The Effects of Digitalisation on Different Industries and on the Region – Case Lapland

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The public discussion on the possibilities of digitalisation in the northern region varies from the proclamation of endless possibilities to extreme pessimism. We decided to find out how the clusters representing the industries in Lapland see the effects of digitalisation in their own industries. We approach the subject by first examining the development of digitalisation and technology in Finland and the global economy. We add depth by presenting the opportunities Lapland has as a region and an operating environment in a changing world. We collected the views industry clusters have on the subject during the spring of 2016. We wanted to keep the information gathering as informal as possible, so we chose the method of free-form discussions as part of cluster meetings. The discussions convey a concrete, albeit slightly cautious idea of how digitalisation currently manifests itself in the industries, and what kinds of changes are expected in the future. The article is part of the 'Work of the future in Lapland' report, prepared as an action of the Northern Cooperation of Foresight project (2015–2018).

1. Introduction

The 'Digitalisation Era' began in the early 1970s when the 'Intel 4004', the first microprocessor for commercial use integrated on one silicon chip, was launched (Koski et al. 2001). This started a development with effects on productivity, economic growth, and demand for labour which are a topic of fervent discussions around the world. According to some views, the largest benefits of digitalisation have already been seen, and the effects are running out (Gordon 2012). If this is true, no major changes are to be expected in the labour market. According to the opposite view, only a fraction of the possibilities offered by digitalisation and technology has been seen thus far. If this is the case, the development will greatly change the demand for labour and cause an even greater change on the labour market than has already been experienced. If this scenario becomes a reality, a majority of the current tasks can be automated (Kauhanen et al. 2015).

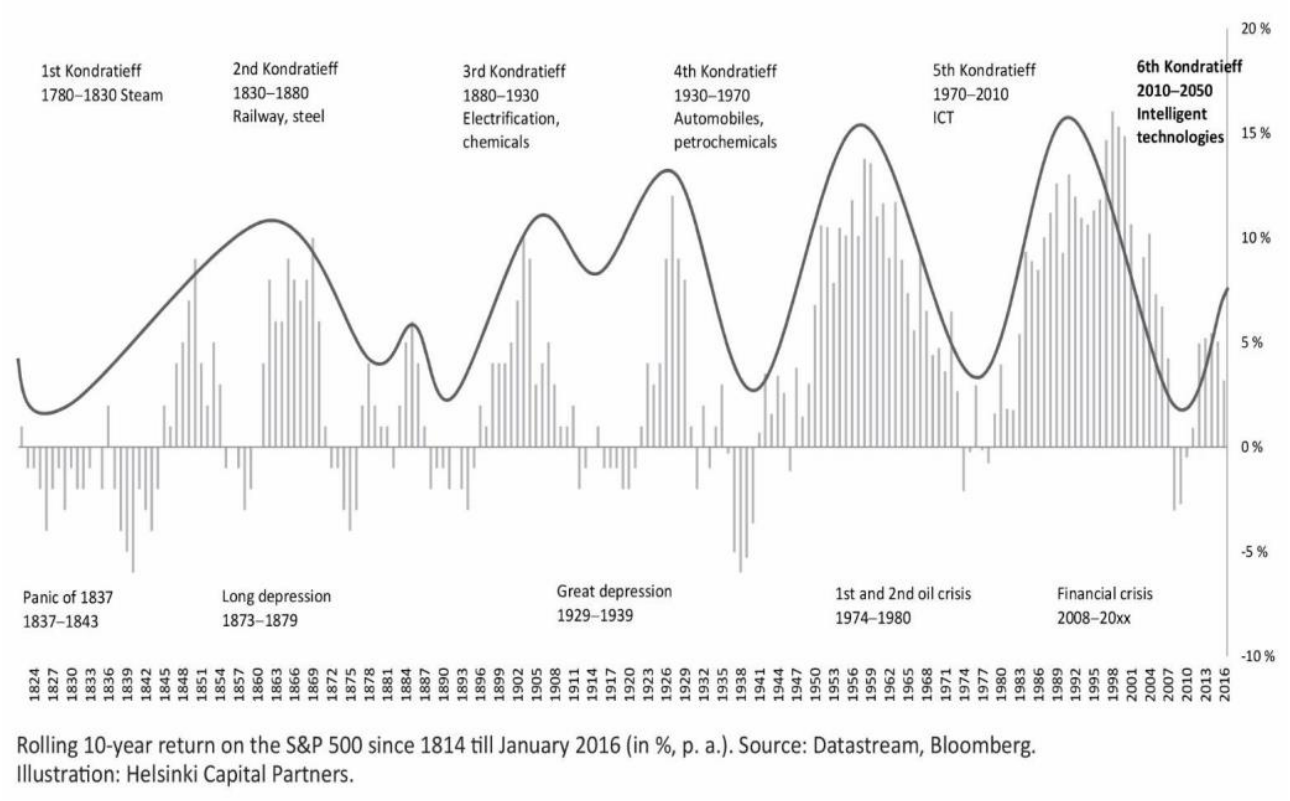
The effects of information and communications technology in different task categories and occupations can be observed according to, for example, the definition created by Autor, Levy and Murnane (2003). At low cost, computers can be programmed to carry out simple tasks requiring speed and precision. Cognitive and manual routine tasks, for example, can be almost entirely replaced by information technology and robotics. Human weaknesses are particularly evident in tasks requiring accurate repetition and correctness; the dosing of medicine, for example, will likely be entirely mechanised. For the time being, tasks involving specialist thinking and complex communication are not as easily replaced by information technology. Humans still outperform machines in these tasks. Information technology is used as a support mechanism, for example, by providing more information for decision-making. In the future, large digital data warehouses and the related analytics will enable the replacement of human labour in non-routine, creative tasks, too. Manual non-routine tasks have been least affected by information technology: it has not replaced the tasks, but neither has it made them significantly easier to perform. In the future, technology will also affect such tasks. (Kauhanen et al. 2015) There are already good experiences from the use of robotic cars, for example, and only time will tell how they will manage in various conditions.

