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Finland's Age of Artificial Intelligence

Turning Finland into a leading country in the application of artificial intelligence

Objective and recommendations for measures

Ministry of Economic Affairs
and Employment of Finland

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Turning Finland into a leading country in the application of artificial intelligence Objective and recommendations for measures

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Abstract

Artificial intelligence has been developed and used since the 1950s, but it was not until the recent rapid developments and successful applications that we have concrete proof of the opportunities it offers. Today artificial intelligence is everywhere, and over the next few years it is believed that it will revolutionise transport, industry, healthcare and working life. We already have success stories of artificial intelligence in abundance, but the real breakthrough is just getting started. Finland has excellent opportunities to be among the winners in this transformation – when comparing the impact of artificial intelligence on economic growth Finland was ranked second among 11 developed countries.

The application of artificial intelligence creates pressures for change and offers opportunities to companies, the public sector, citizens and the whole of society. The extensive and successful utilisation of artificial intelligence creates conditions for strong economic growth and a higher rate of employment, but at the same time a proper response to the transformation of work is needed. The extensive utilisation and application of artificial intelligence offers a vision of a prosperous and healthy Finland of the future.

The race for the utilisation of artificial intelligence has started, and to succeed Finland will have to make systematic efforts to implement the measures proposed in this playbook. The working group on artificial intelligence gives eight proposals through which Finland will enter into a successful age of artificial intelligence. www.tekoälyaika.fi

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Artificiell intelligens (AI) har utvecklats och tillämpats ända sedan 1950-talet, men det är först den senaste tidens kraftiga utveckling och framgångsrika tillämpningar som rent konkret har visat på möjligheterna med AI. AI finns i dag överallt, och det förutspås att den under de kommande åren kommer att revolutionera trafik och transporter, industri, hälso- och sjukvård och arbetsliv. Även om det redan finns många exempel på framgångshistorier relaterade till AI, har AI-revolutionen bara börjat. Finland har utmärkta möjligheter att bli en av vinnarna i denna revolution – i en jämförelse av AI:s inverkan på den ekonomiska tillväxten placerar sig Finland på andra plats av elva industriländer.

Tillämpning av AI skapar tryck på förändring och innebär möjligheter för företag, den offentliga sektorn, medborgarna och hela samhället. En bred och lyckad användning av AI skapar möjlighet till stark ekonomisk tillväxt och höjd sysselsättningsgrad, men samtidigt är det nödvändigt att reagera på de förändringar det innebär för arbetslivet. Omfattande användning och tillämpning av AI ger en vision om ett välmående Finland i framtiden.

Kapplöpningen om utnyttjande av AI har börjat och för att klara sig i den bör Finland målmedvetet genomföra de åtgärder som föreslås i denna strategiska rapport. Arbetsgruppen för artificiell intelligens ger åtta rekommendationer för hur Finland kan bli framgångsrikt i AI-eran. www.tekoälyaika.fi.

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Tiivistelmä

Tekoälyä on kehitetty ja sovellettu aina 1950-luvulta lähtien, mutta vasta viimeaikainen voimakas kehitys ja menestyksekkäät sovellukset ovat osoittaneet sen mahdollisuudet konkreettisesti. Tekoäly on tänä päivänä kaikkialla ja sen uskotaan mullistavan liikenteen, teollisuuden, terveydenhuollon ja työelämän seuraavien vuosien aikana. Vaikka on jo olemassa paljon esimerkkejä tekoälyn menestystarinoista, on tekoälyn murros vasta alkamassa. Suomella on erinomaiset mahdollisuudet olla tämän murroksen voittaja – verrattaessa tekoälyn vaikutusta talouskasvuun, Suomi sijoittuu toiseksi 11 kehittyneen maan joukossa.

Tekoälyn soveltaminen luo muutospaineita ja tarjoaa mahdollisuuksia yrityksille, julkiselle sektorille, kansalaisille ja koko yhteiskunnalle. Laaja ja onnistunut tekoälyn hyödyntäminen luo mahdollisuuden vahvaan talouskasvuun ja työllisyysasteen nostoon, mutta samalla työn muutokseen on välttämätöntä vastata. Tekoälyn laaja hyödyntäminen ja soveltaminen tarjoaa vision tulevaisuuden hyvinvoivasta Suomesta.

Kilpajuoksu tekoälyn hyödyntämisessä on alkanut, ja pärjätäkseen Suomen tulee määrätietoisesti toteuttaa tämän pelikirjan toimenpiteitä. Tekoälytyöryhmä antaa kahdeksan suositusta, joiden kautta Suomessa voi koittaa menestyksekäs www.tekoälyaika.fi.

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Table of contents

PREFACE

Dear reader,

How can we ensure that Finland becomes one of the frontrunners among countries that apply artificial intelligence? At the end of May 2017, Minister of Economic Affairs Mika Lintilä appointed a working group tasked with answering this question. The special nature of the task at hand is that it requires consideration of measures reaching far into the future and at the same time measures that are relevant today. The report's conclusions will have an impact on the whole of society.

The working group on the future utilisation of artificial intelligence summed up its assignment with four questions: (1) How can the public and private sectors best work to ensure that companies receive adequate support for the production of artificial intelligence-based innovations? (2) How can data-driven businesses benefit from the secondary use of the public sector's information resources? (3) How will artificial intelligence affect us as individuals and what will be its impact on the future of work? What will be its wider impact on society? (4) What types of measures are required from the public sector as we move towards the age of artificial intelligence?

This report is the first stage in ongoing work that will hopefully extend over several years. We are only now beginning to understand the importance artificial intelligence will have in regard to wellbeing for Finland. We are also just beginning to determine what actions we need to implement in order to reach our objectives.

A broad network of experts was utilised in the work leading up to this report. This form of working can be called *a network of networks*. It provided knowledge on each of the themes that is as extensive as possible. The working group will continue its work until the end of the current government's term as the steering group for the artificial intelligence programme. It will continue its concrete work, steering Finland into the age of artificial intelligence. The group will carry on in the preparation of changes by focusing, for example, on the open questions presented in the report. The most significant of these is the question of what impacts artificial intelligence will have on future work

and how it will impact society. The recommended measures related to this question will be published in August 2018.

We are already moving full speed ahead on our way to the age of artificial intelligence. To ensure our success, in our report we have provided eight key actions for Finland. These are proposals for actions, drawn up by working groups and networks, which will help open the way for wellbeing in our future. We know for certain that the current view will rapidly change and be updated as this work progresses. For this reason, it is essential that cooperation between different actors continues to be as in-depth as possible. All of Finland is facing a completely new era, and each of us will have an effect on how we understand the future. We can only create new solutions for the changing world if we work together.

We would like to thank all of you who have been involved in this initial stage of the work. You have participated in important voluntary work to develop the understanding of artificial intelligence and your contribution has been vital to building the proposals for key actions. The secretariat has been particularly intensely involved in the work. We received vital content from the steering group appointed for this work as well as from three sub-groups and their chairmen.

Together, we are moving forward into Finland's prosperous age of artificial intelligence.

23 October 2017

Pekka Ala-Pietilä
Programme chair

Ilona Lundström
Deputy chair of programme

ABSTRACT

A prosperous Finland as a target - in the age of artificial intelligence

We do not yet know what artificial intelligence will bring with it in the future or all the things that this will have an influence on. However, we do know that now that computing capacity and data storage volumes have increased enormously, the technology required by artificial intelligence has reached the required level for the strong development of artificial intelligence that we have been promised for over 60 years.

Today, artificial intelligence is already part of our daily lives. Our chats are answered by robots, we ask our phone's Siri for advice and we are currently in the process of preparing transport that will allow us (at some point in time) to eliminate the greatest threat to safety: human drivers. In the future, the role of artificial intelligence as part of our daily lives will grow, and it will be utilised in increasingly challenging tasks, such as in assisting doctors, process engineers or lawyers.

Economic growth will be established with increased work and new investments, as well as the ability of both companies and the public sector to utilise new technology. The ability to utilise new technology accounts for up to two-thirds of growth. For this reason, information and communication technology (ICT) is the most significant single technology on which the improvement of growth and productivity can be built. Artificial intelligence is like a turbocharger in an ICT engine. Or perhaps it is similar to Popeye's spinach, providing almost natural properties to learning neural network-based computer programmes. From the point of view of citizens and users, it is comparable to a new electricity; so commonplace that we do not notice its functions, but so indispensable that we would not be able to get by without it in the future.

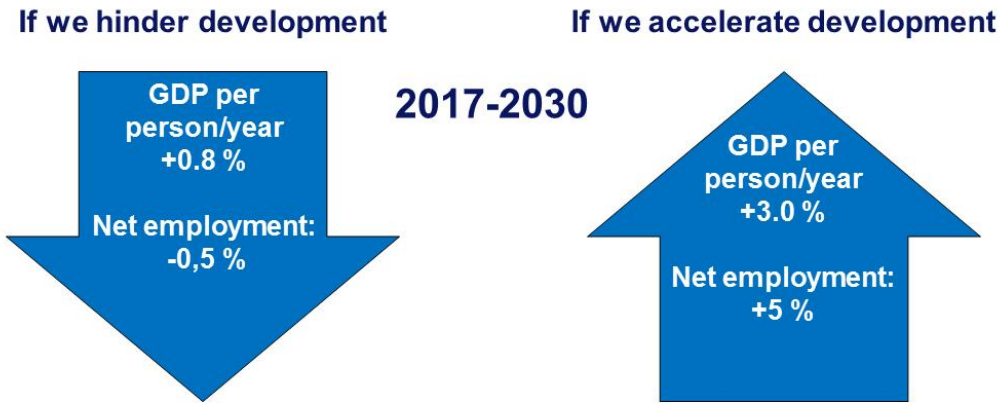
What kind of impact will artificial intelligence have? What will its influence apply to? How quickly will its positive or painful impacts be reflected in our everyday lives? We as a society, as companies, as public sector actors and as individuals must search for answers to these and many other questions. The role of the predictor has been particularly thankless in matters related to technological development. This is also the case with artificial intelligence.

Finland has excellent prerequisites for benefiting from the application of artificial intelligence. Finland was placed second after the United States among 11 developed countries in which the economic growth potential made possible by artificial intelli-

gence has been assessed.[1] This is partly due to Finland's business structure and investment product-driven industry and the public sector's degree of digitalisation as well as Finland's high level of education.

Making use of the economic growth potential brought about by artificial intelligence will require informed decisions and efficient implementation. McKinsey has conducted a study on the future of work and artificial intelligence, as well as on automation, in nine countries considered frontrunners in the digital revolution[2]. Two key questions arise in the section on Finland:

- How actively can companies operating in Finland and Finland's public sector make use of and apply the solutions for the development of operations that artificial intelligence facilitate?
- Will development activities be used primarily for the development of new things and creating growth or for improving the efficiency of current operations?



There significant differences in the alternative projected future scenarios for 2030. If we put the brakes on and fall behind everyone else in artificial intelligence development, and focus out development on improving the efficiency of current activities, this will see our GDP increase annually by 0.8% and our net employment will fall by 0.5% until 2030. These figures will be fundamentally different if active artificial intelligence-based development activities focus on development and the creation of growth in new areas. In this case, Finland's GDP per person would grow by 3% a year until 2030 and our net employment would be up to 5% higher.

[1] Accenture and Frontier Economics, "Why Artificial Intelligence is the Future of Growth", 2017.
[2] McKinsey&Company, "Digitally-enabled automation and artificial intelligence: Shaping the future of work in Europe's digital front-runners", 2017. Finland-specific figures from a non-published country appendix.

Finland's artificial intelligence-based growth potential is thus very high. By making informed decisions, we can have a positive impact on economic growth and net employment. Put simply, this means that in order for Finland to remain a prosperous country, Finland must be able to learn quickly and to apply new technology smartly. This applies to companies and the public sector, as well as individual citizens.

Artificial intelligence-driven new business will split companies more clearly than normal into those that benefit from artificial intelligence and those that are left lagging behind. Pioneering companies involved in the global consumer business can benefit disproportionately from their technological advantage in market share competition. However, examples are not directly applicable to investment-intensive sectors, which the Finnish business structure represents.

The **public sector** will benefit as artificial intelligence creates an exceptional opportunity to accelerate development. We are on our way towards a society that predicts service needs and is able to respond better and more effectively than previously to each citizen’s needs and life situation.

Ordinary citizens will benefit from the numerous new possibilities for a more rewarding working life and the wellbeing that artificial intelligence-based new technology will create. This change will naturally also include transition stages that will bring some challenges and uncertainty.

As for its impact on **society**, artificial intelligence-based new technology – with all its related pressures for change – will measure the capacity for change and the rate of change of multiple institutions in a situation where correctly timed decisions must be made in the midst of greater uncertainty.

A VISION FOR FINLAND IN THE AGE OF ARTIFICIAL INTELLIGENCE

In another five years time, artificial intelligence will be an active part of every Finn's daily life. Finland will make use of artificial intelligence boldly in all areas of society – from health care to the manufacturing industry – ethically and openly. Finland will be a safe and democratic society that produces the world’s best services in the age of artificial intelligence. Finland will be a good place for citizens to live and a rewarding place for companies to develop and grow. Artificial intelligence will reform work as well as create wellbeing through growth and productivity.

1 The role of artificial intelligence in Finland's wellbeing

These days, it seems that artificial intelligence is everywhere. Artificial intelligence is expected to revolutionise transport, industry, health care and working life in the coming years. Even so, artificial intelligence is not a new technology, rather it has been researched and applied in various ways since the 1950s. Over the past few decades, the development of artificial intelligence and the expectations based on this have experienced both up-hills and down-hills. Artificial intelligence and its related expertise have also been developed in Finland from the inception of artificial intelligence. For example, Professor Teuvo Kohonen is one of Finland's pioneers in the field and is known worldwide for his work.[3]

The recent increase in and development of artificial intelligence are based primarily on the rapid growth of computational capacity and easily available and affordable data that can be used for the teaching of artificial intelligence (i.e. educational data). The availability and accessibility of data have particularly influenced the more widespread use of affordable sensors, the growth of storage capacity and a decrease in the cost level, as well as the simplicity of data transfer via the internet. What is artificial intelligence exactly?

Artificial intelligence is an extensive entity for which there is no precise definition. When speaking about the application of artificial intelligence, it is not necessary to give a very specific definition but, rather, it is necessary to give an appropriate one. In this report, *artificial intelligence refers to devices, software and systems that are able to learn and to make decisions in almost the same manner as people*. *Artificial intelligence allows machines, devices, software, systems and services to function in a sensible way according to the task and situation at hand.*

[3] Professor Kohonen is one the world's best-known researchers of neural networks and the self-organising maps he developed were widely adopted in artificial intelligence algorithms.

However, artificial intelligence alone is often not enough to produce benefits – it also needs a great deal of other technology, as well as data resources. Finland's strengths that will allow it to succeed in the global transition to artificial intelligence lie largely in artificial intelligence apps and areas that support the application of artificial intelligence. It is in part for this reason that the objective set for the artificial intelligence working group appointed by Minister Lintilä has been to make Finland a leading country in the application of artificial intelligence. This in turn means that the working group must also look for the ways in which artificial intelligence can be utilised and the ways in which we can best benefit from its development.

The ultimate goal of the working group is to ensure a prosperous Finland in a time when artificial intelligence is widely used. In order to achieve this objective, the working group has prioritised its three main challenges which are examined in this report:

1. How can we ensure that the potential offered by artificial intelligence is utilised to its full extent in order to guarantee the competitiveness and economic growth of business?
2. How can we ensure that the public sector is able to make use of the possibilities offered by artificial intelligence in its own activities and is able in this way to effectively produce high-quality public services?
3. How can we ensure that our social structures adapt to the changes brought about by artificial intelligence and that Finland will be able to continue to provide a well-functioning society and wellbeing for its citizens?

The provision of high-quality public services and a well-functioning society requires economic growth, which has traditionally been based on the growth of capital, labour and productivity.[4] In a country such as Finland, which is technology intensive but has a small internal market, there is no great growth in capital and labour on the horizon. The most significant factor in economic growth has been the development of technology and the ability to apply it both in the private and public sectors.

Finland has excellent prerequisites for the utilisation and application of artificial intelligence. If we are able to take full advantage of the possibilities created by artificial intelligence, the growth of economic value in the Finnish economy is estimated to double by 2030. This will requires that Finland invests in the development and application of technology as well as in our ability to adapt. Unlocking our potential will also require strong scientific support as well as the ability to put possibilities created by artificial intelligence into practice in both the private and public sectors. Legislation should naturally also support the change.[5]

Individuals and their expertise will have a prominent role in achieving the benefits of artificial intelligence. In this respect, Finland is again in a good position as it is able to apply artificial intelligence and develop artificial intelligence-based solutions in an agile manner. However the large-scale application of artificial intelligence also comes with uncertainties and threats related to wellbeing, such as the fear of the loss of jobs. It is difficult to predict the future, but public debate tends to emphasise two areas of concern in particular: the amount of work (i.e. how many people will have a job in the future) and the quality of work (i.e. the ways in which people's work will change). The bleakest predictions indicate that the amount of jobs and work available to people will decrease, the meaningful content of work will decline and the labour market status and earnings trend of employees will become more uncertain. Even so, experiences thus far also indicate the opposite: the amount of human work carried out alongside automation will increase, contrary to expectations, and work tasks will become more meaningful as artificial intelligence assists in the performance of duties.

It is likely that previous major structural changes to the economy, such as transitioning from an agriculture- and forestry-driven society to an industrial and post-industrial one, have been more severe with regard to the loss of jobs than the changes these new changes will bring. The structural change that will come with artificial intelligence will also affect the jobs of people in higher-wage specialist professions such as doctors or lawyers. People working in these professions are often very capable of adapting to change, but in a growing number of cases they may have to take on jobs with a lower wage than previously. It has been predicted that artificial intelligence will further

[4] Elinkeinoelämän Tutkimuslaitos ETLA, ”Mistä talouskasvu syntyy”? (Sarja B 214)
[5] Accenture and Frontier Economics, Why Artificial Intelligence is the Future of Growth, 2017

increase demand for expertise and education, and the wage benefits related to these. One could imagine that the opposite view might also be possible – one where jobs requiring currently available expertise and education will be simplified as a result of the development of artificial intelligence and the extensive application of digitalisation. In any case, we are only just at the beginning of the journey into the broadly scoped application of artificial intelligence technology. As a consequence, the demand and pay level for the field's experts will now increase dramatically. They are the most obvious beneficiaries in this initial phase.

However, in the future, artificial intelligence will have the greatest impact on the work tasks in which it is directly applied and utilised. While it is true that artificial intelligence will transform work, in the short term there is no mass disappearance of jobs in sight. According to McKinsey's study, approximately 10% of all work tasks are those in which over 90% of the work involved in the task can be automated by 2030. On the other hand, around 40% of all could be automated with artificial intelligence, which means that artificial Intelligence is due to change the performance of many different work tasks at quite a rapid pace. In practice, routine data work tasks in particular can be automated, and artificial intelligence apps will increasingly support people in completing different tasks.[6] Therefore, artificial intelligence will function as a form of support intelligence for people in many areas of use and this in turn will facilitate the performance of tasks and improve the quality of the end result.

The change brought about by artificial intelligence is international and will require employees to have the ability to learn how to work with artificial intelligence, what its limits are and how to make the best use of artificial intelligence. In Finland's case, this is a clear opportunity – Finns are highly educated and view technology in a positive light. Finns may therefore be able to adapt to artificial intelligence considerably faster than people in other countries. In addition, Finland has a relatively good basic expertise in the application of artificial intelligence and the technologies that support it. From Finland's perspective, it is essential to actively search for ways to utilise artificial intelligence and to support the training of workers.

[6] VTT Policy Brief 1/2017: Tuottoa ja tehokkuutta Suomeen tekoälyllä

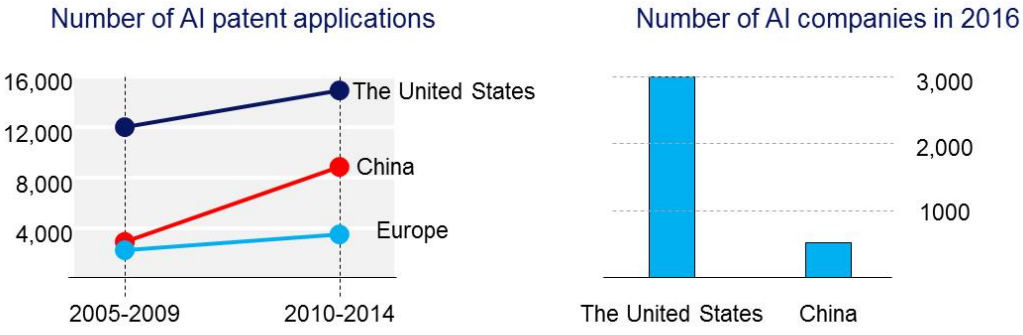
1.1 Artificial intelligence around the world

Artificial intelligence is one of the world's most significant technology revolutions. It will have a significant impact on the competitiveness of both countries and companies.

Investments in artificial intelligence by both countries and companies have increased quickly, particularly in the United States and China. For example, in 2016, artificial intelligence-related investments by technology giants Google and Baidu were estimated to total $20–30 billion, including completed corporate mergers. In addition, risk financing has tripled in three years and it totalled approximately five to eight billion dollars in 2016.[7] Over the past few years, several governmental initiatives have been established that aim to support the private and public sectors in the utilisation of the possibilities produced by artificial intelligence and to ensure the functioning of society at a time when artificial intelligence is widely used.

At the moment, the United States is the leading country in the development and application of artificial intelligence (according to numerous indicators). In 2016, approximately 66% of all artificial intelligence investments were made in the United States.[8] China is closing the gap with strong investments and a state plan (17% of investments made in 2016).

Europe is very clearly lagging behind, and development is hindered by such things as heterogeneous legislation and data resources. However, Europe's development is picking up, especially in the UK, Germany, France and the Nordic countries.[9]



Source: Wuzhen Institute 2017

[7] McKinsey Global Institute, "Artificial Intelligence: The next Frontier?", Discussion paper, June 2017
[8] Ibid.
[9] Galina Degtyareva, "European AI startups landscape", Medium.com, March 21, 2017

Companies as drivers of artificial intelligence in the United States

A number of policy measures have been implemented in the United States, especially during President Barack Obama's terms. These policy measures emphasised in particular society's perspective and assessments have focused on three aspects[10]:

1. How can we support the development of artificial intelligence and promote its positive effects?
2. What impact will artificial intelligence have on workplaces, and how can the population be educated for future working life?
3. How can we support the labour force during this change, and how can we guarantee economic growth and the distribution of income during this revolution?

The United States does not have a state-run artificial intelligence programme in place (such as China does). Instead, development is based on existing structures and efforts. Even so, these efforts are quite significant in size and the public sector's development efforts as well as the defence industry (e.g. NSF and Darpa) have also had a strong impact on speeding up development.

