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How digitalisation is transforming professional roles

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Preface

The aim of this report was to increase understanding of the impacts of digitalisation on professional roles in three industries: agriculture, mining, and transportation. The information collected from those sectors then formed the basis for predictions about future professional roles in the forest sector. This procedure was adopted to both gather sufficient data regarding the matter and to compare different sectors. The study was performed by Daniel Mensah together with Erik Willén and was funded by Skogforsk.

Sammanfattning

Digitaliseringen kan ses som en "game-changer" i samhället, eftersom den påverkar olika aspekter av människors element som privatliv, arbete och produktion. I detta paradigm måste man skilja mellan digitisering och digitalisering. Medan den första innebär en omvandling av fysiska data till digital form, handlar digitalisering om en större förändring. Ett exempel på digitisering skulle se en omvandling av en pappersrapport från ett fysiskt format till en digital uppsättning, till exempel en PDF-fil med oförändrad funktion. Digitaliseringen använder i stället digital teknik som internetbaserad utrustning/tjänster för att identifiera nya sätt att generera inkomstkällor. Detta är John Deeres tillvägagångssätt för att ge förslag till jordbrukare om maximerad jordbruksproduktion.

Digitaliseringen förändrar yrkesroller på många sätt. Denna omvandling medför både positiva- och negativa aspekter som måste övervägas. Å ena sidan sammankopplas och automatiserar den maskiner på arbetsplatser, vilket resulterar i ökad effektivitet, produktivitet och precision. Å andra sidan avslöjar digitaliseringen människans mest utsatta områden, som är det mentala, fysiska och sociala tillståndet. Det behövs en öppen diskussion om hur vi kan dra nytta av digitaliseringen utan att få med nackdelarna.

Syftet med denna rapport var att undersöka digitaliseringens inverkan på yrkesroller. Urvalet av tre områden som rör jordbruk, gruvdrift och transporter gjorde det möjligt att hämta information, som kan kopplas till den svenska skogssektorn.

De tre sektorerna (jordbruk, gruvdrift, transport) visar liknande resultat av digitaliseringen. På den positiva sidan är IoT, molntjänster, stora datamängder och automation bidrar till att förbättra branscherna på olika sätt, till exempel från organisatoriska, finansiella och miljömässiga perspektiv. Yrkesroller förändras som en följd av detta, med ökad digital medvetenhet bland traditionella yrkesverksamma i varje bransch.

Digitaliseringens konsekvenser för skogssektorn visar också på en förändring mot ett mer automatiserat skogsbruk (som omfattar avancerade beslutsstödsystem för planering av försörjningskedjan, AI, robotar och stora datamängder). Utvecklingen av mer AI-baserade beslutsstöd är på gång, vilket resulterar i en förändring av de yrkesroller som behövs i branschen och skapar nya roller, såsom dataanalyserare, AI-ingenjörer och andra specialister. Tillsammans med den förväntade kompetensutveckllingen (både inom kunskap och förmåga) skapar detta en vision om de kommande förändringarna inom den svenska skogssektorn.

Summary

Digitalisation can be viewed as a game-changer in society, as it affects everyone in various ways, such as in their private life, work, and production. In this paradigm, an important distinction needs to be made between digitisation and digitalisation. The former entails a conversion of physical data into digital form, while the latter capitalises on digitisation to strengthen the modus operandi of a business. An example of digitisation would see a transformation of a paper report from a physical format to a digital set, like a PDF. Digitalisation, instead, uses digital technology such as Internet-based equipment/services to identify new ways to generate sources of income. This is the approach taken by John Deere when making suggestions to farmers on how to maximise agricultural production (Puri, 2016).

Digitalisation is changing the roles played by professionals in every aspect. This transformation comes with both positive and negative sides that must be considered. On the one hand, it interconnects and automates machinery in workplaces, which results in an increase in efficiency, productivity, and precision. On the other, digitalisation reveals a human's most vulnerable areas, which are the mental, physical, and social state. An open discussion is needed about how to make use of benefits from digitalisation and how to exclude the drawbacks.

This report aimed to examine the impacts of digitalisation on professional roles. The selection of three cases related to agriculture, mining, and transportation allowed retrieval of valuable information, which was subsequently applied to roles in the Swedish forest sector.