Autor et al. (2003) have divided modern tasks into five categories:

1. *Non-routine cognitive analytic tasks:* These tasks involve the solving of problems with no rule-based solutions. The tasks require creative problem-solving. A majority of expert tasks belong into this category.
2. *Non-routine cognitive interpersonal tasks:* These tasks involve interaction with people in order to acquire or convey information, or to get the other person to act based on certain information. Such tasks include management and sales work.
3. *Routine cognitive tasks:* Cognitive tasks that can be described using logical rules. Simple office tasks such as the approval of various applications and invoicing belong into this category.
4. *Routine manual tasks:* Physical tasks that can be described with rules. Assembly and sorting work, for example, belong into this category.
5. *Non-routine manual tasks:* Physical tasks the performance of which requires perception and fine motor skills. Such tasks include the cleaning of buildings and driving a car in the city.

As professions and tasks change, it is meaningful to examine digitalisation also as part of wider societal development. Wilenius (2015) explains the change and development taking place in the society by means of the Kondratjev wave theory (Figure 1). According to this theory, modern economies change in waves of 40 to 60 years: the wave arises when technological innovations permeate the economic and social structures, leading as a result to an increase in productivity, and an economic boom. Before long, the investments in new technological solutions and the profits gained from them begin to dry up. After a downswing, there will be another innovation, and the improved economic outlook starts a new cycle resulting in not only increased productivity but also social and cultural changes. A certain shape and rhythm are thus repeated in history, but what is new is the content created during each historical era.

Figure 1: Pattern of societal waves of advancement since the birth of industrialisation



Rolling 10-year return on the S&P 500 since 1814 till January 2016 (in %, p. a.). Source: Datastream, Bloomberg.
Illustration: Helsinki Capital Partners.

Source: Wilenius (2016).

The fifth wave, beginning in the 1970s, was based on the development of the information and electronics industries. The early 2010s saw the beginning of a transition to a sixth, genuinely global wave. In this wave, the so called old laws of industry era no longer apply, because the different industrial sectors have merged with each other as well as with people's work and leisure time in new ways. In the intelligent solutions of present wave, physical devices, digital communications and human capital come together. Instead of the devices themselves, the focus is now on building smarter systems that are compatible with each other. This development is also based on a culture that is willing to experiment, where new solutions are tested, information is shared openly, investments are made in continuous learning, and failed experiments are accepted (Wilenius 2015).

Finland has only recently specified countrywide objectives for the utilisation of digitalisation and technology. Digitalisation is the overarching theme of the current government's strategy. One of the focus areas of the government programme is called ‘Digitalisation, experimentation and deregulation’. During its current term, the government aims to develop user-driven, one-stop digital public services that increase productivity and results. The goal of the two spearhead projects is to achieve a situation by 2025 where public policymaking has enabled and created a favourable operating environment in Finland for digital services, industrial Internet applications, and new business models. When the public sector is committed to automate and digitalise its operating methods, genuinely user-driven digital public services can be created. The ‘Transport Code’ currently being prepared by the Ministry of Transport and Communications forms part of the spearhead project creating a growth environment for digital business. It will make data the of mobility openly available, thus enabling new business ideas. The project also promotes the examination of transport systems as a whole and facilitates the interoperability of the system parts (Prime Minister's Office 2016).

2. Toes at the Threshold of Digital Revolution

The era of digitalisation began almost half a century ago, but the societally major impacts of digitalisation are still to materialise (Kauhanen et al. 2015). Mobile Internet, for example, is a solution that may have unprecedented global effects when it develops into a worldwide communications tool available to everyone over the next couple of decades. According to forecasts, the number of mobile Internet users will increase from today's 2.2 to 3.8 bn by 2020 – over half of the world's population (Wilenius 2015). Other recent advances that have sped up the digital revolution are social media, cloud services, advancements in robotics, 3D printing, the Internet of Things, and the melding of technology into a natural part of everyday life (Ailisto et al. 2015).

According to the preliminary results of an innovation study by Statistics Finland (2016), digitalisation is estimated to have a significant impact on the operations of companies. Almost half of service industry companies judge the significance of digital products to be great or moderate, and 45 per cent find digitalisation to be a significant factor in the marketing of their products. In the industry, the corresponding figures were 22 and 30 per cent. Roughly one third of all companies rate the role of digitalisation, cloud services, and the Internet of Things as significant in the production and distribution of products. Service industry companies consider them to have a great impact on business. The utilisation of robotics is most common in industrial companies. 14 per cent of industrial companies and 22 per cent of service industry companies consider digitalisation to play a significant role in design. A bit over one fifth of all companies consider social media to play a large or significant role. When looking at the totalled responses from all

companies, an interesting fact pops up: the option 'does not apply to our company' shows the largest percentages. Over 60 per cent of companies do not consider the utilisation of robotics in the production process to apply to their company. Furthermore, over 50 per cent do not consider the significance of digitalisation in product design to apply to their company.

Labour markets built on various digital platforms, independent of time and place, which have increased in popularity around the world over the last couple of years. The platform companies open the door to a sharing economy, where people give access to their own apartment, car or human capital, such as their expertise, to other people for a fee. The flexibility of work increases, and the labour input and capital are more efficiently used. The platforms also make the organisations lower and change some of the previously paid work to volunteering (Linturi 2016). This change allows many people previously left outside the labour market to participate in the working life. The down side is that those already in the working life may find their position on the labour market to deteriorate. Income which comes from working through digital platforms if often small and sporadic. On the other hand, compared to regular work for a salary, the platforms enable larger than normal income, particularly if the service or product makes a breakthrough on the global market. Digitalisation has also lowered the cost of becoming an entrepreneur. On the other hand, competition is stronger than before, as the opportunities for entrepreneurship have shifted in the same direction on the global scale (Kauhanen et al. 2015).

The number of professionals and companies concentrating on the collection, parsing, sanitisation and analysis of data will increase. In addition to *hard data*, such as the age or sex of the customer, an increasing amount of so-called *soft data* is being collected. Soft data is a more complex analysis of the needs and values of people, such as identifying the needs of different generations. As an example, someone born in the 1980s will use a computer for his or her business, while a child of the 2000s is likely to handle all business on a mobile device. The utilisation of the data separates the winners from the losers. The one who knows how to shift useful from useless data shall prosper. Customer data has been collected using different methods for a long while now, but social media, for example, gives companies the opportunity of collecting data on human behaviour in real time (Koivuniemi, 2016). This opens up new possibilities of customising services to meet the needs of the customer.

