of EU proposals on AI with Norwegian involvement. NAINE is open for everyone in Norway interested in AI and national collaboration and collaboration across Europe. This includes both research and applications, across both academia and industry. NAINE is monitoring activities, forwarding information, and coordinating hearings for calls together with the Research Council of Norway[105].

Norwegian Artificial Intelligence Research (NORA)

Norwegian Artificial Intelligence Research (NORA) is an academic focused network of institutes working with AI research that was founded in November 2018[106]. NORA connects and supports AI research groups at its partnering institutions and gives the individual researchers access to the growing AI infrastructure and expertise throughout Norway. The network shall contribute to develop joint research projects between partners. Lastly, NORA aims at taking an active part in establishing start-up companies in the AI field, as well as strengthening the collaboration between the consortium partners' research communities and the business community. NORA is a collaboration between eight universities, three university colleges and four research institutions within AI, machine learning and robotics in Norway.

Norwegian Artificial Intelligence Society (NAIS)

The Norwegian Artificial Intelligence Society (NAIS) is a non-profit entity promoting research and application of Norwegian AI both nationally and internationally. Its members include Norwegian universities, organisations, researchers, professionals, and students who are active in, or interested in, the area of AI. NAIS is also member of EurAI (European Association of Artificial Intelligence), a European network of AI societies.[107]

Norwegian Open Artificial Intelligence Lab (NAIL)

NAIL is a hub for research, education, and innovation within AI. The objective of the Norwegian Open Artificial Intelligence Lab is to enable both basic and applied interdisciplinary research at high international level and foster strong partnerships between academia and private sector. The lab provides infrastructure and a framework for close cooperation with academic, corporate, and industrial partners[108]. NAIL was established in March 2017.

Proptech Innovation

Proptech Innovation is a business cluster with 82 members within real estate technology, with a focus on data-driven innovation, circular economy and zero emissions[109]. The cluster wants to make the real estate industry smart and sustainable by using knowledge, efficient collaboration, smart technology, data, and AI.

The Norwegian Board of Technology

The Norwegian Board of Technology is an independent body for technology assessment established by the Norwegian Government in 1999. Their role is to identify important technology challenges and promote debate on the opportunities and consequences that new technology creates. Furthermore, the Board shall provide input the Norwegian parliament and other authorities. Current projects include AI, mobile health technologies, the future of jobs, driverless cars and foresight and anticipatory governance[110], and the Board works on ethical and societal implications of AI and data.

The Norwegian Centre for AI Innovation (NorwAI)

The Norwegian Research Centre for AI Innovation is a research centre on AI and big data, established in October 2020. The goal of NorwAI is to develop cutting-edge theories, methods, and technology for efficient, effective, and responsible exploitation of data-driven AI in innovative industrial solutions[111] . NorwAI is funded by the Research Council of Norway.

The Norwegian Data Protection Authority (DPA)

The Norwegian Data Protection Authority (DPA) is a public authority subordinate to the Ministry of Local Government and Regional Development. DPA is an independent body set up in 1980 to protect everyone's right to privacy and is financed by the Norwegian government[112]. DPA addresses the topic of data protection when developing and using AI and is also hosting the regulatory sandbox for AI, which is described in more detail under "National Initiatives".

The Norwegian Digitalization Agency (Digdir)

The Norwegian Digitalization Agency was established 1st of January 2020 and is the Norwegian government's primary tool for faster and coordinated digitalisation of the Norwegian public sector. Digdir gathered several Norwegian IT solutions under the same management. The digitalisation minister stated Digdir's ambition: "Norway will be a global leader within the digitalisation of public services. Our aim is for digitalisation to make public services better and more accessible, simplify processes and increase value creation for businesses and make everyday life easier for most people."[113] Digdir also organises webinars where public organisations share their experiences with AI and jointly push the AI agenda forward in a collective manner.

The Norwegian Directorate of Health

The Norwegian Directorate of Health aims to better the quality in the health service and to promote factors that bring good health to the population. The directorate has developed a "starter kit" that contains information that is relevant if you are researching or developing products based on AI in health, are to carry out a procurement or are going to use equipment based on AI[114]. Furthermore, the directorate offers several open datasets through the service HAPI (the Norwegian Directorate of Health's API service)[115].

The Norwegian Labour and Welfare Administration (NAV)

NAV is another frontrunner in digitisation in the Norwegian public sector. NAV has established "NAV Lab", where users are invited to participate in developing nav.no. Through tests and feedback users can give feedback about ideas, concepts, and prototypes before they are launched. The NAV Lab was established in 2016[116]. When it comes to AI, NAV has put a lot of focus on responsible AI and they have developed their own principles for responsible AI. NAV has developed a model and used AI to predict sick leave.

The Norwegian Tax Administration

The Norwegian Tax Administration is one of the frontrunners in digitisation among the actors in public sector and have also started to experiment with applying AI models. A project has been conducted to create an AI assisted tax return process[117]. Back in 2016, the tax authorities developed a predictive analysis to help choose which tax returns to check for errors or fraud[118].

The Research Council of Norway

The Research Council of Norway is a state-run Norwegian administrative body that funds research and innovation projects on behalf of the Norwegian Government. The Research Council has dedicated funding to projects within AI, robotics, and autonomous systems, which is described in more detail under "National Initiatives". In addition, the council administers SkatteFUNN, a tax deduction scheme for research and development efforts in the business sector. The purpose is to motivate companies to acquire new knowledge, information, or experience which in turn can lead to new or better products, services, or production methods[119] .

Universities

Norway has several universities that have education programs linked to the field of AI. University of Oslo has established d Science which is a centre focusing on computational science and data science[120]. Oslo Metropolitan University has established an AI Lab to conduct research, education and innovation on AI systems that improve the way people work and live[121]. At the University of Agder, the Centre for Artificial Intelligence Research (CAIR) was established in 2017 with 109 master students and three PhD students having graduated from the program to date[122] . NTNU is hosting the Norwegian Open Artificial Intelligence Lab (NAIL) and is responsible for the course "Elements of AI" in Norway.

National Strategies and Policies

The Ministry of Local Government and Regional Development launched Norway's national strategy on AI in January 2020.[123] The strategy deals with the basic prerequisites for being able to develop and use AI, how Norway must develop competence within AI and how the public and private sector should be able to utilise the potential inherent in AI within the ethical framework set forward by the strategy.

The strategy launched several concrete actions to realise the strategy. To highlight some of the actions in the strategy: 1) making data more widely available, 2) establish a regulatory sandbox within data protection and privacy (a regulatory sandbox is an environment where companies can test new technologies and business models in a controlled environment under close monitoring by the regulator), 3) review and evaluate regulations that impede application of AI, and 4) increase the focus on AI in higher education based on business and sector needs, and include ethics, data protection and data privacy in these education programs.

In addition, the strategy focuses on AI to be applied and adopted in an ethical way that respects human rights. Thus, the strategy presents a set of ethical principles for development and use of AI in Norway. In summary the principles focus on respecting the individual's self-determination and privacy, systems developed to be secure and technical robust, algorithms and models must be transparent and verifiable, and that solutions based on AI facilitate inclusion, diversity, and equal treatment.

Beyond the national AI strategy, the Ministry of Transport established a strategy in 2018 to support increased use of open public data from the transportation sector[124]. To achieve this, the public data from government agencies within the sector must be made available and adapted for further use. In addition, the Ministry of Transport has developed a National Transport Plan for 2022-2033 with the overriding objective: An efficient, environmental- friendly and safe transport system in 2050[125]. An important background for this transport plan is that the transport sector, both in Norway and internationally, will be characterised by several important technology trends such as autonomous and driverless means of transport, electrification of the sector, shared mobility, and interactive intelligent transport systems. Norway has become an attractive testbed for autonomous vehicles, and ranked third in the KPMG 2020 Autonomous Vehicles Readiness Index (AVRI)[126].

Moreover, external cloud solutions are a prerequisite for many companies for being able to utilise the potential of AI. In response to this, the Ministry of Local Government and Regional development launched a Data Centre Strategy in 2018 with the goal of to ensure that Norway is an attractive country to build data centres[127]. The strategy was revised in 2021. The Ministry of Local Government and Regional development also published a white paper on data driven economy and innovation in 2021. The government wants Norway to take advantage of the opportunities offered by data to increase value creation, create new jobs, and increase efficiency in the public sector. To achieve this the government is working towards a more efficient and secure digital infrastructure for sharing and use of public data. Furthermore, better utilisation of data is important for Norway to succeed in the transition to a more sustainable society and a greener economy[128].

Finally, the Ministry of Trade, Industry and Fisheries established Digital 21 in 2018. The aim of the strategy is to provide recommendations to the authorities on how companies can develop and benefit from competence, technology, research, and development to succeed with digitalisation. An important part of the 21 strategy is the fact that Norway cannot be best at everything and should prioritise technology areas that can provide the greatest benefit for Norwegian business. Digital21 points to the areas of AI, big data, IoT and autonomous systems as particularly important technologies for Norway in the future[129].