Background

Introduction

Digitalisation can be viewed as a game-changer in society, as it affects everyone in various ways, such as in their private life, work (in specific professional roles), and production (in terms of products and/or services available for purchase and use). In private life, for instance, digitalisation has increased: a) the use of online banking services (Al-Chalabi and Bahram, 2018) rather than physical banking; b) the use of video services such as Zoom when working-from-home instead of working at the office during the corona pandemic (De', Pandey & Pal, 2020); and c) the use of home appliances through digital services and/or products such as TVs, printers and other equipment connected to the Internet (Venkatesh, Kruse & Shih, 2003).

Workers are now expected not only to have the necessary competencies to fulfil their professional role but also to be either digital savvy or in some cases experts within the technological field (McKinsey, 2020a; Tele2, Macklean & LRF, 2017). For example, farmers nowadays need to be able to use digital services that collect and store farm data, irrespective of their assigned professional role. Consequently, work efficiency may suffer due to a lack of this skill in a scenario where it is not provided, considering the interconnection between digital advancement related to work in general. Overall, the production sector (e.g., manufacturing) benefits from this process. This procedure optimises the supply chain to make it an automated and digitalised system. The transformation allows industry to improve its performance and therefore efficiency (IRIS GROUP, 2015). Understanding the implications of digitalisation on society is therefore a relevant aspect to consider.

The impact of digitalisation does not simply extend to the relationship between consumers and suppliers, but also within the company that produces/delivers equipment and/or services. As technologies continue to evolve, so do occupational duties and standards across various industries.

However, it must be said that digitalisation has a dual impact on the workforce. On the one hand, the introduction of high-tech devices/services has reduced the time spent by professionals on monotonous tasks, giving them more time to improve both their own competencies as well as services provided to customers. On the other, this technological operation may, a) reduce job availability on the market, b) increase working hours, and c) increase online supervision through strong management schemes. This notion leads to the point that a wrong approach to advancement in technology could be detrimental to the business rather than an enhancement, if not managed carefully (Petani, 2021). Therefore, digitalisation has both a positive and negative influence on professional roles, depending on the point of view.

What is digitalisation? Measurement and factors relating to the concept

When discussing the issue, it is critical to understand the distinction between digitalisation, digitisation and digital transformation. Digitalisation refers to a procedure that incorporates the use of electronic components in a business operation, contributing to a generation of alternative income and unique chances for the company. This change consequently shifts behaviours and circumstances. Digitisation is an approach that converts analogue data into an electronic form, without significant change of function. Digital transformation concerns the client-focused strategic movement of a company that necessitates multi-sectoral administrative changes in addition to an application of digital techniques (Gartner, 2012; Clausen et al., 2020, pp. 9; Exedsse, n.d.; Harvard Business Review, 2021). The definitions of the concepts must be understood, to avoid confusing the repercussions that each has on society.

The process of digitalisation in itself is not revolutionary, but the ramifications of this concept on businesses/economies is worthy of consideration. The beginning of this transformation can be traced back to the late 1990s, when the introduction of computers and digital avenues was considered revolutionary (Schallmo & Williams, 2018; Deloitte, 2019; Larsson & Teigland, 2020). Fast forward to 2021 and these same inventions are considered a basic requirement for any new digital service. Digital evolution over time must be considered by companies/entities that aim to improve their digital progression and take informed decisions.

A relevant point that is often forgotten in digitalisation is that a connection to a service/product does not guarantee the smooth transition of a community to a digital paradigm. Accessibility to a digital item can be deterred by other factors, such as limited knowledge of the product, restricted time for review, or a lack of electronic supply chains (Mensah, 2021). This leads to the point that the digitalisation of a commodity must benefit its users. In order to achieve this goal, three key aspects are needed to solve the equation: consumer, the enterprise, and the technology (Semcon, 2018). Access to a digital item should be reviewed based on consumers' needs and requirement.