Already today, social media is an essential environment for companies trying to attract young customers. However, the youth of today is best influenced by the opinions and experiences of their own generation. For this reason, many companies have started marketing their product through active social media users. Traditional Bloggers and video Bloggers (vloggers) representing a new form of work and job titles by translating the company message to the language of the youth, showcasing or recommending products, or offering them advertising space on their own blogs. There are already vloggers in the world earning fortunes with videos and advertising cooperation. Even in Finland, the number of people making a living from vlogging is on the increase (Kuonanoja 2016). Social media has become an important marketing channel that offers companies global visibility and work for those for whom 'SoMe' is a natural environment.

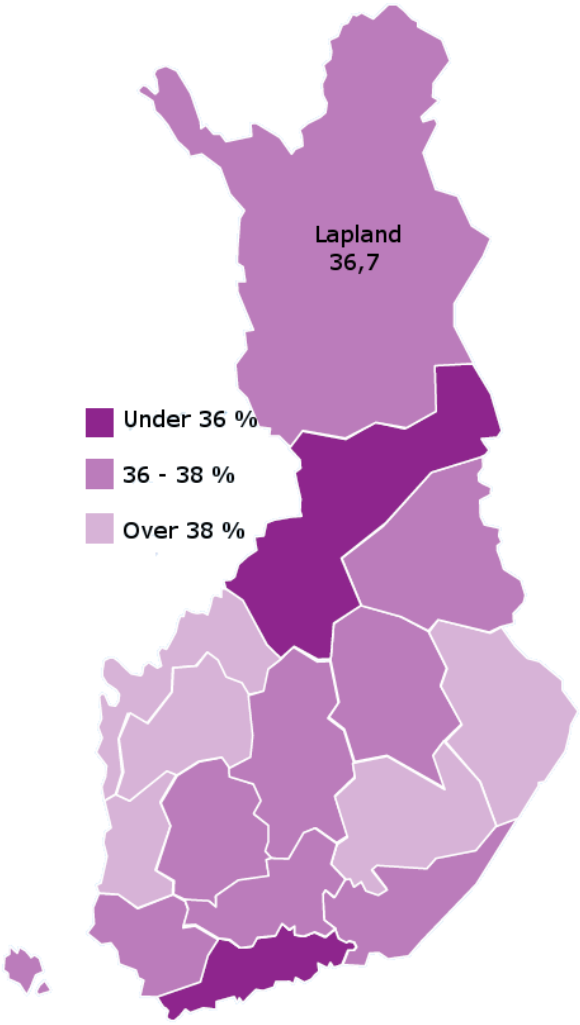
3. Jobs will Appear and Disappear

'Creative destruction' describes the development of the economic ecosystem. In creative destruction, old companies, professions and products make way for new and more functional applications. The raw materials, funding and human resources are thus made available for a more productive use. Creative

destruction has always been present in the world, but digitalisation is now speeding up its progress (Jungner 2015). The change in job structures has a stronger-than-before influence inside the industries, companies and offices. As a result of technological development and globalisation, it is now also easier to automate jobs or move them to a different country. In Finland, too, professions including a lot of routine tasks have been replaced by information technology, and some have been moved abroad (Kauhanen et al. 2015). When intelligent machines make headway in the working life, the human lot will be creative innovation. According to Andersson and Kaivo-oja (2012), work done by people will become alike to non-formal adult education. In this kind of work, people can develop their self-direction, learning capability and creativeness, i.e., the very skills that decide human supremacy over intelligent robots. The business world would also benefit from creative innovators able to open up new horizons and come up with original, even bohemian solutions, and can also make use of the omnipresent technology.

According to estimates, robotics and automation will eliminate around 200,000 jobs in Finland, spelling the end to around 30% of the current job titles (Tiainen 2016). These figures sound likely, as robotics is advancing at a four per cent annual rate (Andersson and Kaivo-oja 2012). Pajarinen and Rouvinen (2014) have analysed materials from Statistics Finland to determine what kind of work, professions and individual tasks the change brought on by technical development is targeted. The analysis delves down to each individual task of a profession to consider whether it is possible to perform it without human labour within the next ten to twenty years. A computational replacement likelihood for each profession has been derived from the materials. The higher the figure, the more of the profession's task time can be replaced. According to the study, 36% of the current Finnish employment belongs to the category changing the most, with over 70% likelihood of replacement. In Lapland, this figure is 36.7% (Picture 1). Workers in the private sector, the less educated, low-pay workers and industrial workers are subjected to a higher pressure to change. Just like the other estimates and calculations, this one also fails to take into consideration the changing of the contents of the job and the creation of new professions. To reiterate, the analyses assume that professions and their contents as well as structures will remain unchanged.

Picture 1: The percentage of the occupations that will most likely be replaced



Explanation: The areas follow the division of Centres for Economic Development, Transport and the Environment.

Source: Pajarinen and Rouvinen (2014).

Although work in the current vein will vanish to a certain degree, it is possible that new kind of work is created to replace it at a similar scale. Instead of routines, the new work will emphasise project-like tasks based on human interaction (Vuoti 2016). The working life is not a limited number of tasks transferred to robots, leaving humans out of work. Every task handled by robotics opens doors for new tasks, because robotisation will make the world complex in a manner unmanageable to machines. For this reason, a new kind of human work is required. As digitalisation progresses, merely retaining the existing jobs does not constitute grounds for opposing the change in the working life (Jungner 2015). Jobs based on new kinds of solutions and technical development require a functional and flexible job market. In Finland, the question of how to get the labour market to be flexible in a changing situation is, indeed, more pressing than the effects of technology. The future will also challenge individual citizens; one must take responsibility for voluntary learning and actively seek for new opportunities (Kauhanen et al. 2015).