National policies	Description
AI Privacy Implications	The Norwegian Data Protection Authority published a report in 2018 on the privacy implications of AI. The report highlights and explains four important challenges related to data privacy and AI: 1) justice and discrimination, 2) specificity of purpose, 3) data minimisation, and 4) transparency and right to information[130].
National principles for use and sharing of data	As part of the white paper published on data driven economy and innovation in 2021, the government established four principles for use and sharing of data: 1) data should be open when they can, and protected when they must be, 2) data should be available, retrievable, usable, and comparable with other data, 3) data must be shared and used in a way that provides value for business, the public sector and society, and 4) data shall be shared and used in a way that respects fundamental rights and freedom, and that preserves Norwegian societal values.
Guidance Material on Data Sharing	The Norwegian Digitalisation Agency (Digdir) is responsible for the Norwegian Resource Centre for Sharing of data, which opened in September 2020. The resource centre works to promote the sharing and use of data by developing guidance material on how to share data, as well as development of legislation that promote digitalisation. Furthermore, the resource centre is an advisor when legal challenges related to data sharing arises[131].

National policies	Description
Act relating to Language	The purpose of the Act is to strengthen the Norwegian language to safeguard it as a complete language. Technological development impacts how we interact and communicate, and several products and services surrounding us are based on language technology. Today, language technology is better in English than Norwegian, and better in Bokmål than other Norwegian dialects and Sami. An important reason for this is that it exists more data for larger languages. The establishment of a language bank in the National Library in 2010 was a response to this challenge[132] . The language bank is described in more detail under "national initiatives".
Policy for Open Access to Research Data	The Research Council of Norway has established a policy for open access to research data, which was revised in 2017. The policy shall contribute to research data being available to relevant users, on equal terms and at the lowest possible cost. The Research Council's policy follows and open-by-default principle regarding access to research data, and states that research data must be accessible, findable, and reusable. Generally, the guidelines apply to all data in projects funded by the Research Council[133] .

National Initiatives and Programs

The most relevant Norwegian initiatives and programmes related to AI and data are presented in the table below. It is important to note that the list is not exhaustive due to the dynamic nature of the AI ecosystem.

Name of initiative	Initiative leader	Description
Visual Intelligence	Centre for research-based innovation (SFI)	Visual Intelligence is a centre for research-based innovation funded by the Research Council of Norway and consortium partners. The centre aims to be the lead provider of novel deep learning-based solutions for cutting-edge complex image analysis. The centre for research-based innovation has been a program run by the Norwegian Research Council since 2005. Visual Intelligence was opened in Tromsø in January 2021.
AI-klinikken ("The AI Clinic")	Cluster for Applied AI	In 2021, the Cluster for Applied AI started the AI clinic. The AI clinic is aimed at companies that want to realize their digital potential. For instance, through data capture and storage, smart cities, industry 4.0 or image recognition. The AI clinic provides access to knowledge and capabilities within these fields, and they help facilitate meetings and workshops where the companies meet those who have the right competence for their type of business and issue.

Data Factory	DigitalNorway & Norwegian Digitalisation Agency (Digdir)	The Data Factory was launched in 2021 and is a mediator of data available from various sources, and a facilitator for SMEs, start-ups, and public organisations to be able to develop new business opportunities where their own or other's data is used. The ambition to the Data Factory is to reduce technical, legal, and business barriers related to sharing and use of data, and by this reduce the threshold to create value from data. Furthermore, fundamental courses on how to get started with data sharing are offered through the Data Factory by DigitalNorway. Lastly, a user forum named Data Village has been established. Through this forum testing and use of available data, as well as open discussions about the topic, takes place.
AI Village	Idletechs, E.C. Dahls Eiendom, AIA Science & Ut-prosjektet	AI Village in Trondheim is an example of an initiative driven by the business community. AI Village consists of a collection of AI companies in Trondheim physically located at the same place. One goal is to bring together companies to make them better equipped for international competition. Another goal of the AI Village is for Trondheim to keep the companies that succeed to stay in the region, as there has been a tendency for companies to move from Trondheim. AI Village was opened in May 2019.

TEA	Innovation Norway	Innovation Norway have had a dedicated accelerator for international scaling for companies that have developed a product, service, or concept utilising AI or IoT, and that have global market potential since 2013. The name of this global accelerator is Tech City Executive Accelerator (TEA) and is based in London. The program is open for all sectors and industries if the company is within the field of AI or IoT and runs for a period of six months with physical gatherings in London. Through TEA the participating companies gets tools, advisory services and competence on international scaling, and the ability to grow their network.
Act on testing of self-driving vehicles	Ministry of Transport	A legislative change was introduced to allow for experimental activities in the field of autonomous vehicles. The law opened the possibility to obtain permission to carry out pilot projects with vehicles without a driver. The law entered into force in January 2018. This law is a premise for adopting systems and technologies based on AI that makes autonomous driving possible.

Artificial intelligence in Norwegian health services	National centre for e-health research (KIN)	A Norwegian research centre part of Helse Nord established in 2021. KIN is a national network for AI within health service consisting of representatives from professional environments throughout Norway. The network has a bottom-up approach, and the purpose is to share experiences and put important issues related to clinical implementation of AI on the agenda. Furthermore, the research centre will collect, produce, and disseminate knowledge the authorities need for e-health policies.
Nordic Machine Intelligence	NORA	Nordic Machine Intelligence (NMI) is a non-commercial, open-access, peer-reviewed journal started in 2021. The journal publishes research articles, literature reviews, conference articles related to NORA's Norwegian and Nordic conferences, and other educational material within all aspects of AI. The journal is published by the University of Oslo (UiO).
NORA Research School	NORA	NORA has established a research school for PhD students with projects related to AI, machine learning and robotics. Membership in NORA's research school is already open to PhD students from a NORA partner institution. The aim of the research that takes place under the auspices of NORA Research School is that it should be relevant to the business sector and industries.

Norwegian AI Startup Landscape	NORA, Cluster for Applied AI & Norwegian Open AI Lab	In January 2022, NORA, Cluster for Applied AI, and the Norwegian Open AI Lab joined forces to establish the Norwegian AI Startup Landscape, as part of the larger European AI Startup Landscape initiative. Up until this point there has not been a common platform for AI start-up companies in Norway to showcase their technology and solutions, as well as get connected with early investors and potential customers. The start-up must fulfil a set of criteria to be evaluated in addition to having AI at their core; the company must be registered in Norway, founded less than ten years ago, and the start-up must have a minimum of one FTE with AI competence.
National Data Catalogue	Norwegian Digitalisation Agency (Digdir)	A public website that provides an overview of descriptions of datasets, concepts, APIs, and information models launched in 2017. The content is provided by various public entities. Digdir is responsible for the operation and development of the website. The catalogue addresses the need to discover, evaluate and access data. As of late March 2022, the national data catalogue contained 1,608 datasets, 181 APIs, 5,470 concepts and 162 information models.

Elements of AI	Norwegian University of Science and Technology (NTNU)	"Elements of AI" is a free online course developed by Reaktor, the University of Helsinki and Feed. NTNU offers the course in Norwegian. To launch the course in Norwegian was mentioned as an action in the national AI strategy. The course was launched in Norwegian in 2020. The course consists of a series of free online courses in AI aiming to encourage as broad a group of people as possible to learn what AI is, what can (and can't) be done with AI, and how to start creating AI methods.
Startuplab Data Science	Startuplab	The Data Science lab at the StartupLab is a program where start-ups can get support for implementation of AI. Data Science Lab can provide a direct communication channel between NAINE and start-ups with focus on practical application of AI. The Data Science Lab was established in 2019, while Startuplab was established back in 2012. The goal of the Startuplab Data Science program is to create a world class cluster for business innovation within big data, machine learning and AI. They have developed their own nine-week course named "Deep Neural Network course", which is a hands-on course for experienced data scientists, data engineering and developers who want to extend their knowledge into machine learning.

Health Analysis Platform	The Directorate of e-health	The Norwegian government established a national solution to make health data available to research and other secondary use in 2018. The goal is to streamline and simplify access to health data for research and analysis purposes to get better use of health data, while at the same time strengthening data privacy. In December 2021 the program was put on hold mainly due to the legal challenge because of Schrems II. The Schrems II judgement imposes severe restrictions on anyone who handles the transfer of personal data between EU/EEA countries and third countries, including the United States, and responds to the US laws giving US authorities the right to access personal data from US companies, including those operating abroad . In the case of the Health Analysis Platform the cloud provider used was subject to US laws.
Regulatory sandbox	The Financial Supervisory Authority	The purpose of the regulatory sandbox is to increase the authority's understanding of new technological solutions in the financial market ("fintech"), and for companies at the same time to gain better understanding of requirements in the regulations and how these affect new business models, services, and products. The financial regulatory sandbox was established in December 2019. The sandbox has been open for participation three times, the latest with deadline for application in December 2021.