Sweden is one of the leading nations in Europe embracing this transformation (Digital McKinsey, 2018), as shown by its e-economy and society index. The country was ranked second among 28 European countries in 2020, according to information gathered before the spread of coronavirus (European Commission, 2020). The adoption of the Digital Transformation Strategy in 2017 underlines the country's commitment to digitalising its society. According to the strategy, digitalisation can be broadly measured through five targets, based on the Government's goals for a digital transformation: Digital skills, Digital security, Digital innovation, Digital leadership, and Digital infrastructure, as shown in Fig. 1 (Regeringskansliet, 2017; Vinnova, Post- och telestyrelsen, Vetenskapsrådet Myndigheten för digital förvaltning, 2021).

Digital skills refer to utilisation and subsequent improvement of an individual's electronic competence. As an illustration, this would be the ability of an individual to express themselves through digital platforms such as emails, social media, Whatsapp, and/or similar services. *Digital security* relates to a user's skill in protecting their private data while surfing online. In other words, no sensitive information is released when browsing the internet, such as address, the three security numbers on the back of a bank card, passwords to emails, and/or similar. *Digital innovation* concerns

promotion, distribution, and utilisation of modern start-ups/developments based on electronic services. Examples of these in Sweden would be KRY (application that enables doctors and therapists to diagnose patients by video), Karma (program that shows consumers food availability with expiry data to identify half-price offers in shops, restaurants and coffee shops, rather than letting it go to waste) or Uniti (a start-up attempting to produce a lightweight e-car suitable for driving around cities) (Swedish Institute, 2018). *Digital leadership* refers to Sweden responsibility as a nation to lead an entire community towards digitally specific, sustainable, and appropriate advancement. Finally, *digital infrastructure* comprises insurance that everyone can access the latest digital frameworks and equipment (e.g., superfast Internet).

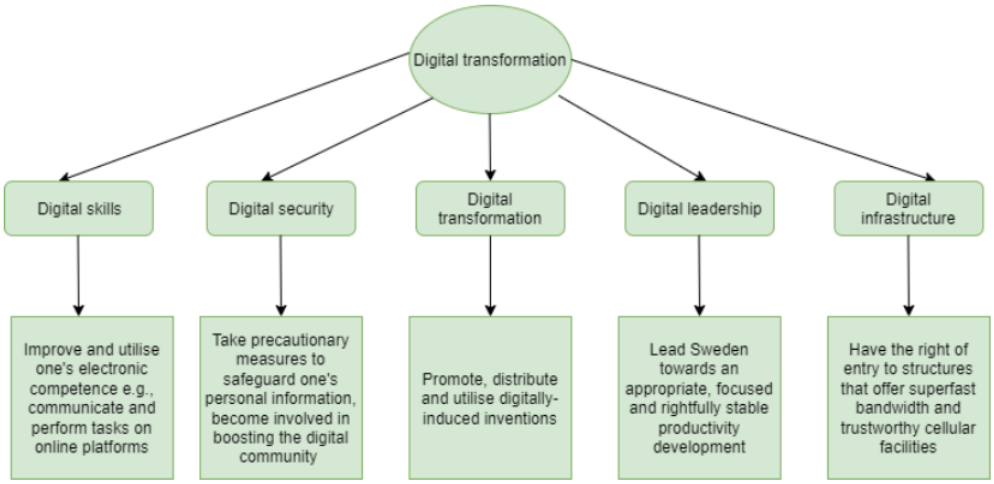

Fig. 1. Digital transformation according to Swedish Digital Strategy (Regeringskansliet, 2017, created using Diagrameditor.com).

The impact of digitalisation on professional roles

New and lost professional roles due to digitalisation

The implementation of modern technology has led to a disruption of professional roles. Among the industries vulnerable to this change are those that require manual labour, such as agriculture, production, and retail. These jobs are expected to be substituted by automation systems, where the routine jobs would be assigned to mechanised entities rather than human workers. In a car manufacturing business, for instance, more robots would be used to produce the entire automobile line, reducing the need for a human workforce. It is also anticipated that professional roles relating to sales and customer service would be affected by this transformation. There is an increasing adoption of artificial intelligence and computerised automation approach in banks, which facilitates an efficient and productive overall service (Karahanli and Touma, 2021; Andersson et al., 2018; Atkinson, 2019). Digitalisation clearly has an impact on employment of professionals.