The United States' strength lies in the efforts and activities of leading artificial intelligence companies. For example, the operating models of global market leaders – such as Apple, Google and Facebook – are based on the digital platform economy. These companies have access to extensive data, on the basis of which they are able to easily and efficiently develop artificial intelligence technology and apply it to various business activities.

There are also a number of innovation hubs, such as Silicon Valley in the United States, where a group of dynamic startups operate alongside large corporations. Universities support companies in their development work by providing access to research results and experts. On the other hand, the research organisations receive data from companies and companies also contribute strongly to research institutes in various ways. However, accessing data has grown more difficult recently as companies have come to understand its value and the competitive advantage it provides.

The government leads artificial intelligence development in China

In China, the starting point is completely different. The Chinese central government has taken control of the sector's development and the creation of related business. In

[10] Executive Office of the President (EOP), "Artificial intelligence, automation, and the economy", 2016

2016, the Chinese government announced that it would create a 15 billion dollar artificial intelligence market by 2018. The investments resulting from this are apparent, for example, in patent and startup statistics.[11] It is true though that there are also corporations that are world leaders in the utilisation of artificial intelligence, such as Alibaba and Tencent, based in China.

In July 2017, the Chinese government published its Next Generation Artificial Intelligence Development Plan. The objective of this plan is to propel China to the position of a global leader in the development of artificial intelligence and to make the country a leading artificial intelligence innovation hub by 2030. The idea is to utilise research and development activities to increase the size of the artificial intelligence industry. The new AI Plan Promotion Office, which is part of the Ministry of Science and Technology, is responsible for managing the centralised implementation of the plan. The plan has been divided into three phases[12]:

> By 2020 China will have a world-leading rate of general development and application. At the same time, the artificial intelligence industry will be an important market growth area.
>
> By 2025 artificial intelligence will be a key driver of industrial and economic reform. China will be a leading country in artificial intelligence research and development, and will apply artificial intelligence extensively in industry and medicine, as well as its defence industry.
>
> By 2030 China will be the world's leading artificial intelligence innovation hub. China has already achieved significant breakthroughs in artificial intelligence, and by 2030 it plans to have achieved a leading position in the utilisation of artificial intelligence.

Europe has numerous differing strategies for artificial intelligence

Europe has no uniform artificial intelligence strategy, but the EU Member States have numerous differing measures in place. The European Commission also has various initiatives which aim to harmonise practices and legislation (for example, MyData, Digital Single Market and Digitizing European Industry) and to support the development of artificial intelligence and digital business. Artificial intelligence is highlighted in the Horizon 2020 Work Programme through various thematic fields. However, EU

[11] The Wuzhen Institute
[12] State Council of the People's Republic of China, "Next Generation Artificial Intelligence Development Plan", 2017

Member States hold responsibility for development, and each of them has differing strategies for the utilisation of artificial intelligence. Large Member States, such as France and Germany, have invested in artificial intelligence with very different strategies, but both very visibly.

France's objective is to clarify discussion and debate on artificial intelligence and to boost the activeness of the French artificial intelligence community domestically and internationally, as well as to agree on nationally necessary measures. There are three main areas of focus in the initiative: 1) research and education (the responsibility of the Minister of Higher Education, Research and Innovation), 2) innovations (the responsibility of the Minister of Industry, Digitalisation and Innovation) and 3) social and economic impacts (several actors hold responsibility for this).

As part of it science and innovation policy, Germany has established an organisation specialised in artificial intelligence. The German Research Center for Artificial Intelligence (DFKI) is Germany's leading centre that develops innovative commercial artificial intelligence-based software. It activities receive both federal and regional funding, in addition to private contributions.

Japan is to become Society 5.0

Japan's approach to artificial intelligence is a combination of the US and Chinese models. It is based on the 5th Science and Technology Basic Plan (2016–2020) of the Japanese Council for Science, Technology and Innovation (CSTI). The plan's objective is to establish Japan as a Super Smart Society (i.e. Society 5.0). The programme is headed by the Prime Minister, and its field-specific programmes are headed by selected corporate heads.

The vision for Society 5.0 is a society in which all the necessary products and services can be provided according to the needs of people in a timely manner. In practice, the objective is to build a national change programme in which society acts as a pilot platform for citizens' services, business solutions and social change. Areas of change include:

- the elimination of barriers between Government and ministries
- the elimination of legislative obstacles
- the elimination of technological obstacles
- increasing education and attracting more experts
- achieving citizens, approval and, for example, creating a code of ethics

Artificial intelligence is one of the project's most important issues involving technology, and a significant sum of resources will be invested in its research, development and

application. For example, the CSTI will allocate 550 million USD via its ImPACT programme to 16 extensive consortiums, many of which are involved in the development of artificial intelligence. Additionally, a total of 250 million USD will be allocated annually from three ministries to the development of artificial intelligence.

What can Finland learn?

Finland can learn about its competitors, but each country will step into the age of artificial intelligence with its own merits. The possibilities for applying artificial intelligence are extensive, and markets for related solutions are global. When comparing international contributions to artificial intelligence, it is clear that the majority of artificial intelligence developments and innovations will take place outside of Finland. What is essential is that we are able to take advantage of these developments and innovations.

Taking part in strong international cooperation is a prerequisite for Finland's success. Competition is global and intense, but Finland can make headway in this competition exceptionally well if it so wishes. This report's proposals for key actions and recommendations will specify in more detail what will be needed to achieve success.

1.2 Finland's possibilities in the global markets

Business revolution

Industry has been going through reform caused by digitalisation for quite some time. This revolution has seen industry become automated and the share of labour costs in overall costs of production decrease. In this way the competitiveness of the manufacturing industry may also improve in countries with high cost structures, such as Finland. Factories will become agile production facilities that can be converted for various needs and places where people and automation work together flexibly. The reform of industry will also mean that production will be transferred to places closer to the market In order for Finland, as a country with a small internal market, to benefit from the change; we need to facilitate a higher value yield in addition to production. This will mean the development of various data-based services and digital business models, in which the utilisation of artificial intelligence will play a key role.

Finland's economic growth and employment rate are securely linked to the success of its export industry. For this reason, it is important that Finnish industry develops and boldly makes use of solutions that utilise digital artificial intelligence and new business

models. This is supported by the special characteristics of Finnish industry, such as our high share of service business among our exports, and in this way the data resources we have accumulated, which facilitate the development of artificial intelligence-based solutions. Ecosystems where data and functions can be shared effectively among actors will play a crucial role; Finnish actors have excellent potential to be part of these global ecosystems and to actively develop completely new ecosystems in their areas of strength.

Finland's process industry has long traditions in areas such as the digitalisation of value chains for forest resources This provides a good foundation for the development of artificial intelligence via the bioeconomy, where effective cooperation between and management of various processes is crucial. Finland has expertise and a significant global industry in the sector, which creates possibilities for the rapid development of artificial intelligence solutions.

Reform of the public sector

The population is growing and its life expectancy is increasing. At the same time, the cost of health care and care for the elderly will continue to grow and cause pressure to create solutions for proactive health care and disease prevention. Artificial intelligence and other technologies facilitate many opportunities for developing new solutions. At the same time, we can significantly improve the efficiency of healthcare processes as well as support the work of doctors and healthcare staff.

Finland has internationally unique healthcare data resources, the correct and appropriate utilisation of which will facilitate the development of unique solutions for the global market as well as for improving human wellbeing. Wellbeing is a rapidly growing market in western countries: there is a need for solutions that can support the wellbeing of people on a more extensive scale and proactively intervene in less acute phenomena that hinder people's wellbeing, such as social exclusion. This is another area in which Finland has significant expertise and business operations (e.g. as a result of Nokia).

Finland has a harmonised and effective education system which makes it possible for Finns to react quickly to new, necessary educational needs. This is exceptional by international standards.

The possibilities made available to Finland by megatrends

Worldwide megatrends also create many opportunities for the utilisation and application of artificial intelligence. The best way to gain access to these is via public-private partnerships, in other words, via cooperation between the private and public sectors.

For example, the Paris Climate Agreement, which nearly 200 countries have committed to, is of great importance. The objective is to limit climate warming to a maximum of two degrees. The largest market for climate solutions is likely to be in those fields that emit the most climate and greenhouse gases. These include energy, transport and the bioeconomy, which account for 70% of global greenhouse gas emissions.[13] These are also the areas in which Finland has clear expertise and business strengths, as well as data resources.

Artificial intelligence will add anticipation capacity to the energy sector

The energy sector is going through a global transition to the use of renewable energy sources. This means, for example, a distributed energy system where there are strong fluctuations in the production of different energy sources. Future energy systems will be required to have the capacity to anticipate what the surrounding conditions and users need and to adjust the complex system accordingly. The application of artificial intelligence in these solutions presents enormous opportunities, but application requires strong expertise in the system, the reliability of which is part of the critical infrastructure of society. Finland can use its strengths to build a competitive advantage in this challenging area.

When compared by international standards, Finland's energy system is very advanced and contains numerous characteristics of a smart grid which are still being developed elsewhere. The system makes it possible to control distributed energy production for instance. Finland has excellent potential to raise its profile to that of a world leader by applying artificial intelligence in its energy sector and creating internationally interesting piloting environments in the sector.

Heading towards intelligent transport

Intelligent transport will also open possibilities for Finland’s world conquest in artificial intelligence expertise. The transport revolution will take place with the steadfast progress of electrification, as well as the servicification of mobility. In both of these areas, the management of data-based, proactive and multidimensional systems is critical,

[13] IPCC 2014

and transport solutions are seen as one of the most significant global areas of application for artificial intelligence.

Finland has strong expertise in mobility, for example in the area of autonomous transport and its supporting communications solutions. Additionally, Finland's legislation is one of the world's most lenient with regard to automatic driving and there are numerous and versatile test areas for accelerating the sector's development. Smart transport thus provides a solid foundation for the development of artificial intelligence and the solutions that apply artificial intelligence.

Artificial intelligence used to create security

The need for security has grown as the world's uncertain state increases and people's standard of living improves. At the same time, digitalisation has made it possible for various threat mechanisms to become more complex and a significant new market is growing alongside the traditional defence industry.

A safe society and secure business require the early detection of threats, preparedness and the guarantee of quick recovery. The application and development of artificial intelligence has the capacity to create solutions to these types of situation, which can help in being prepared for very complex and surprising situations. On the other hand, the application of artificial intelligence accelerates its need for new types of security solutions and related legislation. Although these are major issues, the individual is the central focus of this matter: the protection of individuals and privacy must be guaranteed.

Finland as a European but non-aligned country that is a multiskilled actor in technology has an excellent opportunity to raise its profile as an expert in artificial intelligence in the defence sector and to produce the sector's solutions. The European Centre of Excellence for Countering Hybrid Threats is already based in Finland, and this means that Finland acts as a hub for this significant network. Finland can expand this expertise and at the same time take a major role in other international networks.

Robotics to facilitate better wellbeing

Technological development has meant that the dividing lines between artificial intelligence and robotics have blurred. Robots today are not merely mechanical devices that carry out given commands, but can also be, for example, software that automates challenging data-driven expert work. The application of artificial intelligence and other technologies has meant that it is now easier to teach robots different tasks and they are able to get through various changing situations more independently. The range of

robotics applications has increased significantly and the threshold for their utilisation has lowered.

Traditionally, robotics has been seen as a fixed part of industrial automation and particularly as a method for improving the efficiency of production. Over time, Finnish industrial production has had to focus on output, which is evident in our industry's higher than average rate of automation. This also establishes a solid foundation for the application of artificial intelligence in production and production robotics.

However, the strength of Finnish robotics lies in various high-tech industrial products, such as the machinery industry (so-called field robotics, which is exceptional by global standards: Finnish forestry machines, mining machines and cargo handling machines are global market leaders in their niche areas). These products are also an excellent starting point for the application of artificial intelligence. These are closely linked to service business, which is notably advanced. Almost all of the sector's supplier companies have started to increase their range through service business where data and its utilisation are of key importance. Companies have gathered very large data reserves via their service business activities, which can help on the development and application of artificial intelligence in products as well as in related business operations.

Seamless cooperation between man and machine is vital

Cooperation between humans and machines is closely linked to both artificial Intelligence and robotics. Even as work tasks become automated, most work tasks still require the participation of a human in some role. It is increasingly vital to take seamless cooperation between humans and machines into account, particularly when designing complex and challenging systems. Cooperation between humans and machines, as well as the related user experience, are emphasised in not only industrial robots but also particularly in service robots, with which the ability to adapt to each service need facilitated by artificial intelligence is emphasised. Although service robotics in Finland is still a limited application area, its importance will increase in areas such as healthcare.

Robotics and its development have a significant impact on Finnish wellbeing and economic growth. Various studies on robotics and its application have been conducted recently in Finland. These have aimed to clarify different action needs. The *Robotics Roadmap* describes the properties and scenarios of automatisation applications, mainly from the Finnish perspective. The *Transport Robotics* report discusses the state of development and future of autonomous vehicles and their development needs. The *Technology Roadmaps and Capabilities of Finnish Companies* report

examines the development of the artificial intelligence and robotics sector (AiRo), which emphasises the central role artificial intelligence plays in robotisation. The *Digital Knowledge Base and Impacts of Robotisation* report examines the impacts of robotisation and its various areas on society, and its information needs.

According to the 2016 government resolution on smart robotics and automation,[14] smart robotics and automation provide excellent opportunities for the resolution of many of society's challenges, such as the provision of healthcare services, the improved efficiency of the public administration's information work and the organisation of transport. The actions listed in the government resolution remain very topical and support for their implementation must be taken into account when implementing the actions listed in the Artificial Intelligence Programme.

1.3 Finland's strengths and weaknesses

Expertise, high-quality data and cooperation as strengths

Finland's strength in general in this rapidly developing field is our agile business environment in which collaboration between companies, research institutes and society is seamless. This is also of key importance when examining international references. A significant share of known country-specific initiatives combine the expertise, objectives and impact of the public and private sectors in one way or another. This is supported by Finland's long-time research traditions and purposeful efforts in artificial intelligence, which facilitate the area's swift promotion. Finland's strength has long been the investments made by companies and public organisations in research, development and innovations. However, a worrying decline in investments has been noted for several years, in particular in the area of applied research. In addition, Finland's highly educated and tech-friendly population is skilled in adopting new solutions, which will help business growth and social change.

Finland is also in a great many respects an excellent platform for piloting on, which is considered a critical factor in the development and application of artificial intelligence. Finland's strengths in piloting include a limited and harmonised market, neutrality, abundant technology resources and support for legislation. Promoting an experimentation culture in public administration has brought added agility to the sector's development activities.

[14] http://valtioneuvosto.fi/paatokset/paatos?decisionId=0900908f804c7484

These factors can be further strengthened as Finland has quite a broad consensus on the necessity of large and fast changes. Our rapidly growing startup ecosystem acts as the spearhead for Finland's reform. In addition, Finland's existing companies and public organisations have undergone a variety of structural reforms in recent years that will open up opportunities for the application of artificial intelligence. If implemented correctly, this will offer platforms for the development of solutions in a unique environment.

As Finland becomes more profiled on the basis of its strengths this will lay down the foundation for success in global development and competition. This in turn will contribute to major actors gaining access to important international networks. As part of raising Finland's profile, the state initiative will play an important role in the development of the operating environment with clear choices and efforts.

If we are successful in raising our profile we may be able to centre the interest of actors and at the same time, develop legislation, innovation and policy initiatives. These can be used to affect the functionality of the operating environment. Profiling and correctly aimed investments, as well as the attractiveness of the operating environment, improve our chances of attracting investments and the field's leading experts to Finland.

Finland has unique data resources, which also form an attractive operating environment for companies and researchers. The availability of data and its quality are excellent competitive advantages for Finland, for example in the health sector.[15] Enabling legislation also creates an anticipatory and innovation-friendly development environment.

Weaknesses include limited resources and a small internal market

Finland has traditionally put a great deal of emphasis on domestic business activities in its various sectors. The weakness and lack of international links are evident, for example in research, development and innovations. Of all Finnish companies only a handful are genuinely global and we do not have a strong "Mittelstand". Finland is also not sufficiently attractive to experts from around the world. Over the past few years, the amount of foreign investments in Finland has grown, but the figures are still clearly far below those of comparable countries. A culture of avoiding risks is still deeply entrenched in the Finnish operating environment, although millennials are

[15] For more details, see Lehto & Neittaanmäki, Suomen terveysdataympäristö (https://www.jyu.fi/it/tutkimus/terveysdata)

fearlessly forging their own path as the founders of startups and as international experts.

The lack of an economy of scale in Finland's operating environment is an unparalleled challenge. We have distributed our resources to separate small projects and no clear focus-point choices or economies of scale have been achieved. This leads us to unintentionally underperforming.

A lack of trust in our own competence and financial success have long been a threat to Finland. Political decisions in matters such as the reduction of research, development and innovation (RDI) investments have for their part led to a decline in private investments, which threatens to hinder the renewal of sectors and expertise. Finland cannot afford to lose confidence in expertise as the foundation of wellbeing.

Another area of concern, which has been a topic of discussion for quite some time, is the slow pace and ineffectiveness of work commercialising research. Rigidities related to the implementation of reforms and the labour market also threaten to leave Finland lagging behind its competitors. Additionally, we can always ask whether Finland has a sufficient amount of creative destruction and radical reform. There is a risk that company and public sector reforms will focus on small-scale fine tuning, but that there is a lack of courage to implement larger openings.

A situation picture for Finland's artificial intelligence – a summary of a SWOT analysis

Strengths

- **Seamless cooperation** between actors, an agile operating environment
- A highly educated and tech-friendly **population**
- A harmonised and effective **education system**
- Finland is an excellent **platform for piloting** (having a limited and harmonised market, abundant technology resources and support for legislation)
- Promoting a **culture of experimentation** in public administration has brought added agility
- **Broad-scoped** consensus on the necessity of large and fast changes
- A rapidly growing **startup ecosystem**
- Over the past few years, companies and public organisations have undergone various **structural reforms**
- Unique **data resources**: availability and quality

Opportunities

- **Business revolution:**
  industrial digital revolution, new solutions and business models, data resources gathered from export service business activities, bioeconomy coordination, the control of processes
- **Reform of the public sector:**
  the use of artificial intelligence and platforms in the administration of costs related to healthcare and care for the elderly, improving processes, healthcare data resources, greater demand for wellbeing as quality of life improves
- **Energy:**
  renewable energy sources, a more fragmented and anticipatory energy system
- **Intelligent transport:**
  electrification, the servicification of mobility, control of the entire system
- **Overall safety:**
  the increased need for security as quality of life improves, digital risks, the importance of the protection of individuals and privacy

Weaknesses

- **Weak internationality:**
  placing a focus on domestic activities, weakness and a lack of international links, a limited amount of global corporation, the absence of a strong Mittelstand, experts from different parts of the world are not attracted to Finland, foreign investments are smaller than in comparable countries
- **A culture of avoiding risks**
- **Dispersed resources**, the absence of a scale of economy

Threats

- A **lack of trust** in our own skills, expertise and financial success
- **The reduction of RDI investments** has partly led to a decline in private investments
- **Slow and ineffective commercialisation**
- The implementation of reforms and the **rigidity** of labour market.
- **We lack the courage to engage in large-scale reforms**

2 Artificial intelligence will transform our society

Artificial intelligence will transform and mould our world in all areas and sectors. Companies are the trendsetters for the application of artificial intelligence and new technologies can create significant growth for them. The public sector is still behind companies in this, but as it gains speed, the possibilities are endless. Artificial intelligence will help the public sector become an efficient and personalised service provider. Artificial intelligence will also bring significant changes at the societal level. The labour market will experience a revolution as some of its traditional work tasks will disappear and new ones will be created in their place. Guaranteeing education and expertise will play a crucial role in helping society adjust to this change.

2.1 Companies are leaders in the application of artificial intelligence

Thus far, companies have played the largest role in the development and application of artificial intelligence. It is companies rather than state initiatives that have achieved the most central impacts. Companies will play a particularly important role in applying the benefits of artificial intelligence and in investing in these. Companies also typically have extensive data resources, the utilisation of which is critical to both the development and application of artificial intelligence. For this reason, companies with business models based on the global digital platform, which have thus collected an extensive amount of data resources, have gained the status of today's leading companies in the current development and application of artificial intelligence.

Artificial intelligence companies can be divided into two groups: those that develop and those that apply artificial intelligence. Companies that develop artificial intelligence are sharply divided into two size categories: the vast majority (up to 80–90%) of companies that develop artificial intelligence technology are very small, employing fewer than 50 individuals. There are few medium-sized companies and only a fraction

of artificial intelligence development companies are large corporations that employ more than 10 000 persons.[16] Nevertheless, the development and utilisation of artificial intelligence is dominated by these few large corporations. There is no corresponding strong division among companies specialised in the application of artificial intelligence. There are an estimated 350 application companies in Finland. Of these, three-fourths use an external technology platform, such as those created by Microsoft, IBM and Google.[17]

The importance of data and, on the other hand, the scalability of apps has been previously mentioned as the reasons for the division of companies that develop artificial intelligence. In addition to data, large corporations have challenging and impressive development and research initiatives which attract top professionals. On the other hand, the development of artificial intelligence solutions does not require large investment, as computational capacity can now be bought from cloud services and the tools for the development of artificial intelligence are easily accessible. As a result, startups and the small and medium-sized companies that focus on one artificial intelligence technology or apps have sprung up quickly in the sector. These companies have good opportunities to grow because artificial intelligence solutions are highly scalable and growth does not require direct investments in human resources. Recently, large companies have also actively purchased by promising growth-phase businesses.

Finland lacks platform economy companies but there are a few exceptions. Instead, Finland has numerous companies that have an excellent opportunity to benefit from the application of artificial intelligence and extend their business activities by utilising platform economy business models. As progress has been rapid and the development potential for artificial intelligence has increased at a quick pace, companies specialised in the application of artificial intelligence should be provided information on the opportunities made available by artificial intelligence and on its application methods. In addition to this, there are numerous startups and small and medium-sized companies based in Finland that are specialised in the development of artificial intelligence and whose solutions can make use of the same digital market as their foreign competitors. The availability of educational data and application area experts may pose a challenge to these companies and the availability of these should be guaranteed. The development of artificial intelligence must also be actively monitored as algorithms are becoming more and more efficient, which means that they are less reliant on data. This in turn will again open up new opportunities for Finnish artificial intelligence companies.

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[16] Venture Scanner (www.venturescanner.com)
[17] Digital barometer 2017
www.digibarometri.fi/uploads/5/8/8/7/58877615/digibarometri_2017.pdf

International cooperation is of great importance in all activities

The competitiveness and economic growth of business in Finland with the help of artificial intelligence will require informed and concerted actions. International cooperation is essential in all activities, as is making Finland a lucrative and attractive place for international actors. This will require efforts directed at both expertise and the operating environment, as well as requiring active participation in international networks in which Finland must utilise its strengths in an effort to gain a key role.

The opportunities made possible by the utilisation of artificial intelligence in business operations are not limited to the application of artificial intelligence in business products and processes but can increasingly also mean the application of artificial intelligence in overall business management. In practice, this means that current management models that are based on economic data and are reactive will be replaced with proactive management models that utilise numerous sources of data.