Språkbanken (Language bank)	The Language Council of Norway	The Language Council of Norway works to strengthen the Norwegian language and enhance linguistic diversity in Norway. Språkbanken is a technological infrastructure in Norway composed of digitised language resources that can be used to develop ICT-based technology that handles linguistic data. Språkbanken was introduced back in 2010.
Regulatory sandbox for AI	The Norwegian Data Protection Authority	One of the initiatives in the Norwegian AI Strategy was to develop a regulatory sandbox within the field of data protection and privacy to foster innovation of responsible use of AI. The sandbox supports actors in understanding the regulations and create solutions that are compliant with data protection and privacy. The sandbox was established in 2020. The first time (2020) the sandbox opened for applicants there were 25 companies and organisations that applied. The second time (2021) there were 21 applicants. The third time (2022) the sandbox opened for applications there were 11 applicants.

Test areas for autonomous vessels	The Norwegian Maritime Authority & The Norwegian Coastal Administration	The Norwegian shipping industry is at the forefront when it comes to developing and utilising new technology. Back in 2016 the Norwegian Maritime Authorities established the first test area for autonomous vessels, where AI plays a pivotal role. Subsequently, two more test areas have been approved. As a result of this legislative change, we see commercialisation of autonomous vessels in Norway. There is currently one ship, Yara Birkeland, which is in the process of going from manned operations to full autonomous operation with remote monitoring by the end of 2022. Additionally, Norgesgruppen (ASKO) is in the process of establishing autonomous transportation across the Oslofjord. According to plans, the ferries will be in full operation by the end of 2024.
Collaborative project within digital security, AI, robotics and autonomous systems	The Research Council of Norway	The Research Council of Norway has dedicated funding to projects within AI, robotics and autonomous systems. The aim of these funds is to develop new knowledge within the mentioned fields. To qualify for funding the project needs at least two Norwegian business partners that are not research organisations. Each project may apply for funding between 4 and 12 MNOK. From October 2020 until March 2022, 21 projects have been approved. In total these projects have applied for 250 MNOK in funding.

Best practices

Going through the national actors, strategies, policies, and initiatives related to data and AI shows that Norway places an emphasis on ethical and responsible AI, that there are many actors within the research field of AI, and that there exists state-run soft funding for projects related to data sharing and AI.

Out of these many worthwhile initiatives in Norway, however, there are two initiatives that in particular can be considered as best practices due to their significant impact on sharing and building competency and capabilities within AI. These initiatives include, 1) the regulatory sandbox, and 2) the health analysis platform.

Best practice 1

The regulatory sandbox to support responsible use of AI

One of the topics that has been continually raised in interviews with Nordic experts within the AI ecosystem is the challenge of comprehending and adjusting to the regulatory landscape. This is particularly difficult for SMEs and public institutions who are less likely to have the required resources on hand to break down the applicable regulations and make them easily understandable for the rest of the organisation. Meanwhile, large international companies stand to benefit since they do have the requisite resources and are therefore able to rapidly work their way around the regulations while the rest of the ecosystem tries to catch up.

With this backdrop of a strong need to comprehend relevant regulations, it is especially interesting to see Norway becoming the second country in the world to establish what is known as a regulatory sandbox, after the United Kingdom[135]. This is a safe testing environment for companies and organisations to experiment with products, techniques, and services under the guidance of The Norwegian Data Protection Authority who oversees the environment. The benefits of this approach are two-fold. The first part is that the companies can improve their understanding of the applicable regulations and how to create ethical AI solutions, and the second part is that the DPA can learn about new solutions that may be making their way to the market and to identify potential risks related to them.

The regulatory sandbox is open to companies in various sectors who use personal information to develop innovative products and services that have societal benefits. Once the testing is complete, the solutions are also meant to function as pioneering examples and to help other companies that want to develop similar solutions. Therefore, the essence of the regulatory sandbox is that individuals and society should more rapidly be able to make use of the development of new and innovative solutions that are created with the support of a responsible framework. In turn, this means that companies get the support that they often require to be able to navigate the complex regulatory environment and are therefore more rapidly able to launch new products and compete with the larger companies who otherwise would be getting an upper hand.

Best practice 2

The Health Analysis Platform

Countries and governments around the world are grappling with the complex topic of how to make healthcare more accessible and affordable while the costs continue to rapidly increase as a result of aging populations, unhealthy lifestyles and more expensive treatments. In response to this challenge, one of the most popular solutions with significant potential is the utilisation of data-driven healthcare to both personalise treatments and to succeed with preventative care. However, to achieve any real results with this approach to healthcare, health data needs to become more accessible and useful, which is currently a significant barrier for many countries due to regulations.

While many other governments are waiting for others to make the first move, Norway's Directorate of eHealth created The Health Analysis Platform with the goal of ensuring better utilisation of health data.

With the utilisation of this platform, Norway hopes to support researchers with becoming better at understanding illnesses and disease while also being able to develop better pharmaceuticals and treatment methods. This is planned to be achieved by connecting data that is currently siloed in disparate registers which is making research an unnecessarily slow and arduous process that hinders innovative progress.

In addition to making it easier for researchers to innovate through the use of health data, the initiative is also putting an emphasis on ensuring that the integrity of the data is upheld. In tandem with this goal, the Directorate of eHealth also wants to make it easier for Norway's citizens to track their own health data, including where it is stored, as well as for them to give and retract access rights to others.

Overall, The Health Analysis Platform is an important step in the right direction to reach a more data-driven healthcare sector which is eventually bound to be a cornerstone of healthcare in the Nordics. However, due to the choice of a US-based company as the supplier of the cloud solution used for The Health Analysis Platform, the initiative was placed on hold in December of 2021 because of Schrems II. As described earlier, The Schrems II judgement imposes severe restrictions on anyone who handles the transfer of personal data between EU/EEA countries and third countries, including the US and responds to the US laws giving US authorities the right to access personal data from US companies, including those operating abroad. However, the Directorate of eHealth states that it is working on a new path forward to succeed with the original goals set in 2018.

National AI Development Challenges

The regulatory sandbox and the health analysis platform are two examples of initiatives that positively impact the sharing and building of capabilities within AI. However, the country still faces challenges related to 1) low degree of utilisation of AI by established businesses, and 2) shortage of capabilities and competence.

Challenge 1

Low degree of commercialising AI research and AI pilots by established businesses

The Nordic State of AI report found that Norway has the lowest number of companies utilising AI of the Nordic countries (excluding Iceland)[136]. From the interviews, we learnt that many companies in Norway have had pilots on AI during the last five years, but a low proportion of these pilots were implemented and commercialised. There are several reasons for this; regulatory obstacles, lack of data with sufficient quality, lack of competence to run implementation projects, underestimating the needed changes to culture and processes, and lack of anchoring with internal decision makers due to a bottom-up approach to AI development. Thus, there seems to be a need for management to better understand the potentials and limitations of AI, and in what areas it can have strategic importance for the business.

The introduction of AI solutions will challenge both established and new companies in terms of how to create and deliver value. Implementing AI will require companies to think differently about their business models. Thus, management will need a deeper knowledge of business model innovation related to AI[137]. Our hypothesis is that without a more strategic understanding of AI, and how it will impact the business and business model, Norway will continue to have the lowest degree of utilisation of AI in the Nordics.

Even though the utilisation of AI in SMEs is low, the Nordic State of AI report found that many Norwegian start-ups focus on AI. This is also reflected in the increase of VC investments in AI start-ups in Norway during the period from 2016 to 2020. In total there has been invested 314 million USD in Norwegian AI start-ups during this period, from 5 million USD in 2016 to 142 million USD in 2020 according to the OECD[138].

When it comes to funding of AI research, the perception is that there are good financing options, and that the collaboration between academic research and businesses within public and private sector works well at a research level. However, the transition from academic research to adoption in businesses is less common. In contrast, in the US large companies conduct fundamental research and development on AI. This leads to research on AI and commercialisation of AI going hand in hand.

Challenge 2

Shortage of capabilities and competence

Through the interviews we learnt that Norwegian businesses over the last ten years have shifted from developing models and algorithms in-house to purchasing it as SaaS solutions. Even though the businesses still need to train the models, several of the interviewees were worried about the challenges it raises in terms of not having sufficient capabilities and competence in-house to explain and understand why the models give the output they do.

In Norwegian businesses there are few with in-depth knowledge and competence on AI and there is lack of capabilities to carry out this type of projects in large scale. One additional barrier for the public sector in Norway is the strong focus on the Norwegian language, which makes it harder to attract this type of competence and capabilities internationally.

Historically, there has been little focus on dedicated educations within the field of AI, but this is changing. NORA (Norwegian Artificial Intelligence Research Consortium) has established NORA Research School for PhD students with projects related to AI, machine learning and robotics. The aim of the research that takes place under the auspices of NORA Research School is that it should be relevant to the business sector and industries. During the PhD period, the students will get the opportunity to take internships where they can help businesses apply and adopt AI, machine learning and robotics.

National Strongholds

We find that there is one particular stronghold where Norway stands out in comparison to its neighbours, namely the ability to achieve green and digital transition hand in hand.

Stronghold 1

Ability to do "Twin Transition"

Green transition and digitalisation are tightly linked and is about using digital technology to create new sustainable solutions and reduce climate emissions. The European Commission has introduced the definition "Twin Transition" to describe this dual transition. Across several Norwegian sectors, Norway has an advantage when it comes to the ability to achieve green and digital transition in pair.

