WHITE PAPER

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Comparison of AI policies and programmes in Finland, the Netherlands and Sweden – case Finland

Tiivistelmä suomeksi

Tekoälyä pidetään kilpailukyvyn kannalta keskeisenä teknologiana. Sen vuoksi useat maat ovat valmistelleet ja käynnistäneet kansallisia tekoälystrategioita ja -ohjelmia. Tutkimuslaitokset VTT, RISE (Ruotsi) ja TNO (Hollanti) vertailevat tässä raportissa maidensa kansallisia tekoälystrategioita ja -ohjelmia. Tavoitteena on tunnistaa toimivimmat käytännöt ja hyödyntää toisten maiden kokemuksia. Raportin ensimmäisessä osassa keskitytään Suomeen, sisältäen lyhyen vertailuosion.

Raportin analyysissä hyödynnetään kansallisten tekoälyohjelmien (Suomen Tekoälyaika 2017–2019 ja Tekoäly 4.0 2020–2022), Business Finlandin ja Suomen Akatemian tutkimus- ja kehitys -ohjelmien raportteja ja muita dokumentteja, kansainvälisiä vertailuindeksejä sekä erityisesti ohjelmien suunnitteluun ja toteutukseen osallistuneiden asiantuntijoiden haastatteluja.

Keskeisiä havaintoja ovat

- Suomi, Ruotsi ja Hollanti sijoittuvat tekoälykyvykkyyksiä vertaavissa indekseissä hyvin EU-maiden joukossa, samoin startup-rahoituksessa. Sen sijaan vertailtaessa maailmanlaajuisesti, maat sijoittuvat kehittyneiden maiden joukossa keskikastiin. Suomen sijoitus vertailuissa on pysynyt vakaana.
- Suomen Tekoälyaika (2017–2019) toimi omalta osaltaan merkittävänä keskustelun herättäjänä kansallisesti ja vaikutti siten tekoälyteknologioiden merkityksen tunnistamiseen.
- Suomen Tekoälyaika- ja Tekoäly 4.0 -ohjelmat eivät kyenneet luomaan yhtenäistä kansallista tekoälylinjausta ja konkreettista toimintaohjelmaa julkisille toimijoille esimerkiksi hallinnossa, terveydenhuollossa tai koulutuksessa. Suora vaikutus yksityisen sektorin toimijoihin oli vielä ohuempi. Pääsyy tähän on, ettei

teknologiaohjelmien toteuttamiseen ja seurantaan ole käytäntöjä eikä resursseja. Ohjelmien välillä ei myöskään ollut jatkuvuutta.

- Business Finlandin *AI for Business* -ohjelma rahoitti 347 projektia ja ohjelman volyymi oli 235 miljoonaa euroa. Osallistuneiden yritysten vienti kasvoi lähtötilanteeseen verrattuna 2,5- kertaiseksi 280 miljoonaan euroon 2020 lopussa.
- Perustutkimuksen tulosten siirtyminen yritysten käyttöön ei ole ollut toivotulla tavalla sujuvaa. Pitkälti Suomen Akatemian rahoittaman perustutkimuksen ja Business Finlandin tukeman tuotekehityksen välillä on aukko soveltavan tutkimuksen rahoituksessa.
- Osin yllä mainitun aukon vuoksi ohjelmisto- ja IT-yritykset eivät hyödynnä suomalaisen tekoälytutkimuksen sinänsä korkeatasoisen ja arvostetun tutkimuksen tuloksia. Sen sijaan muilla aloilla, esimerkiksi teknologia-, kemian- ja lääketeollisuudessa yhteistyö tutkimuksen kanssa toimii paremmin. On syytä huomata, että tekoälyohjelmistojen kehitystyökalut ovat pitkälti Euroopan ulkopuolisten teknologiajättien kehittämiä, koska EU:ssa ei ole niihin panostettu. EU:lla ei ole sopivia mekanismeja nopeatempoisten ohjelmistoalan tk-projektien tukemiseen.
- Pitkäjänteisyys ja sitoutuminen ovat keskeisiä edellytyksiä niin korkeatasoiselle tutkimukselle kuin tutkimuksen ja yritysten väliselle yhteistyölle ja sitä kautta vaikuttavuudelle.
- Tutkijoiden ajasta ja työpanostuksesta liian suuri osa on käytettävä rahoituksen hakemiseen. Tämä aiheuttaa järjestelmätason tehottomuutta.
- Ruotsin tilanne poikkeaa Suomesta erityisesti yksityisen Wallenbergin säätiön rahoittaman tekoälyyn keskittyvän tutkimusohjelman (WASP) merkittävän panoksen vuoksi. Toisaalta Business Finlandia vastaavien rahoittajien panos on suhteessa pienempi. Ruotsin tekoälylinjauksiin liittyy myös odotus julkisen sektorin toiminnan tehostamisesta tekoälyteknologioita hyödyntämällä eri palveluja hallintoaloilla. Ruotsissa perustettiin AI Sweden -ohjelma, jonka tavoitteena on yhtäältä koordinoida erialisia tekoälyhankkeita, toisaalta luoda kaksi paikallista ekosysteemiä.
- Hollannissa tekoälyyn liittyvät ohjelmat ovat luonteeltaan laajapohjaisia ja tätä lähestymistapaa halutaan korostaa. Ohjelmien valmistelussa ja toiminnassa ovat mukana hallitus, tutkimus, yritykset ja myös kansalaisyhteiskunta. Strategic Action Plan AI (SAPAI), joka käynnistettiin 2019, linjaa hallituksen tekoälyyn liittyvät tavoitteet. The Netherlands AI Coalition (NL AIC) puolestaan on 250 toimijan laajapohjainen PPP-tyyppinen organisaatio, johon liittyvällä investointiohjelmalla AiNed:llä on nyt 204 miljoonan euron budjetti lähinnä soveltavaan tutkimukseen, jonka lisäksi osallistujien in-kind panostus on suunnilleen samansuuruinen. Dutch Research Council puolestaan rahoittaa perustutkimuksellisempaa toimintaa, jonka tavoitteena on edistää tutkimusta (”Hollanti Euroopan AI teknologiajohtajaksi”) sekä ihmiskeskeistä AI-tutkimusta. Molemmat suosivat missiolähtöisyyttä. Tekoälyn soveltamisessa pisimmällä ovat suuret yritykset; Pk-yritykset ja julkinen sektori tulevat jäljessä. Tutkimuksen ja hyödyntämisen välillä myös Hollannissa nähdään aukko.

Seuraavat, raportin tuloksiin perustuvat suositukset tähtäävät tekoälyteknologioiden tehokkaaseen hyödyntämiseen yritysten kilpailukyvyn ja julkisten palveluiden parantamiseksi.

- **Kysymys ei ole vain tekoälystä,** vaan on huomioitava laajempi joukko digitaalisia teknologioita, joka muokkaa tulevaisuutta. Yksityisten ja julkisten organisaatioiden tulee arvioida tekoälyn, esineiden internetin, tietoliikenteen (6G), virtuaalitodellisuuden ja kvanttilaskennan kaltaisten teknologioiden vaikutus ja hyödyntämismahdollisuudet toiminnassaan. Teknologioiden kehitys heijastuu organisaatioiden strategiaan, rakenteeseen, toimintatapoihin ja liiketoimintamalleihin. Vaikutukset ulottuvat terveydenhuollosta vähittäiskauppaan ja teolli-

suudesta maanpuolustukseen. Organisaatioiden oppimiskyky laajasti ymmärrettynä on avaintekijä uudessa alustataloudessa.

