REPUBLIC OF ESTONIA
GOVERNMENT OFFICE

REPUBLIC OF ESTONIA
MINISTRY OF ECONOMIC AFFAIRS
AND COMMUNICATIONS

Report of

Estonia's AI Taskforce

May 2019

European Union
European Social Fund

Investing
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This analysis was funded by the Operational Programme for Cohesion Policy Funds, 2014-2020, priority 12 "Administrative capacity", action 12.2 "Development of quality of policy-making".

EY
Building a better working world

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The English version of the report is an abridged version and therefore the order of the chapter numbers corresponds to the main report.

FOREWORD

Artificial intelligence is no longer science fiction or merely the dream of technology enthusiasts. AI has already arrived — in our phones, on the Internet and in many other services that surround us.

However, the development of artificial intelligence has only just begun. We are still a way off from machines that can think for themselves, not to mention machines with feelings or consciousness. We currently have applications that perform specific tasks that improve over the course of their work. In a large and ever-increasing number of cases, they are already more accurate and effective in performing tasks than humans.

It is, therefore, high time that we prepare a plan on how Estonia could benefit from artificial intelligence. After all, one of the challenges we are facing is making do with a decreasing number of working-age people, while simultaneously increasing our productivity. Artificial intelligence is a way of doing this, in a new manner which can surpass previous technological solutions. This is evidenced by both experiences from across the globe, as well as the first pilot projects within our public sector.

This report includes proposals for applying artificial intelligence within Estonia on a wider scale. There is no lack of potential, especially in the public sector, but we must lay a foundation for it. The proposals and Estonia's first artificial intelligence plan are focussed on developing the basic competences required for implementation.

Once we are successful, it will soon be time to set more specific, long-term objectives — what exactly should we do with artificial intelligence, going forward. Now, however, it is time for us to get started, encourage the testing of artificial intelligence as widely as possible, and gather essential competences.

In doing so, we must, of course, consider the dangers and manage the risks. 67% of Estonians expect us to be rather careful in applying this powerful technology. We have, therefore, started to call artificial intelligence applications “kratts” — based on Estonian folklore — and the Estonian artificial intelligence plan is known as the “kratt plan”. This is a huge opportunity and a powerful tool for Estonia which needs to be wielded responsibly and safely, so that the kratts won't harm us if left unattended — just like kratts in folklore.

A third of Estonians believe that modern kratts could bring many benefits to Estonia. When looking at the international level, we see that Estonia has all the makings of becoming a role model and testbed for the rest of the world — a place where kratts are put to work for the people's well-being in both the public and private sectors.

I would like to thank the expert group of the kratt plan and everyone else who contributed to these proposals and discussions. We have established a community that helps us to turn kratts into an “Estonian trademark” and bring the e-state and the economy to the next level. Not much remains to be said other than, “let's do it”!

Siim Sikkut

Chair of the AI taskforce
Deputy Secretary General for IT and Telecom
Ministry of Economic Affairs and Communications

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Summary

Artificial intelligence is an important field of technology that is becoming increasingly popular. Its application can increase the added value created by companies and make the work processes of the public sector more efficient. Pursuant to international studies, the increased implementation of artificial intelligence has a substantial impact on the economy. According to an estimate made by the McKinsey Global Institute[1], for example, the implementation of kratts will create an additional 13 trillion US dollars of added value globally by 2030, accelerating the annual growth of the GDP by 1.2%.

At the same time, artificial intelligence is still quite a novel technology which may not have an immediate economic impact within organisations, as it is still being developed. However, the risk of waiting for the technology to mature means lagging behind. Therefore, state attention and support are required for the application of artificial intelligence and mitigation of the risks associated with its implementation so that kratts could have a significant economic impact in the future.

According to the vision of the expert group, Estonia's **objective should be to boost the development of this field in Estonia**, starting with the development of basic competences. In doing so, **particular effort should be made in facilitating the implementation of kratts in the public sector**, as the development of this has only just begun or it receives minor attention in the rest of the world pursuant to the kratt plans of other countries (see chapter 5). If Estonia moves quickly in the area of artificial intelligence, it can stand out and gain a better competitive edge. This is also supported by the general strong foundation of our current e-state, for which the use of kratts would be the next step and an upgrade.

The implementation of artificial intelligence applications, i.e. kratts, is also a high-priority discussion topic in cooperation groups of the European Union, OECD, and the cooperation groups of Nordic and Baltic states that coordinate the development of the region. The results of their work form a framework that should be taken into account when preparing and implementing Estonia's kratt strategy — either as guidelines to follow or cooperation and funding options for boosting Estonia's activities.

Definition of artificial intelligence

According to the definition used in the EU, artificial intelligence includes systems that exhibit intelligent behaviour by analysing their environment and making decisions that are somewhat independent to meet certain objectives.

In Estonia, we have introduced the term **"kratt"** in the framework of this project, **meaning practical applications based on artificial intelligence technologies** (in the narrow meaning of artificial intelligence) performing a specific function. The main difference between artificial intelligence and traditional software solutions is that, in the latter, computer programmes perform orders given to them by the software developer, whereas the algorithms of artificial intelligence have no strictly prescribed programme logic and a kratt must reach the right solution using various algorithms of machine learning (for more information on artificial intelligence, see chapter 3).

The situation in Estonia

Companies and organisations within the public sector in Estonia have already applied artificial intelligence technologies in several fields, such as chatbots, finding the most suitable positions for jobseekers, or analysing data transmission traffic in a computer network.

This project **revealed a clear interest and preparedness among Estonia's public and private sector organisations for introducing kratts and several organisations are already engaging in it**. Several solutions based on machine learning and other technologies have been established and applied in Estonia's public and private sector; however, the scope and usefulness of such technologies is currently limited.

The contact between Estonia's companies and kratts can be viewed from the aspect of both their developers and users.

Companies who are engaging in kratt product development by creating various kratt solutions, as well as companies that are already using kratts — currently larger organisations (banks, telecommunications companies, etc.) — were analysed throughout the course of the project. The challenges related to developing and applying kratts have been described in clause 6.2.

One of the most common applications of kratts in the private sector is chatbots, which can interpret the text inserted by a user and thus help to solve problems by maintaining a dialogue. In addition,

1 NOTES FROM THE AI FRONTIER: MODELING THE IMPACT OF AI ON THE WORLD ECONOMY, 2018, https://www.mckinsey.com/~/media/McKinsey/Featured%20Insights/Artificial%20Intelligence/Notes%20from%20the%20frontier%20Modeling%20the%20impact%20of%20AI%20on%20the%20world%20economy/MGI-Notes-from-the-AI-frontier-Modeling-the-impact-of-AI-on-the-world-economy-September-2018.ashx

various image processing solutions (including vehicle licence plate recognition, assessing the product quality of a manufacturing company based on an image, etc.) and robotics applications are being used.

Estonia has a two-fold position when it comes to the potential of applying kratts. On the one hand, the high level of digitalisation of the public sector, openness of the Estonians towards novel technologies, and the preparedness of the people to implement them create good preconditions for applying kratts. At the same time, the business sector needs to first carry out the primary-level digitalisation of business processes so that they would have datasets to use kratts on. As a result, the measures of the public and private sector differ. Awareness on the solutions of artificial intelligence needs to be raised in both the private and public sector so that it would be considered a viable option in solving business problems.

Estonia's plans for the future

Over the course of this project it was concluded that Estonia should start piloting kratt projects to gain initial feedback and experience and then start planning long-term measures. Although several countries have started to prepare their vision and long-term strategy for artificial intelligence, better understanding of the possibilities and benefits, as well as the dangers and risks of using kratts, need to be gained through pilot projects, in order to prepare a more substantial strategy.

Estonia should apply an agile strategy development process, wherein a biannual action plan is initially prepared and the long-term strategy is developed based upon it on an ongoing basis with the implementation of artificial intelligence. In the initial phase, pilot projects are launched and various measures are applied to find solutions that have the greatest impact on the development of kratts.

The measures planned throughout the course of the project cover the topics of the public sector, the private sector, education, research and development, ethics, and law. The report does not include the topics of adaptation and the social impact related to the implementation of artificial intelligence, as these measures are simultaneously developed by the Ministry of Social Affairs and the Ministry of Education and Research.

The objective of the public sector in using kratts should be to act as a smart customer and pioneer in ordering kratt solutions, thus boosting the development of artificial intelligence in Estonia and acting as its driving force. This would serve the purpose of developing the e-state and information society on a wider scale — such as setting up objectives for improving the quality of services and making the functioning of the state more efficient (including making the services more proactive). For that purpose, measures need to be taken to ensure the availability and quality of data, launching pilot projects, increasing the competence of the customer, and ensuring the sustainability of the projects. While doing so, it is not reasonable to select only a limited number of high-priority fields from the public sector where the development of kratts is given top priority. It is better to foster a broad-based approach and support as many projects as possible in as many fields as possible.

Awareness needs to be raised and research and development activities and innovation need to be encouraged to foster the implementation of kratts in the business sector. For kratt developers, the implementation of high-risk kratt projects (including pilot projects) need to be supported to create research-intensive products. Improvement of the general digitalisation level of potential implementers of kratts is a precondition for applying kratts. Increase in the proportion of research and development activities of companies also plays an important role in the development and application of kratts.

Research and development activities and education form the basis for creating and applying kratts in both the public and private sector, **where the focus is on the education of additional specialists and support of applied research**. In order to introduce kratts on a wider scale, funding of R&D needs to be increased (the goal is 1% of GDP), a competitive grant for doctoral candidates needs to be established, and investments into IT need to be increased significantly.

One of the main conclusions of the legal analysis is that there is no need for substantial changes in the basics of the legal system and there is no need for a so-called harmonised “kratt act”. At the same time, the current legislation requires a number of changes which have been provided as proposals in the report (e.g. to clarity liability related to the implementation of kratts).

Proposed measures for Estonia's activity in the upcoming years:

The area of kratts is complex, requiring constant development and additional support for fostering its implementation. The proposals of the expert group have been prepared from the perspective of the coming years, when basic competences need to be established (including creating standard components for kratts), public and private sector awareness needs to be raised, researchers trained, and pilot projects developed so that the change can start as soon as possible. The proposals have been divided into five categories (longer descriptions of the proposals have been provided in chapter 6 of the report).

Establishing a long-term kratt strategy for Estonia

On the one hand, this expert group report has been created to boost the implementation of kratts in the short term (until 2021). On the other hand, the expert group sees the need to establish a long-term strategy for artificial intelligence in Estonia that would take into account the experiences gained from the initiatives prepared under the current action plan. To prepare this strategy, the expert group proposes putting together a working group on artificial intelligence, tasked with monitoring the performance of the short-term action plan (and initiating additional activities, if necessary), being aware of the developments of artificial intelligence within the EU, and initiating the planning process for Estonia's artificial intelligence strategy.

About the expert group and the methodology

At the beginning of 2018, an expert group — managed by the Ministry of Economic Affairs and Communications and the Government Office — was established and a cross-sectional coordination project initiated. The tasks of the expert group were as follows:

- prepare draft legislation to ensure clarity in the Estonian judicial area and organise the necessary supervision;
- develop the Estonian artificial intelligence action plan;
- notify the public about the implementation of kratts and introduce the possible options (e.g. the website www.kratid.ee was developed for this, idea gathering was organised, etc.)

This report is the summary of the results of the expert group's work.

Conversations with different parties, discussions in various working groups, background study of foreign countries, and proposals from the companies and experts engaged in the field were used as input for preparing the report.

Proposals to encourage the implementation of kratts in the public sector

- Order basic components and "tools" for kratts and make them available in a reusable format.
- Establish a cooperation network of data science and kratts in the public sector.
- Establish and disseminate instruction materials for initiating and carrying out kratt projects (including for responsible development and sustainable operation).
- Organise the dissemination of knowledge and exchange of experiences by introducing the possibilities of kratt projects and conducted projects in various networks and formats.
- From the aspect of the sustainability of the Estonian language and culture, it is important to strengthen the implementation of language technologies.
- At least at the level of ministries and areas of government, establish and fill the positions of chief data officers.
- Ensure flexible and sufficient funding means for test projects, including kratt projects, in the funding measures for the e-state development.
- Develop technological sandboxes for the testing and development of kratt applications in the public sector.
- Prescribe technical requirements for ensuring sustainability in the conditions for funding developments of kratt projects.
- Launch deep learning workshops for data management and create support opportunities for conducting data audits in institutions.
- Create and test the interoperability of kratts and the concept of a personal virtual assistant (i.e. #bürokratt in Estonian).

Kratts in the private sector: proposals for boosting implementation

The measures focus on two target groups: implementers of kratts and developers of kratts. In the case of the implementers, the measures focus on awareness and digitalisation. Assistance is provided to developers of kratt-based products, helping them to overcome the prototyping phase (TRL 4—7).

- Determine an organisation developing the field of artificial intelligence to increase awareness thereof.
- Create a training programme for the implementation of machine learning.
- Order a web-based training programme (MOOC) to increase awareness of kratts on a wider scale.
- Extend industry digitalisation measures to other sectors in addition to the manufacturing industry in a scope of up to 50 million euros.
- Establish an innovation grant with a budget of up to 100,000 euros per project to create a proof of concept for solutions developed based on state databases.
- Support the implementation of kratt-based pilot projects with up to 50,000 euros and 30% own contribution.
- Support the implementation of kratt-based products with up to 200,000 euros and 30% own contribution.

Research and development activity and education in the field of artificial intelligence: proposals

The set of measures for research and development activities and education focuses on increasing education orders and supporting applied research based on the development needs of the public and private sector.

- Make significantly higher investments in higher education in the field of ICT and research and development activities. This includes, among others, increasing the number of ICT lecturers and expanding artificial intelligence studies at master's and doctorate level, as well as providing it horizontally in other fields.
- Establish an artificial intelligence-oriented DIH in Estonia and support its launch from the state budget.
- In addition, Estonia should be actively joining the EuroHPC[2] projects which enable institutions and businesses engaged in research and development access to high-performance computing capabilities.