As described in the introduction to the country, Norway is world-leading in industries such as the energy industry, process industry, green shipping, aquaculture, and petroleum activities. These industries are all relevant for the green transition. According to the national AI strategy Norway should build on the strong sector knowledge in the development and use of AI. The Nordic State of AI report from 2021 emphasis that Norway is well known for its energy industry worldwide, and that the adaption of AI in this industry will increase the efficiency of processes and the sustainability. By this, AI can be an important enabler for achieving twin transition in the energy industry.

The government, the business industries and academia in Norway have all acknowledged the need to accelerate the focus on the joint transformation within green transition and digitalisation. The Norwegian Board of Technology has identified "technology policy for a green transition" as one of three focus areas for the period 2020-2023. Within this focus area AI and IoT are mentioned as enabling technologies. Furthermore, the white paper on data driven economy and innovation from 2021 highlights the importance of better utilisation of data for Norway to succeed in the transition to a more sustainable society and greener economy. Innovation Norway has established dedicated funding to support the green and digital transition[139].

The Norwegian shipping industry is an example of an industry where twin transition has already been achieved. The industry is at the forefront when it comes to developing and utilising new technology. Technology has been utilised to make shipping green through electrification of the vessels and to support autonomous vessels[140].

Back in 2016, the Norwegian Maritime Authorities established the first test area for autonomous vessels, where AI plays a pivotal role. Today, there is one commercial vessel in the process of going from manned operations to fully autonomous operation with remote monitoring by the end of 2022, and there are two additional vessels planned. However, autonomous vessels depend on stable internet connection and is therefore, at this point, limited to nearshore shipping.

Furthermore, Norway stands out internationally with a well-developed infrastructure for electric vehicles (EV), and the high adoption of EV cars in Norway is largely due to the government's incentives[141]. As mentioned earlier in the Norwegian report Norway has become an attractive testbed for autonomous vehicles and ranked third in the KPMG 2020 Autonomous Vehicles Readiness Index (AVRI).

Even though Norway has an existing strong presence in sectors where achieving twin transition will be important to achieve the climate goals, there is a strong need to further increase the competence and capabilities in the intersection of industry domain knowledge, digitalisation, and sustainability[142] to further strengthen this national stronghold. This need has already been recognised by the government, and through the long-term plan for research and higher education for the period 2019–2028 the focus on research and innovation related to green transition is strengthened, and the government wants to set aside 800 MNOK to boost the focus on technology in research and education[143].

Country Reports

Sweden

Introduction to Country

Sweden has a long history of developing strong industries that over time grow to become recognised across the world, ranging from pharmaceuticals, to forestry, manufacturing, and retail.

This trend has continued into the era of technology and software, with Swedish brands such as Ericsson and Spotify. However, when it comes to AI the future is still unwritten with regards to how Sweden will make an impact. Nevertheless, as of 2021, Oxford Insights ranked the country as 6th in the world for government AI readiness, only behind Finland amongst its Nordic neighbours[144].

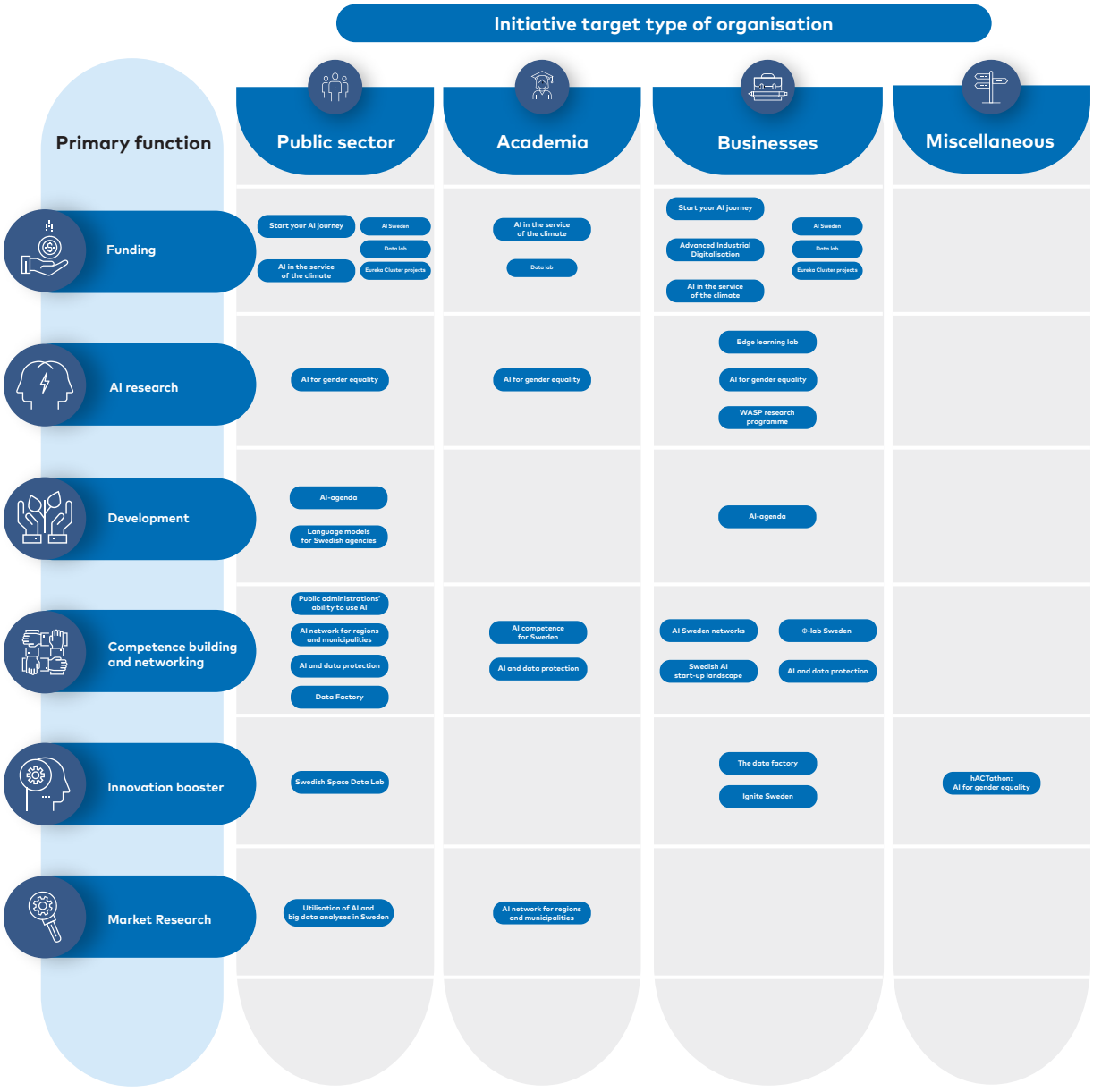
Looking at AI development from a strategic perspective, Sweden was among the first in the Nordics with launching a national AI strategy as early as 2018, albeit again behind its close neighbour Finland. While speed is valuable in such a dynamic market as AI development, the consensus amongst the interviewees is that the strategy does not go far enough and needs to be clearer with the direction and actions that public and private organisations should take.

From the perspective of organisations and networks, Sweden has some strong characteristics that can be leveraged. Starting with the non-profit and public sectors, there are various organisations that work with AI development either through funding, such as Vinnova, through applied AI, such as AI Sweden, and through research, such as Research Institutes of Sweden (RISE). Across these organisations and extending out from them, we also find networks for knowledge sharing that serve as a boost to the local AI development by providing additional support to organisations that need help with topics ranging from data strategies to best practices.

When it comes to the private sector, Sweden has the aforementioned industries as a valuable starting position as they generally have the possibility to make larger investments in AI development, both internally but also externally through various types of collaborations. However, when it comes to collaboration with academia, local experts point to the investments as being too low in order to drive a higher pace of innovation. On the other hand, it is also common for large companies to utilise funding through Vinnova in order to cover a portion of their necessary investments to pursue AI development. In addition to the larger private companies, Sweden also has a vibrant start-up scene, particularly in Stockholm which has recently been ranked second in the world for start-up unicorns (valuations over 1 billion USD) per capita, only behind Silicon Valley[145]. Together, these characteristics provide ways for Sweden to develop AI both within established companies and in a bottom-up fashion.

While these positive features of the Swedish organisations and networks are available to support local AI development, there are also some challenges tied to them that need to be addressed. In particular, our market analysis has shown that organisations have difficulty in launching AI projects past the initial pilot programme stage, and that this is often due to low leadership involvement which is based in a lack of understanding with regard to how to support AI development and which initiatives are worth the necessary investments. In addition, the interviews with local experts have pointed out that Sweden is not quite as risk prone as some other markets like the US, but that is a high bar to top. However, Sweden does have a significant amount of investment capital that is raised, but here the issue is rather that it is being spread too thin across a multitude of projects rather than being focused on a smaller number of large initiatives. Finally, Sweden is also particular in the Nordics with regards to the amount of freedom that organisations in the public sector have, ranging from the regions and municipalities to the various governmental authorities. This makes it more difficult for them to work in the same direction, especially when considering the generic national AI strategy, which means that these public organisations can benefit from additional support, both from a national and Nordic perspective.