- **Kansallisten teknologiaohjelmien toimeenpano ja seuranta on järjestettävä systemaattisesti ja resursoitava, jos niille halutaan vaikuttavuutta.** Nykymallissa kansalliset ohjelmat ja strategiat jäävät raporteiksi ja toivomuslistoiksi, koska millekään tahoille ei osoiteta vastuuta toimenpanosta ja osoiteta siihen resursseja. Julkisen hallinnon toimia voidaan suunnata sisäisillä ohjeistuksilla ja budjetoiduilla resursseilla. Yksityistä sektoria voidaan kannustaa haluttuun suuntaan TKI-rahoituksella, innovatiivisilla julkisilla hankinnoilla, verokannustimilla ja viime kädessä regulaatiolla.
- **Perustutkimuksen ja tuotekehityksen välinen aukko pitää kuroa umpeen soveltavan tutkimukseen panostamalla.** Missiotyyppiset laajemmat kehityshankkeet palvelisivat osaltaan tätä tarkoitusta pieniä erillisiä projekteja paremmin.

Summary

The purpose of this study is to benchmark AI policies and programmes in three European countries, namely Finland, Sweden and the Netherlands. This report focuses on Finland, but it contains short comparison with the two other countries. The following reports will focus on them.

The analysis is based on public reports and documents, semi-structured interviews with persons who have participated in the planning and implementation of the national AI policies and programmes as well as general index-type evaluations. In addition, investment data are used as data sources. The deeper insight to the topic of this study is gained by the in-depth interviews.

The key findings are

- Finland, Sweden and the Netherlands rank high among EU countries in indexes comparing AI competence and readiness as well as in start-up funding. However, in global ranking among developed countries, the three countries position in the middle category. The position of Finland has remained stable in the rankings.
- The national AI programmes, especially Tekoälyaika (2017–2019), were significant in bringing AI to the agenda of decision makers in public and private sector.
- However, the programmes did not formulate a coherent national policy, which would have guided the planning and decision making of authorities, even less that of the private sector. The programme format as seen in Tekoälyaika and Tekoäly 4.0 has some inherent deficiencies: the programmes start from scratch, there is no continuum (new cabinet, new programme); the programme teams use too much time for analysing which may lead into situation where the results are outdated when ready; the composition of programme teams is somewhat arbitrary and often drawn from an “inner circle”. Yet, the most serious issue is that the implementation and follow-up mechanisms as well as resources are lacking.
- The *AI for Business funding programme* run by Business Finland had a volume EUR 235 million and 347 individual projects. It achieved its main goal: the turnover and export of companies participating (= receiving funding) grew strongly to EUR 280 million (2.5-fold) by the end of 2020. The funding was targeted to independent projects, not large-scale missions. VTT (RTO) had key role in building consortia projects based on industry verticals while universities were expected to transfer novel AI research results into use in industry.

- Flow of latest research results from top academic research to industrial and business applications could have been smoother. There is a gap between academic funding by Academy of Finland and very target-oriented Business Finland funding. This gap has been recognized and some measures taken; a co-research funding instrument has been taken into limited use.
- Partly due to the gap between AI research and Finnish companies, the software industry does not benefit from the apparently high-quality of fundamental research on AI in Finland. On the other hand, there is fruitful collaboration between AI researchers – in many cases together with researchers in application domains – and companies in machinery, pharma and chemical industries. It should be noted that companies apply AI tools offered by the US and Chinese technology giants. EU has not been able to support fast paced R&D projects needed for creating such tools.
- Long-term commitment from researchers, university and funding is important for achieving excellence in science.
- Significant resources from the research community are spent on applying funding. This is a big overhead for the whole system and consumes a major share of the work time of senior researchers.
- The situation in Sweden differs from Finland especially because of the significant role of WASP AI research programme funded by the Wallenberg foundation. The public funding dedicated for AI research and development is less significant than in Finland. There are expectations towards more efficient public services and administration by deployment of AI based solutions. AI Sweden programme aims to create and facilitate a hub for the actors within the ecosystem and mitigate the perceived fragmentation of initiatives.
- In the Netherlands national AI policies and programs have clearly more inclusive character than in Finland. The approach is highlighted by the concept of quadruple helix including government, research and industry and civil society. The Strategic Action Plan AI (SAPAI) started in 2019 outlines government's ambitions. The Netherlands AI Coalition (NL AIC) is a PPP type of organization with 250 partners. AiNed is the strategic investment arm of NL AIC. AiNed received a budget of EUR 204.5 million from the Netherlands National Growth Fund for phase 1 (including in-kind contributions from research participants, the amount is about twice as high). As NL AIC focuses on applied research, the Dutch Research Council funds research on AI technology and human centered AI. Both emphasize mission-oriented approach. The deployment of AI technology is growing in large companies, followed by SMEs and public sector. Yet, there is a significant gap between research and practical implementation.

Following recommendations are given for realising the potential of AI technologies for the benefit of the society and business amid turbulent times.

- **It is not only about AI.** AI is one of the technologies shaping our future. Others include internet of things, telecommunications (6G), virtual reality and quantum computing. These technologies are horizontal, as they serve many sectors and fields. In the future, organizations should grasp the potential of AI in broader, strategic scale involving system architecture, organization, and business model. The transformation will impact all sectors from retail to manufacturing and healthcare to defence. Broadly understood, the learning ability of organizations is a key factor in the new platform economy.
- **The national technology programmes would have much stronger impact if the implementation of recommendations was assigned to specific actors**. The enactment of recommendations for public sector, such as administration or healthcare, should be allocated to respective authorities. Naturally, this approach would require resources to be allotted to the responsible players. **Furthermore, follow-up mechanisms** for the national technology programmes need to be put in place.

- **The gap between academic AI research and industry should be bridged** by allocating more resources to applied research. Mission oriented projects with more ambitious and broader goals would serve this purpose, too.

Authors

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Introduction

Artificial intelligence, especially machine learning, is seen as critical enabling technology in industries, healthcare, public sector, and def-sec. Therefore, most nations and EU have created policies and programmes to promote research, development and deployment of AI and AI-based solutions during recent years.

The purpose of this study is to compare and analyse AI policies and programmes in three European countries, namely Finland, Sweden and the Netherlands to assess how different approaches and practices work; how effective they are; what are their impacts on different fields (research community, industries, public sector); and which mechanisms leverage to impact most effectively. The results can be used for benchmarking AI policies and programmes, learning from others as well as in guiding on-going and planning future programmes. Furthermore, the position of RTOs in the AI landscape in each country is analysed.

The results will be published as three consecutive reports, each having main focus on one country and comparing it to the two others. This first report focuses on Finland. The reports are prepared and co-authored by researchers working in the research and technology organizations (RTO) VTT (Finland), RISE (Sweden) and TNO (the Netherlands).

This report is organized as follows. The next section explains the research questions and methods, while the following section describes the AI policies, programmes and their implementation in Finland. Then the results and impacts of these are analysed using publicly available evaluation reports, country indexes and especially interviews with key decision makers and experts, then observations about differences and similarities between the three countries are presented and finally conclusions and recommendations for future are made.