With regard to business, it is essential that Finland has both research of a top international standard and applied research in correct relation to each other. The majority of research will take place outside Finland's borders and, for this reason, Finnish research must network with international research leaders. Research results must be easy for both the public and private sectors to utilise, which will require investments in cooperation between companies and research institutes. Faring well in the development of the rapidly changing field will require a swift and agile innovation system in which sufficient innovation and research funding are available, and this catapults us forward to challenging and renewing objectives.

Actual application must be enterprise-driven and attract companies to invest in Finland. Piloting environments of an international standard that facilitate access to world-class infrastructures and data resources have an essential role. Finnish corporate taxation should also be attractive to investments.

2.2 Artificial intelligence facilitating a more efficient public sector

The Finnish public sector is currently one of the world's more efficient public sectors. However, it should be noted that transitioning to the age of artificial intelligence will require new types of cross-sector management and operating models in which data and resources no longer abide by the traditional boundaries between organisations. Traditionally, we have become accustomed to robots and software being used to optimise processes which people still oversee. This will also change in public administra-

tion. In the future, artificial intelligence will also perform works tasks and duties that we still believe we need people for.

Digitalisation, robotisation and artificial intelligence will also redetermine the performance of tasks in the public sector. Making this change will require new leaders and visions. Operating models for the age of artificial intelligence will be built regardless of organisations. This will mean that data and resources will be utilised where they are needed. Traditional organisation-based activities do not create the best conditions for a digitised society that utilises artificial intelligence.

Artificial intelligence will bring better service

The government's basic task (which is to guarantee the fundamental and human rights of all people) will be intensified markedly as authorities can now respond to people’s needs digitally, independent of time and location. At the same time, the change will help in quickly seizing opportunities as artificial intelligence can help us gain a better understanding of our customers.

Artificial intelligence can already perform many tasks and duties better and faster than people can and the end result is of higher quality. For example, Palkeet has adopted software robots to carry out the government’s internal financial administration. The supervision, reporting and processing of applications and customer service are all examples of tasks in which artificial intelligence is already utilised. This is not just a matter of cost-effectiveness as artificial intelligence improves the quality of services and speeds up administrative decision-making with the help of an automatic decision-making chain. In addition, artificial intelligence has real-time access to public administration and serves citizens and businesses in this way.

In the age of artificial intelligence citizens will receive targeted and proactive service at all stages of their life cycle.

The fundamental role of public administration in the age of artificial intelligence will be to oversee the citizen’s right to use their own data in various services while keeping data protection in mind. A citizen can independently choose which data concerning himself or herself can be utilised so that the services in question could become even better and more proactive.

During the age of artificial intelligence, the number of individual electronic customer services made available to citizens will be reduced to a fraction of what they are currently, and transactions will be handled directly in the natural language with artificial intelligence. In addition, artificial intelligence, together with other technologies, will

facilitate the melding of public administration into people's normal lives, ensuring their wellbeing at all stages of the life cycle.

2.3 Artificial intelligence will revolutionise society

Artificial intelligence will change both society and the way in which we work. However, the impact of artificial intelligence or technology in general on work and society is not deterministic. Effects on work will seem different depending on what kind of time line the effects are being viewed on. Historical analyses on economies' long cycles and the technological revolutions related to these demonstrate that the job-related creative destruction processes that follow the early stages of each revolution have, in the long-term, been followed by creative rebuilding, a period where social institutions adapt little by little, allowing more stable economic growth.

When applying this to the digital revolution it would mean that the first phase of the revolution will target new technologies related to products, services and the streamlining of production processes, and thus take many jobs. On the other hand, the second phase of the revolution, which is based on the business-driven organisational and social innovations facilitated by new technologies, would bring new jobs. Automation and change will only impact parts of work tasks in the majority of professions. The labour input set free in this manner can be used for performing other tasks or used to provide better focus on each profession's remaining tasks that will not be automated, such as meetings with customers.

Impacts in all sectors

In the case of artificial intelligence, we are still likely to be in the situation where the first phase is only just beginning. For this reason, discussion has for the most part been speculative. The impacts are difficult to predict for two reasons in particular: the first reason is that the pace of technological development is difficult to predict and the second reason is that technological development in itself does not determine how work and society will change.

The impact of technology on society is filtered through institutional and cultural filters:

An *ethical filter* sets restrictions for the ways in which technology is applied. From the perspective of artificial intelligence's application, the ethical issues that may be high-

lighted in the future include the openness of health data, location monitoring or the use of robots in nursing and care work.

A *social filter* sets limits for the manner in which technology is applied on the basis of the activities of people and organisations. A well-known recent example of a social filter is how taxi drivers and their backing organisations have opposed Uber and other similar applications.

An *institutional filter* will set institutionally determined limits on the ways in which technology can be applied. This type of institutional system includes the corporate governance model (shareholder vs. stakeholder), the education system and the labour market system.

A *legislative filter* sets legislative and other regulatory and statute-based limitations on the manner in which technology can be applied. For example, the adoption of self-steering vehicles in road traffic will be slow until the related issues regarding responsibilities have been conclusively determined in legislation.

The largest financial and productivity benefits of new technological solutions often come with a long delay and after an economically expensive trial period. This is known as an *economic filter* and means that many companies in the early stages are not yet ready to take on the role of testing out new, possibly even promising technological solutions. Companies that dominate the market may also consciously strive to hinder the spread of new technological solutions.

Small countries and market areas in particular do not have absolute freedom to decide on the filtering of technological impacts. In the scope of international competition, a small country cannot make independent decisions to limit artificial intelligence for such purposes as protecting certain companies or jobs without huge economic costs. The legislation and regulation required by artificial intelligence should also be developed via extensive international agreements.

What will happen to work in the age of artificial intelligence?

Artificial intelligence will cause significant changes in the labour market. Often the structure of employment is expected to change so that the share of medium-salary profession jobs out of overall employment will decline. At the same time, the share of low-salary and high-salary professions will grow. This is called the polarisation of the labour market. In part, this is due to technological development that favours competence and skills (*skill-biased technical change*), which specifically leads to an increase in demand for trained and educated labour. The jobs that typically experience a cycle

of decline are characterised by their routine and repetitive tasks, which computers can perform more efficiently (*routine-biased technical change*) – these jobs include performance-level office jobs and assembly tasks at factories. On the basis of numerous examinations, technological developments over the past few years have influenced the labour market in exactly this manner.

However, artificial intelligence differs from previous technological advancements in that it will also bring about more structural change than before to professions in the top tier of wage distribution. It is evident that, for example, some of the duties carried out by doctors and lawyers can be automated with artificial intelligence. On the other hand, the utilisation of artificial intelligence can increase the productivity of less educated persons, in which case technological development, which favours competence and skills and the polarisation of the labour market, would not continue in their previous manner. Offering artificial intelligence-facilitated opportunities to as extensive a group as possible could thus also lead to a more equal society than we have at present. This is one of the most important topics of follow-up studies and research.

The importance of interpersonal skills and communication will be emphasised

If many jobs become easier to learn, the structural unemployment caused by competence bias should decrease. The jobs that will increase at least proportionally will be those in professions with little routine: the performance of work tasks requires a personal contribution, flexibility, problem solving skills and/or creativity. For the time being, automation and information technology have only been able to replace this work to a limited extent. The importance of presentation skills, communication skills, interpersonal skills and combating shyness are highlighted. This should already be taken into account in comprehensive school education.

Factors affecting labour mobility and questions to address include: 1) What will be an appropriate general level of education for the future labour force? For example, will narrow professional skills be replaced with good basic skills, and the retraining and upgrading of qualifications? 2) How will the length of an individual's remaining working career affect his or her need for additional training? This will apply particularly to the ageing work force. 3) How will the costs for lifelong learning be divided between the employee, the employer and the government? 4) How will rewards and business productivity be arranged in the future? 5) In what way should social security structures be reformed in the age of artificial intelligence? What type of income security would be best? What types of incentives for participation in work would be sufficient and how could employability be improved?

Earnings-related employment insurance has had a position effect on the reform of innovation activities, as well as on the reform of business and office structures: it allows people to take higher risks and makes it easier establish new companies because people dare to take on new jobs in uncertain new companies. On the other hand, "generous" unemployment insurance causes an incentive problem, especially in situations where people are required to transfer from medium-salary professions to low-wage professions. A temporary adjustment allowance or a wage subsidy have been suggested as alternatives for earnings-related unemployment insurance when a person transfers to a lower-paying job.

Education will support society in this time of change

The population’s high level of education and a high-quality education system are also Finland’s strengths in the utilisation of artificial intelligence and robotics, and adjustment to the change in work. However, responding to this need for change will require significant changes to the education priorities. According to a survey sent to Finnish universities, including universities of applied science, as well as to vocational education and training, it can be said that there is high-quality artificial intelligence education available in Finland, but that the education in question is predominantly intended for the technological and mathematical fields. On the other hand, similar studies are not available to an adequate extent in fields that apply artificial intelligence and in which the effects of artificial intelligence are first seen. The response to these educational needs must be effective and an active approach must be taken to find new means of education and teaching. These include, for example, different online courses, virtual qualifications and even virtual educational institutions.

Moving forward with a passive or active strategy?

Either a passive or active social policy strategy can be selected for learning and adopting artificial intelligence technology. In practice, society’s reaction to technological advancements is a combination of both passive and active elements.

A passive approach allows existing key societal institutions to filter the effects of technology on practical working life and society. The active approach sees social regulatory systems proactively adjust their operations so as to be able to guide the solutions that arise with technological development in the desired direction. In Finland's case natural objectives could include a higher rate of employment, the faster growth of productivity and the improved quality of working life, as well as reduced work and social exclusion.

The active social regulation of artificial intelligence will require some type of vision of what is a “good artificial intelligence society”. This question has been touched on in various reports on artificial intelligence, but none of these have yet made an effort to build a strategy the specific objective of which is the creation of a comprehensively good artificial intelligence society.

What exactly is a good artificial intelligence society? Transparency, accountability and extensively notable societal benefit are held as its general principals. However, it has yet to be specified what these principles mean in practice from the viewpoint of various actors and regulatory systems. The input of companies, the field’s experts, researchers, political decision-makers and citizens will be needed in work to determine a definition of a good artificial intelligence society. This work is now being launched in Finland, and it will require us all to take part.

3 Eight key actions for taking Finland towards the age of artificial intelligence: Recommendations by the artificial intelligence working group

1. We will enhance the competitiveness of companies through the use of artificial intelligence

Different sectors and companies are at different stages of artificial intelligence application and thus require different measures: one extreme requires world-class research for their own artificial intelligence activities and competitive advantage, while the other extreme needs to be given a nudge and incentives. Both extremes must be served with the measures that will support them.

Enterprise-driven ecosystems to help in the application of artificial intelligence

Sharp and ambitious innovation ecosystems of an international standard must be created in those fields in which Finland will strongly utilise artificial intelligence (energy, healthcare, transport, industry etc.), as well as in promising emerging fields. An ecosystem cannot be established on the basis of a command from above, but their creation should be encouraged and their construction must be supported. An ecosystem's operations should be based on business reform that is carried out via artificial intelligence. The development of ecosystems and the related innovation activities must be open and encourage international cooperation.

It is clear that experiments and trials alone will not suffice, but rather that establishing competitiveness will require long-term investments in areas which we want to see succeed. Success in this rapidly developing and revolutionary field will require that we set off from the areas in which Finland has world-class expertise and data resources. Additionally, it is critical that the application of artificial intelligence is enterprise driven. Without the natural interest and strong investments of companies, the application of artificial intelligence will not transform into added value and at the same time there is a risk of losing the research results that target artificial intelligence and seeing them being utilised elsewhere.

The development and utilisation of artificial intelligence are dependent on available expertise as well as educational data, such as business data. For this reason, application and utilisation take place via large platform economy actors or in ecosystems where the data resources, expertise and benefits of different actors can be combined and distributed efficiently.

At the moment, Tekes' (Business Finland as of 1 Jan 2018) ecosystem funding and the platform economy roadmap are good starting points for the construction of ecosystems. The new methods for research and innovation funding proposed in this report also support the formation of ecosystems.

Actors:

- Tekes (Artificial Intelligence, Data Economy and Platform Economy programmes are currently under preparation)
- Academy of Finland (flagship search opened)
- Companies and research organisations (providing business-driven ecosystems that utilise artificial intelligence)

Incentives to utilise artificial intelligence solutions

The utilisation of artificial intelligence, the data and platform economies linked to it, and robotics solutions must be made as easy as possible for companies of all sizes at all stages of preparedness. The threshold for the application of artificial intelligence must be effectively lowered, especially for companies that are only in the early stages of digitalisation and need concrete support.

One example of a low-threshold measure is the Tekes innovation voucher for companies. It can be utilised for testing out various artificial intelligence and data utilisation solutions.

Another service intended for all companies is the digital school for entrepreneurs, which will be made available in cities and could in the future also offer training in the application of artificial intelligence.

Other options that are suited for testing out the opportunities made possible by artificial intelligence include an artificial intelligence encoding course that the Federation of Finnish Technology Industries plans to offer companies (autumn 2017, teknologiateollisuus.fi/fi/maankoodauskurssi) and the University of Helsinki's artificial intelligence MOOC (Massive Open Online Course; http://mooc.fi), which will be a two-stage module during which participants can learn the basics of artificial intelligence and gain in-depth knowledge during its coding/trial portion. This course is to be organised in 2018.

A special measure planned for 2018 will be the AI Challenge Tour, which will include the *Äly on tekoja* (Intelligence is Actions) decision-makers forum, training, practical demonstrations and challenge-based competitions. The tour is due to visit cities and selected locations and to bring on board all the relevant networks that companies will need in the application of artificial intelligence and renewal of the business, as well as their partners. During the AI Challenge Tour the application of artificial intelligence should be company driven and innovation activities must be swift.

In 2018, the Federation of Finnish Technology Industries will also launch a growth group related to artificial intelligence. The concept for the growth group is to work under the supervision of a group comprising core companies to design and implement various concrete actions that will help companies get started in the utilisation of artificial intelligence in their business activities. This approach is scalable and it both supports and utilises other aforementioned measures.

In the area of robotics the measures have been outlined in the government resolution on intelligent robotics and automation.[18] Measures that aim to specifically lower the threshold for application are for the most part the same as the measures related to artificial intelligence, and the synergy of these measures must be ensured.

[18] http://valtioneuvosto.fi/paatokset/paatos?decisionId=0900908f804c7484

Actors:

- Tekes innovation voucher (the targeted innovation voucher, the programme Digikoulu 2.0 digital school)
- Finpro (Digikoulu 2.0 digital school)
- The Federation of Finnish Enterprises (Digikoulu 2.0 digital school)
- The Federation of Finnish Technology Industries (encoding course, artificial intelligence group)
- The Ministry of Economic Affairs and Employment (Digikoulu 2.0 digital school)
- The AI Challenge Tour: companies, research organisations, cities, Tekes, Finpro, the Federation of Finnish Enterprises, the Federation of Finnish Technology Industries, ministries

2. We will utilise data in all sectors

Data is the fuel for the development and application of artificial intelligence. In addition to the amount of data available, its quality and availability have a significant impact on the benefits that can be achieved with artificial intelligence. With its active approach, Finland can contribute to the building of data resources and their utilisation in both companies and the public sector.

The accumulation and enrichment of Finnish data resources

A clear legislative framework that will ensure the availability of data must be created. This must be based on the importance of the data to business operations (not on data protection first). This legislation must be extended to the EU level. Companies must be encouraged to share data resources where different types of trials can be carried out efficiently. Clear provisions that can be extended to the international level are needed to support this. A “regulatory sandbox” experimentation environment can be created around the topic area.

Actors:

- Various ministries and other authorities are responsible for specific data resources

MyData will be opened for use by citizens

The extensive collection and utilisation of MyData will be made possible with legislation and projects.

An increasing amount of data is compiled on an individual throughout his or her life. Data is formed when a user enters her or his data via sensors linked to users and user environments (IoT) as well as when gathered by public administration organisations and private service providers via their service apps.

Internationally successful companies have created their own success stories in part by gathering large amounts of data on individuals and at the same time guaranteeing their exclusive rights to use the data.

The new society based on artificial intelligence must guarantee the availability of data to those that rightfully need it. This will establish the rights of citizens to make decisions on the use of data that concerns them. This in turn will lead to the creation of new services and innovations.

A key element will be the identification and availability of the data that concerns an individual. Data that applies to an individual is identified by using identifiers provided by a trusted third-party or identifiers that the user has created. However, a combination of the two is not generally possible or is at least very difficult. In addition, the use of a trusted third party is not possible in many countries.

Actors:

- The Ministry of Transport and Communications' MyData network
- Open Knowledge Finland
- The joint metadata and information management (YTI) programme
- Sitra's IHAN project

The piloting of data providers: In what way can data be turned into a product?

The management of MyData and sensitive data, as well as a business ecosystem for distribution and utilisation that will be built around data, will form an entity that shows great potential, but is at the same time very complex. Individuals, companies and society each have their own angle: an individual can receive added value services, companies can gain new business and society can provide access to better public services for citizens, services that will target their personal needs.

Data provider activities and related business models require testing and piloting so that all parties gain a better understanding of data and the business related to its operation as well as of the benefits that the various parties will gain.

Data provider activities will be piloted at the turn of the year (2017/2018) as an extension of the ISAACUS project via sensitive health data. The matter will be approached via the Act on Criteria for Charges Payable and the objective will be to establish a limited liability company coordinated by the public sector that provides high-speed departures. A limited company will facilitate scaling via its subsidiaries in other sectors (including other regulated sectors) and the involvement of business.

The data provider pilot includes the utilisation of the national architecture for digital services (KaPa) and its interfaces, the application of artificial intelligence solutions in various trials, the development of legislation and the determination of collaboration between various data providers, as well as including interfaces between the different data providers.

Actors:

- The Ministry of Social Affairs and Health, the Ministry of Transport and Communications and other ministries
- The Ministry of Finance and the Population Register Centre
- Sitra
- Tekes
- Open Knowledge Finland

3. We will speed up and simplify the adoption of artificial intelligence

The rate of the development of artificial intelligence is currently very fast, and it utilisation and development are based on experiments. It is therefore of paramount importance that companies have an efficient and fast way of joining the development of artificial intelligence. Companies need help and tools that will facilitate the develop-

ment and acceleration of innovation activities. Legislation on experiments, for instance, allows us to remove unnecessary obstacles and to speed up the application of artificial intelligence.

Using the artificial intelligence accelerator to help us get started

Although, the tools and computational capacity needed for the application of artificial intelligence are exceedingly easy to access, many companies lack the expertise to get started. This will require a different approach than a traditional RDI project.

The artificial intelligence accelerator model makes it possible for a group of companies to test the possibilities offered by artificial intelligence efficiently and to search for new artificial intelligence-based solutions. The accelerator provides companies access to experts and computational capacity, as well as providing access to the newest artificial intelligence tools. Accelerators will be established, for example at research institutes that have adequate resources and networks to organise these activities. An effective and agile financing mechanism must be created to support the construction of accelerators and the activities that take place there.

Additionally, an open development environment to support different types of platform economy trials can also be built and developed in connection with the accelerator.

The operating model for the artificial intelligence accelerator:

- Approximately 10–15 Finnish companies will provide (anonymous) data and funding to an accelerator, which allows for the research of data.
- Two to three Finnish universities or research actors (i.e. Aalto University, the University of Helsinki and the University of Oulu in collaboration with the Analytics Plus ecosystem: www.analytics.plus) will bring their research expertise.
- An independent facilitator (such as the CSC – IT Center for Science) will bring an information secured trial environment as well as computational and storage capacity.
- Hackathon facilitators will support the utilisation of the accelerator environment in various competitions and other challenges.
- Smaller companies will come in to develop and utilise the accelerator environment.
- Consultants will come in to help in the utilisation of the accelerator and trial environment.

An open environment (open data, open interfaces, open source code, trials, challenge competitions) will be built at the artificial intelligence accelerator, which will facilitate the development of the Finnish open source platform as the piloting and utilisation platform for artificial intelligence and data analysis algorithms.

The artificial intelligence accelerator pilot will be prepared by the end of 2017 and it will be launched in early 2018. The objective is to build a limited number of internationally attractive environments.

Actors:

- Companies (data/financing providers, users/developers, consultants)
- Research organisations
- CSC
- Tekes
- The VTT Technical Research Centre of Finland

Areas of free intelligence create an environment for trials

The application of artificial intelligence in practice requires efficient piloting. Open piloting and testing environments are also the basis for the development of ecosystems and facilitate the reform of legislation and the utilisation of experimentation legislation. Open piloting and testing environments are important to the startup and small and medium-sized company sectors (which do not have the possibility of their own environments) and are also a part of Finland's attractiveness for foreign companies. Well-functioning piloting environments can also help in forming international networks.

To form areas of free intelligence we need a simple and fast process for the implementation of pilot areas and trials and for obtaining the required licences. Clear rules and processes must be put in place for the operations and utilisation of these areas, which will ensure good usability. The areas need to use infrastructures that support artificial intelligence as well as access to technology reserves (such as cybersecurity, 5G, IoT).

Actors:

- Research organisations
- Ministries
- Pilot companies

4. We will ensure top-level expertise and attract top experts

Competence is critical in how artificial intelligence can be used to build success and competitiveness. Expertise in the areas of artificial intelligence technology and artificial intelligence's application will also be highlighted in the future. World-class expertise and top experts are of vital importance to Finland in its transition to the age of artificial intelligence. Education and competence also create flexibility for the revolution of work and society.

Creating a Centre of Excellence for artificial intelligence and applied basic research

An international hub for artificial intelligence must be established in Finland. The hub must have adequate resources as well as effective processes for cooperation with both national stakeholders (companies and the public sector) and international stakeholders (research partners and customers). The hub will become internationally prominent in areas in which Finland has clear strengths and which have international appeal.

A virtual university that is specialised in artificial intelligence and the digital revolution must be established within a Centre of Excellence, which will help Finland emerge as an interesting destination for top experts.

In order for Finland to establish itself as a leading country in the application of artificial intelligence, the public and private sectors must have good access to international top expertise and result results. Application alone is not enough – the objective will also require Finland to produce world-class research as a close-knit part of the international network. Finland's research resources are limited, and for this reason resources will have to be gathered both virtually and physically in order for us to achieve a leading position.

Additionally, it must be ensured that research results can be effectively applied and their added value can be made use of. This objective will be supported by efficient operating methods and by monitoring impact in balance with the quality of research. The entity calls for joint contributions from, for example, Tekes (Business Finland) and the Academy of Finland. It is important to engage in a type of national level cooperation at the interface of applied basic research as well as to contribute to cross-organisation focus areas and their research, and experimentation infrastructures.