Visualization of National AI & Data Ecosystem



National Actors

In Sweden, there are many organisations that have started to develop, test, and pilot AI solutions, both across the public and private sector as well as within academia. However, when viewed from the perspective of organisations that are driving forward the AI development on a broader scale than simply within a single function or organisation, then the list of organisations narrows down quickly. In this section of the Swedish report, these key national actors that support AI on a broader scale are described in more detail.

AI Sweden

AI Sweden is the national centre for applied AI, jointly funded by Vinnova and around 100 partners, both public and private. Their mission is to accelerate the use of AI for the benefit of Swedish society and competitiveness, and their projects are tied to areas of national interest, including information-driven healthcare, AI solutions for the Swedish language, data-driven journalism, as well as AI to help tackle climate change. In addition to their research projects, AI Sweden provides training both for their partners and the general public, and they run a Data Factory that enables their partners to share their own data and to access new data while making use of computing power and storage capacity in AI projects.

Agency for Digital Government (DIGG)

DIGG's aim is to accelerate the digitalisation in Sweden and to create a sustainable welfare society. Together with the entire public administration, they work to make the transition a reality, and for the benefit of everyone. For example, the Government Offices of Sweden rely on them in the mission to increase the public administration's ability to make data open for everyone, to conduct open and data-driven innovation, and to make use of AI. Tied to this mission, DIGG is collaborating with other Swedish public authorities, such as the Swedish Public Employment Office, to promote AI within public organisations. While they work with AI on several fronts, DIGG as an organisation has not developed their own AI solutions, but have instead started by publishing guidelines to support other public organisations in their digitalisation and AI development journeys. In addition, AI as a technology is not a separate topic within DIGG's mandate, instead it falls under the general category of digitalisation. At the same time, DIGG has recognised the potential value from developing and utilising AI on a wider scale and have therefore continually pushed for additional funding to pursue increased adoption of AI in the public sector.

Formas

Formas is a government research council that focuses on sustainable development. As a part of its mission, Formas funds research and innovation while also working to develop strategies, perform analyses, and conduct evaluations. Its focus areas include the environment, agricultural sciences, and spatial planning. Through its work with funding, Formas has collaborated with other Swedish agencies, like Vinnova, to provide resources for AI innovation.

Research Institutes of Sweden (RISE)

RISE is government funded organisation that has a well-established history of researching AI that reaches back more than 30 years. This puts RISE in the relatively rare category of Swedish organisations that do not consider AI to be such a new topic and who already utilise AI as an integrated part of their ongoing research initiatives. Furthermore, through their expertise they are establishing a Center for Applied AI which will carry out cutting-edge research in AI, while connecting expertise and applications within RISE, and exploring a wide range of innovative applications within the public and private sectors. As of writing, RISE has more than 75 ongoing AI projects.

Swedish Association of Local Authorities and Regions (SALAR)

SALAR's purpose is to be a network for knowledge sharing and collaboration amongst the Swedish municipalities and regions across a broad spectrum of topics. This objective is applied to AI by acting as an enabler to make it easier for municipalities and regions to implement AI. In addition, together with AI Sweden, SALAR has started a network for cooperation and knowledge sharing, and more about this can be read in the initiatives section later in the report.

Swedish AI council

The Swedish AI Council is an independent non-profit organisation, and it consists of representatives from various industries and academia. Its goals are to define a Swedish model, in the shape of a strategy, for AI, to be a contributor to the AI-debate in Sweden, to encourage acceleration of AI applications and to author reports on the subject. The Council writes that Sweden and Europe are behind other parts of the world in the development of AI, and that the foundation of the well know Swedish model; willingness to hold dialogue, openness, and collaboration, should be the key for Sweden to catch up and be competitive within the field of AI.

Swedish AI Society (SAIS)

SAIS is a society promoting research and application of AI. Its members include Swedish universities, organisations, researchers, professionals, and students who are active in, or interested in, the area of AI. SAIS is also part of the European Association for Artificial Intelligence (EurAI), a European network of AI societies.

The Swedish Energy Agency

The Swedish Energy Agency is responsible for leading the Swedish transition to a more sustainable energy system. As a part of this, it provides facts, knowledge, and analyses about the creation and usage of energy in Sweden. In addition, the agency supports the transition to sustainability through the funding of projects, including specifically for sustainable energy solutions that utilise AI.

The Swedish National Space Agency

The Swedish National Space Agency operates under the Swedish Ministry of Education and Science and is a key component of the Swedish space programme. As a part of its mission, the agency distributes government grants to research and development, including for AI.

The Swedish Public Employment Service

The Swedish Public Employment Service is a leading public organisation with regards to AI development. It works with AI to improve its services and is called on nationally and internationally to share its success stories.

The Swedish Research Council

The Swedish Research Council is the country's largest governmental research funding body, and it supports research within all scientific fields through nearly 8 billion SEK of investments each year. As a part of its mission, the council has collaborated with other Swedish agencies, like Vinnova, to fund AI related initiatives.

The Swedish Tax Agency

The Swedish Tax Agency is one of the leading public organisations with regards to AI development. They currently use AI to classify emails and documents from the district court and to screen declarations to find faulty ones. As a leading AI organisation, the agency has included AI in its business plan and they see great potential in AL and ML.

Vinnova

Vinnova is a Swedish government agency funding research and development in areas of technology, transportation, communication, and labour. Every year they invest around 3 billion SEK on research and innovation across both the public and private sector, including funding many AI -related projects. During 2021, Vinnova funded projects with AI relevance for a total of 735 million SEK. Among these funding projects, there are both small and large initiatives, ranging from thousands of SEK for individual companies to work with AI all the way to 100 million SEK, multi-year agreements to fund AI Sweden.

Wallenberg AI, Autonomous Systems and Software Program (WASP)

WASP is the largest individual research programme in Sweden and a major national initiative for strategically motivated basic research, education and faculty recruitment. Together with five Swedish partner universities, WASP has the ambition to collaborate with Swedish industry in order to advance Sweden into an internationally recognised and leading position in the areas of AI, autonomous systems and software.

Universities

Sweden has several universities that are active in the field of AI, working with topics ranging from researching and developing AI, to providing courses for students, and to collaborating with external organisations. Among the leading universities we find Chalmers University of Technology, Linköping University, Lund University, KTH Royal Institute of Technology, and Umeå University, which are all working together with WASP.

National Strategies and Policies

The Swedish national strategy for AI was published in 2018 by the Ministry of Enterprise and Innovation[146] with the purpose to identify a way forward and set up guidelines for national prioritisations within the field of AI. In the strategy, it is stated that the government's goal is to make the most of the opportunities that come with AI, with the aim to benefit the competitiveness and welfare in Sweden.

As a part of this strategy, the government has identified four key conditions which play a significant role in seizing the opportunities that come with AI, including 1) Education, 2) Research, 3) Innovation and use, as well as 4) Frameworks and infrastructure. Regarding education, it is assessed that higher education institutions have a major role to play in ensuring that the demand of knowledge related to AI will be met. Within the condition for research, it is assessed that Sweden needs strong research within AI, strong bonds with leading international AI research, and a healthy collaboration between research, industry, and the public sector. When it comes to innovation and use, it is assessed that Sweden needs pioneering projects, testbeds and environments in which AI can be developed in a safe and responsible way. Finally, within the framework and infrastructure condition, it is assessed that rules, standards, norms, and ethical guidelines are needed, as well as ongoing measures to be taken to ensure access to data and a joint infrastructure.

In 2021, the Ministry of Infrastructure published a separate strategy to make Sweden the leading country in data sharing, for which the Agency for Digital Government (DIGG) plays a significant role[147]. At the core of the strategy are six focus areas that lay the foundation for long-term work that includes both the public and private sector:

- Increased access to data
- Open and controlled data-sharing
- Cooperation and culture
- Control, regulation, and follow-up
- Research, development, and competency
- EU and international cooperation

With the support of these focus areas, the data strategy is meant to augment Sweden's data-handling and lay the foundation for more concrete AI development. In addition, the data strategy is also closely aligned with the connected AI strategy, with the aim to strengthen Sweden's welfare, competitiveness, and support a sustainable society.

Moving on to the topic of policies, DIGG has already been established as Sweden's authority when it comes to digitalisation. Tied to this objective, DIGG has published a list of six different policies surrounding data which are relevant to Sweden's future AI development and that are to be followed by other public organisations within country.

National policies[148]	Description
Openness as the standard	Organisations should make information open and digitally available for use by external stakeholders, with exception being taken for information that needs to be held classified, such as medical information.
Conduct risk-based and systematic information security work	The information made available shall be classified according to the aspects of confidentiality, accuracy, and availability in order to identify the consequences of insufficient protection when making the data available.
Provide current and updated information with the user at the centre	The organisations should strive to ensure that the information provided is current and contains as much relevant information as possible when it comes to the level of detail and scope over time.
Make information easy to handle	The organisations should strive to use formats, APIs and specifications that are open, standardised, and computer readable.
Use terms and conditions that support wide usage	Information that is published should not come with unnecessarily limiting terms and conditions.
Document and describe information	The information that is published should be documented and described so that it is easy to find, understand, and be used, both by people and computers.