Research questions and methods

Following research questions were set:

1. What kind of national AI policies and programmes have been initiated and how they have been implemented?
2. What has been the impact of AI policies and programmes?
3. What kind of conclusions and recommendations can be made for future policies and programmes based on the analysis?

Analysis is based on public reports and documents, semi-structured interviews with key persons who have participated in the planning and implementation of the national AI policies and programmes as well as general index-type evaluations. In addition, investment data are used as data sources. The deeper insight to the topic of this study is gained by in-depth interviews.

AI policies, programmes and their implementation: case Finland

AI Landscape in Finland: instruments and actors

A simplified schematic of the Finnish AI landscape with instruments and actors is presented in Figure 1. The high-level goals and actions for the parliamentary elec-

toral term, or to be more accurate, for the term of the cabinet, are stated in the programme of the cabinet. This programme usually includes statements about industry, technology and research policies. For example, the Cabinet of PM Juha Sipilä had 16 mentions referring to digitalization or digital services, but none about AI (AI was not yet on the agenda in the Spring of 2015). The programme of PM Antti Rinne and later PM Sanna Marin's cabinet mentions AI in their programme eight times.

The second level in the landscape is formed by national programmes, in this case Suomen Tekoälyaika ("Finnish AI age" 2017-2019) and Tekoäly 4.0 (AI 4.0 2020–2022). The programmes were set up by the Ministry of Economic affairs by forming an ad hoc working group consisting of experts and representatives from major companies and industry associations, academia, VTT and ministries. The working groups were divided into sub-groups, and they were supported by a small secretariat. In the case of both AI programmes, a high-profile industry leader was invited to be the chairperson. The working group has some freedom to organize its activity and to set goals within the broadly defined task given to it by the Ministry. The programmes did not have specific budget allocated for them. The concrete outputs of the work are typically an intermediate report containing an analysis of the situation, general vision for Finland, and initial recommendations, and a final report focusing more on recommendations for actions, for both public and private sectors. The work is expected to have impact through the take-up of those recommendations and by raising the general awareness on the topic, in this case AI.

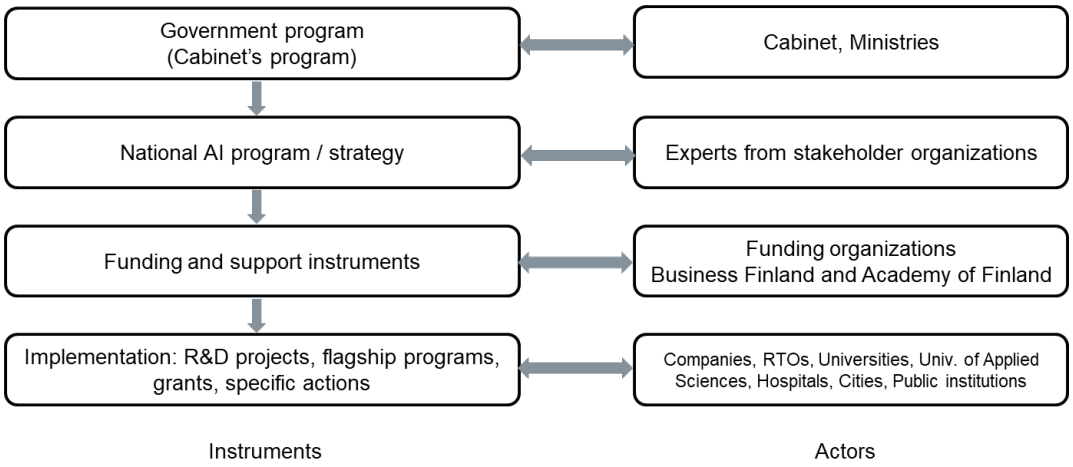

Figure 1. Schematic of instruments and actors in Finnish AI landscape.

One of the expected ways to impact is via funding and support instruments which are offered by Business Finland for RDI and Academy of Finland to basic research. In the case of AI, Business Finland launched a funding programme *AI for Business* in 2018. Academy of Finland, too, targeted funding on AI research, but this occurred partly before the national AI programmes were launched.

The implementation of AI research, development and deployment takes place on the fourth level of the schematic model. The actors are companies, public authorities, RTOs, universities and other parties who execute research, development, proof-of-concept and pilot projects. Furthermore, educational institutions may increase the course offering on the field seen important on national level.

AI policies enter the national agenda

The rapid development of artificial intelligence and its potential for economical and societal impact started gaining attention in 2016 and in 2017 AI was named as one of three most important mega-trends by Gartner. Governments and major companies started to build AI strategies and programmes and major consultancy compa-

nies, such as Accenture, McKinsey and PwC, all published their reports and outlooks on AI and its transformative impacts. Also, academia launched ambitious programmes, such as AI100 by Stanford[1].

The Finnish government was among the first to launch a national AI policy and programme. The government of PM Juha Sipilä (2015-2019) addressed digitalization (not yet AI) in the political declaration and agreement between the coalition parties, the so-called government programme[2]. The emphasis of the centre-right coalition was on national competitiveness and rapid adoption of AI technologies in industry on one hand and on the concern for employment situation on the other hand. These priorities were reflected in the national AI strategy programme "Tekoälyaika" (Age of AI), which is discussed in the next section.

After the parliamentary election of spring 2019, left-green-centre coalition cabinet led by prime ministers Antti Rinne (6–12/2019) and Sanna Marin (12/2019–), took over. The cabinet looked AI from clearly different perspective; the government programme[3] mentions "AI" eight times, of which six refer to the threats and ethical concerns related to AI and the need to regulate AI to prevent hazards, one relates to using AI as a tool for applying social benefits and one is about the need for taxation changes due to AI enabled automation. AI as an enabler for increased productivity, business or competitiveness is lacking from the programme. In practice, however, the differences of the government policies are not as dramatic as the programmes would indicate. In fact, the responsible minister for AI, minister for Economic Affairs and Employment, was Mr. Mika Lintilä in both cabinets. The government of PM Marin launched AI 4.0 programme in 2020.

Government initiate national AI programmes

First National AI strategy programme, "Suomen Tekoälyaika"

As mentioned, Finland was among the first nations to launch a national AI strategy and programme in 2017. The goal of the programme[4] was to ensure that Finland becomes one of the frontrunners among countries that apply artificial intelligence. Three important areas were identified: 1) ensuring that companies receive adequate support for the development of AI-based innovations, 2) facilitate the secondary use of public data as it is essential enabler for AI, and 3) prepare society for the AI age and anticipate the changes imposed by AI.

The programme was organized around four topics and corresponding working groups: Expertise and innovation; Transformation of society and work; Data and platform economy and Ethics. The programme produced and interim report and final report containing 11 recommendations, of which 8 were already given in the intermediate report. The recommendations are rather general, ranging from "Enhance business competitiveness through the use of AI (#1)" to "Ensure top-level expertise and attract top experts" (#4), "Make Finland a forerunner in the age of artificial intelligence" (#8) and "Prepare for security challenges" (#11). Because the general nature of the recommendations, they can be still regarded as valid, but conversely, they do not steer decision making concretely. The final report[5] goes on to list several actions taken, lessons learned and then elaborates the original eight recommendations to more detailed level. Some of the results are quite concrete, e.g., Finland's Artificial Intelligence Accelerator was established in August 2018.