Actors:

- The Ministry of Education and Culture
- The Ministry of Economic Affairs and Employment

Broad-scoped expertise in artificial intelligence and its application

All levels of education and the working age population must be given access to appropriate and high-quality further training. One good example of such training is the national defence course in artificial intelligence held this year (2017). It is always important to ensure the competence of persons returning to the labour market, such as those who have been unemployed or at home caring for their children, but with competence in the area of artificial intelligence the need is emphasised even more.

Artificial intelligence will affect every single person in Finland. Finns must be guaranteed artificial intelligence literacy (i.e. guaranteed a basic understanding of how things will function in the age of artificial intelligence). In addition to members of the working-age population, the elderly will also need these skills to cope in everyday life and to benefit from new opportunities. Lifelong learning, which will become more natural and increasingly important, will take on new forms, and the utilisation of artificial intelligence will only be one of the methods which will make learning more personalised and motivating.

Finland's competitive advantages include a high standard of education and tech-friendly attitudes, which have contributed to the development of business as well as of society. The high standard and impact of the Finnish education system have clearly made Finnish education stand out in international comparisons.[19] A broad competence base creates a foundation for not only the development of artificial intelligence but also for its application. This will also facilitate the resilience to withstand the pressures for change created by artificial intelligence. It is not enough that the part of the population involved in technology development is correctly educated and trained. It is essential that people who hold jobs in which artificial intelligence must be utilised understand the possibilities and limitations that artificial intelligence adds to work tasks.

Universities have a comprehensive range of studies on artificial intelligence methods available, but these are predominantly only intended for students of technology and mathematics. The absence of artificial intelligence studies[20] in fields that apply it is a clear shortcoming that universities must address immediately. The absence of applied studies is also evident in universities of applied sciences and in vocational education and training. However, as stated in the budget proposal, universities of applied sciences will be allocated five million euros for their RDI activities. This appropriation should be used in a targeted way in cooperation with business to create high added-value products and services, especially in the utilisation of artificial intelligence, robotics and digitalisation applications in various sectors.

Providing high-quality teaching quickly will require the utilisation of new teaching methods. Massive open online courses (MOOCs) are an example of a tool that could be used far more often. These allow the creation of shared, high-quality study modules and they can be offered extensively, for example as part of applied degree programmes. This will also open new possibilities for the effective further education of people in the labour market.

[19] World Economic Forum, Global Competitiveness Report 2017–2018
[20] See the survey summary in Appendix 3.

Actors:

- Universities
- Universities of applied sciences
- Comprehensive schools
- Vocational education and training institutions
- Adult education centres

We will work to attract international artificial intelligence experts to Finland

Finland must be made an appealing alternative to international experts in artificial intelligence. *Appealing* means that Finland has top expertise in the field of artificial intelligence (expertise hubs: e.g. centres of excellence and flagship institutes) as well as piloting environments for the testing of artificial intelligence solutions (such as artificial intelligence accelerators and free intelligence areas). These both offer unique possibilities for the utilisation of data and open interfaces for example, as well as for the development of open platforms and solutions. Additionally, PPP cooperation between companies, public organisations and citizens will create new opportunities that cannot be found elsewhere.

Attracting international artificial intelligence experts to Finland is possible when moving to Finland is easy and the necessary services are available also here for the experts' families; these services include a sufficient number of international schools and day care centres as well as employment opportunities for each expert's partner.

In order to attract experts, Finland will carry out a campaign that is bold in both its message and its other implementation, and corresponds with Finland's image as a pioneer in the utilisation of artificial intelligence. The target group will be consulted during the planning and implementation of the campaign.

Actors:

- The Finnish Immigration Service, the Ministry of Economic Affairs and Employment, and Business Finland; a list of current measures will be drawn up
- Talent Boost (tem.fi/talent-boost)
- The Ministry of Education and Culture Talent Strategy

A Master of Artificial Intelligence degree will provide more expertise

A Master of Artificial Intelligence further education programme and degree programme are being created. The programme will be modular and will be possible to complete while going to work. It can also be applied to numerous fields, including healthcare and logistics. The studies will be realised by using the experiences and best practices of pioneering companies and in cooperation with the public sector. The changing needs and development of participants will be the key premises of the programme.

One of the biggest challenges in the application of artificial intelligence has been how those employees that utilise it in their work can be trained and how they acquire the new needed skills. As artificial intelligence will alter tasks and processes, competence must be upgraded in the same manner.

At the same time we are preparing a new model for the distribution of these training costs between various actors, so that the programme could ensure the flexible upgrading of competence as extensively as possible.

Actors:

- The Ministry of Education and Culture
- Companies that are making an effort to improve their utilisation of artificial intelligence and have the desire to develop further education for their needs
- Universities of applied sciences and universities of technology (working together)

5. We will make bold decisions and investments

If our resources are limited, they must be used exceptionally well. Finland’s resources for the utilisation and application of artificial intelligence are marginal when compared to the field's international contributions. In order to access resources for effective and successful implementation, we must make bold investments in certain selected areas. Contributions must be implemented efficiently, placing an emphasis on impact.

Research and innovation funding that will support renewal

Artificial intelligence investments are subject to international competition, in which the functionality of the innovation environment and innovation funding are key factors. Competing countries are investing strongly in artificial intelligence expertise and research. With regard to Finland, in order for the critical measures to be implemented adequate investments and incentives must be available.

The competitiveness of the Finnish innovation system must be secured and its supporting financing should support basic research, applied research and innovation activities equally. In addition to this, financing should be strongly target-controlled and flexibly available. More attention should be given to supporting the international cooperation of ecosystems. For example, co-funding as part of EU funding must be guaranteed.

In order to ensure that the Finnish innovation environment's resources and capabilities can climb to a level where they have international impact, more renewal and contributions will be required from basic research in the same areas as enterprise-driven innovation activities.

The fields of digitalisation and in particular artificial intelligence have highlighted the concept of applied basic research: basic research (algorithms etc.) requires trials and experiments that can also be transferred directly to companies for utilisation. In order to achieve international-level impact, basic research joint contributions will be required from actors such as Tekes (in the future Business Finland) and the Academy of Finland.

Tekes' research and funding programme (in the future Business Finland) is one concrete measure that can be used to promote the application of technologies, the development of new business models and the utilisation of data in all its forms. The Academy of Finland must invest in similar areas by contributing to the building and funding of expertise hubs that are most focussed on basic research (such as flagships and centres of excellence). We will also need joint contributions in research and testing infrastructures.

In order to achieve the best impact, the research and development activities of companies must be linked to the Finnish research and innovation activity networks to ensure they work actively and intensely in this network. The Finnish innovation system and its actors must be able to actively connect with international top experts and expertise hubs.

In the short term, innovation funding should be targeted to the following themes in particular, with €100 m as a permanent increase in innovation funding from 2019:

- The application of artificial intelligence in different sectors and the development of business expertise
- Enterprise-driven ecosystems and strategic projects, the funding models for which will make it possible for new actors to join flexibly.

In the long term Finland must renew its enterprise subsidy system so that it supports the renewal of business and investments in competence and expertise (setting €100 m as the permanent innovation funding level increase from 2020). Finland must also implement the Research and Innovation Council's guidelines in full, which will mean the creation of an effective PPP instrument as well as changing the level of innovation funding back to 4% of the GDP.

Additionally, we must guarantee the sufficiency of the so-called national co-funding for EU-funded Horizon 2020 projects. These measures are supported by an assessment by the OECD on Finland's research and innovation system.

Actors:

- Various responsible ministries (the Ministry of Economic Affairs and Employment, the Ministry of Education and Culture)
- Tekes / Business Finland (an Artificial Intelligence, Data Economy and Platform Economy programmes is currently under preparation)
- The Academy of Finland (flagship search opened)
- Companies and research organisations (business-driven ecosystems that utilise artificial intelligence)

6. We will build the world's best public services

Public administration is undergoing a reform. With the help of artificial intelligence, it will become a service provider free of the confines of time and location. In the future, citizens can receive services seamlessly in the language they need at the given time in the same manner as companies. Succeeding in this objective will require that public organisations are linked with artificial intelligence. In this way, digital services can utilise the correct information at the correct time while always taking data protection into account.

The citizen's Aurora assistant

People need various services at different times, so it is also sensible to give people the opportunity to utilise services at the time they most need these. Such a 24/7 digital service can also help in eliminating unnecessary lines and telephone appointments with different services. In addition, artificial intelligence applications will allow public administration to better anticipate and provide resources for future service needs.

There are numerous examples in the private sector in which artificial intelligence has been harnessed to serve people. One such harnessed servant is the smart phone. Apple's Siri and Samsung's Bixby are personal servants which learn to serve you, the user, specifically. Why wouldn't the public sector do the same?

The management of the administration's numerous service processes must be transferred to artificial intelligence. One such example has already been introduced at the Finnish Immigration Service, where phone calls were answered in all the required languages. Artificial intelligence

can be used to create a new type of servant for every public organisation. These servants together form a robot network where customers are seen as a uniform unending chain. When a customer's service need arrives for any robot to process, it can be assessed and optimised in real-time cooperation with robots from other organisations.

A plan is being drawn up for a national customer service robot network, the Aurora assistant. The Finnish Immigration Service's solution for immigrants will be used as the starting point for the plan. First it will be determined what similar measures are currently underway in public administration and these will then be added to the overall plan.

Actors:

- The Ministry of Finance and other relevant ministries
- The Finnish Immigration Service

Various data must function together

The key requirement for digitalisation, robotisation and artificial intelligence is the data's technical and semantic (i.e. its meaning) interoperability. If the data does not travel or its meaning is not clear, the age of artificial intelligence cannot be achieved. For this reason, it is important to see to it that digital services can make use of the correct information at the correct time and that it is of high quality, while taking data protection into account.

A neural network study will be launched as part of the Joint Metadata and Information Management (YTI) programme. The study will look into the ability of artificial intelligence to create the semantic interoperability of data in place of manual determination work and symbolic modelling.

Additionally, the impacts of artificial intelligence on the act on information management currently under preparation will be determined.

Actors:

- The Ministry of Finance
- The Population Register Centre

7. We will establish new cooperation models

In order for it to be possible to apply and utilise artificial intelligence in a large scope, we will need cooperation and new types of partnerships. Especially cooperation between the public and private sectors will be critical. Well-functioning partnerships will make it possible for us to eliminate unnecessary legislative obstacles from the path of artificial intelligence development and minimise the effects of the work revolution.

A new age of PPP cooperation

The classic dualistic division between the public and private sectors will no longer work if we want to solve the difficult problems of our time. Public administration's structure, division of power and resources will no longer be able to respond to changing global problems.

The world must be viewed and understood multidimensionally. This will only be possible by developing solutions for cooperation between different sectors. Cooperation will be needed between the private and public sectors as well as with individual people. If public administration was previously seen as only a provider of public services, from now on it will act in an active role in broad-scoped ecosystems.

In addition to a new age of PPP cooperation, public sector reform will also be needed. In order for them to succeed, the public sector's reforms will need a strong vision of the possibilities that digitalisation can offer. Although investments have been made in digital expertise and in enabling data infrastructure, coordination is not always at an adequate level and measures lack sharpness. The first pilot and trials on the application of artificial intelligence in central government have been initiated. In order to move forward quickly and in order to be successful at the utilisation of artificial intelligence and other possibilities related to digitalisation, the government must invest purposefully in expertise and its development, and the application of new operating models in central government.

The status of the public sector as a trendsetter in the application of artificial intelligence and digitalisation will be guaranteed by employing a team of top experts in artificial intelligence and digitalisation directly under the Prime Minister in order to spur on the government and ministries. The team will be equipped with the necessary powers, adequate resources and the right to apply the no-legacy policy in the adoption of facilitators of artificial intelligence and related digitalisation in central government. This work will also aim to ensure the adoption of the public sector's new cooperation models, so that the necessary decisions will be made and measures can be initiated in accordance with the age of artificial intelligence clock frequency.

In the short term, the operating capacity of an Ecosystem Forum will be strengthened in order to speed up the utilisation of artificial intelligence. A cross-sectoral artificial intelligence network will be launched. This network will share and distribute lessons and competence on the utilisation and application of artificial intelligence, as well as on its best practices.

Actors:

- The Prime Minister's Office (Ecosystem Forum)
- Other ministries and agencies
- Businesses
- Organisations
- Research organisations

8. We will make Finland a trendsetter in the age of artificial intelligence

Finland has every possibility of becoming a trendsetter in in the age of artificial intelligence. In order to succeed, we must be active in international development and raise our profile by emphasising our strengths.

Finland is in the driver's seat in drawing up a European agenda for artificial intelligence

The European artificial intelligence agenda is only just forming. Finland must actively influence the commission’s work programme because the ethical codes and operating methods related to artificial intelligence are only just being formed.

We are actively making an effort to influence the EU and other international forums on matters related to the direction in which the development of artificial intelligence and digital economy should be steered, and their rules. We will use our activities and examples (artificial intelligence accelerators, open solutions and platforms, free intelligence areas, artificial intelligence centres of excellence, artificial intelligence in public administration, the application of the new PPP schemes etc.) to create a model which will recognised and accepted as pioneering.

Finland must aggressively productise and market its strengths in the areas of digital infrastructure (artificial intelligence and Suomi.fi services) and ecosystem structure. In addition to this, we should work on making Finnish top expertise known in various networks and institutions.

Actors:

- Finland's ministries (EU policy positions)
- Team Finland / the Ministry for Foreign Affairs

Follow-up questions on the road to the age of artificial intelligence

In additions to the recommended measures (i.e. the eight key actions listed above), there are still many subject areas for which recommended measures are only just being prepared. Our primary objective is to form a broad-based consensus on the possibilities that artificial intelligence has brought to Finland. In addition, it is a good idea to create a cross-party social policy strategy which aims to bring about a good artificial intelligence society. The strategy would be based on the active renewal of societal and labour market structures, ensuring that the positive impacts of artificial intelligence are realised in Finland. Discussion on the following topics has begun and work will continue.

The labour market and unemployment security in the age of artificial intelligence

The prerequisite for the broad-based utilisation of artificial intelligence is that the population for the most part has a command of the skills and knowledge needed for its application. The requirements for the age of artificial intelligence should be visible in study content throughout the entire education system. At the moment, it is believed that the importance of skills related to social intelligence will grow.

The social security system must function flawlessly as people's working careers become diversified. Transitions between paid labour and entrepreneurship should be more flexible. Earnings level insurances misfortune allows for risk-taking in the broad sense. On the other hand, comprehensive earnings security insurance inevitably involves incentive problems. The long-term objective should be to increase the inventiveness of both social and unemployment security and improve the strengths related to these.

Professions and job descriptions are going through a more intense level of transformation than previously due to artificial intelligence. This change will also apply to jobs with good salaries. When taking part in labour market activities, one needs to be prepared for this and see to it that the application of artificial intelligence and improved productivity are not hindered with inappropriate limitations.

Actors:

- Labour market regulation / Ministry of Economic Affairs and Employment and labour unions
- Social security / Ministry of Social Affairs and Health and labour market organisations
- Collective agreements / employer and employee unions

The age of artificial intelligence will bridge from work to work

If labour market changes accelerate and job rotation speeds up these will require functioning recruitment and a credible upgrading of the labour force's skills. Artificial intelligence will bring about improvement to employment services: job offers can now be better matched with the worker's competence profile. Issues related to regional and professional mobility are likely to become increasingly important.

A study will be launched on how training and education programmes for the working-age population can be made more flexible and how it could better respond the needs of the labour market during the age of artificial intelligence.

Actors:

- Employment services and growth service reform / Ministry of Economic Affairs and Employment and regions
- Improving regional mobility / Central government and municipalities (zoning)
- The level of competence of the working-age population / Ministry of Education and Culture, Ministry of Economic Affairs and Employment, labour market organisations

Ethical questions related to artificial intelligence

Can a machine learn morals? When making decisions, what are the values artificial intelligence should base these on? What types of tasks are machines suited for? The application of artificial intelligence includes broad-scoped perspectives on the ethics related to the utilisation of technology. Ethical issues can rarely be resolved completely, but the different viewpoints related to them can be examined; these can be discussed and they can be taken into account when developing artificial intelligence solutions and when applying artificial intelligence expertise.

We will launch public discussion on the subject area both at events and online. We will submit the needed reports as work progresses and encourage others to carry out research in the area.

Actors:

- Ministry of Economic Affairs and Employment, Prime Minister's Office

Coordination of digitalisation

The responsibility for the promotion of digitalisation and its various areas will be distributed to a vast amount of actors in the public sector. When planning the administration's reforms, attention should also be drawn to the interoperability of digital services on different levels of administration. This will require expertise and investments. New cooperation models must also be developed and adopted in the public sector, so that the needed decisions are made and measures are launched according to the clock frequency of the age of artificial intelligence.

Actors:

- All ministries
- Future counties
- Municipalities

Overall security

Artificial intelligence apps will influence the security of society in multiple ways. Artificial intelligence apps will change service structures, platforms and many other dimensions of security. The impact on society's operational reliability will also be significant in the digital age, as will citizens' trust in authorities and one another. The impacts of artificial intelligence on security are related to ethical questions and on what type of ownership structures the developed applications will have. Are actors small and agile when platforms are open and development solutions are accessible to many, or are they monopolies dominated by a few actors? These questions must be examined as part of the development of artificial intelligence and the related measures.

4 How will work in the field of artificial intelligence continue?

From the very beginning of the preparation of the artificial intelligence programme, it has been clear that wisdom does not exist in one committee, discussion club or working group alone. For this reason the Artificial Intelligence Programme Steering Group invited a host of helpers to join it in its work from the time work started. Three subgroups were established to support the work of the steering group:

- Expertise and Innovations: Chairman Mika Vehviläinen, Cargotec
- Data and Platform Economy: Chairman Kimmo Alkio, Tieto
- Transformation of Society and Work: Chairman Osmo Soininvaara

In total 64 experts and professionals took part in the work. Additionally, the DigiNYT secretariat and chairman Olli-Pekka Heinonen contributed to the part of the programme that applies to the public sector. Additionally a number many times larger than this took part in workshops.

Join the conversation!

Finland's journey to the age of artificial intelligence is only just beginning, and the networks which will be needed for this are large and international. The work will progress to the implementation stage in the following manner: networks will be created for each topic area or work will be completed together with existing networks and expertise hubs (such as Airo Island ry.) or with institutions of higher education and research institutes. A separate network is already being created for the healthcare sector artificial intelligence apps and a similar discussion is being held in the energy sector.
Sign up to existing and newly forming networks at the tekoalyaika.fi website.
Information on planned open workshops is available on the same website.

Online workshops and courses

Networks for professionals and developers will not suffice when the development at hand will reach into our daily lives, our work and our future. Every person has the right to state an opinion on the development of artificial intelligence and robotics. We invite all citizens to take part in the discussion of what the more widespread use of artificial intelligence and robotics will mean for us, what we expect from it and what we would like to see decision-makers to specifically focus on. The first online workshop will open on the tekoälyaika.fi website on the same day this interim report is published. As the programme progresses we will organise events and campaigns all around Finland which will bring artificial intelligence and robotics closer to people's daily lives.

The application of artificial intelligence among other world leaders means that we are ready to adopt new alternatives in all our tasks and in all sectors. The 53rd specialised national defense course, with the theme "The significance of artificial intelligence for security", will act as a trendsetter. The next in line will be the permanent secretaries of ministers and ministries. Artificial intelligence is part of the training programme for the highest-ranking civil servants, organised by Sitra, the Finnish Innovation Fund. Therefore, measures have already been taken.

Follow the programme's progress

Gauges and indicators will be built to help determine the progress of the programme. Everyone will be able to monitor its progress and press the accelerator at times when the programme's pace seems to lag. The intermediate targets and measures will be updated in a flexible manner along the way. Gauge and indicator work will be carried out by actors such as ETLA and Sitra. The programme will engage in close cooperation with national anticipation activities and, when necessary, it will act as the meeting point for the anticipation of the artificial intelligence and robotics theme.

The final report is to be completed in 2019

The steering group will submit the final report on the progress of the programme in April 2019. This will by no means mean that the realisation of the programme will end at this time, but rather it means that the steering group will hand over the baton to the networks that are building the age of artificial intelligence.

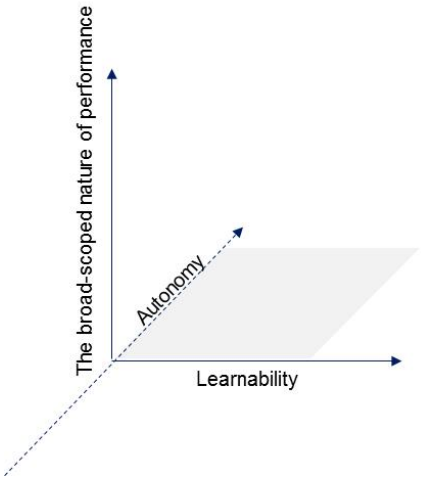
Until then, the programme will be overseen and reported on by the steering group. The group's members are:

Chair	Mr Pekka Ala-Pietilä, Chairman of the Board, Huhtamaki Oyj
Deputy chair	Ilona Lundström, Unit Head of the Ministry of Economic Affairs and Employment
Members	Ilkka Kivimäki, equity investor Jyrki Nurmi, Senior Vice President, Valmet Automotive Oyj Merja Fischer, Director, Staria Oyj Jukka Ryhänen, Managing Director, Finland Combient Ab Sonja Ängeslevä, Product Developer, Unity Technologies Oy Samuel Kaski, Academy Professor, Aalto University Antti Vasara, Managing Director, VTT Technical Research Centre of Finland Oy Taina Kulmala, Head of Unit, Prime Minister's Office
Secretariat	Tapio Virkkunen, Development Director, Ministry of Economic Affairs and Employment Kalle Kantola, Research Director, VTT Technical Research Centre of Finland Mika Klemettinen, Programme Manager, Tekes Olli Koski, Director, Ministry of Economic Affairs and Employment Aleksi Kopponen, Senior Specialist, Ministry of Finance Lasse Laitinen, Specialist, Ministry of Economic Affairs and Employment

Appendix 1: What is artificial intelligence?

This is no one definitive definition for artificial intelligence. It is a collection of various different technologies. When speaking about the application of artificial intelligence, it is not necessary to give a too specific definition but rather an appropriate one. In this report, *artificial intelligence refers to devices, software and systems that are able to learn and to make decisions in almost the same manner as people*. *Artificial intelligence allows machines, devices, software, systems and services to function in a sensible way according to the task and situation at hand.*

The characteristics of artificial intelligence can be described with the help of the following image:



- **Learnability:** Pre-programmed vs. self-learning intelligence Current breakthroughs have been the result of learnability (e.g. deep neural networks).
- **The broad-scoped nature of performance:** The ability to perform selected predetermined tasks vs. the ability to perform generally in any given task. One milestone is performance at a human level.
- **Autonomy:** a predetermined problem with specific learning materials vs. more autonomous problem solving skills.

In order for a software, a machine or a system to be able to function in a sensible manner *according to a given task or situation*, it must be able to adapt to and understand numerous different situations. In practice, this means learnability i.e. the capacity to learn, because not all situations can be programmed in advance unless the application area is very limited in scope. In practice, recent breakthroughs in artificial intelligence have followed learning, where e.g. deep neural network algorithms have opened up new application areas for artificial intelligence.