Hiring of professional workers is predicted to grow in the coming decade, despite elevated incorporation of machine intelligence and automation components within the workplace. A total of 300,000 additional jobs will come into existence by 2030. Duration of working time will increase due to an intensification of robotics alongside common social development factors, such as the population growing older, boosted revenues, funding of new equipment, and new professions (Arbetsförmedligen, 2021; Frick, Källroos & Lindberg, 2020). This means that employment is expected to increase despite the increase in digital elements at work.

Digitalisation is one of the many factors that has further widened the gap between high and low incomes. This is because repetitive activities performed at the medium-income level have been

replaced with automated systems. Jobs that provide a high income are growing, as these professionals use the latest technical equipment to improve job productivity. Employment for low-income earners is also increasing, while demand for some medium-income job opportunities is falling, such as administrative, mechanical, and manufacturing operations jobs. This trend is expected to continue in the forthcoming decade (Arbetsförmedligen, 2021; Granfelt, Stanfors & Julén Votinius, 2020; Arbetsmiljöverket, 2015). Digitalisation is therefore having both positive and negative effects on professional incomes.

Challenges of digitalisation on professional roles

Digitalisation requires changes, both within a company (e.g., workers) and outside the business (e.g., customers). However, getting everyone on board with a new regime can be one the most arduous tasks facing an enterprise. This is because many employees/professional workers might be accustomed to carrying out tasks in a certain way, involving old procedures. The same could be said with customers used to physical rather than digital purchases. While some buyers could be apprehensive about adopting the new system, others would find it easier to switch from a face-to-face purchase to an electronic acquisition. Switches from traditional methods force professionals to re-evaluate their position and develop the new skills needed to deliver productive work for consumers' purchases (Bergqvist & Gabrielii, 2019; Vinnova, 2018).

Another challenge that professionals may face is stress caused by constant connection and accessibility over digital devices and/or platforms (Bergqvist & Gabrielii, 2019; Vinnova, 2018). The never-ending state of being available online can lead professionals to disregard the division between private and work life (Chopra & Sharma, 2020). This situation inevitably results into a dysfunctional time organisation of the professional worker, with further negative impacts on their life in general if appropriate measures are not put in place. The work-leisure balance must be considered when discussing the implications of digitalisation for professionals.

A third issue that may arise for professionals relates to the execution of identical assignments through innovative approaches. For this sudden transition, face-to-face discussions or, at the very least, casual meetings are required between managers and employees. This would help to build relationships and disseminate ideas among the workforce. Mutual trust and inputs from the personnel are important components for such changes, as well as remodeling the workplace to include staff input. Without these key ingredients, a manager or the company in question might be unable to fully implement the concept (Liu et al., 2020; Harvard Business review, 2021).

A fourth obstacle to the smooth operation of professionals is that relevant authorities might not be working in unison when creating an efficient workplace. This creates an environment that is not suitable for professional workers carrying out productive work. Examples are laws and regulations, which could eventually cripple business development (Bergqvist & Gabrielii, 2019; Vinnova, 2018). The relevant administrative bodies responsible for laws or regulations about digitalisation need to come together to ensure a positive progression of professionals in the light of digital changes.

Implementation of digitalisation in a company comes at a cost. New packages and skills need to be taught to workers, so a business must allocate funds to training of staff about upcoming changes to their professional roles. Despite relatively high short-term costs, the enterprise would see efficiency improvements from the adoption of new technological innovations in the working environment in the long term (Bergqvist & Gabrielii, 2019; Vinnova, 2018). Digitalisation of a workforce can therefore entail both high and low costs simultaneously.

Digitalisation in Swedish forestry

Swedish forestry presents both historical and more recent examples of the changes brought about by digitalisation. SDC, later Biometria, has since the 60s built a digital infrastructure, primarily around business related data, measurement of raw materials at industry, transport information and keeping track of information in the chain from forest harvesting to industry. Another area which builds a

fundament for today's implementation of digitalisation in forestry is the development and implementation of different digital standards, i.e. StanFord (Arlinger et al 2020)or papiNet as well as the efforts to build a National Road Data Base with special information of the vast forest road network.