National Initiatives and Programs

The most relevant Swedish initiatives and programmes related to AI and data are presented in the table below. It is important to note that the list is not exhaustive due to the dynamic nature of the AI ecosystem.

Name of initiative	Initiative leader	Description
AI Sweden Start-up Programme	AI Sweden	The AI Sweden Start-up Programme is aimed at start-up who work with AI or who want to learn more about what AI could be used for. The programme consists of three stages, including learning, connecting, and accelerating. The learning stage included various types of learning content, including courses, workshops, and seminars. The connect stage contain access to the AI Sweden start-up community. And finally, the accelerate step includes full AI Sweden partnership, project access, and engagement, as well access to the Data Factory and testbeds, among other things.
The Data Factory	AI Sweden	The Data Factory is an initiative launched in 2019 by AI Sweden that supports their partner organisations by enabling them to bring their own challenges to receive support, as well as to take part in existing projects, or experiments in the available testbed environment. The goal of this initiative is to increase the speed of innovation and usage of AI in Sweden, and several projects connected to the Data Factory have already been launched. Some of these include the Road Data Lab which wants to integrate different types of data related to roads in order to add value beyond what any single dataset could provide, and SCAPIS AI platform which aims to create a secure research environment for use of AI on image data from SCAPIS (Swedish CArdioPulmonary bioImage Study).

Edge Learning Lab	AI Sweden	Edge Learning Lab is a testbed environment located in Gothenburg that enables developers, data scientists, researchers, students, and others to learn about edge learning, including its possibilities and limitations. Its purpose is to speed up the applied understanding of edge learning, including how to use and optimise it across industry, academia, and the public sector.
Networks	AI Sweden	AI Sweden is utilising networks to provide a platform for their partners to discuss and suggest activities within their areas of interest. Each network is driven by participating individuals, and they determine the goals of the group. In turn, the networks can suggest activities, initiatives, or projects that can be proposed or carried out by the groups, some of the partners, or by AI Sweden.
Swedish AI Start-up Landscape	AI Sweden, RISE & Ignite Sweden	In 2020, the Swedish AI Start-up Landscape was launched as a joint initiative to pick out the best AI start-ups in Sweden to increase and contribute to the usage of AI while also making it easier for AI start-ups to access clients, capital, and talent. The chosen AI start-ups together form a landscape that acts as a quality stamp for them while simultaneously providing intel for the innovation ecosystem, investors, the government, and academia. Finally, the initiative is a part of the larger European AI Start-up Landscape which has the same goals but at the European level, and includes other partners such as the German Entrepreneurship, German Accelerator, appliedAI, and Hub France IA. As of 2022, Norway and the Netherlands have also joined the landscape.

Φ-lab Sweden (Phi-lab Sweden)	AI Sweden	Together with the European Space Agency, AI Sweden is opening a lab for AI in new space applications and applications for Earth observation. The lab will open in the spring of 2022 and it brings together industry, investors, and researchers to strengthen the European space research and space industry sector.
Mission to promote public administration's ability to use AI	Government Offices of Sweden	The Government Offices of Sweden setup the initiative from 2021-2023 and gave an 8 MSEK budget to the Swedish Public Employment Service, the Swedish Companies Registration Office, DIGG, and the Swedish Tax Agency, with the mission to explore how the public sector can use AI to support Swedish welfare and competitiveness. The network is aimed at those who work with AI on a strategic and operative level in the public sector, and events are generally held six times per year. During events, attendees listen to inspirational speakers, exchange experiences related to AI development, and setup workshops related to the topic. The attendees cover a wide range of skill levels, ranging from complete beginners to those who have already developed and tested AI solutions.
AI Competence for Sweden Ai-competence.se	Government Offices of Sweden (funding) Örebro University (coordinator)	In 2018, ten Swedish universities created a platform called ai-competence.se. where the participating universities share the educational opportunities which they offer within AI across the industry, public sector, and elsewhere. The initiative also creates a network among the participating universities in which the exchange of ideas and best practices can occur.

Research programs	Knut and Alice Wallenberg Foundation	A collaboration initiative started in 2021 between Wallenberg AI Autonomous Systems and Software Program (WASP), and SciLifeLab and Wallenberg National Program for Data-Driven Life Science (DDLS). The goal of the initiative is to solve complex research questions by creating synergies between the life science and data science communities.
Mission to collaborate regarding the competency supply of digital excellence.	Ministry of Infrastructure	A mission from 2019 to 2022 with the goal to report on how the competency supply of digital excellence can be developed both in the short and long term. The funding for the initiative was 4 MSEK in 2020 and 6 MSEK in 2021 and 2022, shared equally between the Swedish Higher Education Authority and the Swedish Agency for Economic and Regional Growth.
Mission to map the usage of AI and big data analysis in Sweden	Ministry of Infrastructure	From 2019 to 2020, the mission was given to Statistics Sweden (SCB) to produce statistical material regarding the usage of AI and big data analysis in enterprises, public administration, and universities in Sweden.
AI-agenda	RISE	The AI-agenda is a volunteer network initiative started by RISE to gather experts who work with AI from all parts of society. The AI-agenda has shared 25 suggestions on how AI can be used to strengthen Sweden's development and the target group is both private and public sector organisations.

AI Network for regions and municipalities	SALAR & AI Sweden	In September of 2021, SALAR and AI Sweden jointly started a network for regions and municipalities in Sweden with the purpose to increase cooperation and to share knowledge and experiences regarding AI within the public sector. As a part of this network, the involved organisations support each other in identifying resources, requirements, and barriers related to their AI development.
AI and data protection	Swedish Authority for Privacy Protection (IMY) and AI Sweden	From 2021 to 2023, IMY and AI Sweden are collaborating with the goal to offer guidance and support regarding data protection and integrity questions to actors which develop and apply AI. IMY and AI Sweden focus on identifying reoccurring legal questions and investigate how guidance and support can be provided in the best way.
Advanced Industrial Digitalisation	Vinnova	The initiative is a large and long-term funding program that was started in 2021 in cooperation with Swedish industries. AI is an important component of the initiative and some of the areas covered include autonomous mines and autonomous airports.
AI in the service of the climate	Vinnova, Formas, The Swedish Energy Agency, and The Swedish National Space Agency	Between 2020 and 2021, the initiative funded 15 innovation projects related to the utilisation of AI to tackle greenhouse gas emissions. In total, 67.5 million SEK was available for funding and the applicants were required to partner with others in order to qualify. Specifically, at least three actors were required for each application, of which at least one needed to be a research organisation and one needed to be a public organisation or business[149].

AI for gender equality	Vinnova	In response to the issue of gender inequality and how it can be reinforced as a secondary consequence of AI applications, Vinnova wanted to explore how AI instead could be applied to support equality within the framework of the Swedish gender equality goals. The aim of the initiative was therefore to explore how AI could support achieving gender equality goals and speed up the process towards a more equal and sustainable society. The results of the initiative point to great potential in using AI as a tool to solve gender related issues, including through gender equal recruiting processes, promotion of women's entrepreneurship, visualisations of gender inequities in the home, and estimation of the risk of domestic abuse.
AI Sweden	Vinnova	AI Sweden has already been mentioned as an actor in the Swedish AI landscape, but it is worth including among the initiatives as it is one of the most important activities undertaken by Vinnova.
Data lab	Vinnova	From 2020 to 2021, Vinnova created several rounds of funding for organisations who wanted to take on the role as data labs. This role was meant to be used to help other nearby actors to use data for innovation, including for AI, by imparting knowledge about the application of data and by creating the conditions for and developing data-driven innovation.
Data factory	Vinnova	The data factory is a project running from 2022 to 2023 with a budget from Vinnova of about 8 million SEK. This is a separate initiative from the Data Factory run by AI Sweden, and it is aimed at supporting and working with the data-sharing between regions and municipalities. Finally, it is the largest of its kind thus far established in Sweden.

Eureka Cluster projects	Vinnova	Eureka was founded in 1985 as an agreement between 18 countries and the European Commission with the goal to foster competitiveness and market integration and to encourage R&D cooperation. Vinnova plays a role in this environment as a part of the clusters which are funding programmes driven by consortiums of large companies, SMEs, universities, research institutions, and end users.
Start your AI journey	Vinnova	Over the course of 2019 to 2020, Vinnova launched five separate initiatives aimed at helping both public and private organisations to get started on their AI journey. In each round, between 11 and 31 organisations received up to 500 KSEK with the aim of getting an already pre-planned idea off the ground. These initiatives were later evaluated to explore if they managed to reach the goals they set out with or if they learned anything else along the way. More about this initiative can be found in the Swedish best practices section.

hACTathon: AI for gender equality	Vinnova, Nordic Innovation House Silicon Valley, AI Sweden, and Women in AI	Hackathons have become a common type of initiative used to promote the solving of various types of issues ranging from internal company challenges to wide-spread societal topics. In 2020, this type of initiative was utilised in a week-long hackathon with the purpose to arouse interest and emphasise the importance and value of increased gender equality. The available topics to tackle included health, the gender pay gap, power and influence, unpaid work, education, and gender-based violence.
Language models for Swedish agencies Vinnova link	Vinnova (funding) RISE (project leaders)	This initiative is a 3-year project ending in 2022 with 6,6 MSEK in funding from Vinnova and partnerships from the public and private sectors along with academia. The purpose is to develop AI language models which can be implemented in Swedish agencies to, among other things, improve administration processes. As of writing, the initiative has not been concluded, but it has already been used to publish a document on data readiness for NLP as well as the first Swedish evaluation of semantic similarity between a simple Google machine translation API to native Swedish models. In short, the latter result points to native models outperforming multilingual models.