[1] A Century-Long Commitment to Assessing Artificial Intelligence and Its Impact on Society. B. Grosz, P. Stone. Communications of the ACM, December 2018, Vol. 61 No. 12, Pages 68-73

[2] http://urn.fi/URN:ISBN:978-952-287-181-7

[3] http://urn.fi/URN:ISBN:978-952-287-756-7

[4] http://urn.fi/URN:ISBN:978-952-327-248-4

[5] https://tem.fi/julkaisu?pubid=URN:ISBN:978-952-327-411-2

In addition, a specific report on transformation of work was written. In the concluding event of the programme a bold vision was stated: “Artificial intelligence driven Finland in 2025”. When the programme was started, there was a lot of fear of AI causing widespread unemployment. Therefore, the reports and communication of the programme emphasized ensuring employment, especially via re-training of those made redundant by AI.

The emphasis of the first National AI programme was on deploying AI in business and public sector, although concern for employment and transformation of working life was clearly present. The programme did not have budget except for the necessary costs of event arrangements, report writing etc., nor did it have mandate to steer public authorities, funding agencies or regulation. The ways to impact were via recommendations and arousing public discussion.

AI 4.0 – second national AI programme

Minister of Economic Affairs and Employment, Mika Lintilä nominated steering group to prepare an action plan for Finland to speed up the introduction of artificial intelligence and to promote the fourth industrial revolution in November 2020. The name of the programme combines AI and Industry 4.0, and it “identifies objectives and measures that will promote digitalization in Finland[6]. The programme focuses on the development and introduction of artificial intelligence and other digital technologies in companies.” Furthermore, the programme should support the double transition, i.e., green and digital transition. The programme is partially referring to the Finnish AI strategy launched in 2017 and EU objectives.

In the first interim report[7] (Ministry of Economic Affairs and Employment of Finland, 2021) an outlook of the current situation in terms of technology trends and Finnish position is given and then a vision for Finland 2030 is outlined. It should be noted that the programme does not limit to AI only, but it also addresses quantum and high-performance computing, 5g/6g, IoT, distributed ledger and other technology trends as well as applications such as robotics and autonomous vehicles. Yet, AI is clearly seen as the key technology. The vision for 2030 is illustrated by the stories of three fictional companies: a manufacturing company in machinery industry, a health-tech SME and a start-up in data platform business.

The second interim report[8] refined the goals of the AI 4.0 programme. The goals of the programme were structure as four sub-goals, which are 1) “Strengthening the AI leadership [of Finland] by investing in spearhead technologies”, 2) “Nature-smart companies make Finland a triple-winner in sustainability”, 3) “The share of digitally advanced SMEs grows faster in Finland than in other countries” and 4) “Finland becomes increasingly influential in the creation and implementation of EU’s AI, data and industrial strategies”. The four sub-group were tasked to plan actions for respective sub-goals. The final report [9] emphasizes the double transition, green and digital, and sets three goals: Strengthening high-level research on key technologies as well as development activities and investments; Increasing the adoption of digital capabilities and technologies that accelerate the dual transition in industrial SMEs; and Making Finland an international frontrunner in the twin transition.

[6] https://tem.fi/en/artificial-intelligence-4.0-programme

[7] http://urn.fi/URN:ISBN:978-952-327-899-8

[8] http://urn.fi/URN:ISBN:978-952-327-994-0

[9] https://julkaisut.valtioneuvosto.fi/handle/10024/164468

AI funding programmes

AI for Business programme, Business Finland

The goals for AI for Business programme[10] were to increase the competitiveness and productivity of Finnish companies by creating new innovations based on AI and platform economy; grow AI and platform competence in companies, research institutions and universities; advance private public collaboration on digital platforms in order to create innovations; promote the development and deployment of AI and platform technologies for increased productivity; and finally build innovation and business ecosystems and thus make Finland interesting place for investments.

ICT 2023 programme, Finnish academy

Academy of Finland, national funding organization for scientific research, in collaboration with Business Finland, launched a 10-year ICT2023 programme[11] in 2014. The overall aim of the programme is to further improve Finland's scientific expertise in computer science and to promote the broad-based application of ICT. Each year, a specific theme is announced and call for proposals is opened. AI and machine learning were first present in the 2017 call "Computation, Machine Learning and Artificial Intelligence", and later in 2021 "Frontier AI Technologies" was the topic of the call. Naturally, AI methods and research could be included in the proposals for calls on other years, but AI was specifically mentioned in the two above mentioned calls.

Other significant activities

National Flagship programme: Finnish Center for AI

The Finnish Center for AI (FCAI) is formed by a consortium consisting of Aalto university, University of Helsinki and VTT Technical Research Center of Finland. It is one of the ten flagship programmes funded by Academy of Finland. The mission of FCAI is "to create real artificial intelligence for real people in the real world". The flagship comprises of the research groups lead by ca. 60 professors and it has a budget of EUR 20 million from Academy of Finland and an overall budget estimate of EUR 360 million, which includes the total sum of the projects and other resources used by the FCAI partners in AI research and development during the 8-year period 2019–2026. The overall budget comprises of funding from several sources: participating organizations' own funds, Business Finland, Academy of Finland, EU, private companies and other sources.

First AI Accelerator (FAIA)

According to the mission statement "First Artificial Intelligence Accelerator (FAIA) [12] helps established organizations deploy artificial intelligence". The activity was run by Silo.ai (a rapidly growing AI consultancy company), and it supported by the Technology Industry Finland (industry association). FAIA was proposed in the first national AI strategy, Tekoälyaika. FAIA run nine accelerator programmes participated by 44 companies. Furthermore, it produced *AI Landscape* and *State of AI in Finland* reports during its activity 2018 – 2021.

[10] https://www.businessfinland.fi/en/for-finnish-customers/services/programs/ended-programs/ai-business

[11] https://www.aka.fi/tutkimusrahoitus/ohjelmat-ja-muut-rahoitusmuodot/ict-2023/

[12] https://faia.fi/ Originally Finnish AI Accelerator

Aurora AI

Aurora AI[13] is cross governmental programme launched by Ministry of Finance and it run from 2020 to 2022 with a preliminary phase during winter of 2018–19. The programme did not have an exact budget, but it had access to funding in the order of 11 million euro. It had ambitious plans to develop AI based well targeted services for citizens in different transitional phases of life, e.g., when a young student moves to first own home. The goal is stated as follows: "The objective of the AI programme is to offer citizens personalized services at the right time in different life situations and events. This will reduce the need to dash from one window to the next to access services and also promote cost-effectiveness, especially in the provision of public services."

Expected results were the following: 1) AuroraAI network, which is a way of interconnecting services automatically and forms a service infrastructure that enables any compatible service to use the network's functionalities; 2) support the deployment of the AuroraAI network; and 3) a skills and competence development programme with create training contents related to AI (and especially Aurora AI).

AI policies, programmes and projects are depicted in Figure 2.