2 EuroHPC, online, https://eurohpc-ju.europa.eu/

2 Introduction

Photo: Sven Zacek

2.1 Abbreviations and definitions

Abbreviation/term	Meaning
3IA	Interdisciplinary Institutes of Artificial Intelligence
Adapter	Cooperation platform of research institutions https://adapter.ee/en/
AI	Artificial Intelligence
AIGO	Artificial intelligence Expert Group of the OECD https://www.oecd.org/going-digital/ai/oecd-aigo-membership-list.pdf
API	Application Programming Interface
Aurora	Virtual assistant helping the citizens of Finland
CIFAR	Research centre in Canada /ww.cifar.ca/
CyberTech	Focus area supporting cooperation between different sectors: /ww.startupestonia.ee/focus-areas/cybertech
DEP	Digital Europe programme; regulation of the European Parliament and of the Council establishing the Digital Europe programme for the period 2021—2027, COM(2018) 434 final, proposal https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:52018PC0434&from=EN
DIH	Digital Innovation Hub
EAS	Enterprise Estonia https://www.eas.ee/?lang=en
EdTech	Focus area supporting cooperation between different sectors: https://www.startupestonia.ee/focus-areas/edtech
EMTAK	Estonian Classification of Economic Activities https://www.rik.ee/en/e-business-registry/emtak-fields-activities
EuroHPC	The European High-Performance Computing Joint Undertaking https://eurohpc-ju.europa.eu/

Abbreviation/term	Meaning
HITSA	Information Technology Foundation for Education https://www.hitsa.ee/en
HTM	Ministry of Education and Research https://www.hm.ee/en
hackathon	a gathering where programmers collaboratively code in an extreme manner over a short period of time https://akit.cyber.ee/term/9862-hakaton-progemaraton
ICT	information and communications technology
ILO	International Labour Organization
Machine learning	An automatic process for improving a functional unit by acquiring new knowledge or skills or reorganising existing ones https://akit.cyber.ee/term/9968-masinope-automaatope
NUTS	Nomenclature of territorial units for statistics
OECD	The Organisation for Economic Co-operation and Development ttp://www.oecd.org/
RIA	Information System Authority https://www.ria.ee/en.html
RITA	Estonian Research Council https://www.etag.ee/en/funding/programmes/rita/
SMIT	IT and Development Centre of the Ministry of the Interior https://www.smit.ee/
TCC	Technology competence centre
TRL	Technology readiness level https://en.wikipedia.org/wiki/Technology_readiness_level

2.2 Background of the report: the kratt expert group and starting points for preparing the action plan

In the middle of 2018, an expert group was founded at the Government Office and a cross-sectional coordination project (hereinafter project) was launched.

The tasks of the expert group were as follows:

- prepare draft legislation to ensure clarity in the Estonian judicial area and organise the necessary supervision;
- develop the so-called Estonian artificial intelligence action plan;
- notify the public about the implementation of kratts and introduce possible options.

Based on their activities, the expert group prepared this comprehensive report, including proposals for an action plan for the implementation of kratts. In addition, they drafted changes to legal acts and other political documents in the course of their work.

The expert group comprised representatives of state authorities, the private sector, and universities, and the work also involved sectoral experts (Annex 1. The expert group). The expert group was under the leadership of the Ministry of Economic Affairs and Communications with the Government Office, its activity was supported and report prepared by EY.

This report summarises the activity of the expert group, information collected over the course of the project, and proposals made to boost the implementation of kratts in Estonia's public and private sector. Among others, the report pays special attention to issues related to research and development and the judicial area. The report will form the basic input for the Government of Estonia in the preparation of the action plan for kratts, led by the Ministry of Economic Affairs and Communications.

The expert group and the future Estonian action plan for kratts does not include the topic of adaptation and social impact related to the implementation of artificial intelligence (e.g. issues of the labour market and retraining of workers) because Estonia's problems are more related to the lack of a suitable labour force and the use of kratts can help to relieve this. In addition, measures for retraining and refresher training, as well as adaptation to the needs of the labour market, are being developed by the Ministry of Social Affairs and the Ministry of Education and Research, which is why the need for additional activities cannot currently be seen in this area. Should this need arise, the action plan can be supplemented with relevant measures in the future.

Economic background

Estonia's competitiveness plan Estonia 2020 and the Entrepreneurship Growth Strategy acknowledge that although Estonia experienced rapid economic growth after the economic crisis of 2008—2009, the economic growth has not reached the expectations and potential. As the growth potential of the Estonian economy has already nearly been exhausted with regard to employment, growth opportunities need to be found elsewhere, including from the provision of products and services with higher added value. Although Estonia's real productivity growth over the past 10 years has been faster than the European average, the GDP per capita is still low (ca 77% of the EU average[3]).

Therefore, the main option for increasing the productivity of the economy is moving towards the provision of products and services with higher added value, which often requires increasing the volume of research and development in the economy.

In their 2013 analysis, the development fund defined ICT horizontally through other sectors as one of the breeding grounds for the Estonian economy. At the same time, ICT on its own contributes significantly to the Estonian economy. With 5% of the employed, the ICT sector provides 7% of the added value created in businesses, pays 6% of all the taxes, and amounts to 13% of export.

2.3 Methodology of the project

Artificial intelligence is a novel technology for which the applications (kratts) and the practice related to them are still being developed. Therefore, the main objective of the project is to map the activities taking place in Estonia, as well as globally, in the field of kratts and analyse what the measures for supporting the implementation of this area should be within Estonia.

The expert group and experts have worked together to provide proposals that should be implemented as soon as possible to avoid lagging behind in this area; however, the basis for preparing a long-term plan for the artificial intelligence strategy still needs to be established.

3 https://www.err.ee/841157/eesti-skp-elaniku-kohta-on-77-protsenti-euroopa-liidu-keskmisest

The following inputs were used to prepare the report:

Interviews

- With representatives of companies developing and applying kratts in Estonia that provided user stories related to the development and application of kratts;
- With experts from the Ministry of Economic Affairs and Communications, the Ministry of Finance, the Ministry of Education and Research, and their various subdivisions;
- With ICT representatives from universities (Tallinn University of Technology, University of Tartu);
- With experts from the implementing entities of measures for financial support of companies (EAS, Archimedes, KredEx, Startup Estonia, ARIB, HITSA);

Discussions with the working groups assembled in the course of the project (legal, education, and public sector working groups);

Studies on the artificial intelligence strategies of other countries;

Proposals from the kratts conference and professional unions that unite various companies.By analysing the inputs collected throughout the course of the work with the expert group, specialists of the field, and working groups, proposals were prepared that emphasise the need to launch the activities as soon as possible, support companies and institutions engaged with kratts at every stage, and develop basic competences for the implementation of kratts, while also providing input for the establishment of a strategy with a long-term perspective.

It would be reasonable for Estonia's kratt strategy to focus on the implementation of kratts in the private and public sector separately (relevant clauses 6.1 and 6.2) because their solution methods and funding schemes are different, despite having seemingly similar challenges.

Support measures already used in Estonia that support the implementation of new technologies were mapped throughout the course of the work of the expert group. The support measures have been developed further or updated in the work to better address the specific shortcomings of artificial intelligence.

2.4 Definition of kratt

No consensus has yet been reached in defining artificial intelligence, which is why establishing an exhausting definition acceptable to everyone is difficult. The common denominator of various definitions of artificial intelligence is the concept of intelligence, but as defining intelligence is also complicated, the term and limits of artificial intelligence are somewhat vague.

The Encyclopaedia Britannica, for example, defines artificial intelligence as the ability of a digital computer or computer-controlled robot to perform tasks commonly associated with intelligent beings. The term is frequently applied to processes characteristic of humans, such as detecting causes and connections, awareness of the environment, generalisation, and learning from past experiences.

As much of Estonia's activities in the field of kratts should be connected to what is happening in the European Union, this report relies on the definition used in the EU:

> Artificial intelligence includes systems that exhibit intelligent behaviour by analysing their environment and making decisions that are independent to a certain extent to meet certain objectives.

Artificial intelligence is often categorised into narrow and strong. Narrow artificial intelligence includes applications that can only perform some specific task similarly to humans.

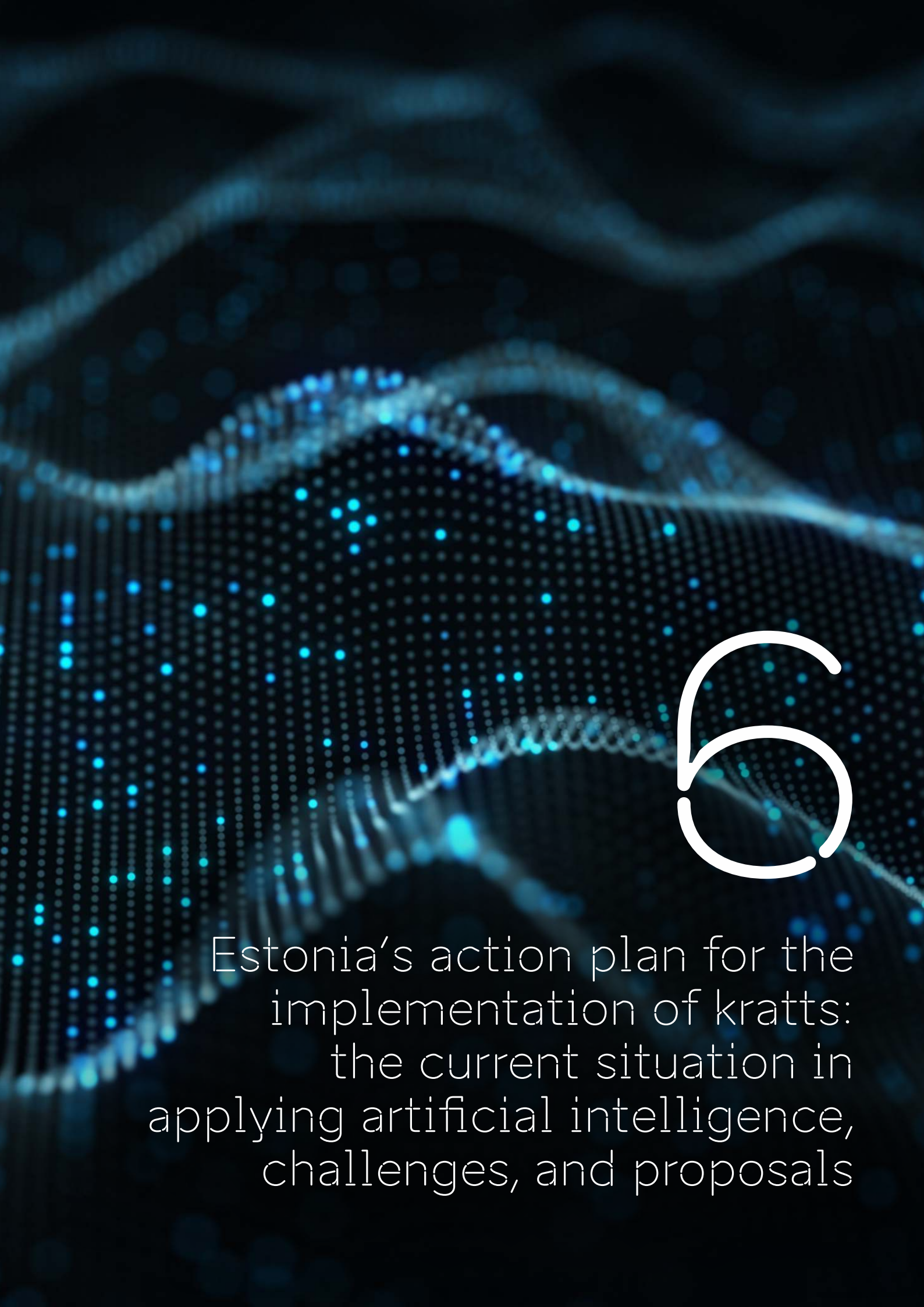
The result may not be as good as with humans, but if it is able to do this significantly more effectively, the efficiency of processes may increase considerably in combination with the role of humans. A typical example of narrow artificial intelligence is a chatbot that can perform the customer service function, solving the majority of simpler problems customers may have.

Unlike narrow artificial intelligence, meant for performing a limited task, strong artificial intelligence means an application or system that is able to solve any tasks similarly to humans.

The term 'kratt' was introduced by the initiators of this project initially as a synonym for fully automatic information systems both in the narrow and strong meaning.

Efforts to specify the term in the course of this project led to a conclusion that at first, Estonia should focus on artificial intelligence in the narrow meaning when talking about kratts, as strong artificial intelligence solutions do not exist yet. Kratts may be purely software-based or installed in the hardware (e.g. advanced robots, driverless vehicles, drones, or applications of the Internet of Things).

> In this project, the term kratt means practical applications based on artificial intelligence technologies (in the narrow artificial intelligence meaning), performing a specific function.



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Estonia's action plan for the implementation of kratts: the current situation in applying artificial intelligence, challenges, and proposals

The area of artificial intelligence and the application of kratts is still in development in Estonia, similarly to the rest of the world. Several solutions based on machine learning and other technologies have been established and applied within Estonia's public and private sector; however, the scope and usefulness of such technologies is currently limited.

This project **revealed a clear interest and preparedness among Estonia's public and private sector organisations for introducing kratts** and several organisations are already engaged in it. The added value received from artificial intelligence technologies can mainly manifest itself in two axes — an increase in efficiency, resulting from process innovation, and structural changes in the economy resulting from product innovation that lead to products, services, and companies that offer higher added value.

The objective of the proposals of the expert group is to **boost the development of this field in Estonia**: starting the development of basic competences. In doing so, **particular effort should be made in facilitating the implementation of kratts in the public sector**, as the development of this has only just begun or it receives minor attention in the rest of the world pursuant to the kratt plans of other countries (see chapter 5), giving Estonia a competitive advantage and allowing the country to stand out if we move fast. This is also supported by the general strong foundation of our current e-state, for which the use of kratts would be the next step and an upgrade.

On the one hand, the high level of digitalisation of the public sector, openness of Estonians towards novel technologies, and the preparedness of the people to implement these make Estonia's position in applying kratts possible. At the same time, the business sector needs to first carry out the primary-level digitalisation of business processes so that they would have datasets to use kratts on.

It was concluded in the course of this project that Estonia should **start piloting kratt projects as fast and in as diverse a manner as possible in various sectors** to gain initial feedback and experience and then start planning long-term measures. Although several countries have started to prepare their vision and long-term strategy for artificial intelligence, better understanding of the possibilities and benefits of using kratts in the Estonian context need to be gained through pilot projects to prepare a more substantial strategy.

Artificial intelligence is a technology that may not produce a significant economic effect in an organisation just yet. However, if one waits for the technology to mature before they start their preparations, there is a risk of permanently lagging behind the rest of the world, or at least the more developed countries.

Therefore, state support to artificial intelligence should be interpreted as mitigating the risks of applying this new technology, presuming that the knowledge and experiences gained would produce a significant economic effect in the near future.

The objective of the public sector in using kratts should be acting as a smart customer and pioneer in ordering kratt solutions, thus boosting the development of artificial intelligence in Estonia and acting as its driving force. This would serve the purposes of developing the e-state and information society on a wider scale — such as objectives for improving the quality of services and making the functioning of the state more efficient (including making the services more proactive).

While doing so, Estonia takes the broad-based approach — it is reasonable to boost the implementation of kratts on as wide a scale as possible throughout the entire public sector and solve the relevant obstacles in a systematic manner. If only a limited number of high-priority areas of use are selected for development, the risk is excessively hindering the wider development.