Views on the increase of new and project-like work differing from the general consensus have also been presented. In their study, Pyöriä and Ojala (2016) state that there is hardly any empirical data on the

increase of project-like and temporary work. According to results based on the quality of work life materials of Statistics Finland from 1984 to 2013, the share of uncertain work has increased only scantly over the last three decades, from ten to twelve per cent. The researchers admit that changes take place in the labour market and that every year, hundreds of thousands of jobs are created and lost. The changes in recent years do not, however, significantly differ from the situation during earlier decades. Pyöriä and Ojala (2016) suggest that a revolutionary change in paid labour should not be expected. From the perspective of foresight, there is reason to ask whether research based on data from years gone by can be used to anticipate the future. With globalisation and technological development, the speed of change touching the entire world will accelerate, and a modest-looking change may prove to be unexpectedly large.

4. Lapland's Opportunities in the Digital Operating Environment

Four phenomena with the greatest impact on the future of the region have been included in Lapland's Regional Strategy 2040. One of these is virtual lifestyle. The drivers of change on the background of this phenomenon have been identified as the digitalisation of the world, the variety of channels, and the increase in the importance of information networks. The goal for the year 2040 is called 'Digital Lapland is a Reality – the Lapps are digi skilled and the world is in anyone's reach'. It is based on the view that the importance of physical locations will decrease. In the province, investments are made in location-independent work, services and education. Another goal is that the public sector will become a pioneer of the virtual lifestyle (Regional Council of Lapland 2014).

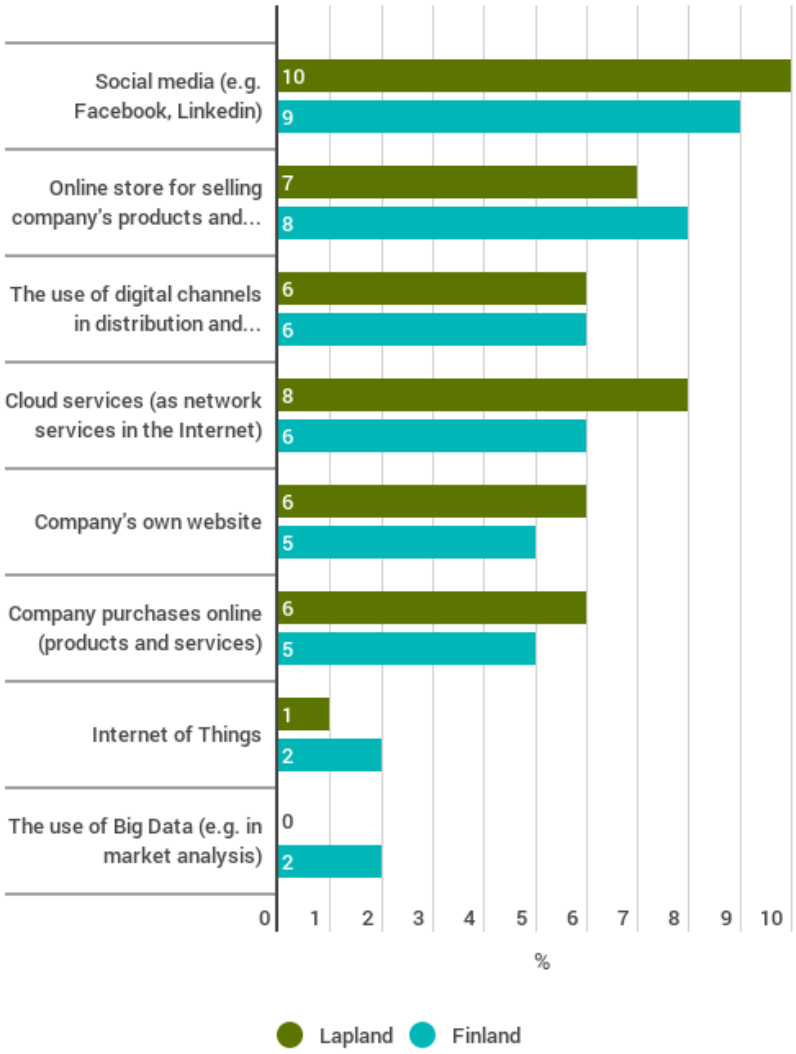
In recent years telecommunications connections in Lapland have improved to some degree, but there are still problems with telephone and Internet connections in many locations. The construction work of 4G connections was finished at the end of 2015. Still, because new base stations haven't been constructed, there are shadow areas in mobile connections in different parts of Lapland. In addition to sparsely populated areas, there are problems in the audibility of wireless connections in and near centres of population. The interest of traditional operators is focusing on the development of wireless networks. However, half of these areas covered by the broadband legislation will remain unbuilt if new actors are not attracted. The municipalities and villages of Lapland will continue to have a significant role in the construction of fixed connections. (The description of the operating environment in Lapland[1].)

With regard to business operations, Lapland invests in the utilisation of digitalisation and the development of robotics in the Arctic environment and conditions, particularly in testing operations. Test subjects could, for example, include vehicles, equipment, materials, services, and systems. The objective is to establish growth environments for digital business, attract international know-how and investments, and give birth to business in the region based on the Arctic conditions and testing operations. The Aurora testing area in Fell Lapland is one example of recent investments. The goal of the project is to create an international transport automation testing environment and competence centre in the area, thus achieving global frontrunner status in the testing of automated driving in Arctic conditions (Ohtonen et al. 2016).

[1] Information about the operating environment in Lapland is collected through co-operation by the Centre for Economic Development, Transport and the Environment, the Regional State Administrative Agency, and the Regional Council of Lapland. Other parties are the University of Lapland, Lapland University of Applied Sciences, Lapland Police Department, Lapland Border Guard District, Länsi-Pohja Hospital District, Lapland Hospital District and the Sámi Parliament.

According to the SME Barometer[2], SMEs in Lapland have adopted digital tools and services. The companies are also planning a wider adoption of digital tools (Figure 2). At the moment, the most commonly utilised tools are the company's own website, social media, and cloud services. Social media is the most common digital tool or service SMEs intend to adopt during the next twelve months. It should be noted that over 60 per cent of the companies have not answered the question concerning digital tools and services to be adopted during the next twelve months. Only one per cent of the companies intends to use the industrial Internet. None of the companies reported that they intend to utilise Big Data. At the national level, two per cent of the companies responded to the survey plan to utilise industrial Internet and Big Data (SME Business Barometer 2016).