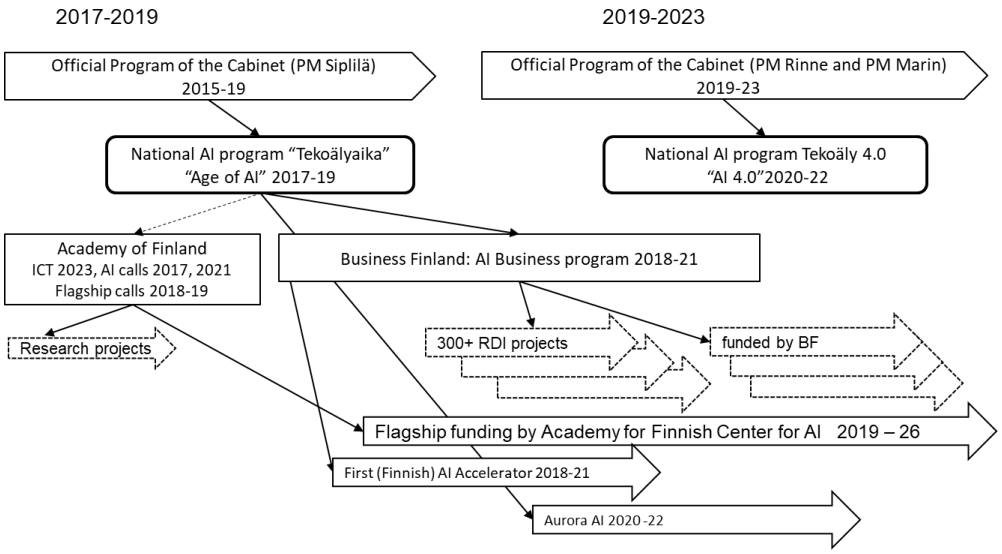

Figure 2. Finnish AI landscape: policies, programmes and projects

Results and Impacts of Finnish AI policies and programmes

In this section the state of AI in Finland is first assessed in the light of AI indexes comparing different countries, then official evaluation and follow-up reports are summarized and finally insights from experts' interviews are drawn.

What country-indexes tell us

Several indexes and country comparisons on AI capabilities, competence and performance exist. They differ in methods, data used, focus and countries included.

[13] https://vm.fi/en/national-artificial-intelligence-programme-auroraai

Indexes and country comparisons relevant for this study are presented here. First, we describe relevant country indexes and comparisons and then summarise their content in Table 1. The data for Sweden and the Netherlands is included as benchmark. When applicable, the development in time is presented, see Table 2.

The Global AI index by Tortoise media combines 143 indicators in sub-areas of Talent, Infrastructure, Operating Environment, Research, Development, Government Strategy and Commercial into single rank number[14]. The USA is ranked first, followed by China and UK. The countries of this report rank between 8th and 19th positions, see Table 1.

The Government AI readiness index by Oxford Insights tries to answer how ready is a given government to implement AI in the delivery of public services to their citizens[15]. The index comprises of 10 dimensions based on 42 indicators. Finland, the Netherlands, and Sweden rank in positions 4, 5 and 6, respectively. The scores are given in Table 1.

The AI watch index 2021 by European Commission provides an overview of the 22 indicators organised around five dimensions[16]. For this study three relevant indicators were chosen. First, activity in EU funded AI projects indicates research activity and collaboration. Secondly, absolute number of AI economic players indicator relates to general activity level, since it measures the number of three types of economic players: research institutes (including universities), firms and governmental institutions. Thirdly, number of economic agents divided by GDP normalizes the activity index in relation to population size. Table 1 contains the results

OECD report estimated that AI start-ups based in OECD countries acquired VC Investments worth ca. 180 billion USD between 2016 and 2020 [17]. The share of US companies is dominant (150 B$) followed by UK (9 B$), Israel, Germany, and Canada with investments around 4 B$. It should be noted that China is missing from the list since it is not an OECD country. The VC investments in the countries studied here range from almost 300 M$ (Finland, the Netherlands) to just over 500 M$ (Sweden). The number of AI start-ups and SMEs in 2020 was ca. 80 in the Netherlands, 55 in Sweden and 45 in Finland according to a report by prepared for EU [18]. According to the same report, all three capitals of the countries fit in the list of ten EU cities with most AI companies. Amsterdam holds the third place; Stockholm is number six and Helsinki number ten.

AI Vibrancy index by Stanford University Human-Centered AI ranks 29 countries with 23 indicators[19]. The indicators describe research and development in terms of academic publication and citation metrics; IP generation; investments and start-ups as well as talent and skills. Rankings are presented in absolute values as well as normalized per capita.

Digital Economy and Society Index (DESI) is a composite index describing the digitalization in broad terms[20]. It includes four areas: Human Capital, Connectivity, Integration of Digital Technology and Digital Public Services. DESI is maintained by EU. As DESI is not focusing on AI, it can be used as a baseline to which AI indexes can be compared. A rank of the countries is shown in Table 1.

[14] https://www.tortoisemedia.com/intelligence/global-ai/

[15] https://www.oxfordinsights.com/government-ai-readiness-index2021

[16] https://ai-watch.ec.europa.eu/ai-watch-index-2021_en

[17] Tricot, R. (2021), "Venture capital investments in artificial intelligence: Analysing trends in VC in AI companies from 2012 through 2020", OECD Digital Economy Papers, No. 319, OECD Publishing, Paris, https://doi.org/10.1787/f97beae7-en.

[18] https://www.eib.org/attachments/thematic/artificial_intelligence_blockchain_and_the_future_of_europe_report_en.pdf

[19] https://aiindex.stanford.edu/vibrancy/

[20] https://digital-agenda-data.eu/datasets/desi

Table 1. Summary of AI related country indexes

Index or comparison	Scale	Finland	Sweden	The Netherlands
Global AI index (Tortoise Media)	rank	13	19	8
Government AI readiness index (Oxford Insights 2021)	0…100	79.2	78.2	78.5
Activity in EU projects (EU)	#	153	209	384
Number of economic agents per GDP *and* their absolute number (EU)	<=	0.9 / 226	0.7 / 325	0.5 / 437
VC investments in AI start-ups 2016-20 (OECD)	USD	284 M$	517 M$	286 M$
AI Vibrancy index	rank among 29 abs. /per cap.	20 / 8	14 / 14	12 / 12
Digital Economy and Society Index (composite)	rank among EU countries	1	4	3

Table 2. Finland in country indexes 2017-22

Index or comparison	Scale	2017	2018	2019	2020	2021	2022
AI Vibrancy (absolute)	rank	22	20	16	18	20	-
Government AI readiness index (Oxford Insights)	rank	#10	#5 (2018 and 19)	#5	#3	#4	#4
Digital Economy and Society Index	rank	1	1	1	1	2	1

All three countries perform reasonably well in the global indexes. Even if the relatively small size of the countries is considered, as in AI Vibrancy index, Finland, Sweden and the Netherlands do not position among the top five, but in the middle section of the 29 countries evaluated. However, if only EU countries are included, the three countries position very well in AI Vibrancy index where they occupy 1st, 3rd and 5th, while in DESI they have positions 1st, 3rd and 4th and in Global AI 1st ,5th and 9th. Interestingly, the internal order of countries varies from index to index. This is understandable since different criteria and measures are used in the indexes. It also implies that certain caution should be exercised when using the indexes.

The ranking of Finland as shown in Table 2 has remained rather stable. Finland ranks very high in government readiness and digital society and mediocre in AI vibrancy. A plausible interpretation is that even though Finland has invested in AI, so have other countries and even holding the same relative position requires effort.

R&D funding programme increased export

Assessment reports for AI for business programme and Academy of Finland programme have been composed. It is noteworthy, that there are no evaluation or follow-up reports on the national AI programmes.