Proposals for the private sector's action plan result from the necessity to start establishing methods supporting the implementation of kratts as fast as possible to raise awareness of companies on the possibilities of kratt technologies, **support the implementation of high-risk kratt projects (including pilot projects), and increase the general basic digital competence of companies**. Increasing the proportion of research and development activities of companies also plays an important role in the development and application of kratts in the prototype development phase.

Research and development activities, as well as education, form the basis for creating and applying kratts in both the public and private sector. Artificial intelligence studies form a part of general ICT education and the funding of research and development activities was generally a focus in Estonia during the time that this work was being conducted. The area requires significant additional funding in the future. The current shortcoming in ICT education lies within the second and especially third level of higher education, as the required specialists will be trained at these levels, considering the complexity of the artificial intelligence technology. The current volume of preparing ICT specialists with a doctorate degree is too small for making significant progress in the R&D activities of companies and universities lack the new generation of ICT lecturers.

The expert group did not focus on the retraining of employees and the adaptation of the labour market to the implementation of kratts, as the Ministry of Social Affairs and the Ministry of Education and Research are dealing with these topics. At the same time, we are aware of the future need for the retraining of employees and, therefore, the promotion of retraining activities (and an increase in funding) by both companies and the state needs to be planned.

In legal matters, the main focus is on making additions to the judicial area to allow the implementation of kratts and ensure legal clarity. **Although the legal**

analysis conducted simultaneously with this project did not detect a need to change the fundamental principles of the legal system, several proposals were still made. Mainly, the **issues requiring additional regulation are related to liability for kratt's actions and its consequences**, the treatment of kratt as a source of increased risk, and the possible need for regulating the manufacturer's liability.

An action plan focussed on establishing key competences should be planned and implemented over two years. This leaves enough time for testing various measures and devising a more long-term plan. In addition, the next long-term competitiveness and sustainable development strategy for Estonia will be finished in 2020 and this provides the framework and greater objectives for the use of kratts. Therefore, a long-term artificial intelligence strategy for Estonia should be developed in 2021. For doing this, and ensuring the implementation of the initial action plan, a more permanent working group for artificial intelligence should be assembled at the state level, tasked with:

- monitoring the implementation of the action plan prepared on the basis of this report in 2019—2020 and initiating additional activities, if necessary;
- monitoring developments in the field of artificial intelligence in the EU, the Nordic countries, and the Baltic States, providing inputs, and discussing Estonia's interest and engagement;
- starting the preparation of Estonia's long-term kratt strategy for 2021.

6.1 Kratts in the public sector: proposals for boosting the implementation

Estonia's public sector has already started with the implementation of kratts — by May 2019, 16 artificial intelligence solutions had been implemented or gone into testing (a year ago, there were only a few). Currently, there are no clear areas of use or certain institutions that have tried to apply kratts — measures are taken in various fields simultaneously.

Examples of solutions that have been introduced:

- Estonian Agricultural Registers and Information Board (ARIB) — detecting whether meadows are being mowed to monitor the use of supports;
- Information System Authority (RIA) — detection of security incidents by monitoring traffic in the X-Road;
- Unemployment Insurance Fund — profiling jobseekers and generating suggestions for open positions;
- Estonian Road Administration — prediction of the condition of roads and, therefore, return on investment;
- Police and Border Guard Board — prediction of locations where highway patrols are required;
- Health insurance fund — prediction model for the health of chronically ill patients and their treatment requirements;
- Statistics Estonia — chatbot in customer service;
- City of Tallinn — detection of the volume of traffic, using cameras.

Currently, the kratts applied in the public sector in Estonia do not adopt decisions independently, but rather help humans in making faster and better decisions. This means that no fully autonomous systems have been applied in the public sector at the moment. Therefore, the implementation of kratts does not necessarily replace humans, but rather supports humans in their work, meaning that processes still become more effective.

The first experiences gained in Estonia up to now confirm the expectation that **kratts can increase the effectiveness of the public sector**. On the one hand, the activities are more purposeful and therefore yield better results; on the other hand, the costs related to the work, i.e. providing services, are reduced. This enables the institution to focus resources on areas where the benefits for the taxpayers are the greatest. In the public sector, kratts help workers to focus more on activities that create added value and leave routine and automatable tasks to kratts. In a country with a decreasing and ageing population such as Estonia, it is essential to automate as many tasks as possible to alleviate the need for labour and make the provision of services more manageable.

The application of kratts **directly supports the general development trends of the e-state** that have been provided in the "Digital Agenda 2020 for Estonia".[18] Thus, kratts help to increase the quality of public services, directly supporting the automation (turning invisible) and personalisation of the activities. In addition, kratts help to make better political decisions based on data, e.g. by using machine learning and methods of artificial intelligence for detecting patterns in information.

The implementation of kratts is developing on a wider scale in Estonia — kratts are used in various areas of activity of the state. Now, several opportunities for the application of kratts have been identified under the leadership of the Ministry of Economic Affairs and Communications and there are several wide-scale projects being initiated throughout the entire public

18 See https://www.mkm.ee/et/tegevused-eesmargid/infouhiskond

sector. This is why the expert group finds that **it is not reasonable to select a limited number of high-priority areas of use for development when preparing Estonia's action plan for kratts**. Rather, **the wide-scale approach that is already under development should be fostered and as many projects in as many areas as possible should be supported.**

Otherwise, there is risk of artificially hindering development.

In the current Digital Agenda 2020 for Estonia, the objective is to put 50 kratts to use in Estonia by 2021. In addition, the action plan for kratts could introduce a measure that expresses and supports the broad-based objective:

- The number of institutions that have applied kratts: 10 (in 2019) → 25 (by the end of 2020);
- Basic components of kratts created (see clause 5.1.4): 0 components (in 2019) → 5 components (by the end of 2020).

If the implementation of kratts is developed on a wider scale, the relevant obstacles also have to be managed on a wider scale.

In the course of this project, interviews, discussions, and experiences from initial kratt projects identified **several problems that hinder the successful (incl. sustainable) implementation of kratts in the public sector**. These are divided into **six categories — awareness of the management and officials, the skills of the officials, funding, the technical launch of projects, sustainability, and data** (see the table below). The following proposals for measures address all of those groups to cover all the links and possible obstacles in applying kratts.

Generating ideas for the implementation of a kratt	Implementing projects for the implementation of kratts — development	Constant application of kratts — preservation
Raising the awareness of the management and officials		
Improving the skills of officials	Improving the skills of officials	Improving the skills of officials
	Ensuring funding	
	Simplifying the launch of projects	
		Ensuring the sustainability of solutions
	Promoting the availability of data	

Table 2. Problems and solutions related to the implementation of kratts

In addition, **it is necessary to pay attention to the interoperability of kratts on the state information system level, right from the outset.** The interoperability of information systems has been one of the success factors of Estonia's e-state and it is also essential for providing services to users in a harmonised way and developing proactive services, for example (which is a trend provided in the digital agenda).

If kratts are created on a wider scale in various areas of activities and institutions, the architectural and technical basis should be established early on, so that the kratts could seamlessly cooperate and work for the benefit of humans in the best way possible.

6.1.1 Raising the awareness of the management and officials

Currently, public sector institutions lack vision or interest for applying kratts. They have no clear understanding of whether and how the strategic goals of public sector institutions correspond to the implementation of kratts — why, where, for whom, and how the kratts should be implemented. Therefore, such projects are not given priority and officials who are interested in them find it difficult to find resources to launch them.

In places, this problem goes beyond the implementation of kratts and applies to the IT area in general. Usually, the main reason for this lies in insufficient knowledge and awareness on technology, its opportunities and areas of use (including existing solutions).

This problem does not only apply to managers. Other officials (specialists in their field) also have insufficient knowledge about the possibilities of using kratts.

This may result in fear or lack of interest to launch projects, as they do not know what can be done in general. They also lack the knowledge of what 'kratt' or artificial intelligence means. In one extreme case, the launch of a project in one institution was delayed because they could not find a common definition for kratt and machine learning.

The objective should be that the application is fostered and clearly connected to the strategic goals on the management level of institutions of the public sector. This is most directly manifested in the number of institutions that have launched kratt projects.

Existing measures

- The Ministry of Economic Affairs and Communications has organised **seminars targeted at managers of institutions that are interested in the area** where kratt opportunities in the public sector are introduced, basic ideas are generated, and the possibilities of applying kratts in institutions are mapped.
- The Ministry of Economic Affairs and Communications has organised **more comprehensive brainstorms for entire institutions that are interested in the area** to generate and map ideas for the implementation of kratts.
- **Institution-based deep dives** are organised underthe leadership of the Ministry of Economic Affairs and Communications, during which experts from the private sector help to think through the initial form of the selected ideas. This results in accelerated project development and better preparation for applying for funding measures.
- The Ministry of Economic Affairs and Communications organises **theme-based seminars introducing the technology**, for example for language technology. Success stories from companies and the public sector are presented there, examples of possible solutions are shared, and awareness on the functioning of the technology is increased.

Additional proposals

- Introduce the topic in **trainings to senior managers organised under the leadership of the Government Office**.
- **Launch a cooperation network of data science and kratts under the leadership of the Ministry of Economic Affairs and Communications** and organise meetings where institutions of the public sector can share their experiences and problems as well as discuss common goals and initiatives.
- **Develop and provide a systematic training course aimed at managers and senior specialists of public sector institutions** titled "Why is data science necessary?" that would include the topic of kratts. The participants are shown why data and kratts are necessary, what roles related to data could exist in the institution, what solutions have been created elsewhere, what the life cycle and work flow of the solutions are like, which aspects require attention in launching kratt projects, etc.
- **Create and publish instruction materials** to launch and evaluate kratt projects and generate ideas(including for responsible development and sustainable application).
- **Create a website for disseminating success stories and examples** that displays all the kratt projects carried out in the country, their short descriptions, and contact information. In addition, the schedule or roadmap for projects planned in the public sector, as well as information and references to software that is available as freeware could be provided. Continuing with the current www.kratid.ee could be considered.
- **Order a web-based training programme from the state to raise awareness on kratts on a wider scale**. According to the experiences from the **Elements of AI**[19] course in Finland, this could be an effective measure for drawing attention, attracting interest in kratts and increasing preparedness for this in companies and on a wider scale.
- The cost of this programme for two years is approximately 250,000 euros.

6.1.2 Improving the skills of officials

An obstacle for the implementation of kratts most often highlighted by the institutions was insufficient ability to devise and initiate kratt projects caused by the lack of skills of officials. In several areas, kratt and data science projects had been on hold for over a year because they were not willing to use an external project manager and did not manage to hire a specialist for the institution.

The discussions with IT departments and buildings revealed a lack of preparation among officials to

19 Website of the Elements of AI training, https://www.elementsofai.com/

launch kratt projects in the "business side", i.e. entities responsible for policymaking and provision of services. The IT departments and buildings themselves do not have a comprehensive understanding of business and are therefore unable to find areas suitable for the application of kratts. The same applies to data analysts, who have a limited overview of the functioning of the organisation.

At the same time, the side responsible for business affairs is unable to see the possibilities for application and submit orders, i.e. devise tasks and objectives for the application of kratts.

In addition, there is a lack of technical knowledge — including in the IT entities — about, for example, how to formulate or plan a kratt project, its cost and objectives. Therefore, even if they have a good idea, the skills of officials to actually launch and successfully carry out a project may be insufficient. While doing so, the technical as well as substantive knowledge about the responsible development and implementation of kratts throughout the entire life cycle of the kratt project needs to be increased so that the kratts would function as planned and not harm the target group.

The goal should be that the technical competences of officials of the public sector in Estonia are improved which also manifests through an increased number of kratt projects.

In order to improve their competences faster, the state institutions can naturally include partners from the private sector and institutions engaged in research and development activities on a broader scale (inducing for mapping the possibilities of using kratts), although they must have the basic knowledge to be a "smart customer".

Existing measures

- **Institution-based deep dives** are organised under the leadership of the Ministry of Economic Affairs and Communications, during which experts from the private sector help to think through the initial form of the selected ideas. This results in accelerated project development and better preparation for applying for funding measures.
- **Digital state hackathons** are organised twice a year under the leadership of the Ministry of Economic Affairs and Communications, where institutions attempt to find a prototype solution to their problems with the help of undertakings. Ideas for developing kratts are also welcome to participate. A more detailed plan for technical development may arise from the hackathon.
- **Different parties are brought together on an ongoing basis** under the leadership of the Ministry of Economic Affairs and Communications to introduce ideas and competences of companies to institutions that might implement them.
- **Technical courses on data science are organised to beginners and advanced users** under the leadership of the Ministry of Economic Affairs and Communications.

Additional proposals

- **Prepare and publish instruction materials** for initiating and evaluating kratt projects and generating ideas (including for responsible development and sustainable implementation).

  Among others, a sample and methodology for the impact assessment of kratts could be established so as to plan such projects better and in a more comprehensive manner.
- **Organise knowledge spillovers and exchange of experiences to introduce the possibilities of kratt projects and the projects carried out in different networks and formats,** where both the "business side" and the IT side of the public sector exchange information and revise it together (e.g. network of IT managers, future cooperation network for data science, public services council, etc.) This is led by the Ministry of Economic Affairs and Communications. The objective is to highlight specific examples of where kratts could be applied and what benefits have been gained from their use elsewhere, what good experiences and lessons have been received during their implementation, etc. Add information and experiences from other countries via the Ministry of Economic Affairs and Communications (e.g. based on exchange of experiences in the EU and between the Nordic Countries and the Baltic States).
- **At least on the level of ministries and areas of government, establish and fill the positions of chief data officers,** who would act as mediators and representatives on the business side in the planning and management of data science and kratts and as advocates of the relevant possibilities in their field and spreaders of information.

  Consider establishing funding for the relevant positions.
- **Organise practical trainings on forms of procurement for the contracting authorities of kratt projects** and disseminate the relevant good practices to introduce innovation and relevant forms of procurement that favour flexible cooperation with parties outside the state. Consider preparing a manual for this. For example, forms of procurement which favour innovation are competitive dialogue, procurement procedure with negotiations, design contest, innovation partnership, and procurement for research and development activities.

6.1.3 Ensuring funding for the development of kratts

The institutions fear that kratt projects will fail, which is why the preparedness to fund these or even apply for external funding is lower than required. In the context of using means of structural funds, the possible failure of a project or incomplete achievement of its objectives entails the risk that the funding received must be returned, meaning that financial cover is needed for this. At the same time, flexible and sufficient funding may give a boost to more testing.

The objective should be that the launch of kratt projects in public sector institutions would not be hampered by lack of funding and courage to use the funding.