Ignite Sweden	Vinnova & The Swedish Energy Authority (funding) SISP (Swedish Incubators & Science parks - coordinator)	Ignite Sweden is a non-profit initiative launched in 2017 with the goal to accelerate innovation and shorten the way to the market for start-ups by connecting them to their first big customer to increase growth. Within their list of top six most sought-after categories is AI & ML.
Swedish Space Data Lab	Vinnova & the Swedish Meteorological and Hydrological Institute (SMHI) (funding)	Since 2019, a collaboration initiative has been ongoing between AI Sweden, the Swedish National Space Agency, RISE, and Luleå University of Technology. The lab is meant to function as a hub for innovation for the Swedish authorities regarding application of Earth data gathered from space and the usage of AI to analyse the data.

When viewed as a whole, the Swedish initiatives and programs cover many important topics related to pushing forward the national AI agenda. For example, in Sweden we find several networking initiatives which have repeatedly been cited as key enablers for organisations across the spectrum of AI development skills. In addition, various types of funds and testbeds are available for those who need a boost to get started with AI, or who simply need access to more data and computational power than their organisations can muster. On top of these, there are also research initiatives, collaboration initiatives between public and private organisations together with academia, as well as various initiatives that tackle ethical topics such as gender equality.

Together, these initiatives and programs showcase the Swedish ecosystem as a well-rounded environment where most types of organisations of differing AI skill levels can find the tools and resources they require to take their AI development to the next level. However, while the whole ecosystem is on the right track, there are two initiatives in particular that can be considered as best practices in Sweden based upon market research and expert interviews.

Best practice 1

Vinnova's Start Your AI Journey

One of the key issues facing many public and private organisations is simply taking the first serious step into developing AI solutions. As an example of this, a recent study of Swedish public organisations found that 25% of them have yet to implement AI in any of their functions[150]. At the same time, on the private sector side, 23% of SMEs state that their biggest obstacle to developing AI are a lack of money and time[151]. These statistics were further supported in expert interviews where the need to aid organisations in getting started with AI was pointed to as one of the key enablers for success on a national scale.

As a result of these inputs, a strong case can be made for Vinnova's Start Your AI Journey initiative as one of Sweden's best practices. As mentioned in the initiatives section, Vinnova has used Start Your AI Journey as a way to encourage AI innovation by providing several rounds of funding to public and private organisations that have required a boost to get started. All of the organisations that have received funding have been required to fill in various types of relevant information that is today available on Vinnova's website, including what their

goals were, how they worked with AI development, and which results they achieved. With regards to the results, there are no readily available statistics on how many organisations have succeeded with meeting their AI development goals with the help of the initiative. However, by reading through the individual projects, it is clear that a large number of organisations did succeed in meeting their project goals. Each of these success-stories represents new skills and capabilities that can further be honed in Sweden. Furthermore, the use-cases can also be used as inspiration for other organisations and to pursue further innovation through the use of AI.

All in all, Start Your AI Journey is the type of innovation encouragement that could be leveraged for even greater value by introducing it within the other Nordic countries. In particular, this type of funding support can aid the Nordics with raising the base-level competencies for AI development while simultaneously opening up for the possibility of new AI solutions being introduced that can both improve internal processes and external services.

Best practice 2

Networks for knowledge sharing and inspiration

Another best practice in Sweden is related to how organisations can learn more from each other and to cooperatively progress faster with AI development than possible in a non-cooperative manner. This type of initiative is not unique to AI, but it has repeatedly been praised by local experts and it has frequently been mentioned in market analyses as one of the keys to more rapidly raising AI competencies across industries. In particular, the public sector in Sweden is especially active with organising networking functions, and the frequent natural creation of these without external instruction from overseeing entities points to the attendees themselves seeing concrete value in cooperation.

While Sweden has several variations of networks for knowledge sharing and inspiration, including the AI Sweden networks, one of the most well-established is the public sector AI development network run by DIGG, the Swedish Public Employment Service, the Swedish Companies Registration Office, and the Tax Agency. Since this initiative is based on a directive from the Government Offices of Sweden, it has a specific mission which is to explore how the public sector can use AI to support Swedish welfare and competitiveness. In addition, as mentioned in the initiatives section, the target group for the network is those who work with AI on a strategic or operative level.

In order to encourage knowledge sharing and inspiration for AI development, the network regularly meets, and the attendees listen to inspirational speakers, exchange experiences related to AI development, and setup workshops related to the topic. Since the attendees cover a large spectrum of skill levels, from beginners to those who have developed and launched their own AI solutions, it is a particularly relevant network for finding other organisations at a similar level to learn from.

Seen from a Nordic perspective, these types of networking initiatives could create further value by bringing together more organisations, thereby raising the possibility for attendees to find similarities with each other and therefore find opportunities to cooperatively learn about AI development. Furthermore, AI networks at a Nordic level is one of the recommendations that was repeatedly mentioned in Swedish expert interviews as something that needs to be established since there are none of them available today.

National AI Development Challenges

When it comes to challenges related to AI development, Sweden shares several of them with its Nordic neighbours and they are covered in the Nordic section. However, when drilling down on Sweden by itself, there is one challenge where the country stands out compared to the rest of the Nordics.

Challenge 1

A vague national strategy creates the need for additional guidance

One of the foundations for setting the course for a group of people or organisations is a clear strategy that is easy to understand and to put into practice. This holds particularly true when each entity has a significant amount of freedom of choice regarding which path to take since this can lead to vastly differing approaches within the group to tackle a challenge, but also to a lack of action due to missing instructions.

In the case of Sweden, public organisations ranging from regions and municipalities to various governmental agencies have a relatively high degree of freedom in comparison to their Nordic counterparts. This setup, in combination with a vague national strategy, has led several interviewed local experts to point to disorganisation as one of the leading challenges in Sweden. In particular, the lack of a concrete strategy is making it more difficult for organisation to work together, whether through data-sharing, development of joint AI solutions, or other means, even when there is an expressed desire to do so. As a result, Sweden's pace of innovation suffers since it is far more difficult for a single organisation to achieve tangible results through AI development than when several organisations band together to innovate in tandem.

While the Swedish AI strategy is too generic compared to what organisations and local experts would like to see, the overall agreement amongst stakeholders regarding the need for improvements showcases the potential for Nordic-spanning organisations to help guide the way. Specifically, stakeholders are hopeful to see a person or entity that can clearly point to a joint goal scenario along with the path to get there. By bringing this type of structure to Sweden, and indeed to the Nordics, the potential to succeed with the Nordic's high ambitions in AI utilisation become significantly more attainable.

National Strongholds

As a leading country in the Nordics on data and AI, Sweden has many ways that it can support the region in pursuing AI development. On the side of national strongholds however, there is one area where Sweden has been performing particularly well for many years, namely the private sector.

Stronghold 1

Private sector innovation

As established in the Swedish introduction, Stockholm is a world-leader when it comes to start-up unicorns per capita. In addition to this already significant credential, Stockholm also creates the largest number of AI start-ups among the Nordic capitals according to Global AI Talent Report[152], albeit slightly lower than Helsinki when viewed per capita. Furthermore, the same report goes on to state that Sweden also has the largest talent pool for AI amongst the Nordic countries.

When viewed from the amount of funding that goes into innovation and start-ups, we find that Sweden invests one of the highest rates in the world from the perspective of R&D as a percentage of GDP. Moreover, the Nordic region is the third largest region for VC investments within Europe, behind the UK and Germany. And out of these substantial Nordic investments, Sweden makes up more than half[153]. Furthermore, when viewed explicitly from the perspective of VC investments in AI start-ups, Sweden has gone from investing 9 million USD in 2015 to 193 million USD in 2020, according to the OECD[154]. That is equal to a compound annual growth rate (average yearly growth) of 85%. To put that into perspective, during the same time-period, Statistics Sweden reported an average yearly inflation rate of 1.4%[155].

These statistics paint a clear picture of Sweden's thriving ecosystem for innovation, and combined with the already established industries, the possibility to utilise the private sector for developing AI is significant. To succeed with this, however, stakeholders from across the public and private sector need guidance on how to successfully leverage all of the talent and funding that is available. In particular, interviewed local experts point out that a prerequisite for more efficient innovation is clarity around how cooperation should function in practice. Specifically, this includes how data can and should be shared between public and private companies as well as academia. Moreover, there is currently a need for additional guidance surrounding the creation of business models that account for these cross-sector partnerships in relation to a complex and dynamic technology like AI. By providing this type of support from a Nordic perspective, the whole region can experience a boost to AI development as the amplified scale from cross-border cooperation will make the impact from innovation even greater, and thereby spur on additional funding in the coming years.