The vast scope of performance i.e. how broadly can artificial intelligence be applied in different areas. The more broad-scoped the task given to artificial intelligence is, the more performance capacity and learnability it is required to possess. In practice, artificial intelligence can perform even better than humans in many narrow sectors such as translation, but the same artificial intelligence cannot fare well in other tasks, such as driving a vehicle, while a human can perform both of these tasks without issue. A re-

quest for a general artificial intelligence is common. This refers to a human-like artificial intelligence that can be utilised to perform a large scope of varying tasks. We are still a long way off from this scenario, but at the same time, artificial intelligence is applied to increasingly broad-scoped areas.

Autonomy i.e. how much artificial intelligence must be taught in advance in order for it to be solve a specific problem and how much artificial intelligence is able to independently determine the problem that requires a solutions and to produce the required solution capability. Even in the case of present day artificial intelligence which is capable of learning, the problem is typically predetermined by determining the materials from which artificial intelligence will learn.

With regard to the development and application of artificial intelligence, it can be said that there is a great deal of hype surrounding artificial intelligence while on the other hand artificial intelligence apps are becoming a part of daily life at a rapid pace. Although the application of artificial intelligence is fast, we should be critical of the more fantastical future visions and threat scenarios. We are still a long way off from these even though development is swift and we have gotten quite far in narrow areas of application.

Appendix 2: Definition of ecosystem

Ecosystem is a widely used concept. This report will utilise the definition of ecosystem given by Tekes i.e. Business Finland in its strategy work. Ecosystems are divided into three entities:

- **Business ecosystem**: A system that creates value with symbiotic solution entities formed by various actors (companies, research organisations and individuals), which id organised around a central idea, actor or platform (often digital) to create value for both its customers and the ecosystem's different parties. Coordination is carried out on the basis of the common strategic vision. The advantage of a business ecosystem for traditional activities is for example in its ability to utilise different capabilities and technologies on a needs basis, which facilitates the fast development of business activities and allows actors to react to necessary changes.
- **Innovation ecosystem** In order to achieve a sustainable competitive advantage, a business ecosystem needs an innovation ecosystem to provide support in the development and commercialisation of new solutions. An innovation ecosystem is often built around numerous ideas and needs and is able dynamically make use of a very broad network (companies, research organisations and individuals) in addition to the network's core actors. Innovation ecosystems also involve a larger risk than business ecosystems and an innovation ecosystem is often a starting point for the development of a new business ecosystem.
- **Digital platform ecosystem:** In most cases, business and innovation ecosystems are organised on digital platforms. These refer to IT systems and shared operating principles related to these, which different actors (users, providers and other stakeholders across organisational boundaries) use to together realise activities that will bring added value. Digital platform ecosystems are part of a larger group of ecosystems, which is strongly defined by a new resource: digital information, data, as well as technologies that aim to refine it, in particular software and automation. Digital platforms facilitate the accumulation of data (e.g. customer behaviour and transactions that have taken place on the platform) and in this way the creation of new business models specifically for the needs of new customer groups, in which case platforms will act as a complex market. It is typical for these markets that the mechanisms for creating value are continuously developed as data accumulates. The advantage achieved in the pursuit for this complexity and dominant market position as a control point for accumulated data and also the core of platform economy productivity.

Appendix 3: Current state of artificial intelligence education

According to a survey on the status and scope of artificial intelligence education created for Finnish universities, universities of applied sciences as well as vocational training, it can be said that Finland has a great amount of education and training in the areas of artificial intelligence technologies (e.g. machine learning, deep neural networks and machine vision) and AI supporting technologies (e.g. analytics and data processing) available. This is especially the case at universities of technology and departments of computer sciences at universities. There are also some studies available that focus on the ethics and history of artificial intelligence.

On the other hand, there are clearly fewer educational and training options available on the application of artificial intelligence and for preparing people for the changes this will cause. There are voluntary artificial intelligence basic studies available that students in the application area can complete, but these studies are not systematic in nature. This is a clear shortcoming, as the area in which the application of artificial intelligence will be fastest will include just the various expert positions, and it would be preferable if these people in particular were provided the basics on artificial intelligence and other technologies that will change and transform work tasks in the future. The lack of applied education is also evident in vocational education and training, which is also one of the areas in which AI will likely change work tasks in the future.

Appendix 4: Citizens' opinions

A survey titled "How will we make Finland the leading country in the application of artificial intelligence was open to the public on the otakantaa.fi website until 22 September 2017. Otakantaa.fi is a website that facilitates interaction and discussion between citizens, organisations and authorities and improves participation. A total of 46 answers were submitted via the website to the survey's seven questions.

The responses were of high quality and the respondents clearly had both expertise and views on the subject. The responses concerned the different themes related to artificial intelligence such as work on the programme. In the area of proposals for measures, a majority of the responses focused on education, research and expertise. Interesting points presented in the responses have been added to this appendix. The texts that are in cursive are direct quotes from the responses. The bolded texts have been added afterwards.

It is noteworthy that artificial intelligence is already here e.g. in various control and alarm systems The encoders of these systems must already make at least morally undefined, perhaps even illegal solutions as the necessary legislation is completely missing. A stand must also be taken on the ***moral regulation of artificial intelligence systems****; can a fire alarm system be allowed to lie to residents on lower floors telling them there is no reason for worry at the same time as floors higher up are being evacuated in order to prevent a rush and possible injuries resulting from a crush.*

Lastly, I feel that on a larger scale people's understanding of artificial intelligence is inconsistent. ***It is not uncommon for a purchase order to state "one artificial intelligence, please".*** *Artificial intelligence also shows in places where it does not actually exist - hardcoded software than mimics humans is not artificial intelligence. Perhaps it would be important from a societal perspective to clarify the content and differences of essential terms such as artificial intelligence, machine learning, robots, etc. so that the subject area could be discussed without running into misunderstandings.*

Artificial intelligence and technology development in general will probably eliminate a large part of the jobs in the next 10 to 30 years. There is a threat of ***large-scale unemployment and income being centralised*** *to technologies owners, possibly to foreign ones.* ***Finland has the opportunity to submit a solution to this threat which concerns numerous developed countries.***

Many repetitive work tasks in administration and support functions will be automated and many manual analysis & adjustment tasks will be replaced by "robots". However, ***at least for the foresee-***

able future, the number of work tasks in these sectors will not decline *because this is merely a matter of adopting unutilised resources (including the Big Data) and, on the other hand, tasks that will be robotised will still require more specific instructions and teaching from human workers for quite some time.*

Assumption: ***Finland will not be able to compete in particular with American and Chinese technology giants as a creator of artificial intelligence platforms except at best in some niche areas****, because giant corporations possess enormous data masses.*

Therefore, Finland must focus on the innovative utilisation of platforms. In practice, this could mean ***focusing on the development of artificial intelligence applications in areas where Finland is otherwise internationally successful****. For example, forestry, biotechnology, social services and health care*

Finland is only an applier of artificial intelligence products that does not have its own platform economy capabilities. Platform economy capability will require ***1-2 new software universities in addition those that currently exist as well as a national unit for strategical digital management under the Prime Minister's Office.***

The greatest risk is posed by allowing large corporations (Google, IBM, Microsoft, etc.)*, who are aggressively dominating the artificial intelligence market at the moment* ***to get hold of nationally vital data*** *(health, shopping data, etc.) providing slapdash solutions developed on the basis of this data that have not been tailored to our needs.*

Artificial intelligence does not function in the air, but needs infrastructure and a well-functioning ecosystem around it *E.g. Self-driving trucks. Who will maintenance? Who will retrieve them "when artificial intelligence gets stuck"?*

It should be noted that ***artificial intelligence applications will allow a worker with a lower level of education will be able to perform jobs previously carried out by people with higher-level educations (e.g., a nurse can use an app to carry out a doctor's work)****. Especially, the public sector and health care will utilise this opportunity in an aggressive manner.*

For example, even though we are currently experiencing ***a nationwide shortage of skilled workers in the software industry, based on my experience in the field most workers will still have to carry out very many trivial work tasks.*** *Artificial intelligence could help us find solutions to our expert shortage, when we free up this large brain power to cognitively more demanding tasks.*

It is not worthwhile for Finland to only develop artificial intelligence nationally; instead it should do so ***in close cooperation with e.g. the United States, other EU Member States and Japan****.*

Starting the related university education now will yield results at earliest 10 years from now. *This is much too long a time. This will require the involvement of*

companies - people must be able to complete artificial intelligence MBAs, Bachelor's degrees and theses while they work.

***Artificial Fintelligence** innovation programme (three years, a minimum of 5 MEUR /year)*

*To draw up **clear targets for efficiency improvements** e.g. replace 30% of the public sector labour force with artificial intelligence over a period of 15 years.*

*Finland must ensure that both higher education and selections made during internal product development at companies emphasise the implementation of artificial intelligence solutions, by using open source computational platforms and libraries (TensorFlow, Torch, DyNet, Keras...), instead of purchasing packaged solutions (IBM Watson...). In this way, Finland will come to have real experts whose competence will also remain relevant in the future will come, **in the same way as investing in programming education instead of learning how to use Excel was necessary for the creation of the software industry.***

*Startups in which the Government is a part-owner. **All current enterprise subsidies will be eliminated and the funds in question will be used for establishing startups.** There are no doubt people interested in founding a startup, if they had access to the initial capital needed for the realisation of their idea.*

***Finland could become the world's leading startup fund** (cf. the Norwegian oil fund).*

*It is particularly important to understand that experts in the field will be required to have greater expertise than at present specifically in the core areas of artificial intelligence, machine learning, statistical modelling and algorithmics -- **the demand cannot be covered by adding software industry or computational science education,** and especially not with retraining and upgrading of qualifications.*

*However, development programmes are often fragmented and internal market focused. **Artificial intelligence knows no limits.** Projects should focus on globally scalable issues, the platform economy, e-Government and education.*

Appendix 5: Assignment and activities of the Artificial Intelligence Programme Steering Group

The purpose of the Artificial Intelligence Programme 18 May 2017

On 18 May 2017, Minister of Economic Affairs Mika Lintilä appointed Pekka Ala-Pietilä to head a steering group tasked with preparing a proposal for Finland's Artificial Intelligence Programme. According to the decision to appoint the group, the purpose of the Artificial Intelligence Programme is to establish artificial and robotics as the cornerstones for the success of Finnish companies. Finland's objective is to be the best country in the world at applying artificial intelligence.

The Artificial Intelligence Programme Steering Group has been assigned the following list of tasks:

1. To generate a snapshot of the current status and prospects for artificial intelligence and robotics around the world and in Finland.
2. To propose a goal state, which Finland should strive to achieve in the application of artificial intelligence in collaboration with companies, research institutes, educational institutions and public organisations.
3. To enter a proposal on measures the implementation of which are necessary in order to achieve the stated objectives. Special attention must be given to the field's innovation activities, preparedness for changes to working life, the addition of education and upgrading the qualifications of those in the labour market.
4. To draw up a model for the implementation of the plan that will ensure the efficient realisation of the operational programme
5. To prepare a proposal for the expansion of the working group's task description and composition, so as to allow it to develop the measures necessary for the promotion of artificial intelligence in the long-term and analyses the more broad-scoped societal change related to digitalisation and provides proposals for solutions to the Government.

Work

The steering group has met five times thus far. In addition to this the group's secretariat and chairs have met multiple times during the programme term. The members of the steering group have appeared in numerous different forums to talk about the preparation of the programme and its objectives. Close-knit preparation work has also been carried out in sub-groups. Experts were also consulted during the work. As part

of the preparation of the programme, an open preparation workshop was organised. A total of 72 experts from different sectors took part. The realisation of the programme will continue in close cooperation with various stakeholders and the network will be expanded during the realisation of the programme.

Publication of interim report
This report was published in Finnish on 23 October 2017 at Finlandia Hall at the ”Suomi ja tekoäly alustatalouden aikakaudella” (“Finland and AI in the age of platform economy”) event where the Digital platform economy roadmap was also published. The programme's website is tekoälyaika.fi.

Sub networks
Starting from the second half of the programme work thus far, three sub-groups have worked under the Steering Group (see above How will work in the field of artificial intelligence continue?).

Expertise and Innovations

Mika Vehviläinen, chair
Heikki Mäkijärvi
Sauli Eloranta
Riikka Heikinheimo
Anita Lehikoinen
Minna Aila
Samuel Kaski
Ilkka Kivimäki
Merja Fischer
Kalle Kantola

Data and the Platform Economy

Kimmo Alkio, chair
Harri Valpola
Harri Nummela
Johannes Koponen
Jukka Viitanen
Leena Niemistö
Ville Peltola
Taru Rastas
Aleksi Kopponen
Hannu Hämäläinen
Pekka Sivonen

Sasu Tarkoma
Antti Vasara
Jukka Ryhänen
Mika Klemettinen

Transformation of Society and Work

Osmo Soininvaara, chair
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Mika Maliranta
Ville Kyrki
Tuomo Alasoini
Anu Järvensivu
Seija Ilmakunnas
Mikko Kosonen
Mika Kuismanen
Vesa Vuorenkoski
Juha Antila
Antti Koivula
Tuulia Hakola-Uusitalo
Taina Kulmala
Merja Fischer
Penna Urrila
Niilo Hakonen
Leila Kurki
Kai Husso
Kari Rintanen
Susanna Siitonen
Olli Koski

Additionally, the secretariat of the group led by Olli-Pekka Heinonen tasked with monitoring the Government programme digitalisation objective and the public administration's ICT development (DigiNYT) has contributed to the portion of the report concerning the public sector.

Pekka Ala-Pietilä
Timo Ali-Vehmas
Antti Eskola
Juha Haataja
Kimmo Hyrsky
Hannu Hämäläinen
Jouni Kangasniemi

Nina Nissilä
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Mika Klemettinen
Aleksi Kopponen
Ville Peltola
Petri Takala
Riikka Pellikka
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Uski Suvi
Vesa Silfver

Finland's Age of Artificial Intelligence

Turning Finland into a leading country in the application of artificial intelligence

Objective and recommendations for measures

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Work in the age of artificial intelligence

Four perspectives on the economy, employment, skills and ethics

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Abstract

The report Work in the age of artificial intelligence is part of the Artificial Intelligence Programme set up by Minister of Economic Affairs Mika Lintilä. The programme's steering group is chaired by Pekka Ala-Pietilä. A working group on the transformation of work and society, chaired by Osmo Soininvaara, Lic. Pol. Sc., wrote the report.

The report is a collection of four main articles that discuss (1) the effects of artificial intelligence on general economic and employment trends; (2) the transformation of work and the labour market; (3) reforms on education and skills maintenance; and (4) ethics.

Artificial intelligence is a general-purpose technology that changes working life and society extensively. It opens the possibility for rapid productivity growth and for a higher standard of living. To harness the potential of artificial intelligence, society must invest in updating workers' skills, facilitating workforce mobility and generating innovations that complement human labour. The importance of a well-functioning labour market will be even greater.

One of the working group's proposals for further preparation is a lifelong-learning reform where every person of working age would be given a skills account or voucher that they could use to update their skills. Employees, employers and society together would bear responsibility for updating workforce skills. This would create a demand-based market for education and training.

Olli Koski (Innovations and Enterprise Financing, Ministry of Economic Affairs and Employment / tel. +358 29 504 7174)

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Rapporten Arbetet under den artificiella intelligensens tidevarv är ett led i programmet för artificiell intelligens, som är tillsatt av näringsminister Mika Lintilä. Programmet har en styrgrupp som Pekka Ala-Pietilä är ordförande för. Rapporten har utarbetats av arbetsgruppen med politices licentiat Osmo Soininvaara som ordförande.

Rapporten består av fyra huvudartiklar, som behandlar (1) den artificiella intelligensens inverkan på den allmänna utvecklingen av ekonomin och sysselsättningen, (2) arbetets förändring, (3) utbildning och upprätthållande av kompetensen, samt (4) etik.

Artificiell intelligens är en genombrottsteknologi som i stor utsträckning omdanar arbetslivet och samhället. Artificiell intelligens möjliggör en snabbare ökning av produktiviteten och därmed en förbättrad levnadsstandard. För att uppnå fördelarna med artificiell intelligens bör samhället investera i att uppdatera arbetskraftens kompetens, att underlätta arbetskraftens rörlighet samt att få fram innovationer som kompletterar det mänskliga arbetet. Vikten av en välfungerande arbetsmarknad accentueras.

För den fortsatta beredningen föreslår arbetsgruppen bland annat en reform för livslångt lärande, där varje människa i arbetsför ålder får ett kompetenskonto eller en kompetenssedel som hen kan använda för att uppdatera sin kompetens. Arbetstagarna, arbetsgivarna och samhället får tillsammans bära ansvaret för att uppdatera arbetskraftens kompetens. Samtidigt uppstår i Finland en utbildningsmarknad.

Olli Koski (arbets- och näringsministeriet / tfn 029 504 7174)

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Tiivistelmä

Tekoälyajan työ -raportti on osa elinkeinoministeri Mika Lintilän asettamaa tekoälyohjelmaa, jonka ohjausryhmän puheenjohtajana toimii Pekka Ala-Pietilä. Raportin on tuottanut ohjelman alaisuudessa toiminut Työn ja yhteiskunnan muutos –työryhmä, jonka puheenjohtajana toimi VTL Osmo Soininvaara.

Raportti koostuu neljästä pääartikkelista, jotka käsittelevät (1) tekoälyn vaikutuksia yleiseen talous- ja työllisyyskehitykseen; (2) työn muutosta ja työmarkkinoita; (3) koulutusta ja osaamisen ylläpitoa; sekä (4) etiikkaa.

Tekoäly on yleiskäyttöinen teknologia, joka muokkaa työelämää ja yhteiskuntaa laajasti. Tekoäly tarjoaa mahdollisuuden tuottavuuden nopeampaan kasvuun ja siten elintason paranemiseen. Hyötyjen saavuttamiseksi yhteiskunnan tulee investoida työvoiman osaamisen päivittämiseen, työvoiman liikkuvuuden helpottamiseen sekä ihmistyötä täydentävien innovaatioiden synnyttämiseen. Työmarkkinoiden hyvä toimivuus on entistä tärkeämpää.

Työryhmä esittää jatkovalmisteluun muun muassa elinikäisen oppimisen reformia, jossa työikäisille luotaisiin osaamistili tai -seteli, jolla voisi päivittää osaamistaan hankkimalla koulutusta palvelujen tarjoajilta. Työntekijät, työnantajat ja yhteiskunta kantaisivat vastuun yhdessä työvoiman osaamisen päivittämisestä. Suomeen syntyisi koulutuskysynnän ylläpitämänä koulutusmarkkinat.

Olli Koski (TEM, Innovaatiot ja yritysrahoitus / puh. 029 504 7174)

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Table of Contents

INTRODUCTION

On 18 May 2017, Minister of Economic Affairs Mika Lintilä appointed a steering group chaired by Pekka Ala-Pietilä to prepare a proposal for a Finnish artificial intelligence programme. According to the appointment decision, "the objective of the artificial intelligence programme is to turn artificial intelligence into a success factor for Finnish companies. Finland's goal is to be a global leader in applying artificial intelligence". Five sub-groups worked under the steering group, one of which was the working group on the Transformation of work and society chaired by Osmo Soininvaara. The working group met nine times. For a list of its members, see Appendix 1.

When participating in the drafting process of the report, the working group members did not represent their background organisations, and these organisations are not committed to the views expressed in the report. Each member contributed to the report independently based on his or her personal expertise. The objective was to invite to the working group members with highly diverse expertise and different viewpoints. The policy recommendations and conclusions of the report do not necessarily represent the group's joint views. While they were not formulated unanimously, they do represent a majority opinion.

The report consists of four chapters on different themes (Chapters 2 to 5). Each chapter is an independent whole prepared by the working group members in different compositions. Rather than aiming for a fully consistent format, the report wished to emphasise the members' personal views.

1 Reflections on work in the age of artificial intelligence

Artificial intelligence (AI) has been compared to electricity. It is a general-purpose technology that will over time make its way to almost every aspect of life. This may bring about significant changes in work and society. As the impacts of artificial intelligence and other aspects of digitalisation are difficult to tell apart, neither did our working group find it necessary to make a clear distinction between them.

Consumers will mainly find artificial intelligence to their advantage as inexpensive or completely free products which make their lives easier or improve their comfort come into the market. In parallel with this optimistic vision, pessimistic views concerning the future of work and development of societal inequalities have been expressed.

Ideas of to what extent and how fast artificial intelligence will do away with current jobs vary greatly. We must be prepared for changes that may take place at a very fast rate. The impacts of artificial intelligence will be smaller in Finland than in such countries as Germany. In 2015, approx. 9% of Finnish jobs were so-calledTaylorised jobs containing routine tasks which lend themselves to automation easily, whereas this figure was approx. 30% in Germany based on the same definition (Makó, Illésy & Borbély, unpublished working paper, 2018).

According to a McKinsey report on Finland, artificial intelligence will destroy some 15% of jobs by 2030 and change the nature of work in a considerably larger proportion of tasks. The estimate recommends that we should be prepared to retrain one million Finnish workers. Similarly, advanced applications of AI will make many completely new products and occupations possible.

While the rate at which jobs will disappear appears fast, it is considerably lower than rates Finland has faced in earlier decades. Previously, however, workers mainly moved from unproductive work to higher-paid jobs. This time around it may be that many workers who lose their occupation will have to settle for a job with lower pay. Artificial intelligence will also affect the work of highly educated professions, including lawyers, physicians and bank managers.

Artificial intelligence may also improve the functioning of the labour market. The efficiency of employment services can be improved immensely as a jobseeker's properties can be mechanically compared to all available jobs at once. A job exchange robot may also look for jobs for those in employment, ensuring that as their skills improve, workers could move on to roles that are a better match with their competence and free up less demanding jobs for the unemployed and those entering the labour market.

Productivity growth and the creative destruction brought about by it slowed down in the 2000s in all industrial countries. If artificial intelligence meets the expectations placed on it, we may see another boost in productivity and creative destruction. This change will reduce certain kinds of jobs and increase the number of others. At the same time, the demand will decrease for certain skills and grow for others. Without corrective actions, this will worsen the labour market mismatch and exacerbate structural unemployment. It is generally predicted that an increasingly high level of education will be required of the labour force. According to McKinsey's prediction, the proportion of highly educated labour will increase from 44% in 2016 to about 51% by 2030. This change will set challenges to the Finnish education system, as the improving trend in the level of education in Finland stagnated in the 1990s.

Artificial intelligence development and introduction as well as the general digitalisation of society will challenge the conventional and siloed practices of political decision-making and central government. More consolidated thinking will be needed to enable the implementation of comprehensive development measures across the boundaries of administrative branches and sectors. In a broader context, this is about the public sector's ability to respond to changes in the operating environment and new ways of doing things together.