Existing measures

- The Ministry of Economic Affairs and Communications has formulated **the conditions for applying for IT development supports funded from the EU structural funds in a way that allows performing test projects, including kratt projects**. Prototyping and preliminary analyses are supported in the course of the call for proposal "Conduct of preliminary, business, and applicability analyses for developing public services". The project-based support amounts to up to 100,000 euros, 15% of which must be own contribution. A project does not have to be sustainable, meaning that the project may fail without a refund obligation, as experiences gained from the failure are still valuable. These funds can be used until 2020.

Additional proposals

- **Ensure flexible and sufficient funding opportunities for test projects, including kratt projects,** with an above-average failure rate **in the funding measures for the e-state development (i.e. after the EU structural funds)**. For example, reaching 50 kratts by the end of 2020 means 7—8 million euros of initial investment for IT developments. There is no need for a separate funding measure for this if these funds will still be available in the future under the general funding measures of e-state developments.
- **Organise practical trainings on forms of procurement for the contracting authorities of kratt projects** and disseminate the relevant good practices to introduce innovation and relevant forms of procurement that favour flexible cooperation with parties outside the state. Consider preparing a manual for this. For example, forms of procurement which favour innovation are competitive dialogue, procurement procedure with negotiations, design contest, innovation partnership, and procurement for research and development activities. The aim is to increase the likelihood of success.
- **When evaluating funding applications for IT developments, consider the possibility of awarding extra points to projects** that are guided by transnational development trends for the e-state, including, for example, the application of kratts. This would encourage prioritising these developments instead of other IT developments.

6.1.4 Simplifying the technical launch of projects

Cooperation, coordination, and information exchange between the institutions of the public sector is weak. As a result, similar projects are launched or planned simultaneously in various institutions and solutions that have already been created (i.e. funded by the tax payers) are not sufficiently reused, meaning that efforts and resources are doubled and too much time is lost from the state point of view. At the same time, there are no complete solutions or at least components for partially completed solutions that the institutions of the public sector could easily introduce.

In a situation where the ability of the public sector to launch projects can be weak, overcoming these obstacles would significantly boost the (successful) realisation of projects and make it more likely.

Existing measures

- The Ministry of Economic Affairs and Communications organises **matchmaking between the parties** to facilitate cooperation regarding finished applications and the ones in progress.
- RIA and the Ministry of Economic Affairs and Communications have initiated **the development of the state code repository**[20] that would make the source code, etc. of kratt projects available for reuse in the future.
- **The primary development activity for the application of an artificial intelligence and automatic knowledge-based decision support software in state institutions of Estonia is funded under the RITA programme.** As part of the research, at least five reusable minimum viable products (MPV) are established. The budget of the research is 805,260 euros and the activities will continue until October 2021.
- The **language technology programme** is organised under the leadership of the Ministry of Education and Research. The annual budget is 800,000 euros and it is used for the development of basic resources for language technology and practical applications in institutions engaged in research and development activities.

Additional proposals

- **Order the basic components for kratts and make them available in a reusable form** — basic modules of kratt solutions that the next institutions can "train" based on their data and needs and thus apply without major development works in their field.

  The ordering and development of such basic components would be carried out in cooperation between the Ministry of Economic Affairs and Communications and other state institutions: they are developed based on specific practical cases of use in the course of the relevant test or pilot projects. For example, the following solutions could be considered (including models, libraries, modules, etc.): for tagging videos, tagging images, tagging audio files, process mining, chatbots, analysis of attitudes, and application of translation, transcription, and other language technology. The objective should be implementing at least one pilot project from each field by 2020. The implementation of language technology possibilities and creating the relevant basic components is essential to enable the use of kratt-based e-services in Estonian (including using speech in Estonian).

  All the created basic components and their further developments will be made available in the state code repository as freeware (including for the private sector). In addition, possibilities for cooperation at the international level should be sought to create such tools together and join forces. For example, cooperation in this field would be possible with Finland, Latvia, and Canada (these opportunities were identified in the course of this work), and maybe also at the level of the Nordic and Baltic states.
- **Organise information exchange for the implementation of ideas and solutions of kratt projects in various networks and formats** under the leadership of the Ministry of Economic Affairs and Communications (e.g. network of IT managers, future cooperation network for data science, public services council, etc.) to ascertain common needs and disseminate solutions that can be reused
- **Create a website for disseminating success stories and examples** that displays all the kratt projects carried out in the country, their short descriptions, and contact information. In addition, the schedule or roadmap for projects planned in the public sector, as well as information and references to software that is available as freeware could be provided. Continuing with the current www.kratid.ee could be considered.
- **Prepare and publish instruction materials** for initiating and carrying out kratt projects (including those for responsible development and sustainable implementation).
- **Develop technological sandboxes for the testing and development of kratt applications in the public sector** to hasten their implementation. For example, temporary access to the required infrastructure resource can be provided for testing (e.g. for high-performance computing), platform solutions could be made available in the test environment, etc. Measures of this area have been planned on the EU and the Nordic and Baltic level. Once these become more detailed, Estonia could consider joining the initiatives (e.g. for co-funding or to access a more comprehensive technical base). In the context of kratts, we see the need for technological, rather than regulative test areas, i.e. sandboxes.
- **Consider the implementation of joint procurements** to make the resources of development partners available faster to state institutions launching kratt projects without the need for unnecessary additional public procurements.
- **Consider the development and provision of a joint infrastructure** so that the data processing and other infrastructure would be available for use by the state institutions in a more cost-efficient, large-scale, and fast manner. This can be done, for example, on the basis of a state cloud and/or the Estonian high-performance computing centre.

20 http://koodivaramu.eesti.ee/

6.1.5 Ensuring the sustainability of kratt solutions

In the case of projects within the public sector, it is difficult to ensure the sustainability of the solutions established due to the lack of experience; for example, there is a risk of rapid code-rot. If the sustainability of a kratt model is not ensured, there is a risk that the model performs in an unexpected way or at the very least, its prediction accuracy and therefore effectiveness decreases. However, public service solutions must be highly reliable and the technology of the kratt models must be continuously developed and they must be able to adapt to changing business needs.Attention and skills are required to monitor kratt solutions and control them throughout their lifecycle.

One possibility for ensuring sustainability is to purchase kratt solutions as a comprehensive service that is constantly developed from a partner outside the public sector, but even this requires awareness and skills from the public sector institution to control the lifecycle of kratts.

Existing measures

- As of yet, no separate activities have been launched in Estonia within this area.

Additional proposals

- **Create and publish instruction materials** for initiating and carrying out kratt projects (including for responsible development and sustainable implementation). Among others, a sample and methodology for the impact assessment of kratts could be established so as to plan such projects better and in a more comprehensive manner.
- One condition for funding IT developments should be **continuous development instead of preparing a one-off project**. This would ensure the relevance of the model in a changing environment and in changing conditions. Institutions must find funds for upkeep from their own budget or apply for additional means from the state budget.
- **Prescribe technical requirements for ensuring sustainability in the conditions for funding developments of kratt projects.** For example, one requirement could be that the developments use a component for managing the workflow (e.g. Airflow, Luigi, etc.) The use of a workflow management component helps to identify problems in processes, save costs and time, and ensure the effectiveness of the workflow. Another example of what the developments should always include is a back-end monitoring system (e.g. Kibana). The Ministry of Economic Affairs and Communications can develop a more detailed manual and requirements.

6.1.6 Increasing the availability of data that's suitable for development (including open data)

An overview of Estonia's public sector data is insufficient. For example, there is no central location from where to gain an overview of the data stored by institutions. This hinders the launch of kratt projects, as there is no certainty as to the existence of the required data, its quality, and how the data has been described.

The availability of open data — that would otherwise alleviate the situation — is also low in Estonia. Among others, this also limits the implementation of kratts in the private sector that could rely on the non-sensitive data stored by the state when developing new products and services (including those that are kratt-based).

If data is considered the basis for developing kratts, then the public sector has problems with the usability of data. In general, the quality of data has also been a problem in previous kratt projects.

For example, in health care, the launch of projects was hindered by the use of open field texts in electronic health records. There have been similar cases where the data was collected in insufficient volumes or their quality was poor. The issue of data quality was especially prominent in projects where data was required from other institutions. Improving the quality of data in a kratt project could mean that a large proportion of the budget is spent on organising the information and the projects take considerably longer.

Changes in these areas do not happen overnight, but it is important to start carrying out these works so that the overview of the data, its availability as reports, and the quality of the available information would be improved, starting with the data stores and data sets with the highest potential for use.

Existing measures

- **The manual for ensuring data quality and a tool for determining the level of maturity will be updated** under the leadership of the Ministry of Economic Affairs and Communications and Statistics Estonia, and will be made available to state institutions during 2019.
- Pursuant to recent changes in legislation, **data stewards will be appointed in public sector** institutions. These stewards are tasked with assuming responsibility for data and its quality across the organisation. Plans are in place to develop and provide training, instruction materials, etc., so that the data stewards could start effective work as soon as possible.
- **Active work is being carried out to increase the supply and demand of open data**, including organisation of the work and community events of the relevant working groups, technical counselling of institutions when opening data, etc. under the leadership of Open Knowledge Estonia (OKE), ordered and coordinated by the Ministry of Economic Affairs and Communications.
- **The Estonian open data portal has been updated**[21] and many more data sets have been made available there. The implementation of a communication channel for the open data portal is being introduced so that interested parties could request, from the state institutions, data that has not yet been made available in the portal as open data in a more efficient manner.
- The Ministry of Economic Affairs and Communications and RIA have started **establishing the concept for reorganising the RIHA, i.e. the state information system catalogue** (under the activities of the architecture council) that should result in a new central environment for gaining an overview of the data.
- A pilot project for an **authorisation service** has been initiated in cooperation between RIA and the Ministry of Social Affairs to create a platform solution for people where they can allow access to the secondary use (including outside the public sector) of their personal data if they so wish and consent to it.
- The **principles of responsible use of data** are being developed under the leadership of the Ministry of Justice in cooperation with the Ministry of Economic Affairs and Communications to create legal clarity and thus favour a wider use of (personal) data in the public sector and other services, as well as data analysis (including research and development activities).

Additional proposals

- Launch data management deep dives **in cooperation between Statistics Estonia and the Ministry of Economic Affairs and Communications**, during which the institutions are helped to prepare a data catalogue, organise their metadata sets, and gain initial evaluation of the data quality along with proposals for developments.
- Create a **support option for the conduct of data audits in state institutions**. In essence, the data audit would form a preliminary project for the test project. Its objective is to determine whether it is reasonable to launch a test project: whether the required data for this exist.
- As one requirement for funding the developments, establish **the requirement that each new IT development must be "suitable for kratts"**: data must be created in the established or upgraded information system so that it would be applicable in kratt projects of the future. The relevant notification and instruction materials are also required.
- **Update the semantic interoperability framework** that would meet current and future needs, including for kratt projects, to evaluate and improve data quality.
- **Monitor EU initiatives for developing a joint data infrastructure and joint data platforms** to be connected with useful projects as early as possible and join them if they are suitable. This would give parties in Estonia access to more comprehensive data sets.

21 https://opendata.riik.ee/

6.1.7 The concept of #bürokratt: ensuring the interoperability of kratt solutions and creating a virtual assistant for the e-state

People, i.e. the end users of e-services, want the state to function as a whole and not be divided into single institutions. So that new isolated institutions or information systems would not be created, or current ones amplified as a result of the action plan for wide-scale kratt development, the interoperability of kratts must be ensured early on. Even more so because the development trend established for the e-state in Estonia is the provision of comprehensive proactive services that are as invisible as possible.

If this cannot be made automatic, the users of public services at least want to get things done "in one go". The minimum precondition for this is a comprehensive user interface, behind which various kratts work together, seamlessly transferring the user session and data between each other, following the distributed architecture peculiar to Estonia. In the long term, the aim would be to create a personalised virtual (autonomous) assistant for people that would take care of the bureaucratic transactions for them "automatically" in an M2M interaction within the limits of authorisation granted to them without the person having to think about it or necessarily interfere.

Another important aspect is that, should there be need to interact with #bürokratt as a virtual assistant, this could be done in Estonian. This helps to ensure the viability of the Estonian language. Therefore, the possibilities of language technology must be applied as much as possible when developing #bürokratt.

It would be reasonable to also apply the distributed architecture used in data stores to the kratt-based state information system or architecture of the relevant services, as it provides sufficient continuity (if one kratt is "broken", the others can continue functioning) as well as flexibility for new or further developments. In the case of a rapidly developing technology such as artificial intelligence, applications should be continuously upgraded or even replaced. This is a complex process for example in the case of a single large chat kratt functioning on the state level, compared to ten interoperable chat kratts that can seamlessly meet the users' needs together.

The #bürokratt concept was born from the aforementioned need and vision: this is a vision of system architecture, an ecosystem, and a user interface of the e-state in the age of kratts all at once.

More specifically, the following should be included in the plan in 2019—2020:

- a more detailed definition of the requirements for interoperability and architecture for kratt solutions;
- establishing the relevant technological platform and/or protocols;
- developing a more detailed concept for the autonomous agent i.e. #bürokratt that represents the citizens/undertakings, and designing its requirements;
- carrying out test projects with one or a couple of cases of use to try out and develop various outcomes in practice.

The #bürokratt idea largely coincides with the development of the Aurora concept in Finland and it would, therefore, be reasonable to cooperate between these developments — at the very least, exchange ideas and experiences, but also develop a part of the technical solution together, if possible. Among other things, this would enable the development of the interoperability of state kratt ecosystems of Estonia and Finland so that the virtual assistants or kratt sessions could also function as cross-border services, or under them. The common digital space of Estonia and Finland is one of the priorities of the digital policy of Estonia and in this way, this could also be continued in the kratt age.

6.2 Kratts in the private sector: proposals for boosting the implementation

In Estonian companies, kratts are already being used in several business areas for optimising business processes, automating customer service, in product quality control, risk mitigation, and elsewhere. Nevertheless, they are not yet widespread, which is partly caused by the fact that this technology is still being developed and there are no solutions that can be applied easily. Another reason is the lack of awareness on the possibilities to introduce kratts.

A number of companies that develop and apply artificial intelligence were mapped in the course of this project to gain an overview of the situation in Estonia regarding kratts — on the one hand, to find out what solutions have been implemented, and on the other, to identify the obstacles to applying artificial intelligence.

For example, one of the most common applications in the private sector is chatbots that can interpret text inserted by a user and thus help to solve problems by maintaining a dialogue. The popularity of chatbots can be attributed to the fact that they allow making labour-intensive work processes, especially those related to customer service, more effective, automatically solving some of the customer inquiries. In Estonia, chatbots are used in companies with a large customer base, such as finance,

telecommunications, and transport undertakings.

In addition, various image processing solutions (including vehicle licence plate recognition, assessing the product quality of a manufacturing company based on an image, etc.) are being used. Efficiency has also been increased by applying several solutions for automatic planning, for example in trip planning and price formation. By using this, ride-hailing services such as Taxify offer a route planning service and optimum balancing of price lists to their drivers.