Recommendations

The final chapter of this report is dedicated to recommendations for how the Nordic region can create added value through initiatives tied to the responsible use of data and ethical AI. The initial collection of recommendations is on a more general level in order to describe some of the overarching activities that the Nordics could pursue, while the later section explores more detailed examples of potential pilot projects.

Recommendation 1

The Nordics should pursue increased sharing and utilisation of national datasets

One of the strongholds in the Nordics is the availability of national datasets that cover many important areas, including healthcare, taxes, and employment. These datasets can be responsibly used for analytics by making them more available which has the potential to enable improvements across many aspects of public organisations, and to be used by private companies to develop new services. However, by utilising these large datasets in combination with ethical AI, the Nordic countries have the potential to gain a competitive advantage on an international scale while also creating added value through significantly improved services and optimised processes.

Recommendation 2

The Nordics should build a competitive advantage on the responsible use of data and ethical AI

Another stronghold in the Nordics is the importance that each of the countries place on ethics and equality, and the international recognition that the countries are receiving as a result of this. Today, other countries, and even the EU, are working on and implementing policies and strategies tied to the responsible use of data and ethical AI. However, the Nordic countries have the potential to build their own competitive advantage in this field by establishing it as a focus-area for innovation and development tied to data and AI. This emphasis, in combination with the Nordic countries' already recognised positions as leaders in ethics and equality, will help to attract international attention and investments as the Nordic region's brand for the responsible use of data and ethical AI is built.

Recommendation 3

The Nordics should raise the AI and data competency level among organisational leaders

One of the challenges within the Nordics is the lack of knowledge and competency on the topic of data and AI among organisational leaders. As has been described, this challenge ends up hindering innovation as leaders are hesitant to significantly invest in areas that they do not fully understand. In addition, these leaders are also less likely to personally drive innovation forward which forces developers and operative personnel to push forward through a bottom-up approach which

is less likely to succeed in the long term without leadership support. Due to these hinderances that are based in leadership competency, it is important for the Nordic countries to pursue initiatives that aim to introduce organisational leaders to the concepts of responsible utilisation of data and ethical AI. In turn, this will help to support an increase in successful innovation as the leaders are more likely to make the necessary investments and to be able to discern which initiatives are actually worth the investment.

Recommendation 4

The Nordics should support businesses and academic institutions in finding relevant partners for solving the AI and data challenges

Another challenge facing stakeholders in both the private sector and academia is finding the right cross-sector partnerships to pursue. This is often based in a lack of knowledge from the business side regarding which types of academic research that is relevant for solving their needs. Similarly, academic researchers are largely unaware of which business needs could be solved through the application of their research. Because of this disconnect, the Nordic region could benefit by providing a bridge between these two sectors as more complex AI research could be applied to real-world challenges faced by businesses. In turn, this would more effectively leverage the available expertise in the fields of responsible utilisation of data and ethical AI while also supporting new and innovative services for the Nordic region.

Recommendation 5

The Nordic countries should share best practices, use-cases, and knowledge with each other.

As has been explored throughout this report, the Nordic countries have many ways in which they differ. These differences range from the policies enacted, to the initiatives undertaken, to the strongholds that they have, and each of these is an opportunity to improve the Nordic region as a whole. By focusing more on sharing what has been learnt and cooperating more frequently, the countries can increase the pace of innovation and the responsible utilisation data and ethical AI, both across the public and private sector. In addition, cooperation has the potential to give a boost to organisations and countries who are lagging behind as they can learn from those who have already cleared the challenges that they are currently facing.

Examples of potential pilot projects to launch

Overall, there are many ways to improve the responsible use of data and ethical AI in the Nordics. Due to this, the following section aims to bring some additional clarity to the potential paths forward by describing more granular examples of pilot projects that could be launched.

Pilot project 1

Nordic workshops to align on a more unified AI and data direction

In order to succeed with reaching a more unified AI and data strategy in the Nordics, the policymakers from across the region, together with leading actors within AI and data, can work together to discuss the best way forward. As a group, these stakeholders have the potential to recognise what the local public organisations need to know in order to commit to new projects and to progress in the fields of AI and data. In addition, the stakeholders can ensure that the future strategy covers the responsible use of data and ethical AI. As a result, over time these stakeholders can develop and set course on a clear direction for all of the countries to pursue that will provide alignment across national strategies and support a faster pace of innovation.

Pilot project 2

Challenges for start-ups and SMEs to learn from each other while creating solutions built on external datasets

Challenges could be used to achieve capability-building and knowledge-sharing between start-ups and SMEs through the support of larger public organisations or private companies. As has been mentioned, there are already relatively accessible national datasets within the Nordics . These could be utilised for training, providing everyone involved with a better understanding of how to responsibly use data and work with ethical AI. In particular, these types of initiatives are likely to be especially valuable to smaller organisation who may not otherwise have access to datasets that can support development of ethical AI.

Contributors

Representatives from the following organisations have provided input to this report through interviews. We would like to thank each contributor for their invaluable insight into the Nordic data and AI ecosystem.

Denmark

AI Denmark

Agency for Digitisation

Aalborg University Business School

Danish Business Authority

Finland

Business Finland

ELLIS Unit Helsinki

Finnish Center for Artificial Intelligence (FCAI)

Helsinki Institute for Information Technology (HIIT)

Ministry of Economic Affairs and Employment (MEAE)

Silo.AI

University of Helsinki

VTT (Technical Research Center of Finland)

Iceland

Ministry of Finance and Economic Affairs

Norway

Agder Energy

EY

Kaptapult Invest

NAV

NORA

Norwegian Open AI Lab (NTNU)

Smart Innovation Norway

Tomra

Wilhelmsen / Massterly

University of Agder

Sweden

AI Sweden

Agency for Digital Government (DIGG)

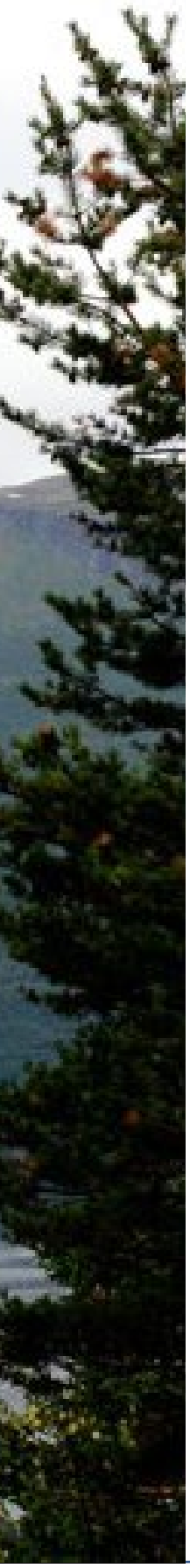
Research Institutes of Sweden (RISE)

Swedish Public Employment Office

TietoEvry

Vinnova

Appendices



Definitions

Key word	Description
Artificial Intelligence (AI)[157]	AI is the ability to perform tasks in complex environments without constant guidance by a user, i.e. it is an autonomous process. AIw also possesses the ability to improve performance by learning from experience, hence it is also an adaptive process. AI is often used as an umbrella term for technologies that enable machines to mimic human intelligence, such as computer vision, language processinWg and machine learning.
Nordic stronghold	A Nordic stronghold is defined as an area where the Nordic countries complement each other and together possess the necessary prerequisites for the Nordic region to become a frontrunner in the field of AI and Data.
Nordic added value	Cooperation across the Nordic region creates new synergies and leads to greater benefits than each Nordic country could obtain individually.
AI actor[158]	AI actors are those who play an active role in the AI lifecycle. Public or private sector organisations or individuals that acquire AI to deploy, operate and/or use them are also considered to be AI actors.
Strategy[159]	A long-range plan for achieving something or reaching a goal, or the skill of making such plans.
Policy[160]	A set of ideas or a plan of what to do in particular situations that has been agreed to officially by a group of people, a business organisation, a government, or a political party.
Initiative[161]	A new plan or process to achieve something or solve a problem
Best practice[162]	A procedure that has been shown by research and experience to produce optimal results and that is established or proposed as a standard suitable for widespread adoption.

Methodology

Literature review

A literature review has been performed in order to set a baseline of qualitative information for the report. In addition, the gathered information has been used to compare and contrast with expert interviews in order provide a more well-rounded and robust analysis.

Ecosystem mapping

The ecosystem of actors relevant for the responsible use of data and ethical AI is continuously growing and changing, but for the purpose of this report some of the most important stakeholders have been described for each country. This mapping has largely been done through desktop research and then complemented with information gathered through interviews.

Interview method

A total of 29 interviews have been conducted, with interviewees from both the public and private sectors as well as academia. The represented organisations have differing roles in the ecosystem, including businesses, public and private funders of innovation, AI and data researchers, and network coordinators.

The interviews were conducted in a semi-structured qualitative style, and the resulting information was reviewed and analysed in conjunction with other interviews as well as the information gathered during literature reviews and the ecosystem mapping.

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