Figure 2: The percentage of Lapland's SMEs which are going to bring into use digital tools and services during the next twelve months

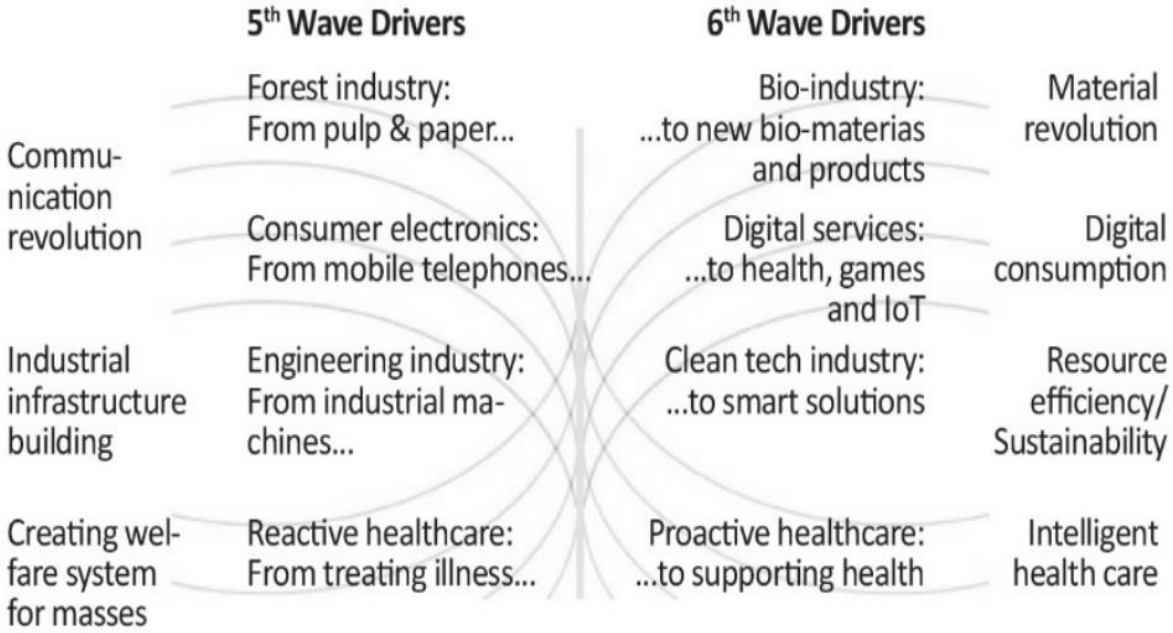


Source: SME Business Barometer (2016).

[2] The Federation of Finnish Enterprises, Finnvera and Ministry of Employment and the Economy publish an SME barometer twice a year. The barometer describes the activities and the financial operating environment of small and medium sized enterprises.

Wilenius (2015) has examined the challenges Finland is facing as it makes a transition from the fifth wave of societal development to the sixth wave (Figure 3). When these challenges are projected to the industries in Lapland, it can be seen that there is significant potential in the region to rise to the forefront of development with the correct resource management.

Figure 3: The challenge of the changing wave: case Finland



Source: Wilenius (2016).

In addition to tourism and mining, Lapland still sees heavy investments in the traditional forest and metal industries. Due to fierce competition, the production volumes of the metal industry are seeing hardly any growth, and despite of hopeful expectations, there is a looming threat of the industry shrinking even further. However, it is possible for the region to create new jobs and business based on low carbon and the sustainable use of natural resources. With regard to future growth areas, cleantech and bioeconomy companies as well as companies promoting resource and material efficiency can create new jobs in Lapland. These kinds of new opportunities will have a large impact, particularly in scarcely populated areas. (Regional Council of Lapland 2014). If Finland's goal to become a leading country in bioeconomy becomes a reality, the industry will create 100,000 jobs by 2025 (Ministry of Employment and the Economy 2014). A significant part of these jobs may be located in the northern part of the country.

Wilenius (2015) points out that the golden age of bioeconomy may be postponed to the seventh wave, the years 2050 to 2100. The development of resource-efficient technology does, however, build a foundation for the more extensive use of biomaterials, and the positive development of bioeconomy will also be reflected to other industries. The northern region can act as an excellent environment for the development and testing of new solutions. The region has a considerable potential for creating and implementing new products and services which are a result of combining intelligent systems and bio-based materials. The products and services promote the transition from non-renewable and limited raw materials towards renewable raw materials. In order to not leave the development of bioeconomy and energy solutions

hanging from the already existing plans and structures, the industry must be made attractive to new generations. The matter has been promoted through projects implemented by educational institutes in Lapland, for example, aiming to meet the needs of the education development in the bioenergy and forestry sectors.

The game industry is on the rise in both Finland and the rest of the world. According to reports, the rapidly growing game industry will need more skilled labour than the Finnish education system is currently able to produce. The gaming trend has also been noticed in Lapland. Education in many different fields is available in the region; when correctly planned and implemented, it could meet the increasing demand. There is a drive to apply gaming principles to the products and services of different sectors, and their development. In the northern region, this 'gamification' can be utilised in, for example, well-being industries, tourism and experience industry (Lapland University of Applied Sciences). Combining gamification with strong industries can give birth to new innovations and globally attractive products. Business related to healthcare and well-being is also increasing each year, and in a couple of decades, it can become the largest industry in the world (Wilenius 2015). 'Green care' in particular, or the use of nature, animal and farm-assisted methods in connection with well-being and health services or tourism, is a trend that Lapland needs to grip more systematically. The nature and forests of Lapland, and the clean natural products they yield, such as fish, berries and mushrooms, provide an opportunity for the creation of new jobs and livelihood – and for conquering the global market.