There are several companies in Estonia that develop innovative products using artificial intelligence. For example, Milrem Robotics is the first in the world to develop driverless crawlers assembled from modules that can be used both in the civil and military sector. Skillific profiles jobseekers based on machine learning algorithms to find them the most suitable position. There are also companies from traditional sectors that increase the value of their conventional business by integrating artificial intelligence services into their manufacturing processes. For example, the defect recognition software for the timber industry offered by LeanEst — which is based on image processing — allows the increase in manufacturing efficiency. Smart Load Solutions develops smart heating controllers that help to manage heating systems and consumption in a smarter manner, using machine learning algorithms based on stored heating parameters.

The following table (table 3) provides a selection of developers and implementers of artificial intelligence solutions in Estonia.

Company	Area
Milrem Robotics	Driverless crawlers that can drive on any landscape
Mindtitan	Advanced solutions using artificial intelligence components
LeanEst	Comprehensive solutions where image recognition is based on artificial intelligence. For example, this is used in the timber industry to detect and categorise defective planks.
Alphablues	Chatbot
LHV	Chatbot
Elisa	Chatbot
Proekspert	Industrial automation, smart environmental solutions, and data science
Mindtitan	Consultation undertaking specialised in artificial intelligence solutions
Sifr	Consultation undertaking specialised in artificial intelligence solutions
Smart Load Solutions	Building automation for underfloor heating solutions
Taxify (Bolt)	Ride sharing service
Fujitsu	Predictive device maintenance in the industry, health technologies
FlowIT	Solutions for automating activities, algorithms predicting purchase orders
Datel	Data interpretation and visualisation solutions for the state geographical information system application. For example, supplying the Estonian Rescue Board with geographic data, landscape analysis
Cleveron	Last mile logistics and solutions for parcel machines
Skillific	Automatic matching of profiles of jobseekers

Table 3. A selection of developers and implementers of artificial intelligence solutions in Estonia

Conditionally, companies engaged in artificial intelligence solutions can be divided in two: developers of kratts and implementers of kratts. Developers of kratts are companies that develop innovative solutions using the artificial intelligence technology either for other companies or to use them in their own business activity (products/services). The latter is referred to as so-called product innovation type development, where the developed solution reaches the consumer. Usually, implementers of kratts are companies from a traditional field of activity that apply kratts to make the processes of their main area (e.g. traditional manufacturing) more effective and they outsource the actual kratt development. This is so-called process innovation.

Challenges faced by companies

In order to boost the implementation of kratts and devise measures for creating the relevant basic competences, the obstacles faced by companies in the development or application of kratts should be observed. The working groups of this project revealed that the main obstacles seem to be a lack of knowledge of kratts, poor availability of specialists, lack of financial capacity, and generally a low level of digitalisation.

As the policy measures proposed in this project to overcome these obstacles are related to the business policy of Estonia that uses a categorisation of target groups of companies (leaders, ambitious companies, and growth companies), the obstacles have also been categorised into target groups. This categorisation comes from the distinction of companies that is based on objectives and economic indicators and categorises companies into leaders, ambitious companies, and growth companies.

Leaders are characterised by large-scale export (> 30 million euros), ambitious companies by moderate export (> 1.25 million euros) or high added value per employee (> 25,000 euros) and growth companies by rapid growth or rapid increase in export volume (> 20% annually).

With regard to the potential of introducing kratts, one of the categories — the leaders — should be expanded. When focussing solely on export companies, the significant potential of applying kratts to partially increase the performance of sectors aimed at the domestic market would not be used. Therefore, the measures should include the leading companies of all the sectors that have innovation capacity and a sufficient level of digital maturity (i.e. their processes have been digitised) under the leaders category.

Obstacles faced by companies in developing and applying kratts depending on the category and role of each company (developer or implementer) have been provided in the following table (table 4).

Table 4. Obstacles and opportunities of developers of kratt products in kratt projects..
Red = obstacles, yellow = neutral, green = opportunities

Company type / Target group	Kratt-based product developer	Implementer
Leaders Companies with a large export volume	Financial capacity	Financial capacity
	Labour force	Commercial viability
	Availability of data (for development)	Digitalisation
		Ambition
		Awareness
Ambitious companies Export > 1.25 million euros or added value > 25,000 per employee	Ambition	Ambition
	Labour force / R&D partner	Commercial viability
	Availability of data (for development)	Awareness
		Digitalisation
		Financial capacity
Growth companies Rapidly growing or increase in export > 20%	Ambition	Commercial viability
	Financial capacity	
	Cooperation in R&D	
	Availability of data (for development)	

We base our measure proposals on obstacles faced in the implementation of kratts so that the measures would support the companies every step of the way.

For kratt developers, the main obstacles are the lack of qualified data scientists and engineers and the availability of the data required for development, for example in the form of open data and area-specific data stores (which may be text corpora, weather, population, and/or other data). While leaders and ambitious companies have usually ensured sufficient funding — thanks to their size and maturity and because the product being developed is ready to enter the market — growth companies require additional financial measures which support development to develop a product prototype based on the product concept. These companies are usually in the phase of product development where primary studies have been carried out, but a product prototype has not yet been made based on them. The costs of product development are high in this product development stage, but the risk of investing in the product is high as well, as there is no insurance that the product will be successful.

The main obstacle faced by leading companies with the potential to apply kratts is the lack of knowledge about kratts as a technology as well as its benefits and possible applications in their company/field. In addition, they are not prepared to invest into unproven technology (fear of risks). At the same time, these companies generally have a sufficient level of digitalisation, organised data, and financial capacity that creates good preconditions for the successful application of kratts.

Some of the obstacles for ambitious companies with kratt application potential may be the lack of knowledge of kratt solutions but even more so the lack of data, weak financial capacity, and questionable value of applying kratts.

The export volume of companies in this group is already considerable (1.25 million) or business processes have been sufficiently optimised so as to achieve relatively high added value, but the company lacks sufficient data to use in training a kratt to carry out certain work processes. In order to evaluate the quantity and quality of data and possible kratt applications in the company, a pilot project is required, which may not be a reasonable investment for the implementation of the technology due to the risks related to the project. Companies of this category may achieve more success by using measures for digitalising the company, such as the implementation of ERP, where the project's impact and cost for the company can be evaluated with greater likelihood.

Growth companies that are only just starting their business activity will not usually gain much from the implementation of kratt technology in the processes of their company, as the costs of the implementation exceed the benefits. For example, this category includes a company that is starting manufacturing, has a small turnover (below 200,000 euros), and focusses on the launch of their business activities. Often, the company only has a few employees in this stage and no software solutions for the manufacturing process are in place.

The analyses and discussions indicated that irrespective of a more detailed analysis of obstacles, the solutions for different types of issues faced by the companies are generally similar. Therefore, proposals to boost the implementation of kratts in Estonia's private sector have been provided as a set, categorised into larger obstacle groups. Solutions for challenges related to specialists, i.e. the labour force, partnership in research and development, and cooperation have been provided in clause 6.3, as these are identical for supporting implementation in both the public and private sectors.

6.2.1 Raising awareness on kratts

Currently, the awareness of companies on the possibilities, development, and risks of applying kratts is rather low. This is also evidenced by the assessment of the undertakings themselves. Low awareness on kratts does not allow companies to evaluate the possible outcomes of projects — what exactly could be achieved with artificial intelligence solutions. One of the main reasons for this is the lack of practical experiences and lack of known success (and failure) stories of application.

The focus of raising awareness should be on increasing the knowledge of middle management staff in leader and ambitious companies that apply artificial intelligence projects, as increased awareness has the most impact on the projects created in these companies through the optimisation of the company's processes.

The previous measures are not directly focussed on kratts or do not ensure sustainable activity.

In order to boost investments into digitalisation, practical and functional sample applications should be created and information about them disseminated: to show that the application of kratts is useful and manageable. In addition, the conduct of analysis and pilot projects for introducing kratts should be supported (including in more traditional industries) to prompt larger leading companies to make additional investments in kratt solutions.

Existing measures

- **Focus areas supporting cooperation**[22] between the community of start-up companies of the KredEx Startup Estonia programme and various sectors. The aim of the programme is to hasten the establishment of start-up companies and raise awareness on the measures aimed at them and possibilities of developing the companies. In addition, the programme is aimed at supporting cooperation between companies of the area in focus.
- **Activity of North Star, the NGO that joins specialists in the field of artificial intelligence,** which includes organising various events with the aim of hastening spillover in the artificial intelligence community.
- **The website kratid.ee,** created as part of the work of this expert group to collect proposals for creating kratts and introducing previous user stories from the state and private sector and the action plan for kratts.

Additional proposals

- **Appoint an organisation that develops the field of artificial intelligence and engages in the systematic increase of awareness, or establish one if necessary, to raise awareness on artificial intelligence.** For example, this could be one of the tasks of the digital innovation centre that is currently being devised. There is need for consistent action and therefore an organisation that would keep the discussion on artificial intelligence and its application going in Estonia, organise events, unite the relevant community on a wider scale, exchange information and success stories on kratts, etc.
- **Maintain and upgrade the kratid.ee portal** so that it would, among others, be a channel of general education with recommendations, implementations of possibilities of use, and cautionary tales, where companies could also get practical information on the realisation of kratt projects. This could be the task of the organisation put forward in the previous proposal.
- **Order a web-based training programme by the state to increase awareness on kratts on a broader scale**. Based on experiences from the *Finnish Elements of AI*[23] course, this could be an effective measure for drawing attention, attracting interest in kratts, and increasing preparedness for them both in companies and on a broader scale.
- **Development and implementation of a training programme for the application of artificial intelligence aimed at leaders and ambitious companies with a potential of introducing kratt solutions.** We recommend it to be based on a masterclass-type training programme of EAS, as the programme is sufficiently detailed to allow companies to implement the information gained.

6.2.2 Support of investments made by companies to apply kratt-based products

Companies with the potential to apply kratt solutions often have a relatively low ambition to invest in unproven technologies, as they prefer to wait for solutions with a definite return on investment. Other obstacles for applying the projects may be the level of digitalisation of the company and poor quality of data. The reason for this is that one of the significant preconditions for the projects of artificial intelligence application is the general digital maturity of companies.

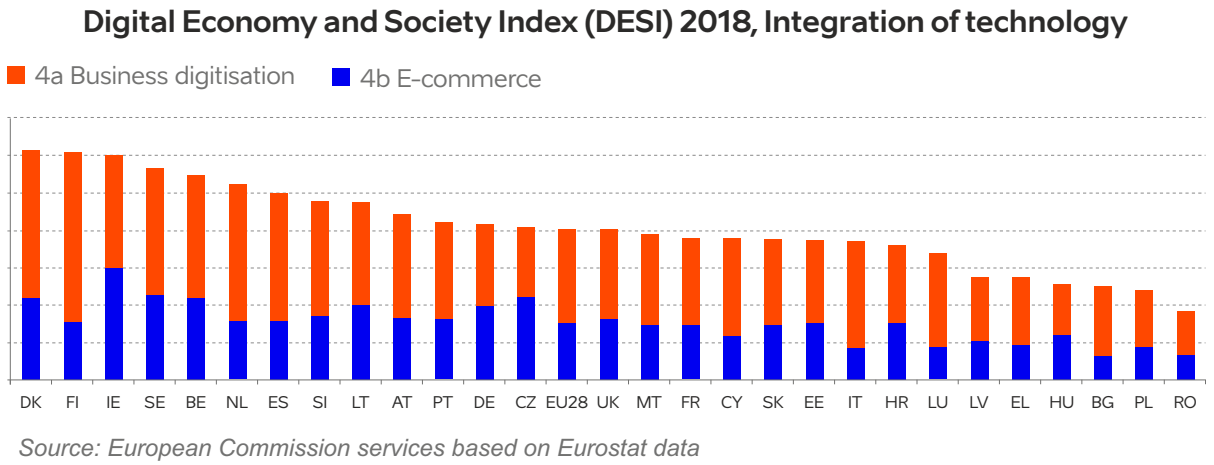
The digitalisation of the business processes of companies usually provides a data set that is necessary for carrying out artificial intelligence projects.

The level of digitalisation is measured, for example, with a study of the European Commission where the DESI index, i.e. the Digital Economy and Society Index of countries[24] and one of its sub-indexes — Integration of Digital Technology — are calculated. The latter indicates, among others, the level of digitalisation of business processes of companies (including the scope of application of business software). Estonia ranks ninth in the general DESI index and twentieth on the integration of digital technology index (see figure 5).

22 Focus areas of Kredex Startup Estonia, https://www.startupestonia.ee/focus-areas

23 Website of the Elements of AI training, https://www.elementsofai.com/

24 https://ec.europa.eu/digital-single-market/en/desi



Source: European Commission services based on Eurostat data

Figure 5. DESI Integration of Technology index

As the state has started the promotion and support of the digital revolution in companies on a wider scale, additional efforts are required from many companies to take advantage of the potential of kratts so that their level of digitalisation would be sufficient for testing and applying kratts.

Existing measures

- The **digital diagnostics measure**[25] of EAS. The aim is to support the preparation of digitalisation and automation diagnostics for the manufacturing industry (division C of the EMTAK) and mining industry (2008 division B of the EMTAK). The measure was created to support companies with various levels of digitalisation during the innovation of the process. The budget of the measure is 1 million euros, the remaining amount of which is 800,000 euros at the moment the report is being prepared. The digitalisation support measure of 3 million euros will be added to this measure.
- The **product development grant** of EAS aimed at manufacturing companies. The grant provides up to 200,000 euros per project. The development of projects by companies is supported. The budget of the measure is 1 million euros.

Additional proposals

- **State support measure for the digitalisation of companies** with a budget of 50 million euros in 2019—2021 that supports faster and more vigorous digitalisation (including using artificial intelligence) of selected economic sectors. The budget of the previous digitalisation measure is only sufficient for approximately 20 companies, which is not enough for establishing a sufficient database for the application of kratts. In addition, the previous measure has only been aimed at manufacturing companies, but digitalisation should also be supported in companies of e.g. wholesale and retail trade, transport and storage, and construction.
- **Expand the existing digitalisation measures of EAS** so that kratts are added to the guidelines for good practices of the digital diagnostics measure to enable the evaluation of the implementation of kratts in the framework of the digitalisation planned in a company.
- **Increase demand for kratt solutions of the public sector** and sharing ordered solutions for reuse purposes. As a result, more kratt-based solutions with a proven commercial advantage will be added to Estonia that could also be used as examples for the implementation of kratt-based solutions in companies. In part, the applications ordered by the state (e.g. central components) can also be reused in companies in the future and thus hasten the application if they are made freely available. More specific activities have been provided in chapter 6.1.