Threats associated with artificial intelligence include growing structural unemployment and inequalities in society. In conditions of a political democracy, a situation where the majority of the population would find their position weakened is almost impossible. It is vital to be able to anticipate social problems, or threats of such problems, created by the change.

While the challenges of artificial intelligence do not require any solutions of a completely new type that would not have been suggested already, they will significantly increase the need for certain actions. The change in the labour market will stress the need to protect the most vulnerable groups, while it will exacerbate the obstacles created by labour market rigidities. Responsibility for protecting those in the most vulnerable position must be shifted towards social policy whose costs are paid by the central government. As such, the Nordic welfare state is much better placed to face the change than such countries as the United States, where the safety net is thinner.

Making proposals related to social policy was not part of our working group's mandate. However, we can note that the need to make accepting work worthwhile is stressed, as is the need to reduce equilibrium unemployment through pay subsidies or income transfers complementing earned incomes.

The requirement of lifelong learning is also not new, but the need for it will increase strongly. In order to turn it into reality, the question of who will pay for the education and training must be resolved. The working group proposes setting up a skills account for each Finnish person, in which funds entitling the holder to training will be accumulated. The costs could be paid for by the central government together with employers and employees. Entrepreneurs should have equal rights to upskilling. This would also create a training market maintained by the demand in Finland.

Osmo Soininvaara
Working group chairperson

2 Impacts of artificial intelligence on growth and employment[1]

2.1 Digitalisation and artificial intelligence as a technological leap

So far, digitalisation has already revolutionised the modes of production and work in many occupations and different fields. It has also made away with old tasks and created new ones. Key manifestations of digitalisation in recent years include the wider use of mobile internet, cloud services and big data and increased computing power. However, the greatest impacts on the world of work of artificial intelligence, machine learning and applications associated with these technologies, including advanced interactive robotics and autonomous transport, quite obviously are yet to come (see Appendix 2 to the report).

In the context of digitalisation and artificial intelligence, we can talk about a revolution of technological development created by them. This leap in the advancement of technology influenced by many different factors will change entire society. Ultimately, it is about a new relationship between humans and machines in productive activities. In the era of the steam engine and electrification, machines mainly replaced physical effort and complemented human work (the so-called first machine age). As technologies advanced further and the second machine age dawned, machines could already be used to direct physical work, and cognitive tasks that lent themselves to simple coding could be transferred to them.

1 The authors of this Chapter are working group members Anu Järvensivu, Seija Ilmakunnas and Ville Kyrki.

In some occupations, machines could replace human work completely, and such occupations of dwindling work have often been found around the middle of the distribution of earnings.

The job descriptions of diminishing jobs are characterised by routine tasks and repetition, which computers can manage more efficiently. Examples of this include non-executive office occupations (routine information occupations) and industrial assembly occupations (routine manual occupations). At the same, occupations with few routines at both the bottom and top end of the distribution of incomes have increased their relative shares.

Their relative position has been improved by the requirement of a personal approach, flexibility, problem-solving ability or creativity associated with the work (which is more difficult to digitalise). These changes associated with the development of information technology and globalisation have been discussed in a number of studies on labour market polarisation.

In the second wave of the second machine age, rather than only operating on the basis of pre-programmed inference rules, machines themselves are learning to use neural networks and large datasets. This has added to the possibilities of utilising automation in many new applications associated with such fields as translating languages, pattern recognition, diagnosing illnesses and self-driving modes of transport. These new application areas mean that the impacts on employment will also touch many information occupations with few routines which, in the light of earlier polarisation studies, were believed to increase rather than lose their share.

The identification of society's points of transition is always open to interpretations – at least in beforehand. The development rate of the actual technology is fraught with uncertainties, and it is unlikely that the changes in employment will be as rapid as indicated by technological advancement. The impacts of technological development on society will be filtered through many factors. First of all, companies may be unwilling to take up new technologies if this requires major reorganisation. Legislation incompatible with new circumstances and ethical issues awaiting solution may at least slow down the development.

However, the interpretation pointing to a fundamental change is supported by a number of factors, including the fact that artificial intelligence as a general-purpose technology already enables even radical product and process innovations in many different sectors. The changes may take place rapidly and make existing physical and intellectual capital unproductive at an unpredictable rate. The advancement of information technology has also meant that more and more products have a global market, reproducing digital products is often almost free, and major economies of scale are available in production. This makes for rapid changes in the market, and a 'winner(s) take(s) it all' phenomenon is typical of many markets. A very small group of companies may corner a major share of profits and markets. The possibility of exploiting a monopoly position and lack of competition are apt to exacerbate the risk of uneven income distribution. The possibility that the benefits of the new technological leap will be divided less evenly than the benefits of earlier similar leaps can be considered a threat.

In national economy statistics, the impacts of digitalisation development on economic growth have been more moderate than anticipated (Itkonen 2017). An observation of poor productivity development coinciding with digitalisation leads to an inconsistency that calls for explanation. On the one hand, the background factors to this include the difficulty of measuring the economic significance of digital goods. Completely new goods, free services, changes in quality and global intellectual capital have proven a challenge to measuring digitalisation. Improvement in ICT devices and services is a factor whose impacts on price development have been difficult to estimate. In practice, the price development has been overestimated, among other things because the quality improvement in ICT products has only been taken into account partly, and the better quality has incorrectly been manifested as higher prices. This means that economic growth, or GDP development in constant prices, has been similarly underestimated. As a conclusion, we can say that the impacts of digitalisation on improving the standard of living have not been fully reflected in economic statistics.

Another explanation is that large-scale productivity growth will only take place when innovations complementing human work have been developed and introduced comprehensively, including new ways of organising work. This, on the other hand, will require investments in intellectual capital, such as education and research, at the level of both society and companies. Even if artificial intelligence

technology already enables many types of profitable technologies today, visions will not be turned into reality unless people invent and develop innovations required to complement them. While some of these will be technological in nature, a significant share will be social or socio-technological (Brynjolfsson et al. 2017).

It is also possible to interpret the current situation more fundamentally as a type of regression in the innovation concept and a return to technological determinism. The innovation concept based on technological determinism means a model where technologies developed through research are expected to spread to companies and have a linear impact on growth, employment and the modes and practices of work. This model was challenged decades ago, however, and co-operative innovation models including 'open innovation' or 'quadruple helix' were proposed to replace it. In these models, policy-makers and government, business life, researchers and citizens work together to create the future and to implement structural changes (Kopp et al. 2017; Arnkil et al. 2010.).

2.2 Employment impacts in the light of research

The current discussion about the impacts of artificial intelligence on the world of work can be divided into two main streams. The first stream concerns itself with employment impacts: a) will sufficient quantities of new jobs be created to replace disappearing jobs or tasks, or will the number of those without work and income grow; and b) which occupations are the most at risk and what types of new tasks will be generated (e.g. Frey & Osborne 2013; Pajarinen & Rouvinen 2014; McKinsey 2017; Linturi & Kuusi 2018). The second one focuses on qualitative changes in working life: what types of changes will take place within tasks and modes of work, including employment relationship models or the times, places and organisation of work, and whether the entire set of concepts relevant to work and the world of work should be re-thought (Järvensivu 2010; Gratton 2011; Dufva et al. 2017; Antila et al. 2018). The emphasis of this report is on the employment impacts of artificial intelligence.

The impacts of automation on employment have been discussed since the early days of the industrial society. The latest debate on the employment impacts of

technologies and their scale began with an article written by Frey and Osborne (2013), who classified occupations according to how likely they are to lend themselves to automation. Occupations were placed in high, medium and low risk categories. The results indicate that in the USA, up to 47% of employment will be automated with a 70% likelihood within 20 years. A similar analysis on Finland showed that one third of employment is exposed to the threat of automation (Pajarinen & Rouvinen 2014).

Occupations consist of many types of tasks, and the likelihood of these tasks being automated varies significantly. Using the OECD's international PIAAC data, this analysis can be focused on tasks. Studies drawing on these data published by the OECD have concluded that the aforementioned predictions have probably overestimated the impacts of automation. A study published in 2016 covered 21 member states, and task-level analyses indicated that only approx. 9% of the employment could be automated. Differences between countries turned out to be significant; in Finland, for instance, it was estimated that only less than 7% of the jobs would lend themselves to automation (Arntz et al. 2016).

In the most recent OECD study, the group of countries examined was extended to 32. Its results show that 14% of jobs are exposed to a high risk of automation (Nedelkoska & Quintini 2018). In addition, the risk of automation is 50–70% in one third of jobs. In other words, these jobs also contain a considerable share of tasks that can be automated, which significantly increases the pressure to change the skill requirements of persons working in them. According to the results concerning Finland, approx. one third of jobs are affected by either a high (over 70%) or medium (50–70%) risk of automation. This figure is the third lowest after Norway and New Zealand.

The latest OECD study strives to also describe employment exposed to the greatest risk of change based on the population groups most affected by the change. According to the report, the changes would affect low skills level employment the most, and there would be a linear reduction in the risk of automation as the education and skills level increases. Young people, who often work in labour market entry level occupations with a high risk of automation, are exposed to the greatest risk.

Major international management consultancy firms have contributed to the discussion on the employment impacts of technology. The level of analysis selected for the McKinsey report (2017), which has received some attention in publicity, is functions and capabilities needed for performing them. According to the report, approximately one half of the functions could be automated using modern technologies, whereas only 5% of occupations could be fully automated. However, up to 60% of occupations contain functions that could be automated.

Looking at various studies, we can see that there are great variations between the predictions. Different levels and periods of analysis and dissimilar sets of concepts are used in them. The big picture of disappearing jobs is difficult to perceive, and the situation is not made any easier by the fact that the impacts of artificial intelligence are hard to pinpoint among the impacts of other technologies. As a conclusion we can note, however, that while automation is not likely to completely make away with many occupations, it will replace some of the human work in many tasks (Koski 2018). At the same time, it will change job descriptions. The fact that new tasks and occupations will also be created means that the prediction is associated with major uncertainty (Linturi & Kuusi 2018).

It is also good to note that artificial intelligence will not have the same effects on the work and employment of all people. The introduction of new technologies will also have impacts on income distribution. Artificial intelligence may bring about even more such impacts, as it is expected to affect not only routine but also high expertise tasks. The risks of polarisation and increasing inequalities are real (Korinek & Stiglitz 2017), as are the possibilities of social and political disorder, especially over the short term (Eurofound 2018). Consequently, development of societal and economic institutions will be needed. In this development, the criticism levelled at technological determinism should be addressed, and practices that extensively allow and support the participation of different actors, which are easily enabled by digital tools, should be used.

2.3 Policy recommendations

1. National action plans on artificial intelligence should focus on innovations that complement human work, a significant share of which are social and socio-technical. Productivity will only grow extensively once artificial intelligence technology is complemented by changes in the modes and organisation of work that support the take-up of AI.
2. In education contents, the need for combining technological and interaction skills should be addressed, as artificial intelligence will shape the task contents of most occupations. While the proportion of employment that can be automated in full is relatively small, a considerable share of jobs contain tasks that will be automated. This means workers will face changing skill requirements.
3. Technological development is associated with a so-called skills mismatch, also in the context of artificial intelligence: there is a shortage of experts, while those with a lower education level cannot find jobs. To ensure a sufficiently high level of employment and reduce the risk of exclusion, ensuring that everyone has adequate learning skills and that the number of those with no education after comprehensive school is as small as possible is crucial.
4. The scaling of AI technology makes the creation of monopolies possible. Any abuses of dominant market power should be intervened through smart regulation and competition oversight.
5. Labour mobility should be supported to move workers on to tasks that are a better match with their skills, for example by improving employment services. The use of non-competition obligations should be restricted.

Anttila, J., V. Eranti, J. Jousilahti, J. Koponen, M. Koskinen, J. Leppänen, A Neuvonen, M. Dufva, M. Halonen, J. Myllyoja, V.-V. Pulkka, M. Annala, H. Hiilamo, H., J. Honkatukia, A. Järvensivu, M. Kari, J. Kuosmanen, M. Malho & M. Malkamäki (2018). Tulevaisuusselonteon taustaselvitys. Pitkän aikavälin politiikalla läpi murroksen – tahtotiloja työn tulevaisuudesta. *Valtioneuvoston selvitys- ja tutkimustoiminnan julkaisusarja* 34/2018.

Arnkil, R., A. Järvensivu, P. Koski & T. Piirainen (2010). Exploring Quadruple Helix. Outlining user-oriented innovation models. *University of Tampere, Work Research Centre, Working papers* 85/2010.

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Brynjolfsson, E., C. Syverson & D. Rock (2017). Artificial intelligence and the modern productivity paradox: a clash of expectations and statistics. *NBER Working Paper* 24001.

Dufva, M., M. Halonen, M. Kari, T. Koivisto, R. & J. Myllyoja (2017). Kohti jaettua ymmärrystä työn tulevaisuudesta. *Valtioneuvoston selvitys- ja tutkimustoiminnan julkaisusarja* 33/2017.

Eurofound (2018) Automation, digitalisation and platforms: Implications for work and employment. Publications Office of the European Union, Luxembourg.

Frey, C. B & M. A. Osborne (2013). The future of employment: how susceptible are jobs to computerization? The Oxford Martin School, Programme on Technology and Employment, Working Paper.

Gratton, L. (2011). *The Shift. The future of work is already here.* Collins, London.

Ikonen, J. (2017). Digitalisaation mittaushaasteiden vaikutus kansantalouden kokonaiskuvaan. *Kansantaloudellinen aikakauskirja* 4/2017.

Järvensivu, A. (2010). Tapaus työelämä – ja voiko sitä muuttaa? Tampere: TUP.

Kopp, R., J. Howaldt & J. Schultze (2016). Why industry 4.0 needs workplace innovation: a critical look at the German debate on advanced manufacturing. *European journal of workplace innovation* 2(1), 7–24.

Korinek, A. & J. Stiglitz (2017). Artificial intelligence and its implications for income distribution and unemployment. *NBER Working Paper* 24174.

Koski, O. (2018). Tekoäly ja muuttuva työ. T*yöpoliittinen aikakauskirja* 1/2018, 11–22.

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Nedelkoska, L. & G. Quintini (2018). Automation, skills use and training. *OECD Social, Employment and Migration Working Papers* 202. OECD, Paris.

Pajarinen, M. & P. Rouvinen (2014). Computerization Threatens One Third of Finnish Employment. ETLA muistio 22, 13 January 2014.

3 Labour market dynamics in a technological revolution[2]

3.1 Economic growth stems from productivity, but productivity growth has stalled

Economic growth measured by gross domestic product (GDP) increases the average happiness[3] and wellbeing[4] of citizens, also in developed national economies. Economic growth is the sum total of growth in employment and labour productivity. A stalling of economic growth has been observed in developed countries everywhere in this millennium. This slowing down cannot be explained by problems of measurement.[5] While no full consensus concerning the explanations for this has been reached by economists, it appears that the most significant productivity potential offered by the previous technological leap has been mostly used up for the time being. The dynamics of business and jobs has stagnated in developed countries.

The long-term growth in labour productivity is ultimately based on technological development, which can be conceived as a multiplication of ideas. This

2 The authors of this Chapter are working group members Mika Maliranta, Niilo Hakonen, Juha Antila, Mika Kuismanen and Susanna Siitonen.

3 Stevenson, B. and Wolfers, J. (2013). Subjective well-being and income: Is there any evidence of satiation? The American Economic Review: Papers & Proceedings, 103(3), 598-604.

4 Jones, C. I. and Klenow, P. J. (2016). Beyond GDP? Welfare across countries and time. The American Economic Review, 106(9), 2426-2457.

5 See e.g. Byrne, D. M., Fernald, J. G. and Reinsdorf, M. B. (2016). Does the United States have a productivity slowdown or a measurement problem? Brookings Papers on Economic Activity, 2016(1), 109-182 and Syverson, C. (2017). Challenges to mismeasurement explanations for the US productivity slowdown. Journal of Economic Perspectives, 31(2), 165-186.

multiplication, for its part, depends on 1) how many people are developing new ideas, and 2) what the level of productivity of the people developing these ideas is, in other words what the level of productivity of research is. Recent analyses have shown that the number of researchers has increased strongly in the last few decades, while the productivity of research has declined: more and more researchers are needed to come up with a new idea. This can be seen in many sectors and in many ways[6].

Information and communication technologies have had a major impact on productivity growth since the mid-1990s. However, this effect dwindled in the first years of the 2000s. Research findings pointing to this phenomenon mainly originate in the United States. As technology development is global, similar trends are likely to also affect other developed countries, although they can sometimes be masked by other country-specific factors. Artificial intelligence is such a new issue that it has not had time to make a major impact on productivity at the level of national economies.

In other words, the advancement of wellbeing still depends to a significant degree on the growth of employment and, above all, labour productivity in the national economy. These growth rates, on the other hand, are greatly dependent on the effectiveness of the labour market: how high an employment rate can be reached? How smoothly is the labour force transitioning from low-productivity work to higher-productivity jobs, or how well is the creative destruction working? In other words, economic growth is undermined by people being unable to find work, or being struck with jobs where their skills cannot be used. If a large number of workers were forced to take on less productive jobs with lower pay, this would also have negative consequences in terms of economic growth.

Not only economic growth measured by GDP but also technological advancement, including artificial intelligence, influence production taking place outside the market in a manner that improves welfare. According to researchers' estimates, however, these benefits are not sufficient to balance out the slowing down of

6 1Bloom, N., Jones, C. I., Van Reenen, J. and Webb, M. (2017/2018). Are ideas getting harder to find? NBER, Working Paper No. 23782.

productivity growth in the market.[7] Such free services as Google searches and Wikipedia make citizens' everyday lives easier, which is not reflected in GDP growth, but when these tools are used as free intermediate products in companies, their productivity is increased, and the need for such employees as informaticians is reduced. In this respect, technology development is measured in the national economy level productivity statistics.

A significant consumer surplus is often generated in the market. This means that many consumers would be prepared to pay a price higher than the market price for a product. To illustrate this point, we could imagine what level of monetary compensation the average consumer would require for being unable to use an electric light or indoor toilet, watch television, surf the net or read and update the Facebook for a year. All these aspects of life are clearly more valuable for the consumer than indicated by the price paid for them, which increases the GDP[8]. In digital products, the proportion between the consumer surplus and the price sometimes is particularly great, as the products can be reproduced in almost unlimited quantities, and their marginal production costs are thus low. Consequently, we can expect artificial intelligence to improve citizens' well-being in the future more than what the official GDP metrics show. On the other hand, it is important to remember that earlier key innovations, such as sewage pipe systems, electric light and washing machines, generated immense consumer surplus that we still continue to enjoy.[9]

When interpreting economic growth, we should thus consider how the relationship between consumer surplus and GDP has changed over time. This issue is more hotly disputed than the idea of a significant and drawn-out slowdown in productivity growth.

7 Syverson, C. (2017). Challenges to mismeasurement explanations for the US productivity slowdown. Journal of Economic Perspectives, 31(2), 165-186.

8 Brynjolfsson, E., Eggers, F. and Gannamaneni, A. (2018). Using massive online choice experiments to measure changes in well-being. National Bureau of Economic Research.

9 Gordon, R. J. (2018). Why has economic growth slowed when innovation appears to be accelerating? : National Bureau of Economic Research.

3.2 Digitalisation and productivity growth

Digitalisation has been deemed to offer important potential for improving productivity.[10] Information and communication technologies enhanced labour productivity in the United States in the mid-1990s in those sectors in which they were used significantly. This growth became more sluggish in the early years of the 2000s, affecting mostly the sectors which had earlier seen the most rapid productivity growth.[11] Digitalisation could also be expected to improve the productivity of research and thus accelerate technology development and the growth in national economy productivity. An article about research productivity notes, however, that an increasing number of researchers are needed to create a new invention or innovation[12]. This may mean that the fruit on the lower branches have already been picked — in many sectors, the ideas that were the easiest to invent have already been discovered, only leaving the trickier ones. On the other hand, a new scientific breakthrough may generate an entire wave of innovations.

The creation and destruction of jobs at a rapid pace is part of the productivity growth generated by technology development.[13] However, it appears that the micro-level dynamics of jobs has slowed down rather than accelerated both in Finland and the United States[14].

A technological revolution is often associated with growing productivity gaps between companies. Companies that have been successful in applying new technologies increase their productivity, while others are treading water. In

10 Pohjola, M. (2006). ICT, productivity and economic growth: What will be the next wave? In P. Heikkinen and K. Korhonen (ed.), Technology-driven efficiencies in financial markets (pp. 9-33). Helsinki: Expository studies A:110, Bank of Finland.

11 Fernald, J. (2014). Productivity and potential output before, during, and after the great recession. In Nber macroeconomics annual 2014, volume 29. University of Chicago Press.

12 Bloom, N., Jones, C. I., Van Reenen, J. and Webb, M. (2018). Are ideas getting harder to find? : NBER, Working Paper No. 23782.

13 Aghion, P., Akcigit, U. and Howitt, P. (2013). What do we learn from schumpeterian growth theory? : NBER, Working Paper No. 18824; Comin, D. and Mulani, S. (2009). A theory of growth and volatility at the aggregate and firm level. Journal of Monetary Economics, 56(8), 1023-1042.

14 Kauhanen, A., Maliranta, M., Rouvinen, P. and Vihriälä, V. (2015). Työn murros – riittääkö dynamiikka? Etla b 269. Helsinki: Taloustieto Oy; Molloy, R., Trezzi, R., Smith, C. L. and Wozniak, A. (2016). Understanding declining fluidity in the US Labor market. Brookings Papers on Economic Activity(1), 183-259.

this respect, the findings are somewhat inconsistent. The dispersion of labour productivity between companies within industrial sectors in Finland increased from the early 2000s until 2010, after which year it has decreased slightly. A very similar trend has been observed in Sweden. The dispersion of labour costs also increased slightly in Finland in that period, however clearly less than in Sweden. On the other hand, productivity differences between companies in service sectors have grown in Sweden but not in Finland, which indicates a difference in innovativeness. However, this growth has also declined in the Swedish service sectors in the 2010s. All in all, while dispersion of productivity and pay has increased, the development appears to have stagnated in the 2010s.[15]. This issue is interesting and important, as analyses produced in the United States show that pay gaps between individuals are to a significant degree caused by increasing pay and productivity differences between companies.

In terms of economic growth, the crucial question is whether digitalisation will be able to accelerate productivity growth in the years to come. Promises of this are offered by robotisation and, above all, artificial intelligence. If (and when) they begin to shape the content of work, eliminate tasks and create new ones at an accelerating rate, there will be potential for faster productivity growth. This will have many types of effects on economic structures and dynamics. The best tool for examining the economic impacts of automation in economics currently is the framework proposed by Acemoglun and Restrepon (forthcoming)[16]. It can be used to anticipate future trends but also assess the need for government measures.

Artificial intelligence will have a significant *substitution effect*, thanks to which the same output can be produced with a smaller work input. This will result in elimination of tasks, while also making it possible to channel the freed work input to higher added value tasks, or complete existing tasks better through artificial intelligence.