5. Digitalisation in the Point of View of Lapland's Industry Clusters

In Lapland, there are ten industry clusters in the central and developing fields of business: Road Haulage and Logistics, Industry, Energy, Well-being, Mining, Business Economics, Natural Resources, Tourism, Construction, and Creative Industries. The industry clusters aim to form insight about the present state and development outlooks of their sectors, and about their future in Lapland. They also discuss employment prospects and future fields of expertise. The clusters set out to forecast the labour force, education and training needs of businesses and other employers, and the preconditions for successful business operations. In the clusters' operations, key importance is on business representatives' insight into their respective fields, into the availability of labour force and into the development measures needed. Cluster operations also support expertise in different sectors, improve co-operation between businesses, regional authorities and education providers and improve information exchange. The cluster activities bring the needs of business into the development of the region as a whole.

The clusters have meetings twice a year. We gathered the following material in the meetings of six clusters during spring 2016: Construction, Energy, Industry, Natural Resources, Road Haulage and Logistics and Well-being.

At the discussions we focused on the following questions:

- How digitalisation has already affected the industry?
- What kind of new digital solutions are already in sight?
- What kind of new requirements does digitalisation place on the employees and organisations? For example knowledge and skills.
- How digitalisation will affect the industry in a long term perspective (25 years ahead)?

- What kind of special challenges or opportunities does the operational environment of Lapland create from the point of view of digitalisation?
- What kind of leap of digitalisation is expected, feared or wished for in the industry?

Construction

The construction industry has taken great leaps thanks to digitalisation. The measuring strings and spirit levels used only a couple of years ago have now been replaced by electronic devices. The industry has invested heavily in the adoption of 3D systems, in particular. The construction plan and its phases are modelled in 3D in an electronic and printable format. 3D images make it easier to grasp the overall idea; particularly when building demand for structures, it is useful to see what they look like and how they function once finished. 3D is also utilised in renovation construction, because geometrical models can be created of existing buildings. In the coming years, housing companies will offer their customers a chance to take a virtual tour of the building to be constructed before the construction work even begins.

Materials technology has developed with digitalisation, and some building elements can be printed with 3D printers. In the future, even entire buildings can be printed. A lot of research and empirical tests are still needed, however, before printable elements can be mass produced. Research data on how practical, durable and cost-effective printable elements and materials are must be obtained. As resources dwindle, the target life cycle of buildings is now hundreds of years instead of the couple of decades of today. This goal is helped by sensor technology measuring and monitoring the condition of the buildings. Software responsible for the building conditions, such as air conditioning and temperature, analyses the data gathered by the sensors and automatically makes the necessary adjustments. The building data over its entire life cycle is saved in a digital maintenance journal. Automation and robotics will be increasingly utilised also during the construction phase. Robots are already used in, for example, the laying of yard stones. As technology develops, robots can be used in more demanding and complex tasks than today.

Energy

The energy industry is investing in forms of energy based on low-carbon and renewable energy sources, aiming to create new business from them. The development of fuel cells and the production of synthetic fuels with solar and wind power, for example, create opportunities for the utilisation of solar and wind energy also in the northern conditions around the year. The breakthrough of global energy solutions of the future can be very close. There are numerous plans, but their implementation is not yet solid enough to launch the products. For example, if an accumulator with significantly greater power and number of recharges could be productised, it would have a revolutionary impact in every industry.

Manual labour has changed into system design and management, and data gathering, analysis and management. Concretely, the change is evident in things like how one device can be used to control several production facilities, and systems that can be controlled by, for instance, tablet computers. In the future, centralised functions will become even more prevalent. Teams will also include an increasing number of information and communications technology experts, analysts and data processors. There is a new trend of energy producers and suppliers opening up their data for use by their customers and competitors. This forces one to consider the interfaces of open and secret information and who owns the information. When data is shared on a network, it must be taken into consideration that the systems become vulnerable to malware and cracking. The information and digital strategies of production facilities and energy companies steer the data processing and utilisation, and help prevent any misuse.

Digital and mobile services in the energy industry will proliferate in the coming use. Intelligent electrical grids will be utilised on business premises and in residential buildings, and data gathered of the energy consumption of the buildings will be monitored in real time. In the future, inbuilt sensors in the structures of the properties will monitor the amount of light and temperature, for example. The sensors send the data they have collected to a system controlling energy consumption that then adjusts the conditions of the apartment to suit the time of day and the purpose of use. At the moment, the wider adoption of energy automation by households, in particular, is slowed down by the high price of the technology. As the prices fall, more and more new and renovated buildings will be equipped with intelligent energy technology. People who are aware of consumption and the environment wish to monitor their own energy usage and affect the type of energy produced through their choices. The customer's role has changed to that of a partner who, together with the energy producer, moulds the processes and services to be as user-friendly as possible.

Industry

Different industries utilise a great number of technical solutions. For example, electrical power technology, production and emissions measurement have been automated to a great degree. The remote use of factories and technical laboratories is also possible. Although the industry wishes to utilise solutions that are as efficient and modern as possible, refurbishing old factories is difficult and expensive, making it nonviable to begin the renovation work. Industrial SMEs are already reasonably digitalised, so no large changes are to be expected on their behalf. Some companies lag behind in advancement due to the costs or other reasons, so in the near future, they will focus on adopting the currently available new equipment and solutions.

A major transition is taking place in manufacturing: the products are designed on a computer, and the final product is manufactured with a 3D printer instead of the machinery used today. The importance of design will be emphasised in the production process. When automated equipment handle the manufacturing of products, more labour is allocated to the beginning of the production chain, the modelling of products and processes, and other design tasks. In order to avoid mistaken investments, experts are relied on in software selection. Digital systems allow the utilisation of experts around the globe, because the person chosen for the task does not necessarily need to go on-site to perform the task.

Machines and equipment collect a lot of data of the different stages and processes, but the analysis of this data is found to be difficult. When the next level in analysis is achieved, it can be expected that industrial processes will take great leaps forward. In the future, increasing attention will be given to utilising raw materials as well as possible. The aim is to also increase the value added to the raw materials through refining. In Lapland, the intention is to refine wood in particular more than today before it is exported to the global markets. The traditional forest industry is at the threshold of a new era, also due to digitalisation. Because demand for paper and print products has decreased, the forest industry must be able to reinvent itself. A pulp plant, for example, could be extended with a weaving machine and a sewing factory to have the wood go out to the world as cloth or finished clothes. There is also demand for innovative wood-based products in the construction and interior decoration industries.