25 EAS, digital diagnostics, online, https://www.eas.ee/teenus/digidiagnostika/

6.2.3 Support of investments made by companies to develop kratt-based products

One of the obstacles to the development of kratt-based products is the large amount of problems with current support measures implemented for research and development activities. Although several measures aimed at product developers exist, their application is complex from the administration point of view, awareness on them is low, and the support amounts are insufficient for the development of kratt-based products.

This mainly affects growth companies that are at the early stage of product development and require an environment that supports them with both specialists and funding to bring their product to the market. However, kratt projects are peculiar because the risks of product failure in product development for creating prototype solutions is significantly higher than with traditional ICT solutions. Kratt-based products always have probabilistic model accuracy — for example, a chatbot may "understand" 80% of the text written by customers, at the same time, the accuracy of the created model may also be below 50%, meaning that it is not reasonable to continue with the development of the solution. Because of this, pilot projects are conducted as part of the projects. Pilot projects are carried out to evaluate the accuracy of the model based on the data of the company and introduce the necessary changes in processes and other systems.

In research and development activities, it is important to make a distinction between the levels of maturity. For kratts, it is also possible to still be analysing the basic principles of artificial intelligence, test the artificial intelligence methods in lab conditions, or apply kratts in the actual working environment. Categorisation of companies into those technology readiness levels (TRL)[26] helps to identify at which stage the companies may require assistance for the application of a novel solution.

The typical shortcoming in research and development in Estonia, as well as the rest of the world, is overcoming levels 4—7 of TRL. Solutions are required for this.

The following figure describes the TRLs, parties to the process, and the division of funding (see figure 6).

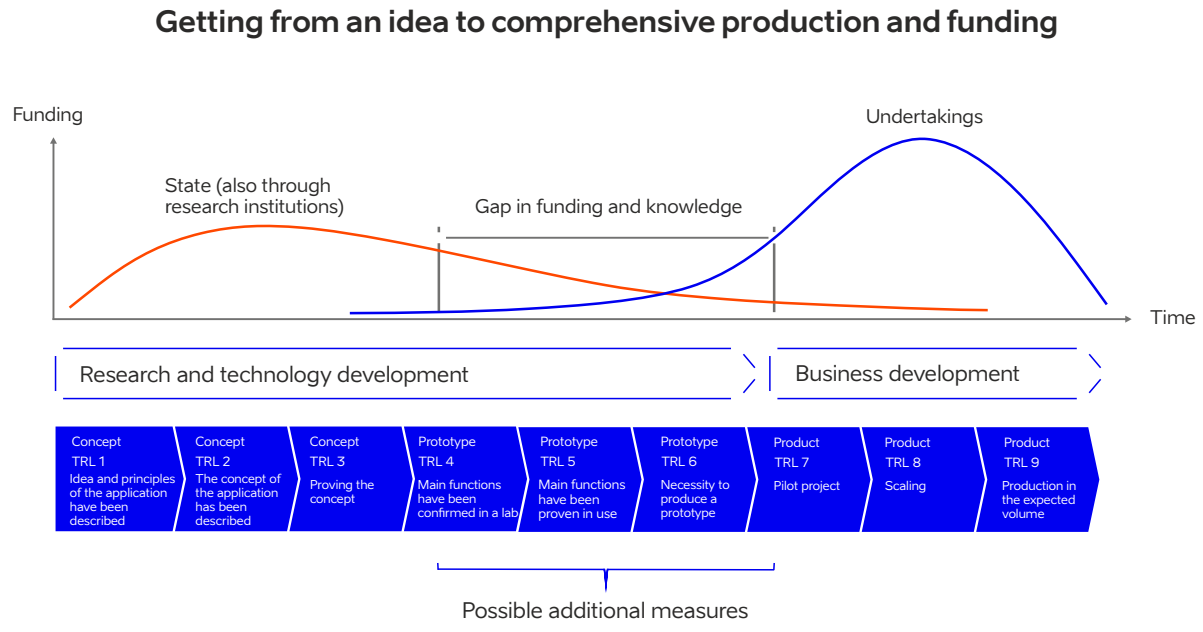


Figure 6. Technology readiness levels (TRLs)

In order to overcome the obstacles of product development, access of companies developing artificial intelligence-based products to the resources of research and development activities should be made easier. Several current funding measures consider more conventional projects of creating prototype solutions and validating ideas by EAS and companies with an already established customer base from the point of view of KredEx.

At the same time, there are no measures that support more research-intensive development and pilot projects of kratt projects.

26 https://en.wikipedia.org/wiki/Technology_readiness_level

Existing measures

- The **innovation voucher**[27] of EAS. The measure is aimed at small and medium-sized enterprises. In cooperation with a higher education institute, test laboratory, or intellectual property experts, it enables the development of innovative solutions for obstacles to development, carry out tests with new materials, gather knowledge on technologies, conduct studies in intellectual property databases, etc. The total budget of the measure is 4 million euros, the remaining amount of which is 2.5 million euros at the moment the report is being prepared. The maximum grant is 4,000 euros per application and the maximum grant percentage from the entire cost is 80%. At the moment, a research institution is accepted as a service provider, but an IT specialist is not.
- The **development voucher**[28] of EAS. The measure is aimed at small and medium-sized enterprises. This enables the inclusion of high-level know-how from the best specialists in the field to evaluate the feasibility of a development idea. The total budget of the measure is 6 million euros, of which 3 million euros remain at the moment the report is being prepared. The maximum grant is 20,000 euros per application and the maximum grant percentage from the entire cost is 70%. At the moment, a research institution is accepted as a service provider, but an IT specialist is not.
- The **product development grant**[29] of EAS. The measure is aimed at small and medium-sized companies in the processing industry. It enables processing companies to make more daring investments in development activities, which increases the added value of the undertaking and sales turnover from new products. The budget of the measure is 1 million euros. The maximum grant is 200,000 euros per application and the maximum grant percentage from the entire cost is 70%.
- **Investment vehicles with KredEx participation**[30,31] **in companies with higher risk and growth potential**. The measures enable to support the use and development of kratt technologies by making capital investments in the companies.

  The measures do not focus directly on artificial intelligence.

Additional proposals

- **Organisation of an innovation competition**: the state would grant up to 10 supports with a budget of approximately 100,000 euros to analyse possibilities for creating kratts based on the state's data stores and, if possible, to also create applications with a concept that is proven effective and could be developed further in the private sector to create a product or develop a solution for the public sector. 10 ideas with the most potential will be selected in the course of the competition and the state will finance their implementation. If necessary, the state will also grant the implementers with access to data stores used by the state if these are not open data.
- **Supporting the pilot projects of kratt product development with up to 50,000 euros per project** with 30% own contribution. The main objective of the measure is to gain easier access to the funding of artificial intelligence product development on TRL levels 4—6. The project is not expected to be profitable but provide experiences on applying the technology. The measure may be an expansion of EAS development voucher, enabling, among others, to hire an artificial intelligence expert in the company. Recommended total budget of the grants: 2 million euros over 2 years for at least 40 pilot projects.
- **Supporting the projects of kratt-based product development with up to 200,000 euros per project** with 30% own contribution. The main objective of the measure is to gain easier access to the funding of artificial intelligence product development on TRL levels 5—7. As a result of the project, the solution created must be commercially profitable after 2 years (on TRL level 7 by the end of the project). The measure may be an expansion of the EAS product development and focus on the creation of kratt-based solutions, enabling, among others, to hire an artificial intelligence expert in the company. Budget: 4 million euros over 2 years for at least 20 projects.
- **Increase the demand for public sector kratt solutions** (see clause 6.1 with proposals to boost the implementation of kratts in Estonia) and share the ordered solutions for reuse purposes.

In part, the applications ordered by the state (e.g. central components) can also continue to be reusable in companies and thus hasten future kratt development if they are made freely available. Specific proposals have been provided in clause 6.1.

27 EAS, Innovation Voucher, https://www.eas.ee/teenus/innovatsiooniosak/

28 EAS, Development Voucher, https://www.eas.ee/teenus/arendusosak/

29 EAS, product development grant, https://www.eas.ee/teenus/tootearenduse-toetus/

30 KredEx, venture capital, http://www.kredex.ee/riskikapital-12/

31 AS SmartCap, subsidiary of KredEx. The state invests 10 million euros through the high-tech investments fund, https://smartcap.ee/uudised

6.3 Artificial intelligence R&D and education: proposals

By nature, the development of artificial intelligence and kratts is a complex field of technology, which is why companies must involve funding for research and development to introduce artificial intelligence in their business processes or develop new products in this field.

At the same time, the volume of research and development activities is small in Estonia, considerably lagging behind the EU and OECD average, especially in the industrial sector. The Estonian indicator is four times smaller than the EU average and seven times smaller than one of the leaders in this area, Finland. The level of research and development activities is higher in the service sector, but this is primarily owing to the high indicators of the ICT sector. The proportion of expenditures made in research and development is small in traditional service sectors (e.g. retail trade).

The companies carry out the majority of the research and development activities without including the relevant institutions (above all, universities). Similarly to most countries, the private sector in Estonia incurs 90% of the costs on research and development inside the company[32] and cooperation with research institutions (especially universities) is weak, **meaning that there is risk of not including sufficient high-tech competences in R&D activities.**

These challenges need to be overcome so that the companies could move forward with artificial intelligence.

In essence, the problems with research and development in the field of artificial intelligence are not significantly different from research and development on a broader scale. There are several core reasons for the aforementioned problem. One of the reasons is that while for the society, research and development activities are necessary to move towards a higher added value economy, it is a high-risk investment for companies due to the novelty of the technology, which the companies are not always prepared to bear. Therefore, effort should be put into mitigating these risks similarly to other developed countries so that research-intensive investments seeking innovations could be made.

Especially in the field of artificial intelligence, one of the limits to research and development activities is **the lack of ICT experts who have a good command of the methods of artificial intelligence (including machine learning)** because universities do not train enough specialists. At the same time, more successful companies solve this problem by hiring employees outside Estonia (e.g. under the Work in Estonia programme). This action plan proposes to find solutions to advance the increase of ICT and artificial intelligence competences in Estonia, primarily using domestic resources by way of expanding higher education in ICT and greater specialisation in artificial intelligence. This ensures the long-term sustainability of ICT education, as an academic basis for ICT and artificial intelligence which is required for conducting basic research in the long term and which will form the basis for innovation cannot be created by simply filling the current gap with foreign workers in Estonia.

In conclusion, two main problems with education and research and development in the field of artificial intelligence can be highlighted:

- Although cooperation in research and development for artificial intelligence is carried out between research institutions and companies in Estonia, the volume of this cooperation is too small when compared to countries with higher added value that serve as role models for Estonia.
- The universities of Estonia do not train enough specialists with skills and knowledge in artificial intelligence that would meet the needs of the private and public sector, which limits the implementation of kratts.

6.3.1 Expanding the education of specialists in the field of artificial intelligence

As higher education in artificial intelligence forms a part of broader ICT education, an analysis of what is happening in ICT education in general should be carried out to evaluate the current situation in Estonia. An analysis conducted by the Information Technology Foundation for Education (HITSA) in 2018[33] indicates that 846 students graduated from an ICT field in the 2016/2017 academic year, which amounted to 9.3% of all graduates. In the 2017/2018 academic year, 10.2% of prospective bachelor's and 15% of prospective master's students chose to study ICT (937 and 595 students, respectively).

At the same time, conventional ICT education is not enough to create artificial intelligence applications — we need to train a sufficient number specialists at the master's and doctorate level who have engaged in this topic in greater depth.

The greatest problem here is that only a few ICT students continue their studies at the doctorate level. While 12.5% of all the graduates of the 2017/2018 academic year continued their studies at the doctorate level, this figure was only 9.8% in ICT studies.

One of the reasons for the lack of popularity of doctorate studies in ICT is the low grant for doctoral candidates that has increased over the past few years but is still significantly lower than the wages in the ICT sector. The current monthly state grant for doctoral

32 Mürk, I., Kalvet, T. (2015). TIPS Study 4.3. final report. Role of research-based companies in Estonia's R&D and innovation system

33 Analysis of the capacity of the economy, higher education and research and development of the ICT sector; HITSA 2018

candidates is 660 euros, to which 440 euros is added for some of the doctoral candidates in smart specialisation fields.

However, this falls significantly below the wages of specialists with even a lower level of qualification paid in both the private and the public sector, not to mention wages of data science or kratt specialists. The problem is made more acute by the competitive headhunting of doctoral candidates by foreign countries, leaving an even smaller number of people with a doctorate degree and high level of professional preparation in Estonia.

In addition to the immediate issue caused by the insufficient volume of doctoral studies in ICT, which manifests itself in a smaller volume of research and development activities, the fact that doctoral studies provide the next generation of lecturers for our universities is another problem in the long run. As this is a long-term process, the consequences will be revealed after several years. The current lack of lecturers in the ICT field is caused by measures not taken in the 1990s and 2000s.

Although artificial intelligence as a field is part of ICT, we now realise that artificial intelligence applications affect most of the areas of our lives. This is why artificial intelligence education should also be part of other fields in addition to ICT.

Measures need to be taken so that universities would prepare a sufficient number of high-level specialists in artificial intelligence and these specialists would come in contact with practical problems faced by companies (this problem can be solved with the support measure for applied research provided in clause 6.3.2).

When kratts are applied on a wider scale, providing this education solely on the higher level will not be enough.

It is important to address the topic of artificial intelligence on the secondary and vocational education level, as well to attract interest in this area among young people and inspire them to study ICT fields (including artificial intelligence) at a higher level.

Generally, the financing of higher education can be divided in two:

- operating support for universities consisting of basic funding and performance-based funding, ensuring stable financing of universities for infrastructure and researchers;
- additional funding mechanisms.

Currently, the following schemes are used in Estonia as additional funding mechanisms:

- The focus curricula of the **IT academy**[34] with the objective of ensuring the labour resources required for this area and establishment of preconditions to achieve economic growth with the help of ICT by offering competitive ICT education.