15 Maliranta, M. (2016). Reaalisten yksikkötyökustannusten kehitys ja siihen vaikuttavat tekijät Suomessa ja Ruotsissa. Kansantaloudellinen aikakausikirja, 112(1), 22-46.

16 Acemoglu, D. and Restrepo, P. (Forthcoming). The race between machine and man: Implications of technology for growth, factor shares and employment. American Economic Review.

At the same time, mechanisms that increase demand for labour are at work in the economy. Due to the *productivity effect*, production costs and thus product prices will decrease and households' purchasing power will grow, driving the demand for labour in the economy. Due to automation development, a machine can be used to perform tasks that could previously only be completed by human work. This creates the aforementioned *substitution effect*. Automation also contributes to improving the efficiency of machines that replaced human work. This generates a similar productivity effect as the one described above. This is about the *deepening of automation*, which will improve capital efficiency and increase the demand for labour using such capitals.

The framework outlined above helps to structure what happens in the economy when automation picks up speed. It can be used to examine what the new balance will be like and how the transition into it will take place. The model can also naturally be used for considering policy measures. It indicates that more automation will take place in a free market than what is optimal for welfare. Without taking the negative effects of doing so into account, companies will substitute labour for machines as much as this is appropriate for the company. Distortions of capital taxation and shortcomings in the labour market will exacerbate the gap between the actual and ideal situation. Labour market rigidities and other ineffectiveness will further increase the tendency to substitute machines for labour in excess of what is rational. Capital taxation distortions will also have a similar effect. While inequalities will also grow during a transition period, the self-correcting mechanism of the economy described above will keep the long-term effects in check. From earlier episodes in history, including industrialisation in the 19th century, we know that the adaptation period may be rather drawn out. In other words, the economy may be afflicted by labour market disruptions, slow pay development and increased income gaps for an extended period. The development thus also contains the risk of long-term increases in inequalities.

Acemoglu and Restrepo's framework also offers a tool for seeking the reasons for the slowing of productivity growth described above. Lack of skills will become a barrier, but this will be about specific types of skills rather than general skills levels. Competence that was previously valued highly may become outdated very quickly. The demand for some capabilities will increase, will other skills will be less in demand. The labour market value of some workers' skills will decline, as many types

of skills gaps will be created. The education system will not necessarily be able to respond rapidly to such changes in demand.

As automation increases productivity, the same production can be achieved with a smaller labour input. The demand for labour will remain at the same level if production is stepped up. A saturation point in the demand for labour may be reached, however, even if product prices go down. On the other hand, technological advancement will enable the development of totally new products, and the labour force may transfer to producing them.

Policy measures and labour market institutions will influence not only the rate of automation but also the form it will take: to what extent it will be about replacing old tasks with machines, and to what extent about the type of automation that enables the creation of new tasks. The aim of innovation policy should not be speeding up automation. Instead, the priority of public measures should be research and development aiming to complement automation in order to speed up the creation of new and new types of tasks in the economy. Acemoglu and Restrepo highlight the importance of academic and applied research and stress the need to understand the societal factors associated with artificial intelligence development. They warn that due to political pressure, policy solutions may end up hindering technological progress and thus the development of welfare, unless the impacts on income distribution related to automation are taken seriously enough.[17]

It is extremely important to ensure that the transition will treat citizens fairly and reasonably. Failing to do so will result in eroding societal trust, which in recent years has been seen as societal protests both outside the political system and within it in elections and referendums.

The Nordic welfare society is clearly better placed to face the social risks brought about by the transformation of work than, for example, the United States. In Finland, this has been underpinned by both the government's social policy and labour market practices and by legislation that protects the weaker party. On the other hand, the obstacles created by various degrees of rigidities in the labour

17 Acemoglu, D. and Restrepo, P. (2018). Artificial intelligence, automation and work. National Bureau of Economic Research.

market will be highlighted in the conditions of a technological revolution, and the idea of transferring the focus on social policy and redistribution of income should thus be favoured. In this case, however, care must be taken to ensure that this will not become a factor slowing down adjustment to the change.

3.3 Digitalisation, the platform economy and the labour market

The most rapidly growing manifestation of the digital economy that mounts the greatest challenge to conventional business thinking is web-based trading venues, or platforms. The platform economy will create plenty of economic efficiency benefits and diversify the labour market through new modes of work. Similarly to trading venues, platforms also enable the meeting of demand and supply in an organised fashion and with low trading costs, and they thus are a tool for the efficient targeting of economic resources. On a platform, funding providers, product ideas and innovations can meet, enabling crowd financing and small investments in developing new ideas. Platforms today also offer a meeting place for jobseekers and employers, and they can be used to offer and find small on-call jobs. Platforms can be used to offer goods for those who need them, which enables not only the selling of second-hand items but also the shared use of many things.

The success of platforms is based on the network effect: each new user makes the platform more attractive. Digitality ensures that the network effects spread rapidly, increasing the scaling potential of platforms. In other words, digitality offers good preconditions for a productivity-enhancing change in company and workplace structures, or creative destruction. A prerequisite for this is that the other requirements for creative destruction, including competition between companies and smooth mobility of labour, are in place.[18]

As the platforms are digital, data is accumulated from all platform activities, offering a significant added value factor for the commercialisation or development of the

18 Maliranta, M. (2017). Tieto- ja viestintäteknologia, tuottavuus ja "luova tuho". In M. Lehti and M. Rossi (ed.), Digitaalinen suomi 2017 (s. 567-581). Vantaa: ERWEKO Oy.

actual platform or the building of third-party applications linked to it. Data is the capital of the platform economy, which cannot be used up; on the contrary, as it is used, it accumulates and is processed further. In addition to consumers, platforms are making their way to the B2B market.

As part of the platform economy, goods in private use, including houses and cars, can be integrated in the sharing economy. This creates a policy challenge: how should the rules on consumer protection, terms and conditions of work and insurance, taxation etc. be formulated to provide a level playing field in the markets between conventional activities and the platform economy? However, the more efficient use of resources that sharing results in cannot be considered a distortion. The platform economy is also associated with a significant risk of monopolisation. In that case, competition authorities and regulators must be up to their tasks. A level playing field is a key precondition for reaping the benefits generated by creative destruction.

3.4 Digitalisation and entrepreneurship

Digitality offers significant new opportunities for updating business models and improving competitiveness. This is why entrepreneurship policy must support the generation of new, innovative entrepreneurship on the one hand and create preconditions and incentives for the renewal of established companies on the other.

According to Statistics Finland, there were approx. 152,000 self-employed people aged 15–64 in the labour market in 2013. In 2000–2013, this figure increased by approx. 32,000. The greatest growth has been recorded in the number of sole traders (excluding farmers) and freelancers. In the last few years, the number of sole traders has increased by some 4,000–5,000 a year. The proportion of sole traders compared to employees grew in the aftermath of the financial crisis in 2008–2016, in particular. It should be noted that not all sole traders operate on a full-time basis. While the number of the self-employed has increased somewhat, it remains relatively small when the structure of the labour market is examined as a whole.

This group's total proportion of the employed aged 15–64 was some 6% in 2013, showing an increase of slightly over one percentage point since 2000.

Self-employment through enterprising is especially compatible with the platform economy and digitalisation development. Firstly, the platform economy enables non-hierarchic activity, even without an employer organisation. Platforms also make it possible for demand and supply to meet in an organised fashion and with low trading costs, and they thus are a tool for the efficient targeting of economic resources. Secondly, self-employment as an entrepreneur often is an efficient way of seeking operative flexibility and thus productivity growth.

Over the years, numerous working groups have considered the possibilities of creating a new category of so-called light entrepreneurs between employees and entrepreneurs. This category already exists in such countries as the Netherlands. In Finland, however, these efforts have proven fruitless. Risk-taking is part and parcel of entrepreneurship. Should the category of so-called light entrepreneurs be created, who would enjoy the security of employees and the possibilities of entrepreneurs, this could distort competition in the same way as if small companies were exempted from value-added tax. The line between employees and entrepreneurs is sometimes blurred, but replacing one boundary with three others would not necessary make things any easier.

Previously, a similar debate about the line between an employee and an entrepreneur was had in the context of agency workers. In the early 1990s, temporary agency work emerged in public discussion as a new phenomenon, and at that time, concerns were also expressed over the manner in which the new mode of working would be integrated in the labour market. The role of agency employers gradually changed to comprise legal activities in which the modes of having work performed and contractual rules became accepted. In the early phase, these activities were marked by questionable and even illegal features. The willingness of large operators who remained in the sector to shape its image as respectable and normal activity gradually resulted in a situation where the operation of the temporary agency work market is acceptable in terms of competition and respectable regarding terms of employment. The change of culture in the sector eliminated pressures to create a separate status for people engaged in temporary agency work and specific statutes on companies in this

sector. The current discussion about the so-called third category needed for work performed on platforms, or devising a new category between employees and entrepreneurs, reflects the poor level of development in the operating culture of platform economy work. As in temporary agency work, it is also possible to build legal business on the basis of the current classifications. While there is an obvious need for updates and adjustments in individual issues related to social security, it is hardly necessary to set up a whole new category.

In platform work, the algorithm used by the platform and changes made in it will affect the terms of work, whether you are in the position of an entrepreneur or a wage-earner. In other respects, working through platforms is associated with similar questions of taxation, social security and labour market position as in the case of any wage-earners, self-employed persons, sole traders, the unemployed or students who are thinking about accepting or giving up work. It is good to remember that in different stages of his or her life, the same person may have a number of different roles, some of them even simultaneously.

Clear rules, smoother transitions between different roles, and predictable decisions and outcomes concerning such aspects as social security, pensions and the net income are on people's wish list. These are goals that society should also aim for. They will be particularly important if working through platforms becomes a route to work, the labour market or entrepreneurship for an increasing number of citizens.

3.5 Digitality and well-being at work

Digitality already is a cross-cutting phenomenon in the Finnish world of work – not something that is on the horizon. For example, most members of the trade unions affiliated to the Central Organisation of Finnish Trade Unions - SAK also use other digital technology in their work apart from communication devices, or a mobile phone and e-mail[19]. Digitality has an even bigger impact on work in white-collar occupations. Additionally, many people have already become accustomed to

19 Miten uusi teknologia muuttaa palkansaajien työtä? SAK:n työolobarometri 2018.

effective digital services at home and at school and also expect to have them in the workplace to support their work.

The message from a number of different indicators is rather consistent: the level of well-being at work is on average higher than before in Finland, and higher than in our competitor countries. Well-being at work correlates positively with the quality

of leadership.[20] The average quality of Finnish leadership is also relatively good by many standards and by international comparison, but as has been observed in every country, there are great variations between companies.[21]

The impacts of digitality on well-being at work depend on leadership practices. Digitality increases the need to see to the employees' upskilling. Taking older employees into account when introducing new technologies is especially important. It has been observed that most older people in the position of employees are struggling to use technology, and they also are less motivated to learn to use new hardware and software than their younger colleagues. Unless sufficient attention is paid to this issue, the goal of extending careers is at risk.

Digitality makes it possible to improve the meaningfulness of the employees' work, but this strongly depends on the possibilities the employees have of influencing the purchases and uses of new technologies. In the language of the labour market, this is about employee participation. Successful employee participation is a precondition for the personnel seeing changes as meaningful and being motivated to use new technology in a way that improves productivity. The majority of workplaces have not succeeded in using technology optimally[22]. Smooth employee

20 Bloom, N., Kretschmer, T. and Van Reenan, J. (2009). Work-life balance, management practices and productivity. In International differences in the business practices and productivity of firms (pp. 15-54). University of Chicago Press.

21 See e.g. Maliranta, M. (2017). Johtamisen laatu, talouden uudistuminen ja tuottavuus: Arvioita Suomen tilasta. Työpoliittinen Aikakauskirja, 60(2), 33-49; Maliranta, M. and Ohlsbom, R. (2017). Suomen tehdasteollisuuden johtamiskäytäntöjen laatu. Research Institute of the Finnish Economy, ETLA raportit No. 73. Jokinen, J., Sieppi, A. and Maliranta, M. (2018). Johtamiskäytäntöjen laatu suomen ammatillisessa peruskoulutuksessa. Kansantaloudellinen aikakausikirja, 114(2).

22 SAK:n luottamushenkilöpaneeli, kevät 2018.

participation has close links with the workplace culture, in which leadership plays a crucial role.

It is natural to think that the quality of leadership is accentuated at the time of a technological revolution, as companies have more urgent needs to renew themselves. Good leadership is a factor that improves both productivity and welfare, thus creating a positive correlation between productivity and well-being at work. In a competitive environment companies have incentives to develop leadership, as it improves productivity and profitability. Good productivity also requires a skilled and motivated workforce, and in a competitive environment it is thus economically profitable for companies to invest in well-being at work.[23].

The possibility of using digitality in all sectors and almost all workplaces is a positive trend. Workplace practices and culture form a filter through which technology is implemented. Leadership and well-functioning work communities play a crucial role in this. From the public policy perspective, work communities should be supported, as deficient technology implementation will undermine working life quality and the potential of digitalisation.

3.6 Policy recommendations

The starting point of the recommendations is that technology does nothing by itself; things are done by people, individually and together. Rather than what is technologically possible, the essential point is what is also expected to be profitable and desirable. The use of artificial intelligence and digitalisation enables a productivity leap, but this leap can and should be taken without impoverishment in society.

23 Maliranta, M., Jokinen, J. and Sieppi, A. (2018). Johtamiskäytäntöjen tutkimus: Havaintoja suomen ammatillisen peruskoulutuksen oppilaitoksista ja teollisuuden toimipaikoilta. Labour Institute for Economic Research, Talous & Yhteiskunta 2/2018.

An effective labour market will be more important than ever

1. When new technologies are introduced, an effective labour market will be more important than ever. Measures are needed to promote the transition of those who are employed to tasks and jobs that are a better match with their skills and more productive, in a manner experienced as secure. Change should appear more attractive than preserving status quo. This way, the nation's skills can be used better, and vacancies will also become available for new entrants in the labour market. In order to promote labour mobility, employment services should also be offered to the employed. Concrete measures could include a notification service of suitable vacancies implemented using artificial intelligence and directing employment services to not only the unemployed but also those already in employment. Complementary income transfers or pay subsidies could also be used more, as is done in Sweden.
2. In an era of a technological revolution and transformation of work, the harmful effects of an ineffective labour market are exacerbated. On the other hand, employees' need for security and fair treatment is increased rather than reduced. If the current means for achieving this become more costly, it would be justified to consider new means for ensuring security. The security offered for employees by labour market rigidities can be made up for by strengthening the social security and education systems. From workers' perspective, secure transitions between jobs enable the requisite labour market dynamics.

Public support should not lead to market distortion

3. In the reconciliation of earned incomes and social security, solutions should be avoided that put sole traders in a better position than SMEs competing with them, for instance, or otherwise distort the market function, hampering

productivity-enhancing change in business and job structures, or creative destruction.

4. The positive impacts on productivity of such revolutionary technologies as artificial intelligence are born from creative destruction with which the government should not interfere. Some companies will not be able to take up the possibilities offered by the technological revolution. While public policy may promote the preconditions for taking up technologies, public funds should not otherwise be spent on subsidising such companies.

No need for a regulated new category between entrepreneurs and wage-earners

5. Setting up new categories in between entrepreneurs and employees is not recommended, as they could easily blur the roles of these actors vital for the national economy in a manner that would distort entrepreneurship. New categories can also easily create new marginalised groups. Instead, the current social security system should be improved, providing for smoother transitions with more predictable consequences between different roles in the labour market, including studies and unemployment.

A workplace development plan to promote complementary artificial intelligence innovations

6. In years to come, the greatest impacts of the transformation of work and technology will be seen in the workplaces, and they should thus be at the core of development and the measures that support it. It has been estimated that when new technologies and ways of organising work are used, work content, practices and the required skills and leadership will be gradually renewed in all sectors and work communities and all types of tasks. Programme-based and long-term working life development should thus be continued in Finland, and it should be linked to innovation

policy with the aim of promoting artificial intelligence innovations that complement human work.

Back to basics in innovation policy

7. It is recommended that rather than accelerating automation development, innovation funding should increasingly be targeted at innovations that generate new types of production, as they create new tasks and jobs. For example, organisational and social innovations needed for the successful utilisation of new technologies should be supported.
8. The central government should encourage multidisciplinary and versatile research with closer links to basic research which also builds up cooperation between universities, companies and public organisations. Eligibility for support should depend on the level of ambition and viability of the innovation, not such criteria as company size. The level of research and innovation funding should be increased, and Finland's R&D investments should reach 4% of the GDP by 2030 as recommended by the Research and Innovation Council.
9. The universities' performance guidance and incentive scheme should be updated to create clear incentives for participating in cooperation and network projects and commercialisation of research. Experience has shown that R&D funding should be increased gradually through a multiannual programme requiring commitment.

4 Learning and skills in a transition[24]

4.1 Impacts of artificial intelligence on skills

The utilisation of general-purpose technologies based on artificial intelligence in society will change the world of work and the skills needed in it extensively. Issues related to competence and learning will then unavoidably emerge. General-purpose technologies have also had diverse impacts in earlier times: while they have been used to develop working methods and efficiency, they have also created new markets and services.

In addition to skill requirements, these impacts extend to learning itself. This can be illustrated by imagining a situation where no electricity would be used in the learning environment. The use of electricity was introduced gradually: first came lighting, which naturally had an important effect. The other impacts really only became visible when the use of audiovisual materials or computers in teaching began. Major impacts have only become apparent now as we transition to digital learning environments.

It is good to realise how late electricity, for instance, started having more in-depth significance in learning situations. This example shows how long it may take before new general-purpose technologies have a more significant effect on human activities, such as learning. The impacts of technology have been felt radically faster in work and skill requirements than in learning. In the case of artificial intelligence, the impacts may materials at an equal rate in the economy and the labour market

24 The authors of this Chapter are working group members Vesa Vuorenkoski, Anita Lehikoinen, Tuulia Hakola-Uusitalo and Penna Urrila.

as in learning, as artificial intelligence is particularly useful in terms of learning (Brynjolfsson, Rock & Syverson 2017).

4.2 About skill requirements

Technologies based on artificial intelligence frequently improve the efficiency of tasks performed by humans and thus productivity. Machine learning and artificial intelligence are particularly useful in tasks in which analysing big data and pattern recognition are required. While artificial intelligence facilitates and may even replace individual tasks, it probably cannot be a substitute for entire occupations or persons carrying out the work on a particularly rapid schedule. AI-based technologies have so far only replaced routine, highly structured and repetitive tasks (Brynjolfsson & Mitchell 2017).

Workforce skill requirements are influenced by changes in the demand for labour in the labour market. In the future, we can expect the demand for labour to reduce first in occupations where a large proportion of tasks can be performed by AI-based technologies. On the other hand, the demand will grow most strongly in tasks focused on developing artificial intelligence or its applications. In terms of the overall impact, the number of meaningful occupations generated in which human work and artificial intelligence complement each other will also be important. These new occupations will require new combinations of skills. The changes occurring in skill requirements have been approached in at least four different ways. (Acemoglu & Restrepo 2018, Brynjolfsson & Mitchell 2017)

Firstly, skills related to tasks that will be replaced by artificial intelligence will become useless for humans, at least in practice if not necessarily at the theoretical level. This is associated with the question of which skills will be difficult to replace by AI-based technologies and which tasks artificial intelligence will perform better than humans. We should work on not only people's preparedness for change and learning but also companies' preparedness to renew themselves and to support the upskilling of their employees. Society's formal education system should also support continuous development of skills and lifelong learning.

Secondly, the skill requirements associated with artificial intelligence will change as AI use increases. If and when artificial intelligence is used extensively to replace and complement human work, employees must still understand what tasks AI is performing on their behalf, and they must learn to use the artificial intelligence that performs the tasks in question. In order to use learning systems, we may also have to teach them. Even if teaching an AI-based system were not necessary, its operation and efficient use requires an understanding of its operating principles, as is the case with any tool.

Thirdly, work improved by artificial intelligence may provide the person performing it with an opportunity to achieve something else with the work input replaced by artificial intelligence. Workers will have an opportunity and a need to improve their skills in order to produce new added value. This means that the tasks contained in occupations will be diversified and developed. Companies should be able to adapt their employees' job descriptions in cooperation with the employees. Regulation related to occupations should also be examined from the perspective of this development.

Fourthly, artificial intelligence will also change the skill requirements more directly. The wider spread of artificial intelligence will certainly create a great number of jobs that we cannot anticipate yet. This has happened before as a consequence of general-purpose technologies. New occupations with new and as yet unknown skill requirements will be created. The best way of responding to a change of this type is ensuring the sufficient flexibility and ability to respond of systems related to developing society and skills. Learning is possible if citizens have a good level of basic skills and a broad knowledge base.

It is not likely that artificial intelligence will replace humans in tasks that require versatile communication, expressing emotions, drawing on intuition or creativity, or understanding culture and human actions. Applying artificial intelligence is also difficult when the operational situation requires extensive application of general knowledge or background information. Teaching machines or artificial intelligence has so far also been a task for humans. As machine learning advances, the tasks based on skills listed above will no longer necessarily be completed outside the realm of AI application. The launch of large-scale AI use will only take a little longer in the case of these skills. (Brynjolfsson & Mitchell 2017)

Understanding the way in which the nature of skill requirements will change is important because the new requirements brought about by artificial intelligence will at least to some extent be incompatible with the current skills of the workforce. It has been suggested that this incompatibility will slow down the growth in demand for labour, increase inequalities and reduce productivity growth. (Acemoglu & Restrepo 2018)

The incompatibility of the workforce's current knowledge and skills with the demand will lead to an increased need for labour mobility. Different legal barriers and obstacles related to social security and skills for moving between jobs should be dismantled and replaced by bridges that facilitate doing so, and security should be improved. In terms of skills, this means that education programmes strictly producing specialised competence in a specific field must be cut back. In addition to highly specialised competence, education should also offer capabilities for learning new things.

In the midst of major structural changes of the economy, great alterations often take place in the value of competence, or human capital. Many skills that a moment ago were a guarantee of good pay and appreciation may even become completely useless as a result of technological development. Economic history can provide numerous examples of this. Individuals themselves in many cases have the best understanding of their skills. Employers, on the other hand, have the best knowledge of changes in skill requirements. Consequently, we should consider how power over and responsibility for maintaining human capital could be decentralised in a sustainable and acceptable manner. A more effective education market should be devised for the purposes of lifelong learning.

4.3 Learning is changing

It is likely that artificial intelligence will also change the ways in which we learn. It will help to address individual differences in learning better and assist learning (Acemoglu & Restrepo 2018). Artificial intelligence and digitalisation will make it possible to offer individualised teaching of a good standard to a larger group of people at a lower cost.

In learning support, AI-based technologies offer possibilities against which it would be difficult to compete with conventional methods. Similarly to the digital systems that have now been introduced in teaching, AI-based systems will be used to support learning in the future. Those education systems that can apply artificial intelligence the most productively to supporting learning will be successful.