The AI for Business programme by Business Finland ran from 2018 till the end of 2021 and the total volume, including BF grants and contributions from participating companies and research parties reached EUR 235 million. The programme supported companies aiming at growth and internationalization, i.e., increasing their export as well as research parties collaborating with such companies. In total 347 projects were awarded grants, which were available to individual companies and consortia. The average project size is EUR 677 000.[21]

According to Business Finland, the programme more than doubled the exports and personnel in Finnish AI companies (2.5-fold increase of exports to EUR 280 million). In addition, Business Finland says that digital B2B services have become a strong area in Finnish exports, partly due to the programme. Building international collaboration via events organized by the programme was less successful.

The exports of companies participating in the AI for Business programme more than doubled their export to EUR 280 million p.a.

ICT2023 funding programme has been evaluated in 2020[22]. The programme consisted of yearly funding rounds totalling in ca. EUR 60 million, of which about 10% was clearly targeted for AI or ML research. The evaluation panel consisting of esteemed researchers saw that the programme had been successful with its main objectives. However, according to the panel, the role of AI and ML should have been more significant, as they stated: “The panel also thought that the programme has underplayed some major trends in computer science with huge relevance to the world of tomorrow. The clearest example of this is ‘Machine learning and its applications’ …”.

FCAI flagship programme is now in halfway of the eight-year duration. The volume of research under the auspices of FCAI is approximately EUR 60 million p.a. The number of peer reviewed publications in three years totals 1270. An evaluation by experts appointed by Academy of Finland in 2021 gave FCAI good marks and after their recommended funding for next period was granted. The programme has so far reached or exceeded the KPIs in publications, project volume and company collaboration. However, number of patent applications and start-ups is below target.

First Artificial Intelligence Accelerator run nine accelerator programmes which were participated by 44 companies. Furthermore, it produced *AI Landscape* and *State of AI in Finland* reports during its activity 2018–2021. According to the interviewed experts, FAIA served its purpose in educating and activating people first in large and midcap companies, later in SMEs.

Aurora AI programme received stark criticism from the programmes own ethical group. Citing the members of the ethical group, newspaper Helsingin Sanomat published a critical review[23], where the Aurora AI was seen as potential “big brother” threat on one hand and a technical failure on the other. Aurora AI fell short of its goals and failed to create successful pilot cases and engage a developer community despite the EUR 11 million budget. It seems that the programme was over ambitious and had deficiencies in planning and execution. The problems were amplified by the exaggerated expectations encouraged by the public communication of the Aurora AI.

Insight from interviews

[21] AI for Business Program 2018-2021, Final Report. Outi Keski-Äijö and Julia Reponen, 2022.

[22] https://www.aka.fi/globalassets/2-suomen-akatemian-toiminta/4-julkaisut/julkaisut/ict-2023-interim-evaluation--panel-report

[23] https://www.hs.fi/sunnuntai/art-2000009205265.html

The interviewed decision makers participated in the formulation of the national AI policies by contributing to the Tekoälyaika and Tekoäly 4.0 national programme teams. Consequently, they are well informed about the programmes and the goals set. Since the interviewed experts represent different backgrounds and stakeholders, an overarching understanding of the Finnish AI landscape and the impacts of the national AI policies can be formed by combining the insights gained in the interviews.

The key take-aways of the interviews are presented here. The statements are not tied to individual persons, and some statements are aggregations of two or more similar original ones. The names and roles of interviewed persons are given in appendix 1.

- The national AI programmes, especially Tekoälyaika (2017-19), were significant in bringing AI to the agenda of decision makers in public and private sector. It is likely, that the national AI programme speeded the uptake of AI technology in business and society to some extent. However, the programmes did not formulate a coherent national policy, which would have guided the planning and decision making of authorities, even less that of the private sector. The final reports of both national AI programmes were rather abstract and did not contain binding directions.
- The programme format as seen in Tekoälyaika and Tekoäly 4.0 has some inherent deficiencies: the programmes start from scratch, there is no continuum (new cabinet, new programme); the programme teams use too much time for analysing which may lead into situation where the results are outdated when ready; the composition of programme teams is somewhat arbitrary and often drawn from an “inner circle”. Yet, the most serious issue is that the implementation and follow-up mechanisms as well as resources are lacking.
- Indirectly, the national policy and Tekoälyaika programme gave impetus and justification for the EUR 200+ million funding programme *AI for Business* run by Business Finland. The funding programme emphasised applications of deep learning and ML to business, not research in AI technology as such. Also, “new platform economy” was supported. Speed and agility were prioritized over meticulous preparation because of the rapid development of AI technology. The funding was targeted to independent projects, not large-scale missions.
- Main goals of the AI for Business programme were achieved, e.g., the turnover and export of companies participating (= receiving funding) grew strongly (2.5-fold). VTT (RTO) had key role in building consortia projects based on industry verticals while universities were expected to transfer novel AI research results into use in industry.
- Flow of latest research results from top academic research to industrial/business applications could have been smoother. There is a gap between academic funding by Academy of Finland and very target-oriented Business Finland funding. This gap has been recognized and some measures taken; a co-research funding instrument has been taken into limited use.
- Partly due to the gap between AI research and Finnish companies, the software industry does not benefit from the apparently high quality of fundamental research on AI in Finland. Furthermore, AI based software products or tools are not developed in Europe. Instead, AI tools offered by the US and Chinese technology giants are deployed to individual use cases within industry and public organizations. Typically, it is about predictive analysis or process optimization. Same situation seems to hold for Europe in general, SAP maybe being the only exception. The tools originating from US or China mirror their business and organization structures and values. Situation is due to the fragmentation of European market and company size, the companies being too small for expensive development efforts. The problem is emphasized by EU’s lack of mechanisms to support or fund fast paced large-scale software research and development projects. European market is fragmented because of different lan-

guages, business cultures, and regulation. For example, the threshold for open bidding in procurement varies from 50 k€ to 250 k€. Even though EU directives give guidance, the national regulation may differ.

- AI technology is still far from the everyday life of software company managers and decision makers.
- Nevertheless, there is fruitful collaboration between AI researchers – in many cases together with researchers in application domains – and companies in machinery, pharma and chemical industries.
- Growth engine start funding, a specific instrument by BF, had significant role in speeding up the growth of Silo.AI into largest specialized AI consultancy in Finland and in the Nordics. Likewise, FAIA accelerator spreading knowledge of AI's potential among members of industry association Teknologiateollisuus ry (Technology Industries of Finland) benefitted from the funding.
- Finland has a long tradition in data analytics, machine learning and other AI research which Academy of Finland has supported constantly since 1970'ies. This gave Finland strong scientific base when AI trend rose around 2015. In the research AI trend was already there, when Tekoälyaika national programme started in 2017, so the national programme was trailing, not leading from viewpoint of academic research. But since it was more towards industry, not research, the timing was quite good.
- Long-term commitment from researchers, university and funding is important for achieving excellence in science.
- Significant resources from the research community are spent on applying funding. This is a big overhead for the whole system and consumes a major share of the work time of senior researchers. To improve the situation, a track-record oriented funding system should be put in place.

Comparison to Sweden and the Netherlands

Sweden

The Swedish government released an AI policy statement in 2018. The statement is non-binding and comes without specific resources or governance structures, akin to Finland. The overall ambition was to orchestrate existing initiatives for Sweden to become world-leading in AI uptake. In short, the ambition was excellence in utilizing the benefits of AI and not necessarily research into AI as a technology.