  Curricula are offered in cooperation between the Tallinn University of Technology and the University of Tartu from bachelor's to doctoral studies.[35] The budget of the programme is 3.5 million euros for approximately 4,300 ICT students per year.[36]
- The objective of **development projects for higher education in ICT** is to support the increase of quality in ICT higher education and the development of curricula in both ICT fields and other fields of study to promote specialised ICT education. This enables to apply ICT-based technical skills in the students' own field and therefore promote the development and efficiency of the field and improve the employability of students.
- The **ICT research support measure**[37] with the objective of developing innovative products and services that decrease resource-intensity in cooperation with institutions, companies, and state agencies engaged in research and development, increasing the capacity of research groups in priority research axes, and connecting research and development with the learning activities.
- Among others, the supported research axes include the launching and activity of research groups: artificial intelligence and machine learning, data science and big data, robot-human cooperation, and the Internet of Things in industrial processes. Between 2018—2022, the budget of the support is 3 million euros per year, including 500,000 euros per research group. The measure covers the wages of ICT researchers in the research groups on a one-off basis and, therefore, partially mitigate the problem of a lack of lecturers with specialised knowledge, including by providing additional funding to doctoral studies and attracting additional doctoral candidates to the university.
- The **training procurement of the Ministry of Economic Affairs and Communications**[38] to develop a curricula for **master's studies of data science specialists** and organise its studies to train 50 students in four years. This is an exceptional measure that directly enables universities to train students for the state with the required specificity based on competition. However, this is a one-off short-term measure

34 HITSA, the IT Academy programme, https://wwwn.hitsa.ee/ikt-haridus/ita

35 HITSA, ICT curricula in Estonia, https://www.hitsa.ee/ikt-haridus/ikt-oppekavad

36 HITSA, the IT Academy programme document for 2016—2020, Tallinn 2016, https://media.voog.com/0000/0034/3577/files/IT%20Akadeemia%20programm%202016-2020.pdf

37 HITSA, support measure for ICT research, https://www.hitsa.ee/ikt-haridus/ita/teadusmeede

38 Register of Public Procurements, online, https://riigihanked.riik.ee/rhr-web/#/procurement/1543443/general-info

that requires sustainable continuation that reassures universities and meets the needs of the labour market so that long-term trends could be realised. The narrow field modules of the programme also include modules of artificial neural networks and other artificial intelligence technologies.

The listed measures for supporting higher education in ICT help to lay the groundwork for training specialists in artificial intelligence.

The data science and machine learning subjects are also included in the ICT curricula; however, we need more specialists who have acquired artificial intelligence training at a higher level, as companies lack more complex ICT positions.

Proposal to apply new measures

- **Invest considerably more in new ICT specialists**: in the relevant higher education and research and development. The need for investments is long-term; however, in the first four years, this means additional investments in higher education with an approximate volume of 5 million euros, including the following measures:
  - **Hire 8 high-level lecturers** (annual cost 0.8 million euros) that helps to also meet the need of teaching kratt technologies horizontally to students of other fields of study.
  - **Increase specialisation in the field of kratts at the master's level and the relevant learning opportunities** (for example with relevant fields of study, support for developing specialisation, or ordering student places). The objective should be that in two years, there are at least 50 master's students who have specialised in kratt-related topics or fields.
  - **Support the development of elective subjects on artificial intelligence in other fields aside from ICT in post-graduate training.** Elective subjects of modules allow participants to become familiarised with the opportunities of artificial intelligence in all fields of study.
  - **Include the topic of artificial intelligence in the digital skills programmes of general ICT education in schools** (for example the Proge Tiger and Technology Compass launched by HITSA) with the objective of providing an overview of artificial intelligence technologies and opportunities to pupils along with other knowledge on ICT.
  - **Increase specialisation in the field of kratts in doctoral studies and the relevant learning opportunities**. The objective should be that in two years, there are at least 20 students in doctorate studies who have specialised in kratt-related topics or field. The total annual costs for one doctoral candidate are approximately 50,000 euros; therefore, if we set the target of admitting e.g. 20 doctoral candidates over four years (5 each year), we should invest 2.5 million euros in this.

6.3.2 Research institutions and the capacity of R&D

According to the common development model, a company or institution that requires a kratt acquires a kratt solution (e.g. a chatbot) with its implementation from a developer specialised in this. Therefore, competences in artificial intelligence and research and development are primarily required by the developer, as it may not be possible or reasonable for them to recruit these kinds of competences.

This need is especially acute when developing a new product on TRL[39] levels 1—6, i.e. in carrying out research at the experimental and prototype level.

In Estonia, the main partners in product development are universities, TCCs, and various private undertakings. At the same time, universities lack the capacity to actively promote the sales of its development service and create order-based applications in addition to research and education. This results in low activity of research institutions in providing development services and limited opportunity to provide administrative support to companies interested in research and development in finding and organising funding sources because the funding mechanisms are complex and companies are generally not aware of them.

At the same time, private sector research institutions and companies that provide development services are not usually categorised as service providers under the support measures.

Current measures of research and development aimed at cooperation with private sector companies include:

- Measure to support **applied research on smart specialisation**.[40] The objective of the measure is to provide additional funding to companies for carrying out applied research and product development in cooperation with research and development institutions. The advantage of this important support instrument is that its required own contribution is low and the requirement of reporting and guaranteed results is moderate, which is in proportion with the risks of conducting applied research on TRL levels 1—6.

39 Technology Readiness Level, Estonian Research Council, https://www.etag.ee/wp-content/uploads/2019/01/Tehnoloogilise-valmiduse-tasemed.pdf

40 Support to applied research in growth areas of smart specialisation, http://adm.archimedes.ee/str/taotlejale/periood-2014-2020/nutika-spetsialiseerumise-rakendusuuringud/

The activities are funded from the EU Structural Funds that are about to end. Funding for the period after 2020 has not been decided yet, meaning the measure may not be funded in the transitional period.

As at April 2019, approximately 10 million euros of the total budget of the measure (25 million) had not been used. If the current application volume continues, this will be enough to last until the end of 2020.

- The **technology competence centre (TCC) measure**[41] of EAS is a support programme aimed at motivating companies to create innovative products and cooperate with research institutions. For example, the competence centre specialised in machine learning and data science STACC[42] engaged in creating artificial intelligence solutions was established as a result of this programme. The aim of this measure is to motivate companies to create innovative products and cooperate with research institutions in doing so. In practice, companies that wish to carry out research-intensive product development can contact the TCC that finds the competence required for solving this task among their employees or partners. The TCC measure in its current form will end with the ongoing EU funding period; therefore, solutions for supporting similar research and development activities in the future need to be found.
- The **support measure for centres of excellence**[43] for carrying out fundamental research, applied research and development activities, and acquisition and upgrade of equipment. The IT centre of excellence — Excit — operates in Estonia. Its objective is to join all the ICT fields in Estonia from hardware to software, focussing primarily on creating error-proof and secure IT solutions. The activities of the project are funded until 2023.
- A Cooperation platform for research institutions, **Adapter**.[44] Adapter enables companies to quickly contact the researcher or specialist they need.
- The **development grant**[45] is a competition-based research grant for experimental developments to test and/or create preconditions for the commercialisation of research outcomes. The grant may be applied for with approval from the Research and Development Council of Estonia and the manager of the development project must have a doctorate degree. Employees with the relevant qualification for carrying out the prescribed research tasks who work in the company may also participate in the project. The total budget of the 2019 call for proposal is approximately 400,000 euros and the maximum amount per project is 100,000 euros.
- The **DIH** (Digital Innovation Hub) measure.[46] The objective of the DIH network, initiated at the EU level, is to promote the digitalisation of the industry. DIHs are so-called one-stop-shops that help companies to improve their competitiveness, find funding, engage experts, and carry out research projects through digitalisation. Currently, 4 prospective DIHs have been registered in Estonia and each of them has marked artificial intelligence as one of their areas of activity. The DIHs are funded on a competition basis from measures of Horizon 2020 and the Horizon Europe that replaces it. In addition, one DIH in the field of artificial intelligence can be funded under the DEP programme[47], which means more secure funding.

In conclusion, the expert group finds that although there are several measures supporting the cooperation in research and development between companies and research institutions, the issue on the one hand is confusion caused by many different measures with a similar objective and on the other, the administrative complexity involved in using such measures.

Pursuant to the aforementioned, the expert group makes additional proposals:

- **Guarantee the continuation of applied research in smart specialisation in the 2019—2022 period.** The awareness of companies on the possibilities of the measure needs to be raised to make the measure more popular. It is important to ensure that the gap between the EU funding period would be covered from the state budget, if necessary.

  In addition to funding applied research, the conduct of applied research by companies should be made easier.
- Establish organisational capacity for companies to actively provide opportunities for applied research, **including monitoring the development trends in technology and** selling technology development projects to companies by finding state or EU funding for the projects and taking a leading role in preparing project applications, connecting the company with a suitable research and development institution, and offering support in the matter of intellectual property. The expected capacity would include guiding the development

41 EAS, Technology Competence Centres, https://www.eas.ee/teenus/tehnoloogia-arenduskeskused/

42 STACC, https://www.stacc.ee/et/

43 archimedes.ee/str/taotlejale/periood-2014-2020/teaduse-tippkeskused/

44 Adapter, https://adapter.ee/

45 Development grant, ETAG, https://www.etag.ee/rahastamine/uurimistoetused/arendusgrant/

46 Digital Innovation Hub, European Committee, http://s3platform.jrc.ec.europa.eu/digital-innovation-hubs# (inglise keeles)

47 Proposal for a regulation of the European Parliament and of the Council establishing the Digital Europe programme for the period 2021—2027, COM(2018) 434 final, https://eur-lex.europa.eu/legal-content/ET/TXT/HTML/?uri=CELEX:52018PC0434&from=EN

activity at the partner institution and communication with the contracting authority from the private sector. There are several options for creating this capacity, one example of which is a DIH (see the next proposal).

The objective of the measure is to offer comprehensive support to companies in developing a kratt, i.e. a high-tech product.

- **Launch a measure for a DIH** (Digital Innovation Hub) **focussed on artificial intelligence in Estonia**[48] as fast as possible, i.e. before the EU support is opened — initially supported by the state budget to launch the necessary activities (the success of several other proposals depends on these) and successfully apply for future EU funding.

  The objective should be a cross-Estonian DIH specialised in artificial intelligence that mediates the relevant cooperation between companies and research and development institutions.

  In the future, this DIH would forward information on international funding opportunities opening from the EU artificial intelligence action plan and other sources to parties in Estonia and the state point of contact provided in the artificial intelligence action plan in matters related to artificial intelligence.
- **In addition, Estonia should actively be joining the EuroHPC**[49] **projects** to make high-performance computing capacity available to research and development institutions by means of co-funding, as investing in it alone is probably not feasible for Estonia. Participation requires a 2 million euro investment.

6.4 Shaping the judicial area for the implementation of artificial intelligence: analysis and proposals

6.4.1 Summary of the legal analysis

There is no need for substantial changes in the basics of the legal system and there is also no need for a so-called harmonised "kratt act" for the following reasons:

- both now and in the foreseeable future, kratts are and will be human tools, meaning that they perform tasks determined by humans and express the intention of humans directly or indirectly (also if the human has granted seemingly large "freedom" to the kratt);
- today, there are no known so-called super agents that are able to operate independently and have intentions independent of humans, so the subjects of the legal regulations are humans.
- For the sake of legal clarity, it should be ensured that when exercising public powers or performing other public tasks, the actions of a kratt will be attributed to the state through the company or body that used the kratt in the meaning of state liability. In private relationships, for both natural and legal persons, the kratt's actions should be considered the actions of the kratt's user. Matters related to criminal liability need to be expanded, e.g. to include kratts and their use by expanding the definition of instrumental execution.

Granting artificial intelligence (agent) a subject of law status would create illusionary legal certainty and would not solve issues of liability.

There is no need for a central register of autonomous intelligent technologies that do not have a subject of law status, as this would constitute unreasonable anticipatory regulation and can be solved by self-regulation tools, such as open standards and information exchange.

We define three necessary axes for developing legislation with regard to the wider implementation of kratts:

- remove outdated norms — which do not consider or allow the use of kratts and therefore hinder the benefits gained from kratts for the society — from the legal system;
- ensure legal clarity required for the functioning of societ on the one hand by including sufficient provisions regarding the use of kratts in the valid legislation (i.e. legal acts contain norms which can be applied in cases related to the use of kratts) and, on the other hand, by defining liability with sufficient clarity regarding the use of kratts (including who is liable, to what extent, how liability is distributed, etc.);
- establish rules and limitations for the development of kratts, their use, and legal matters related to them so far, as there would be grounds to presume significant harmful consequences to the interests and rights of humans, communities, and the society without state intervention.

48 Digital Innovation Hub, European Committee, http://s3platform.jrc.ec.europa.eu/digital-innovation-hubs#

49 EuroHPC, https://eurohpc-ju.europa.eu/

6.4.2 Changes aimed at the public sector

Although the laws favour the implementation of kratts, the valid general regulation of administrative proceeding cannot be considered sufficiently flexible to promote a more wide-scale application of kratts.

Several elements of the administrative proceeding have been formulated in the valid legislation in a way that presume immediate action by humans, even though there are no fundamental obstacles to automating these processes, i.e. carrying them out without human intervention. Similar norms on formal requirements of executing public authority, where absolute necessity for human intervention cannot be detected, are also included in several specific laws regulating the execution of public authority.

In order to favour the implementation of kratts, it is reasonable to abolish direct and indirect requirements for human participation in activities that can be carried out without immediate human intervention, considering the values of human society and need to protect the rights of people (e.g. the requirement to sign a document, etc.)

Implementation of automated solutions in legal proceedings requires a more in-depth analysis but considering that preparing automated regulations in expedited processing of payment orders has been allowed by law since 2014, expansion of the use of similar solutions should not be ruled out.

Coordinated action is required from the public sector to avoid creating and applying different or even contradicting solutions by agencies that have the opportunity or need to use agents.

In public law relationships, the state is liable for damage caused by unlawful and, in some cases, also lawful actions on the conditions and to the extent provided in the State Liability Act. For the sake of legal clarity, it should be ensured that when exercising public powers or performing other public tasks, the actions of a kratt used by a responsible authority or body for this purpose will be attributed to the authority or body that used the kratt in the meaning of state liability. The state cannot escape liability by referring to a mistake by the kratt's creator, error in data that formed the basis for the kratt's functions, etc. If the state had not applied sufficient measures to ensure that the kratt is functioning as required before putting the kratt into use and during its use, the damage caused as a result of the kratt's actions will be equated to a situation where the public authority causes damage wrongfully.

The state is liable for damage caused in private relationships pursuant to the principles of civil law.

6.4.3 Changes aimed at the private sector

The main challenge is distributing the risks between the creator, manufacturer, and user of an autonomous agent in a situation where the autonomous agent causes damage to or violates the obligations of a party. In general, the current legislation of Estonia provides mechanisms that enable the fair and specific distribution of compensation for damage caused by devices that are too complex or dangerous (e.g. sections 1056 and 1061 of the Law of Obligations Act). In tort law, increased liability is so-called risk liability (strict liability) which can only be avoided in the case of force majeure.

In many jurisdictions, “source of increased danger” is related to motor vehicles, buildings, and very specific devices and equipment, such as main switchboards, vessels that have not broken ground, nuclear power plants, or road construction. In principle, this legal doctrine can be applied to the activity of artificial intelligence.

In the case of devices or activities with an increased risk liability where human control is limited and risks are increased, voluntary or mandatory liability insurance can be applied so that persons who benefit from the advanced technology would bear the liability for risks associated with operating the devices (this is not connected to guilt or negligence).