Natural Resources

Various digital devices and applications are a natural part of today's business and working life in industries based on natural resources. Assessments previously carried out visually in the field, for example, are carried out using various digital systems today. Laser scanning is an effective method of obtaining accurate, three-

dimensional data on the structures of the growing stock and the terrain. The mapped data is available in cloud services, and there is no need to store large amounts of data on one's own computer. In the forest industry, materials tracking and management take place fully digitally from the forest to the plant, and the operation of the forestry machines is monitored in real time. In the future, the driver will not need to sit in the machine; instead, the driver can control the machine virtually from anywhere in the world. Reindeer husbandry, a traditional livelihood, is also made easier by digital solutions. Reindeer herders carry out their own monitoring electronically, utilise cloud services and track the movement of the reindeer with the help of GPS locators.

Help is desired from robots for the gathering of natural products, such as berries and spruce sprouts, used in foodstuffs and cosmetics. The slow and physically strenuous work would suit robots better than humans. With robots gathering the raw materials, humans could concentrate on product development and marketing. Several companies in the natural resources industry already have their own website, and some also sell their products via an online store. Websites and social media are seen as channels through which the companies can tell about themselves and a story of how the company's products were created. However, updating the website is easy to forget, or gets sidetracked by other, more urgent business.

Education in the natural resource industries actively utilise and develop digital learning environments and databases. Virtual materials, online education and improving data communications connections guarantee that gaining an education in the sector does not depend on the location. Individual courses and entire study programmes can be taken remotely, which facilitates the availability of skilled labour in sparsely populated regions, too. Young people seek fields with public visibility and a positive image among the youth. In order to retain and develop the industry, it is considered important that information on the employment opportunities provided by natural resources is available in social media.

Road Haulage and Logistics

The vehicles and logistics chains are already automated to a great degree, today. Software and systems make work easier and quicker. The problem is that the different systems are not necessarily compatible with each other. The vehicles collect a countless amount of data of, for example, the conditions, driver activities and the different stages of transport. Only a fraction of the data is utilised, however. The effective usage of the data and the compatibility of the systems would help the creation of new innovations, thus supporting the development of the industry. Lapland offers a safe environment for testing robotics and transport automation, as traffic there is rather light. Testing the operational reliability of the equipment is efficient, as if the equipment works in the Arctic conditions, it will also work elsewhere.

The industry is seen to have a positive outlook. Even if the transport modes were to change, the vehicle and logistics industry will remain, because people need food and other supplies, and the other industries need raw materials. Although 3D printing becoming more common in households will decrease the demand for manufactured goods, the demand for the materials and supplies needed for printing will increase. Even if the materials transported will change, logistics will be needed. Intelligent transport will develop and become a more natural part of the different transport modes and services. The government investments in digitalisation are seen to have a positive impact on the development of the industry. The operational reliability of robotic cars and, as a result, their number, will increase significantly. Despite the increased automation, the role of the driver is seen as important; in challenging driving conditions, for instance, the cooperation between man and machine will ensure the safety of the transport and the other traffic. Fully automated transport based on robotic cars places such high requirements on the condition of the road

system that in the northern conditions, it is not considered to be possible in the near future, at least in sparsely populated areas. Due to scant public funding, road maintenance is focussed in areas where the majority of people live. When the automation of transport and logistics rests on a sufficiently high-quality and secure foundation, major investments will target populous areas where significant savings can be achieved through intelligent transport.

Well-being

Therapy and humanoid robots are already reasonably common in assisted living facilities, schools and hospitals, providing care and stimulus and increasing the feeling of safety. Personal robot assistants provide help in everyday tasks for people with limited or no use of their arms. Hospitals utilise surgery robots in surgeries requiring particular precision. The cooperation of a surgeon and a robot facilitates the quick recovery of the patient. Although robots and automation are used in the well-being industry, an attitude change is still required from both the staff and the customers. There is opposition to change, particularly amongst the older customers, who often find technical devices alien at first. Indeed, the benefits of these aids are noticed after a period of use. It may also be difficult for the staff to accept the new devices and equipment as part of their working life.

The efficiency of the organisations and the well-being of the patients are expected to increase, with robots performing routine and mechanical work, allowing humans to concentrate on working close to the patients. The dosing of medicine, for example, is a slow and precise work, which should be left to robots in order to utilise working hours efficiently and for the sake of patient safety. Linen maintenance is a physically strenuous task, and transferring it to robots would, in turn, promote the well-being of the staff. As technology develops, automation may provide more assistance in warehouse management and data analysis.

In intelligent care environments, smart devices such as wristbands, clothes and subdermal microchips will collect data on the lifestyle of people (for example, quality of sleep, diet, exercise), and the data is automatically saved in a nationwide information system. The customer does not need to move in order to receive service. The care staff has comprehensive data on the patient available, which speeds up a correct diagnosis and choosing a treatment suitable for the patient. Healthcare also aims to utilise genetics-related information in the prevention of illnesses. The widescale adoption of smart products in the public sector is currently hampered by the high price of these products. Digitalisation and technological development also support the individual's actions in advancing their own health. Smart devices monitor the person's health and well-being; in the future, they can, for example, suggest increasing the amount of vegetables in one's diet or to go to bed at an earlier hour. Because the devices provide accurate data on the individual's state of health, people can also be given more responsibility on their own well-being.

6. Diginatives in School and Working Life

The industry clusters we interviewed brought up challenges created when those born into a digital world – the so-called diginatives – and those who have lived amongst more traditional learning and working methods meet each other at school and in the working life. Concern about the equality of teaching was particularly emphasised in the discussions. It was considered that teaching systems and plans must keep abreast of the development so that every level of education is able to give sufficient readiness for success in further education and the working life. Teaching is increasingly investing in keeping up with the rapid

change, which places challenges to the professional skills of the teachers. When things previously learned by heart can be found on the Internet in just a couple of seconds, the focus can be moved on the skills required in the working life of the future. Digitalisation and technological development also enable different teaching and learning methods. Writing, for example, can be practised with various devices instead of pen and paper only, test materials can be uploaded in an audible format, and remote studies are possible. In order to achieve equal quality of teaching regardless of one's place of residence, primary schools in particular must have sufficient resources for adopting the new technology.