4.4 The Finnish education system and artificial intelligence

Renewal at different levels of the public education system is slow, for justified reasons. Consequently, the ways in which the education system can be updated to respond to the challenges created by increased artificial intelligence use should be addressed at an early stage.

While artificial intelligence and automation will replace skills in the tasks of all workers, lower education level tasks are still expected to be the most severely affected by the change. The education system must be modified, both vocational education and training and higher education. Additionally, more investments should be made in updating the skills of workers already in the labour market, and the lifelong learning system should be reformed. (Ministry of Education and Culture 2018)

More funding alone is not a sufficient response to renewing the education system in the face of the requirements brought about by artificial intelligence. The diversity of education programmes should be increased, adding to them modules that enable the use of new technologies and artificial intelligence and the complementary use of AI.

More emphasis should be placed on skills of the AI era, including communication and social skills as well as cognitive skills that require creativity. In addition, as AI technologies are being developed, the education system should offer studies that develop mathematical skills comprehensively and, in particular, encourage not only boys but also girls to pursue studies in mathematical and technical fields.

Increased flexibility will be needed in the education system to ensure that the offer of teaching can respond faster to the new and changing demand in the labour market. Education must be reformed by offering programmes that support students' freedom of choice and mobility, in which AI technologies are used to support learning. It should be possible to complete studies as modules, from which students could select the ones most useful for them. Ensuring broad access to higher education studies both for young people and those already in the labour market will be especially vital.

Vocational education and training should be changed dramatically by integrating new skills in it, facilitating the possibilities of those pursuing vocational studies of also studying in higher education programmes, increasing freedom of choice and flexibility in terms of content, enabling student mobility between education programmes, and encouraging workplace contacts. (Haapakorpi 2018). While major changes are needed in vocational education and training contents, teaching methods should also be updated.

Additionally, higher education programmes should be modified to respond to the changing skill requirements described above. Young people starting in higher education in 2020 who have completed their matriculation examination in a digital format may still be at working age and able to work in the 2070s. By that time, a number of current occupations will have changed so radically that workers fulfilling today's skill requirements will no longer be able to cope.

Funding for higher education institutions will be developed by expanding the funding basis. It must also be possible to lower costs through AI technology use. The emphasis of resources use should be shifted from premises to offering teaching of a new type, technology use and research.

It has been estimated that in the future, up to one million people in the Finnish labour market should receive continuing training or re-training. The education system should thus offer the working-age population modular opportunities for lifelong learning that are much more flexible, efficient and of a higher quality than today. When developing lifelong learning, we should take into account the fact that young people completing their basic education today may have gaps in their knowledge and skills and that a large proportion of adults have insufficient basic

skills for lifelong learning. Reforms at multiple levels will thus be needed to develop lifelong learning.

4.5 Employers' investments in upskilling

A major share of people's skills are based on on-the-job learning. Artificial intelligence will first be utilised in employers' activities, and employers together with employees will discover the incompatibility between the currents skills and the new skill requirements.

Employers' responsibility for upskilling will grow as, in the context of AI utilisation and specification of the skill requirements related to it, employers are best placed to assess the exact needs for new skills. In this connection, we should note that it is in an individual company's interest to train employees based on their own needs, and companies' training investments are as such insufficient to meet the workforce's training needs. On the other hand, the advancement of technology will lead to more and more new technological and service standards that will enable improved comparability of workforce skills in the labour market.

Successful companies will have made skills development a key part of their strategic management. A precondition for this is higher awareness of changing markets and the potential for new technologies based on artificial intelligence. In terms of digitalisation, it has been observed that excluding start-ups, SMEs are slow to take up new technologies.

4.6 Humans and learning

The wider spread of AI technologies will render some of the tasks performed by humans today unnecessary and, in some cases, these technologies may even fully replace humans in certain jobs. The working-age population will experience a need to update their skills if they intend to stay in the labour market. The great question thus is how to motivate people to continue learning throughout their lives. In the

current political debate, initiatives have been proposed to extend compulsory education to the secondary level. Should we then launch a debate on compulsory lifelong learning?

In any case, learning will become a key coping skill for humans that will increase their likelihood of remaining in the world of work. When creating education systems of the future, methods that stress the themes of responsibility, self-regulation and willingness to learn should be emphasised.

Provision of incentives for learning cannot be limited to the education system, however. The social security system will also play a key role in encouraging learning, and this system must also be geared to supporting, encouraging and enabling lifelong learning.

4.7 Policy recommendations

Elementary skills in preparation for the artificial intelligence era for everyone

1. Artificial intelligence will change the content of occupations and jobs. A risk of exclusion of those with a lower level of education and an increase in structural unemployment is always inherent in structural changes. In order to prepare for the changes, it should be ensured that young people completing their basic education have general knowledge and skills which give them eligibility for further studies and promote lifelong learning. In order to combat high structural unemployment in the future, a competence programme will be drawn up, which will ensure in practice that everyone will have at least a secondary level qualification. In addition to providing more places in education and training, compulsory education will be extended to the secondary level.

High-quality vocational education and training

2. Artificial intelligence will have extensive impacts on occupations, and the quality of vocational education and training should also be improved to respond to the new requirements. In vocational education and training, mobility between education programmes and participation in third-level studies will be enabled for students. Contacts between workplaces and vocational education and training will be promoted by enabling overlaps in vocational teaching and work, also using apprenticeship contracts.
3. More extensive knowledge and skills will facilitate adaptation to changes in occupations. Opportunities for expanding qualification contents will be integrated in education programmes. The aim is to avoid highly specialised competence in an excessively narrow field. AI era competences will be included in the education programmes of different fields, including communication and social skills.

Higher education

4. Education and research programmes for developing and applying AI technologies will be set up.
5. Taking studies structured around modules should be enabled, thus providing more flexibility and freedom of choice for students. Additionally, a comprehensive range of studies that improve mathematical skills should be offered, encouraging especially girls to pursue studies in mathematical and technical fields more often.

All levels of education

6. Use of technology in education should be promoted at all levels with the aim of offering more individualised education content of a higher quality in a cost-effective manner. Incentives for using artificial intelligence to support learning could be created for education providers.

Reform of lifelong learning

7. Finland may be facing an immense education and training challenge as the skills and competence of an estimated one million working-age adults must be updated along with changing occupational structures. In order to respond to this challenge, a lifelong learning reform has to be planned, with the aim of reforming the education system and offering working-age adults diverse, flexible and faster opportunities for lifelong learning.
8. To promote lifelong learning, a skills account or voucher could be created for all working-age people, which they can use to update their skills and purchase the training they need from training service providers. Employees, employers and society have shared responsibility for upskilling the workforce. At the beginning of 2019, the Unemployment Insurance Fund and the Education Fund will merge to form the Employment Fund. The administration of skills accounts or vouchers and tasks related to developing the market for lifelong learning might be assigned to the Employment Fund, while also ensuring that the unemployed and working-age people excluded from the labour market have the right to upskilling. The details of the system would be worked out appropriately as part of the reform. Entrepreneurs should also have equal rights to upskilling.

Brynjolfsson, E.; Rock, D. ja Syverson C. (2017). Artificial Intelligence and the Modern Productivity Paradox: A Clash of Expectations and Statistics. National Bureau of Economic Research, Working Papaer No. 24001

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5 Good application of artificial intelligence technology and ethics[25]

In its most unassuming form, good application of technology means being aware of the potential negative impacts or problems associated with it and applying the technology accordingly. The most ambitious definition also includes a conscious attempt to use technology to promote certain societal goals regarded as valuable. We start out discussion with the more ambitious goal.

We look at the criteria based on which good application of technologies can be assessed and the ethical perspectives which are associated with technology application in more general terms. The primary object of our scrutiny is AI technology that can be considered to have features of a so-called artificial agent. This concept refers to software, systems, machines and devices as well as the technologies underpinning them that possess autonomous intelligence, or an ability to act and learn through experience and interaction, also without the direct intervention of humans or other actors. Examples of artificial agents are learning algorithms that make decisions, intelligent robots, autonomous modes of transport and many other learning machines and devices featuring advanced automation. In particular, we look at viewpoints which concern the good application of AI technology in the workplace.

25 The authors of this chapter are working group members Tuomo Alasoini, Antti Koivula and Leila Kurki.

5.1 Why do we need debate on good application and ethics?

"Ultimately the question is not only what computers can do. It's what computers should do."

Brad Smith & Harry Shum, in "The Future Computed: Artificial Intelligence and its role in society", 2018. Microsoft Corporation, Washington.

Artificial intelligence technology is disruptive: it revolutionises older practices. It is used to create new solutions which render old technologies and methods unnecessary and change the markets, earning models and modes of leadership, organisation and work based on them. We are living through a revolution where AI-based applications are becoming more common at an accelerating rate. Today's solutions point the direction in ways that may well have highly significant economic, social, political and cultural impacts on the development of societies extending well into the future. These impacts are multiple and, due to their dynamic nature, difficult to anticipate.

Crucial questions include the extent to which this will take place on a commercial basis and driven by companies' business logic, and the extent to which the government will attempt and be able to influence the development. The ways in which the government exerts influence may include education, research, working on attitudes, public procurement or even more direct interventions. The government's possibilities of influencing the way in which technology will be taken up and applied and the rate at which this is happening will, among other things, depend on whether or not a societal vision steering this development can be achieved. The vision should have sufficient political weight and extensive political endorsement. This vision of a good artificial intelligence society should contain values that inform technology use and application, and principles, rules and practices derived from the values.

The issue of a good artificial intelligence society has been touched upon in many reports on AI application. As far as we know, however, none of them has directly attempted to put together a strategy or an action plan aiming for a comprehensive good artificial intelligence society. The reports have often highlighted transparency, responsibility and extensive societal benefits as the values of a good artificial intelligence society. However, detailed definitions of what these mean in practice

and as measures from the perspective of different actors and regulation systems have rarely been put forward in the debate.

5.2 Values of a good artificial intelligence society

In the following sections we analyse what the aforementioned three values could mean in practice in terms of the good application of artificial intelligence in the Finnish world of work.

Transparency

Among other things, transparency refers to openness regarding 1) what data are collected and for what purpose (to underpin decision-making based on artificial intelligence), and 2) what the aim of the algorithms supporting and making decisions is. The employees of work organisations using artificial intelligence in decision-making should also be aware of this. In terms of the transparency of decisions made in a work organisation, it makes no difference in principle if the decisions are made purely by humans, by an algorithm, or by some combination of these two. The importance of transparency of algorithms is accentuated in a very special way in the decision-making of public organisations, where the decisions in many cases concern citizens' statutory rights and obligations.

Another crucial feature associated with transparency is the possibility of tracing the purity and integrity of the data underpinning decision-making based on artificial intelligence and the grounds for making decisions. This is vital for a number of reasons, which include potential errors or structural biases contained in data or the decision-making process, legal protection of those the decisions concern, clarification of responsibility issues, principles of transparency contained in democratic decision-making, safety-related perspectives (for example, the possibility of humans to intervene in the operation of autonomous learning technology), and building up technology developers' expertise regarding the logic of the operation and learning of intelligent machines. The requirement of traceability is highlighted as the functions become more security critical. Particularly accurate traceability should be required in functions directly concerned

with human health and safety. These applications of artificial intelligence are found especially in healthcare, transport, energy production and national defence.

A machine is not a normative learner in the same sense as a human. It is not directed by an idea of learning that is morally correct, or the importance of absolute truth over statistical truth. As deep neural networks and in-depth learning develop, it will be more difficult to get at the grounds of individual decisions made by a machine due to the non-linearities generated in the system. In this case, rather than the grounds of decisions made by individual algorithms, the requirement of traceability focuses on comprehensive understanding of the operation of the entire neural network system.

The problem of traceability can partly be responded to by clarifying the rules of when a machine makes the actual decision and when only a prediction that supports final decision-making by a human. The more security critical the activity and the more difficult to trace the decision, the higher the threshold should be for a machine making independently a decision on the basis of which action is initiated. However, the point of departure in all cases is that humans assume ultimate legal and moral responsibility for the decisions.

Responsibility

Among other things, responsibility means that decision-making based on artificial intelligence does not pose a threat to anyone's health or safety. This requirement applies to an individual's physical and psychological health as well as data protection and protection of privacy. The requirement of responsibility also means that decision-making may not exacerbate structural inequalities found in society or otherwise do injustice or damage or cause suffering to individuals or groups of people. One way of influencing this is promoting the diversity of artificial intelligence developers and other experts. Without sufficiently strong guarantees of responsible decision-making based on artificial intelligence, it is difficult to imagine that the citizens would support the government's attempts to promote the introduction and application of AI technology and innovations based on it.

Responsibility can also be examined from a broader perspective. In situations where society's resources are used to promote AI solutions, society should also

assume a particular responsibility for any resulting job losses. In a market economy, creative destruction brought about by new technological solutions is a normal, and to some extent even desirable, phenomenon as such. If society wishes to consciously promote breakthroughs and solutions based on artificial intelligence, however, it is not fair that people who are affected negatively by these solutions are left without society's special support – after all, they have funded the promotion of these solutions through their taxes.

Extensive societal benefits

Extensive societal benefits mean that AI-based solutions benefit all groups in society. This value should be a key guideline informing all government support for the development of AI technology and applications based on it. The threat to social cohesion caused by an uneven distribution of benefits, which manifests itself as growing income and wealth gaps, is a significant cause for concern. A happy medium should be found in regulation exercised by society and the promotion of extensive distribution of the benefits where excessive restrictions will not reduce incentives for innovation provided for companies and researchers. At the same time, it should be possible to ensure citizens' approval and support for government measures aiming to promote AI technology through income transfers or other mechanisms of sharing the benefits.

It is vital to make an active effort to grasp the opportunities provided by artificial intelligence to develop the world of work. The automation of individual work functions will create opportunities for thinking, organising and shaping tasks in ways that may be radically different. Technology as such will not determine whether the trend will be towards combining the remaining work functions performed by humans into more demanding, diverse jobs that promote humans' opportunities for learning and developing, or increasing fragmentation and depletion of work content. It is important that this room for manoeuvre contained in the technological revolution for developing task content and the entire world of work will be recognised and discussed at the level of the whole society as well as individual work organisations. Ultimately, this is about whether technology will be assigned the role of serving and empowering humans at work, or vice versa.

Influencing the decisions made by large, international technology companies from Finland is difficult. It is crucial, however, to be able to develop technological and work-related competence in Finland that can be used to influence the decisions made by work organisations operating in this country. In this context, Finland can also strengthen and promote regulative initiatives related to digitalisation and artificial intelligence put forward in Europe.

5.3 Policy recommendations

In addition to its far-reaching social impacts, the ethical viewpoints associated with artificial intelligence should also be taken seriously, as they will directly influence companies' business. The values guiding companies in the development and use of artificial intelligence may in the future become highly important factors affecting companies' brand value. The leading companies in the sector have already understood this. For these reasons, the ethical viewpoints related to AI technology should be an important object of technological, business management and political science research in the future, both in Finland and internationally. Finland should also actively promote international research cooperation concerning the ethical viewpoints of artificial intelligence, information exchanges relevant to this theme and the mainstreaming of good practices as well as serve as a pioneer of ethical discussion in the implementation of the EU's artificial intelligence initiatives.

Due to the complex disruptive societal impacts of AI, rather than leaving the definition of a good artificial intelligence society to companies, experts of the field and policy-makers, ordinary citizens should also be able to play an active part. The best way of supporting extensive participation is building up citizens' understanding of AI technology – its operating principles and potential – as a new civic skill that covers all groups of citizens.

Key policy recommendations:

1. The Finnish artificial intelligence strategy should build on the existing ethical value base of our society, which stresses trust and communality. Monopolistic and state-controlled

practices, for example, should not be adopted. The Finnish model relying on the European democratic tradition could serve as an example of a good practice in the EU and globally. A parliamentary monitoring group should be set up to promote the ethical value base of artificial intelligence more extensively in society, and to monitor and evaluate pilots and technology development associated with the ethical aspects of artificial intelligence. The group should also support the creation of rules and assess practices in the context of defining responsibilities in situations where a machine is making decisions autonomously.

2. The ethical value base associated with artificial intelligence should aim for the common good. In practice, however, the value base will be defined individually for each application area. A key area of AI ethics currently is the secondary use of social welfare and healthcare data, in which ethical rules are being formulated, also for more extensive use. Ethical AI will be piloted in the healthcare ecosystem, for example as part of the health sector growth strategy. The task of testing the ethical use of artificial intelligence in occupational health care will be assigned to the Finnish Institute of Occupational Health.
3. The models for ethical rules currently stem excessively from business models based on social media. B2B cooperation and business are a great opportunity for Finland, and it's a field whose ethical rules have not yet been specified so much. In cooperation with the Ministry of Economic Affairs and Employment and businesses, a group of B2B companies making strong investments in artificial intelligence will be put together to jointly formulate key rules for the B2B sector and to create a foundation for a centre of excellence associated with this task.
4. In the development and use of AI technology, attention should be paid to societal heterogeneity and participation. Diversity should be promoted – including different educational backgrounds, linguistic and ethnic

groups, genders and age groups – among AI developers. It should also be ensured that citizens have capabilities for participating in broad-based discussion on the artificial intelligence society. General understanding of the potential generated and challenges created by artificial intelligence should be built up.

5. Obligations may also be imposed on platforms. The EU General Data Protection Regulation (GDPR), which became valid recently, shows that obligations and prohibitions may also be imposed on major global platforms. The prohibition may also apply to a certain part of an algorithm when it distorts or groundlessly restricts competition or is unreasonable from the perspective of those working through the platform. Platforms could also be required to ensure that the income earned through them is reported to the Tax Administration.
6. Trust, appreciation and cooperation have been keys to the success of our small nation before and may be again when we transition to artificial intelligence use. The impacts of a new technology of this type often are unexpected, at least in part. Consequently, it often makes sense to update regulation concerning new technology only after experiences of using it have been gathered. This has also been done before. In Finland, we have every reason to continue trusting our national institutions and their ability to make the required decisions. Plenty of positive experiences of experimentation policy have been gathered in recent years in different areas of society, and stepping up experiments concerning artificial intelligence would be justified.

Appendix 1. Composition of the working group

Chair:	Osmo Soininvaara	Aalto University
Members:	Tuomo Alasoini	Business Finland, from 1 June Finnish Institute of Occupational Health
	Juha Antila	Central Organisation of Finnish Trade Unions (SAK)
	Merja Fischer	Staria
	Tuulia Hakola-Uusitalo	Ministry of Finance
	Niilo Hakonen	Local government employers
	Lauri Ihalainen	Parliament
	Seija Ilmakunnas	Labour Institute for Economic Research
	Anu Järvensivu	University of Jyväskylä
	Antti Koivula	Finnish Institute of Occupational Health
	Mikko Kosonen	Sitra
	Mika Kuismanen	Federation of Finnish Enterprises
	Taina Kulmala	Prime Minister's Office
	Leila Kurki	The Finnish Confederation of Professionals (STTK)
	Ville Kyrki	Aalto University
	Anita Lehikoinen	Ministry of Education and Culture
	Mika Maliranta	Research Institute of the Finnish Economy
	Susanna Siitonen	Ministry of Economic Affairs and Employment
	Penna Urrila	Confederation of Finnish Industries
	Vesa Vuorenkoski	Confederation of Unions for Professional and Managerial Staff in Finland Akava
Facilitators	Kai Husso	Ministry of Economic Affairs and Employment
	Olli Koski	Ministry of Economic Affairs and Employment

Appendix 2. Definitions of artificial intelligence

A short discussion on the definition of artificial intelligence

In the 1950s, Alan Turing asked if machines can think. His definition of an intelligent machine was acting in a manner no different from a human. Following this definition, intelligence can be defined based on functionality. No single and generally applied definition of artificial intelligence exists, however, but a frequently used one is a system's ability to operate in a goal-oriented fashion and anticipate its environment. In practice, however, this definition is not anywhere near covering all systems termed artificial intelligences. The variety of definitions means that accuracy is needed when interpreting studies, and in many cases, artificial intelligence is used as a synonym for digitalisation.

Artificial intelligence as an enabler of automation

One of the key societal impacts of artificial intelligence is likely to be the automation of tasks and functions it enables. Automation can be divided into the automation of information processes (information work) and physical processes (physical work). In a near future, artificial intelligence (in addition to other digitalisation) will probably have the most powerful impact on information processes, as a number of strongly repetitive physical tasks have already been automated, and the level of the technology will not be sufficiently high for more varied tasks, for instance those of a carpenter, even over the medium term. In sectors seeing a high level of investment, for example in automated vehicles, the technology is likely to mature faster, and a revolution is possible also in physical tasks over the next ten years. It should be noted that automation does not necessarily require artificial intelligence, as automation is facilitated by digitalisation in its different forms.

About AI technology

At the end of the day, artificial intelligence is a computer program. The recent artificial intelligence boom is for the greatest part due to the growth in computing capacity and the volume of data in digital format. These aspects are thus influencing the possibilities of using artificial intelligence in different application areas, and a number of international major companies are currently grabbing both computing capacity and data almost aggressively.

Intelligence in machines, as in humans, is a complex property. The majority of the abilities offered by artificial intelligence can be divided into detection (e.g. pattern or speech recognition), building of internal models (e.g. observing interdependencies), and decision-making. In addition, other more application-specific abilities include processing natural languages (e.g. machine translation), mobility (e.g. robots) and computational creativity.

As we have seen, the current AI systems consist of specialised components for each subproblem. This also applies to such systems as the IBM's Watson, which has different modules for various subproblems. Strong general-purpose artificial intelligence almost reaching the human cognitive level is not within our sights even over the medium term.

Typical decisions that can easily be made by artificial intelligence include those that humans can make quickly and instinctively if enough examples of similar decisions are available. These decisions include many image recognition problems. What artificial intelligence finds particularly difficult are problems where a new solution must be found for a known problem. Problems containing plenty of variation are also difficult, as sufficient example data for machine learning is usually not available.

Work in the age of artificial intelligence -report

The report Work in the age of artificial intelligence is part of the Artificial Intelligence Programme set up by Minister of Economic Affairs Mika Lintilä. The programme's steering group was chaired by Pekka Ala-Pietilä. A working group on the transformation of work and society, chaired by Osmo Soininvaara, Lic. Pol. Sc., wrote the report.

The report is a collection of four main articles that discuss (1) the effects of artificial intelligence on general economic and employment trends; (2) the transformation of work and the functioning of the labour market; (3) reforms on education and skills maintenance; and (4) ethics.

Artificial intelligence is a general-purpose technology that changes working life and society extensively. It opens the possibility for rapid productivity growth across the economy and for a higher standard of living. To harness the potential of artificial intelligence, society must invest in updating workers' skills, facilitating workforce mobility and generating innovations that complement human labour. The importance of a well-functioning labour market will be even greater.

One of the working group's proposals for further preparation is a lifelong-learning reform where every person of working age would be given a skills account or voucher that they could use to update their skills by getting the necessary training from providers of training services. Employees, employers and society together would bear responsibility for updating workforce skills. This would create a demand-based market for education and training.

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