In the context of autonomous agents, this would mean that the user of the technology also bears increased liability in the case of absence of guilt and even if they have the right to share this liability with software developers and/or manufacturers, irrespective of the non-performance of their own obligations (e.g. resulting from manufacturer's liability).

Software applications (including those based on artificial intelligence) do not pose a threat in and of themselves (similarly to motor vehicles). This is why it is important to differentiate. In especially sensitive areas of use, such as digital applications in medicine or use of service robots, increased source of danger liability applied to digitally automated processes should be considered based on analogies of liability from animal husbandry, road pavement, and pharmacy — at least when these could damage significant legal interests in an especially permanent manner, particularly with relation to injuries and death.

In distributing legal liability in risk-sharing, the following leading principles are adhered to: those who benefit from self-learning software applications should bear liability for the errors and risks caused by the software applications even if the system is unpredictable. There is no immediate need to establish special regulations to connect kratts with the concept of increased danger.

The judicial area gives sufficient opportunities to use this legal approach in relevant cases and, insofar as the market and scope of using kratts is only just

developing, the application of risk liability should belong in the sphere of competitive legal argumentation that is assessed by the legal practice and legal awareness of the judge separately in each specific case.

In the future, there is a need to additionally analyse the use of kratts that are directly linked to the life and health status of humans and determine or categorise such cases of use of kratts to establish a doctrine for the application of the principle of increased source of danger on a case-by-case basis.

6.4.4 Criminal liability

Penal law should regulate upon which conditions an action realised through a kratt which meets the necessary elements of a criminal offence can be attributed to a specific legal or natural person — so-called instrumental execution. The criteria of attributing an action to a legal person should be updated so that if a legal person uses a kratt for their benefit, the action carried out through the kratt will be attributed to both a legal person and the member, executive, or competent representative of the legal person's institution that had the most immediate control over the use of the kratt.

Creating a kratt that poses a threat to property and/or the environment should be regulated as a punishable act.

6.4.5 Product safety and consumer protection

The manufacturer is liable for damages caused by deficiencies in their product and stricter, i.e. increased, liability rules apply to the manufacturer. The manufacturer can only escape liability if they can prove that, due to the level of scientific and technical knowledge at the time of placing the product on the market, the deficiency could not have been detected (clause 1064 (1) 5) of the Law of Obligations Act. Directive 85/374/EEC allows to hold the manufacturer liable even if they proves that the state of scientific and technical knowledge at the time when they put the product into circulation was not such as to enable the existence of a defect to be discovered (article 15 1 (b)). Five Member States have also used this opportunity; two of them apply this principle to all sectors, two exclude liability with regard to pharmacy products, and one with regard to products made from the human body.

The rules of burden of proof should be reviewed, insofar as in practice, bearing the burden of proof, which falls on the consumer upon submission of a claim, may prove to be impassable for the consumer from a technological standpoint.

The consumer must provide proof for the damage, along with a causal link between the action or inaction which caused the damage and the injurious effect to the injured party, as well as the unlawful act.

Although it is generally believed that the existing product safety and manufacturer's liability regulations are sufficiently flexible to also ensure product safety and manufacturer's liability related to new technologies by updating and amending such regulations as needed, a working group of experts of new technologies and liability was formed in 2018, tasked with consulting the European Commission and helping to develop necessary principles and amendment proposals for the product liability directive. Guidelines and frameworks from the European Commission regarding artificial intelligence, the Internet of Things, and the liability and safety of robots is expected in the middle of 2019.

6.4.6 Data protection

An important question is, on which basis personal data can be used, i.e. when the processing of personal data is lawful. Consent from a natural person, i.e. data subject in the meaning of the protection of personal data, is not always required for the processing of personal data if the processing falls under another legal basis, even if the processing of personal data is carried out using artificial intelligence.

There is no need for regulation from the general aspect of personal data processing and legal bases when involving artificial intelligence, as the provisions of the EU General Data Protection Regulation (GDPR) and local legal acts regulating the protection of personal data of Estonia apply. The processor of personal data (controller, processor, or joint controller) must already ensure that they use legal bases for processing personal data pursuant to the current regulation.

Such liability is also not ruled out by the use of artificial intelligence, as the data protection regulation is technology-neutral and applied to any processing of personal data, including processing of personal data using artificial intelligence.

Personal data can be collected for exact, clearly defined, and legitimate purposes and they may not be later processed in a manner that contradicts these objectives. From this aspect, the processing of personal data by using artificial intelligence may be hindered by the fact that artificial intelligence may

only process personal data for initially defined purposes.

Therefore, such processing of personal data that contradicts the initial legitimate purpose of processing of personal data is prohibited even when using artificial intelligence.

The principle of minimality of processing personal data should be considered, according to which it must be ensured that the processed data are relevant, important, and limited to what is necessary from the point of view of their processing ("data minimisation"). Pursuant to the aforementioned, processing personal data in a greater volume than minimally required is not allowed — this also includes the use of artificial intelligence. Data processing, including cross-usage of data by artificial intelligence, must be reviewed in the context of the data quality standard and status and accessibility of data stores.

Technological advancements, analysis of big data, and the possibilities of machine learning have made profiling and making automatic decisions easier; however, this may significantly affect the rights and freedoms of individuals.

The controllers who carry out profiling based on personal data must ensure that they follow the rules of data protection. One example of automatic decisions in practice is imposing fines for speeding based on photos made by speed cameras. Controllers may carry out profiling and make automatic decisions if they follow all the principles and they have legal basis for processing. Imposing fines using the aforementioned method is lawful, as the processing of such personal data is allowed, pursuant to the Traffic Act.

Similar legal regulation in the public sector will also be needed in the future from the aspect of legal bases to regulate more specific situations.

6.4.7 Competition and tax law

From the point of view of competition policy and law, the question is whether the use of technology in making economic decisions and transactions may give rise to new issues related to competition rights.

Issues of competition related to the use of algorithms have been covered quite thoroughly in legal literature. Research on e-commerce, organised by the European Commission, indicates that the use of algorithms is widespread — more than two thirds of undertakings use automated systems to monitor the prices of their competitors, and some of them also use software solutions that adjust their prices according to the prices of their competitors. Therefore, the use of algorithms (including kratts) affects competition in several ways. Automated price monitoring and application of adjustment systems poses the risk of price agreements (cartel). What is important is how such systems are applied by the undertakings. Undertakings may use the algorithms to knowingly reach price agreements (cartel) or establishing a resale price in a forbidden way.

In addition, undertakings may be considered parties to coordinated activities simply due to the way the algorithms they use operate: coordinated activities have several forms and the European Commission finds that some of those may occur in automated systems. Software developers must be careful when developing price-setting algorithms and observe that these do not essentially constitute coordinated activities or cartels. The liability of users of algorithms under competition law is one thing, but whether the person who created such software can also be held liable should also be assessed.

Even if, up to now, the earlier practice has focussed on contracts entered into by persons from the competition law standpoint, it does not mean that if agreements are reached by automated systems, contracts entered into by computers (agreements) are not monitored under competition law. Automated systems used in business activity have already led to proceedings under competition law with relation to taking advantage of the dominant position. Technological advancements and use have also given rise to questions from the aspect of controlling concentrations, i.e. how to ensure that concentrations that do not require prior consent from the Estonian Competition Authority, but could potentially affect product markets (by restricting consumer options or hindering innovation) could be monitored by the Competition Authority. Pursuant to the aforementioned, the main issue is preventing technology that should potentially be beneficial for society from being abused to violate the rules of competition. It should be ensured, with regard to concentrations related to technology, that the rules and practice would also prescribe inspections to such concentrations for which notification is not mandatory according to the rules, but that have potentially significant impact on the welfare of society or consumers.

We must take a stand on if and how the state uses big data and artificial intelligence for calculating taxes for individuals and making tax-related decisions. Another important aspect to consider is if and how the work conducted by robots should be subject to taxation.

6.4.8 Ethical questions related to the implementation of artificial intelligence

This work does not go into detail on questions regarding the ethics related to artificial intelligence, but briefly explains the general connections and principles resulting from EU law.

By introducing artificial intelligence, or rather integrating it into society, we gain new benefits, but there are also risks of the novel technology associated with it. We must be able to maximise the societal benefits of artificial intelligence against the risks. We strive for trustworthy artificial intelligence.

A high-level expert group of the European Commission has developed instruction materials of ethics for the development and implementation of trustworthy artificial intelligence (hereinafter "instruction").[50] The expected deadline for the finished instruction material is March 2019.

Pursuant to the instruction, trustworthy artificial intelligence has two essential features. First, trustworthy artificial intelligence must be guided by the principles of human rights, positive rights, and values, thus ensuring the ethics dimension and objective. Second, trustworthy artificial intelligence must be based on high-quality hardware execution, which must ensure reliability and minimise circumstances that cause unintentional harm when meeting the objective.

The development of principles and values related to artificial intelligence has been based on the fundamental rights of citizens provided in EU agreements and the Charter of Fundamental Rights. The bearers of such rights are humans. The contact of humans as subjects of law with artificial intelligence may give rise to questions on ethics regarding fundamental rights. Therefore, it is necessary to define a catalogue of ethics principles related to artificial intelligence upon which we can base our actions.

Such ethics principles are higher-level norms that the developers, launchers, users, and regulators of artificial intelligence must follow to meet the objectives related to maximising the interests of persons and the trustworthiness of artificial intelligence.

According to the instruction, the following areas of fundamental rights should be considered above all with regard to artificial intelligence:

- The r**ight to human dignity.** Each human is a unique individual and not just a data subject. Therefore, the dignity of humans must be respected.
- The r**ight to freedom.** Such freedom means protection from direct and indirect interference, deception, and manipulation.
- **Respect of the principles of democracy and the state, based on the rule of law**. Humans hold political power. Artificial intelligence is not entitled to interfere with democratic processes.
- **Right to equality, non-discrimination, and acknowledgement of minorities**. This means equal treatment of people irrespective of their factually different situation. In addition, everyone is entitled to benefits provided by technology.
- **Civil rights**. Artificial intelligence has a high potential to increasing the effectiveness and quality of public services. Nevertheless, citizens should reserve the right of being informed about automatic data processing related to them and request to terminate such processing.

Ethics principles related to artificial intelligence:

- The principle of usefulness: Do good!
- The principle of refraining from causing harm: Do not cause harm!
- The principle of autonomy: Respect the right of persons to make their own decisions!
- The principle of fairness: Be free from prejudices!
- The principle of clarity: Act with transparency!

In conclusion, the following is important when meeting the ethics objective of artificial intelligence:

- ensure that artificial intelligence is human-centric;
- stem from fundamental rights, ethics principles, and values. It is especially important to turn attention to more vulnerable groups in society (children, disabled persons, minorities, employees);
- be aware and cautious of the fact that in addition to benefits, artificial intelligence may also bring along unintended consequences. It is especially important to remain vigilant in areas of critical significance.

50 Ethics guidelines for trustworthy AI, design; Brussels, 18/12/2018, https://ec.europa.eu/newsroom/dae/document.cfm?doc_id=57109

Annex 1

Expert Working Group

Photo: Jaak Nilson

Annex 1. Expert Working Group

Member / Alternate Member	Organisation	Position
Siim Sikkut / Ott Velsberg	Ministry of Economic Affairs and Communications	Deputy Secretary-General for IT and Telecom / Government Chief Data Officer
Marten Kaevats	Government Office of Estonia	National Digital Advisor
Viljar Lubi / Mikk Vainik	Ministry of Economic Affairs and Communications	Deputy Secretary General for Economic Development / Project Lead for Smart Economy
Kristi Talving / Külli Kraner	Ministry of Economic Affairs and Communications	Deputy Secretary General for Internal Market / Head of Internal Market Department
Kai Härmand / Kärt Karus	Ministry of Justice	Deputy Secretary General of Legislative Policy / Adviser at Private Law Division
Indrek Reimand / Katrin Pihor ja Martin Eessalu	Ministry of Education and Research	Deputy Secretary General (Higher Education, Research and Language Policy)
Tõnu Tammer / Raimo Reiman	Information System Authority	Head of Incident Response Department / Head of State Portal eesti.ee Department
Mart Mägi / Andres Kukke	Statistics Estonia	Director General / Deputy Director General
Jaak Vilo / Mark Fišel	University of Tartu	Head of the Institute of Computer Sciencе / Associate Professor in Natural Language Processing
Tanel Tammet / Maarja Kruusmaa	TalTech	Professor / Professor
Mart Susi / Sirje Asu	Tallinn University	Professor of Human Rights Law / Legal Counsel for Research Affairs
Seth Lackman / Maarja Rannama	Estonian Association of Information Technology and Telecommunications	Board Member / Cluster Project Manager
Allan Selirand / Raido Lember	Enterprise Estonia	Director / Deputy Director
Taivo Pungas	Veriff OÜ	Expert
Markus Lippus	MindTitan OÜ	Expert
Siim Aben / Martin Meisalu	Ernst & Young Baltic AS	Advisory Senior Manager / Advisory Senior Consultant
Keith Strier	EY Global Advisory	AI Leader

Annex 2

Legal Working Group

Photo: Kristoffer Vaikla

Annex 2. Legal Working Group

Member	Organisation	Position
Reet Pärgmäe	TalTech	Head of the Legal Working Group
Tanel Kerikmäe		Professor
Katrin Nyman-Metcalf		Professor
Kuldar Taveter		Senior Researcher
Mari Minn		Lecturer
Innar Liiv		Associate Professor
Thomas Hoffmann		Associate Professor
Evelin Pärn-Lee		Early Stage Researcher
Kärt Salumaa-Lepik		PhD Student
Maria Claudia Solarte		Guest Lecturer
Olga Shumilo		PhD Student
Alexander Antonov		PhD Student
Kaido Künnapas		Senior Lecturer
Helena Rozeik		Administrator of AI Law Research Project
Jaanus Tehver	Advokaadibüroo Tehver & Partnerid	Attorney-at-Law
Kärt Karus	Ministry of Justice	
Mirjam Rannula		
Kai Härmand		
Arvo-Mart Elvisto	Ministry of Rural Affairs	
Tanel Ermel	Tax and Customs Board	
Maria Tolppa	Ministry of Foreign Affairs	
Heddi Lutterus	Ministry of the Interior	
Ingrid Muul	Ministry of Defence	
Mati Kaalep	Ministry of Culture	
Triin Nymann	Ministry of the Environmen	
Paula Soontaga	Ministry of Finance	
Nele Nisu	Ministry of Social Affairs	
Helen Tralla		
Madis Sassiad	Goswift - ITL	
Kristiina Maasik	Telia — ITL	
Markus Lippus	MindTitan	
Roland Pihlakas	Simplify	
Risto Jõgi	Ministry of Economic Affairs and Communications	
Sandra Särav		
Kristi Talving		
Külli Kraner		
Thea Palm		

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