Different universities and the Wallenberg foundation's WASP programme, with committed budget of SEK 5.5 billion (EUR 500 million) for 15 years had already started before the government gave the AI statement in 2018. WASP has a strong emphasis on academic research coupled to the needs of Sweden's main export industries. Overall, the private sector invested SEK 5.6 billion (EUR 560 million) in AI-technologies in 2019 while the public sector invested approximately SEK 150 million (EUR 15 million) in digitalization.

Different national authorities have a general mandate to organize their own work as long as it is within the government assignment and budget. Several authorities have therefore invested in digitalization of their services, such as social benefits and declaration of taxes. In 2018 a new authority was also created with the specific assignment of facilitating the digitalization of public administration, the Agency for Digital government.

The agency for innovation shifted focus towards AI at the same time but the new ambitions were again within existing budget and mandate. One of the initiatives was the creation of *AI Sweden* together with two regional municipalities. The ambi-

tion was to create and facilitate a hub for the actors within the ecosystem and mitigate the perceived fragmentation of initiatives.

AI Sweden was created by funding from three public bodies where the Swedish innovation agency contributed SEK 100 million (EUR 9 million) over five years. The funding was enabled by a re-prioritization within the existing budget. Other examples of initiatives within budget are life-long education of professionals, labs and resources and an SME strategy, totaling less than SEK 100 million (EUR 10 million). The Swedish research institute RISE was at the same time created and assigned by the Government to facilitate the application of "advanced digital services and tools", equivalent to SEK 70 million (EUR 7 million) over four years. The assignment reflects the national policy statement from 2018.

The Swedish public initiatives have focused on developing digital infrastructures such as data labs enabling data sharing, common interfaces for data access and resources for cyber security, besides AI uptake. Another perspective is how national authorities have invested in digital services for citizens and automated decision-making systems. The latter is not necessarily perceived as AI since they need not rely on machine learning but classical rule-based AI.

In Sweden the publicly funded initiatives have been managed within existing mandates and budget and therefore followed the usual audit and evaluation procedures. This has been complemented with specific governmental assignments to promote AI competence within public administration and a new authority for the overall digitalization of government. Their mandate is to provide guidance and recommendations. This means that it is business as usual in terms of publicly funded initiatives relating to AI in terms of funding and evaluation. Similar approaches have for instance been applied for life-science, a Swedish strategic business area.

In 2018 the Swedish innovation agency recognized the fragmentation of the Swedish ecosystem and initiated instruments to increase career mobility between academia and industry. The strategic innovation programmes funded by the agency were also asked to increase AI awareness in their research agendas. The gap is still a priority and one of the focus areas of AI Sweden and RISE.

In 2022 the Swedish innovation agency initiated a restructuring of the strategic innovation programmes towards mission-oriented research agendas. The initiative will transition into second phase in 2023 and it is too early to assess the impact of the changes.

The Netherlands

The initiative for a Dutch national strategy aimed specifically at Artificial Intelligence (AI) was taken by ***AI voor Nederland*** **(AINED**), a small informal group consisting of organisations representing employers in the private sector, industry, applied and fundamental research. In 2018, AINED published a document[24], intended as a call to action to secure the position of the Netherlands in the international AI arena and reap the potential benefits of the technology for Dutch science, economy and society. Together with another report[25] published by thinktank DenkWerk around the same time, the AINED document inspired the first official AI strategy of the Netherlands government. Entitled ***Strategic Action Plan Artificial Intelligence*** **(SAPAI**), the official government AI strategy was published one year later, in 2019 under the aegis of the Netherlands Ministry of Economic Affairs and Climate Policy. Until SAPAI, AI had not been a standalone government policy priority in the Netherlands

[24] AINED (October 2018). AI voor Nederland: Vergroten, Versnellen en Verbinden. https://order.perssupport.nl/file/pressrelease/a253ded8-1863-4d07-b79d-72639baefc51/6be5dcdc-b9d8-4675-bd80-9425826c840c/AIvNL20181102final.pdf

[25] DenkWerk (2018) AI in Nederland, https://denkwerk.online/media/1029/artitificial_intelligence_in_nederland_juli_2018.pdf

but featured in other national innovation or industrial policy agendas (in particular in the Dutch ICT & digitalization and the Key Enabling Technologies agendas).

SAPAI outlined the government's ambitions for AI in the Netherlands: as a vehicle *"to create and benefit from societal and economic opportunities and protect the public interests, thus contributing to welfare and wellbeing"* [26]. SAPAI set out three strategic action lines: 1) capitalizing on societal and economic opportunities for AI; 2) creating the right conditions for AI research and innovation; and 3) strengthening the foundations for human-centred AI. Two accompanying policy documents expanded on the government's commitment to public values and legal safeguards associated to AI.[27]

Institutionally, SAPAI is not supported by a dedicated government outfit (i.e., something akin to a "Ministry of AI"). Instead, AI policy issues might be addressed by the interdepartmental working group on AI, by the recently (2022) setup department for digitalization (within the Netherlands Ministry of the Interior), by the ministry of Economic Affairs and Climate Policy, or by other national government departments.

The task of putting into practice some of the ambitions formulated in SAPAI was organized as a bottom-up initiative. **The Netherlands AI Coalition (NL AIC)** took on the challenge of rallying up and organizing the Dutch AI ecosystem. NL AIC, like AINED, started as an informal group of industry representatives, academic institutions and institutes of applied scientific research, with additional support from the Netherlands Ministry of Economic Affairs and Climate Policy. NL AIC started in 2019 with 65 member organisations and EUR 23,5 million of kickstart funding from the Netherlands Ministry of Economic Affairs and Climate Policy[28]. By 2021, the number of member organisations had grown to 250. Structured as a public-private partnership (PPP), NL AIC together with its member organisations define the main themes of their activities (i.e., buildings blocks for AI, such as data sharing, trustworthy AI, human capital, etc.); as well as the sectors[29] of application (i.e., those likely to deliver maximum impact to benefit the Dutch economy and society). Furthermore, NL AIC also takes on a regional approach, expanding the ecosystem further from regional centres of AI expertise.

NL AIC's strategic R&I investment programme named **AiNed** is tasked with organizing the actual projects in which members and non-members of NL AIC participate. AiNed received a budget[30] of €204.5 from the Netherlands National Growth Fund for phase 1 (including in-kind contributions from research participants, the amount is about twice as high); and selected the first projects in 2022. The desired impact of projects funded by AiNed is to strengthen the Netherlands' economic position, and to contribute to the development of human-centred AI. The so-called **"quadruple helix"** is the favoured approach, meaning that projects should aim to involve representatives of four main categories of stakeholders: government, research, industry, and civil society[31]. Furthermore, AiNed projects focus on a subset of the sectors selected by NL AIC. In addition to projects aimed at developing and applying AI-solutions, AiNed finances other types of activities, as well. One example are the so-called **ELSA Labs** - living labs or innovation labs where ethical, legal and social aspects (ELSA) of AI are explored; places for experimental, iterative and

[26] Ministry of Economic Affairs and Climate Policy (2019). Strategic Action Plan for Artificial Intelligence (SAPAI) [Dutch], p.10. https://www.rijksoverheid.nl/documenten/beleidsnotas/2019/10/08/strategisch-actieplan-voor-artificiele-intelligentie

[27] Ibid.