Diginatives have been born into the world of computers, mobile devices and applications. Social media youths find it natural to use various devices and software, but studying theory and concentrating are often difficult. The clusters emphasised that one cannot move to the working life, however, without understanding the basics of one's chosen profession, because mere technical performance is not enough. The use of mobile devices in practical work compared to free time must be considered in teaching and practical training. As the working life changes, the border will likely blur or entirely vanish, but in the near future, there will be a need to attune the ways different generations do things with each other. On the other hand, there is nothing new in this, because with every generation, new methods and solutions are introduced in studying and the working life.

In vocational education, in particular, it often comes up that young people are not used to manual labour. While before, children also had to participate in making a shared living, it is enough today that only the parents go to work. Legislation also limits the tasks that can be assigned to children of different ages. The regulations are so strict that they make the completion of practical training periods more difficult. Some of the practice can be carried out in virtual learning environments, but in the construction industry, for example, it is important learning-wise to get to work at a real construction site. In Finland it is nowadays typical that children are allowed to remain children for a longer time. Consequently the transition to the world of adults may feel like an abrupt change. A carefree youth should become a responsible and diligent employee in just a couple of years. Although manual labour will become rarer, the working life of the future will still require the ability to roll up one's sleeves and get down to business – perhaps even more than today, if the livelihood of an increasing number of people depends on the success of their own companies.

7. Conclusions

The discussions had with the clusters show that the effects of digitalisation are evident in all industries, but with slightly different emphasis. The construction industry cluster talked a lot about 3D modelling and the Internet of Things, while the discussions with the energy industry concerned Big Data analysis, information security and data ownership. In some industries, the functions are automated to a very high degree, while others are still to face the greatest changes. Digitalisation, automatisation of functions and robotics are seen as an opportunity but also as a great challenge. What will happen to the labour input of humans? How will the work of a nurse, for instance, change, when robots can perform a majority of the tasks in the future? How about drivers? Will they still be required if robotic lorries conquer the roads? The automatisation of functions and robotisation decrease the time required for data analysis and the number of human errors, but on the other hand, human labour input is required for ensuring safety and taking the operating environment into consideration. Indeed, cooperation between man and machine should be smooth. Machines also make strenuous work easier, maintaining the working capacity of people at a good level. As machines perform the heavy and monotonous work, people can concentrate more on brainwork

and design. In the healthcare industry, robots cannot replace human presence and touch. The well-being industry also expects that with robotics, humans would have more time for taking the customers into consideration and customising the services to meet the needs of each customer.

The cluster operators were mainly expectant with regard to the effects of digitalisation. A very active frontrunner role was not in evidence in any of the industries; everyone was more or less waiting for new solutions to come from elsewhere. At the moment, the new systems still have kinks and are difficult to use in some regards. The incompatibility of the different systems also poses challenges. Indeed, several industries are waiting for the technology to develop to the next level. Consumers are also seen to play an important role in the advancement of digitalisation. The more consumers demand or adopt new solutions, the quicker they are adopted by companies and taken into account in education. The clustered considered it to be important to keep abreast with the development and contemplated on how to adopt new solutions as cost and resource effectively as possible. Old ways of doing things change only slowly, however, and the high price often hampers the adoption of new solutions.

With regard to the special characteristics of Lapland affecting digitalisation, the interviewees brought up, in particular, the long distances, sparsely populated areas and the Arctic conditions. In Lapland, the province of the long distances, digitalisation could play an even larger role than it does today. However, the development is hindered by the partially poor data communications connections that hamper the wider adoption of consumer and corporate services based on video and cloud technologies. The new services and the increased demands of the consumers do, however, require even faster speeds and better reliability from the data communications connections. Digitalisation gives even the smallest companies in Lapland access to the global market, but this requires fast and functional data communications connections. In the management of the long distances, the public sector has particularly invested in videoconferencing equipment in order to save time and money. The challenging weather conditions during the winter, in particular, encourage the use of remote connections instead of travelling.

It has been challenging to have sufficient broadband connections built in sparsely populated areas, leaving the residents partially outside the services that have moved online. The public services, especially those of the social welfare and healthcare sector, moving increasingly online would require comprehensive data communications connections, however. The poor digital skills of the elderly also slow down the adoption of online services. Likewise, the Arctic conditions pose a challenge to the durability of digital devices, due to which testing and piloting are seen as opportunities for Lapland. Activity in vehicle testing in particular has increased, but it could also be extended to other industries. If the equipment and systems work in the Arctic conditions of Lapland, they will work anywhere.

The concept of a job is also undergoing a transition in the public, private and third sectors in Lapland. Particularly in design and information work, the place where the work is performed is no longer meaningful. Just a couple of years ago, the public sector considered remote work as a privilege of the few, or as a mandatory evil dictated by necessity: those performing paperless work based on online applications were entitled to not come to the workplace, or they worked remotely if weather prevented them from coming to the workplace. Today, partial remote work is even encouraged. Lapland would have an excellent opportunity to also attract new skilled labour to the region by offering high-quality remote working possibilities. The nature of Lapland is seen as a great attractor that could make people want to work at least part of the year from Lapland. The facilities and leisure services offered by the tourism centres make

Lapland an attractive remote work location. Once the data communications connections have been sorted out, remote workers can be attracted to the northern region also from the rest of the Finland and around the globe.

The problem in assessing the effects of digitalisation is that the future development cannot be seen very far ahead. Although the outlooks were assessed by the clusters concentrating on anticipation, the discussion was particularly focussed on describing the situation and phenomena of today. The development of digitalisation should be monitored more closely on the international level, as the actors in Lapland must keep up with the global development. Lapland would have plenty of opportunities to make use of digitalisation, but it needs more extensive investments and cooperation with other goal-oriented parties. More courage is required from Lappish actors to discard the safe and familiar operating models and adopt a proactive, anticipatory stance in utilising digitalisation.

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