[28] NL AI Coalition (2019). 65 organisaties slaan handen ineen om Nederland op de kaart te zetten als AI-land. [Dutch] https://nlaic.com/nieuws/organisaties-slaan-handen-ineen-voor-ai/

[29] Currently, the selected sectors include among others: Culture & Media; Defence; Energy & Sustainability; Financial services; Built environment, Health; Education; Maritime, etc. The full list of NL AIC prioritized sectors can be found at: https://nlaic.com/toepassingsgebied

[30] The actual budged has been scaled down from the originally planned investment of €2,1 Billion

[31] AiNed (2022). Artificiële Intelligentie: Nederland aan de slag met AI voor welvaart en welzijn. [Dutch]: https://ained.nl/wp-content/uploads/2022/02/Publicatie_AiNed_Investeringsprogramma.pdf

incremental development; environments for collaboration and knowledge-sharing; accelerators of (responsible) innovation.

While activities of NLAIC and its investment programme AiNed focus primarily on the application of AI, **scientific research** into AI is coordinated by the **Dutch Research Council** (Nederlandse Organisatie voor Wetenschappelijk Onderzoek, **NWO**). NWO drafted the **Artificial Intelligence Research Agenda** for the Netherlands and organized it around specific AI challenges, with the end goal of contributing to the Netherlands' ambition of "being a European leader in AI technology and contributing to the shared European vision of human-centred AI".[32]

Both, however, share a number of priorities and approaches to AI research, development and innovation (R&D&I), such as a **mission-oriented** approach or a "**Top sector**"-approach (the latter referring to prioritized economic sectors); focus on the **EU**; on **people-centric** and **trustworthy** AI etc.

The R&D&I infrastructure described in the previous paragraphs does not cover all **AI-related activities** in the Netherlands, nor does it aim to do so. Many such activities preceded it; others continue to emerge and function outside it.

For the latter category, next to self-funded activities, there are various other channels and (policy) **instruments** available, aiming to encourage (adoption of) innovation. Most of them are generic, rather than AI-specific (for example instruments used by the Netherlands Enterprise Agency (RVO) to help SMEs and start-ups).

Efforts put into promoting and developing AI is beginning to show some **results.** AI applications are slowly making their way into the private sector, with higher adoption by large enterprises, lower adoption by SMEs, high year-on-year increase across the board, but overall, still relatively limited (both in numbers and sophistication of AI). AI applications are also used in the public sector – in some cases controversially[33] so.

However, the **gap** between AI research and implementations of AI remains significant for now, and activities of R&D&I infrastructures as described above play an important role in bridging this gap.

Discussion and recommendations

This study shows that the national policies and programmes have had indirect impact by raising AI to the agenda of decision makers and public discussion. The use of AI solutions in private companies has increased remarkably since 2017, although this is not necessarily result of the national policies or programmes. However, the direct impact of the programmes appears to be very limited, since the programmes did not have mandate or resources to enact their recommendations. Implementation and follow-up mechanisms were lacking. Because of this, some rather obvious opportunities were not used, for example, committing public administration and public healthcare to prepare and deploy interoperable processes, practices, and tools to exploit AI technology. Likewise, opportunity for mandating public procurement to include innovative use of AI or setting up regulation to endorse exploitation of AI was missed.

[32] NWO (2019). Artificial Intelligence Research Agenda for the Netherlands (AIREA-NL), p.8. https://www.nwo.nl/nieuws/eerste-nationale-onderzoeksagenda-voor-artificiele-intelligentie

[33] For example in the case of the Systeem Risico Indicatie (syri), an AI application developed and used at the initiative of the Netherlands Ministry for Social Affairs to predict various forms of fraud (such as unemployment benefit fraud) was challenged in court, found to breach Art. 8 of the European Convention on Human Rights and eventually forbidden. https://www.rechtspraak.nl/Organisatie-en-contact/Organisatie/Rechtbanken/Rechtbank-Den-Haag/Nieuws/Paginas/SyRI-legislation-in-breach-of-European-Convention-on-Human-Rights.aspx

The above does not mean that AI technology was not endorsed by government. On the contrary, funding programme by Business Finland was a significant investment and many public authorities initiated at least pilot-level experiments and projects with AI. Yet, lacking an all-encompassing guidance, both the funded RD projects as well as pilots in public sector remained isolated and thus the opportunity for synergy was missed.

If the national policies and programmes are to have stronger impact, several means can be foreseen. Government and public sector, most importantly healthcare and education, could be instructed and supported in applying interoperable data- and AI-solutions. Research and development funding could be organized around national level missions for benefitting the transformative AI technology. Finally, regulatory means and tax incentives could be used to speed-up the deployment of AI solutions.

Following is a list of recommendations for future AI policy in context of broader digitalization and societal and business transformation.

- **It is not only about AI.** AI is one of the technologies shaping our future. Others include internet of things, telecommunications (6g), virtual reality and quantum computing. These technologies are horizontal, as they serve many sectors and fields. Too tight focus on AI in public discussion has led neglecting other aspects of digital strategy in business, especially “new platform economy”. In the future, companies should grasp the potential of AI in broader, strategic scale involving system architecture, organization, and business model. The continuous learning capability of AI/ML is essential, as it enables learning systems. Since AI technologies become woven into processes, organizations, products, and services, it should be critically evaluated, how much Finland should emphasize pure AI research or more application-oriented research for applying AI into industry, public services, and into other sciences.
- **The national technology programmes would have much stronger impact if the implementation of recommendations was assigned to specific actors**. The enactment of recommendations for public sector, such as administration or health care, should be allocated to respective authorities. Research can be directed via funding programmes, as has been already done. Private sector can be guided by RDI funding, public procurement, tax reliefs or regulation. Naturally, this approach would require resources to be allotted to the responsible players. **Furthermore, follow-up mechanisms** for the national technology programmes, in this case AI programmes, need to be put in place. Currently, there is no systematic methods either for enacting or follow-up of the programmes. National programmes should also be improved by making them faster to ramp-up, more action oriented, concrete, and focused.
- **There is a gap between academic AI research and industry.** Same holds to use of research results in the public sector. Because of this, the impact of Finnish research remains weaker than it should. Focus and resources should be put in bridging the gap through applied research and other means.
- **Mission oriented projects with more ambitious and broader goals** than current rather small separate RD projects are called for. Finland should consider ecosystem project for AI, broader and more strategic than single projects. The ecosystem project would consist of companies who “have seen the light” and aim at significant impact by using AI broadly. Research partners would contribute with their competence.

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Claudio Lazo is a Digital Strategy & Policy Researcher at TNO in The Netherlands. He has published about AI ethics, governance and policy and works in the European VISION project to support four large AI research networks with roadmapping.

Appendix 1 Interviewed experts

Outi Keski-Äijö managed the AI funding programme AI for Business in Business Finland.

Heikki Mannila is the former Director General of Academy of Finland (AoF), now full professor at Aalto (AI area), contributed as sub-group member to the first national AI programme Tekoälyaika.

Petri Myllymäki, full professor (AI) at University of Helsinki, vice director of FCAI. contributed to the latter national programme Tekoäly 4.0 as sub-group member.

Tero Ojanperä is the founder of Silo.AI and Professor of Practice at Aalto university. He contributed to the background discussions of Tekoälyaika programme.

Rasmus Roiha is the Managing Director at Finnish Software and e-Business Association and board member of several software companies, contributed to both national AI programmes, Tekoälyaika and Tekoäly 4.0

Samuli Savo, Senior Vice President of Product Management and Innovation, Packaging Solutions and former CDO at Stora Enso, sub-group leader in both national AI programmes.

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