More recent examples are laser scanning, artificial intelligence (AI), drones, and robotisation. Each of the latest digital tools is a significant factor in the development of Swedish forestry. For instance, laser scanning allows sizeable forest areas to be mapped accurately. Forest owners can then use the collected data when planning their forest management. Another example is the application of AI. Thanks to this technology, Biometria (a member-owned organisation in the forest industry) can now objectively measure pulpwood (Mistra Digital Forest, 2020; Mistra Digital Forest, 2019; Skogforsk, 2021b; Biometria, 2020).

While this transformation affords possibilities, including an easily attainable and direct interface, maximisation of the forest supply chain, or automation of vehicles (Centigo, 2020), the issues surrounding this process should also be considered. Challenges facing forest professionals include: 1) varying levels of digital literacy within the industry; 2) an inefficient distribution system, dictated by both insufficient information across the sector and the various digital literacy levels; 3) low digital proficiency level, and the ability to communicate, elaborate and share information in relation to digital services and/or products; and 4) low level of service creation, and inadequate renovation of ideas dedicated to services within the sector. The main focus is on the development of products rather than services that would provide customers with attainable solutions to improve the industry.

Applying these obstacles to the Swedish workforce would bring: a) changes in the employment market; b) over-qualification, under-qualification, and a need for skills development of workers; and c) a modification of the gender structure (Johansson & Abrahamsson, 2021). Holmström (2020) suggested the following measures to address the issues: 1) programs to increase digital literacy; 2) a digital ecosystem scheme, an online framework (with auto-regulatory, rating and durable abilities) that deals with social and technical issues; 3) policies to improve IT skills; and 4) procedures to improve the service innovation system. Both the positive and negative consequences of forest digitalisation should be considered when attempting to understand the changes that this transformation would have on the industry.

Purpose and goal

The purpose of this report was to analyse and evaluate the impacts of digitalisation on professional roles. To relate this subject to the Swedish forest sector, three case studies were selected, focusing on agriculture, mining, and transportation.

The aim was to use the findings of the case studies to predict effects of digitalisation on possible forest professional roles. The approach increased knowledge about the possible repercussions of this transformation on the forest sector.

Report materials and methods

Literature review

The review was conducted using Google search and Google Scholar. A ratio was established to ensure that half of the references were academic documents and the other half were non-academic reports (e.g., documentation from consulting companies, governments, and other parties). The area of study was restricted to Sweden as far as possible, due to the country's socioeconomic and environmental position. Information from other Scandinavian countries was considered and incorporated when deemed appropriate. In the scenario where neither Sweden nor the other Nordic countries could contribute valuable data on the subject, knowledge from other countries was reviewed and included if it added further value to the subject. The objective of this approach was to find a balanced view between scholars and non-scholars.

Case studies

Case studies were used to obtain reliable and detailed information about the impacts of digitalisation on three sectors – agriculture, mining, and transportation. These sectors are relevant to rural business and are thereby comparable with the forest sector. The information was subsequently used to make projections about possible implications that digitalisation would have on future professional roles in those industries.

Results and discussions

The following section presents information gathered from case studies on agriculture, transportation, and mining. This data was collected mainly from research and management consultancy groups. Additional details from other sources were added to the case studies when information from either of the main source groups was insufficient or lacking.

Case Study 1 – Effects of digitalisation on agriculture

Future returns and efficiency of the agricultural sector revolve around several features, among which precision farming, digitalisation, and optimum administration play vital roles for the industry's development (Lantmännen, 2019, pp. 6-7). As the objective of Swedish agriculture is to reduce the impact on climate change (Swedish Climate Policy Council, 2021; Bowen & Dietz, 2016), the aforementioned areas combined with plant breeding can help to achieve that intention. These approaches would be environmentally beneficial, by improving the quality of water and soil, while promoting biodiversity. However, the use of these approaches brings several challenges, such as practicality and ease of use of the systems, normalisation of automated systems, and data provision. These obstacles represent examples encountered through transformation of the agricultural sector (Lantmännen, 2019, pp.18).

Digitalisation of the rural network brings innovative ways of thinking, as well as modern technological services/products to improve workers' tasks. Agricultural professionals learn to think in terms of systems and make informed decisions based on information from technological tools and other sources. For instance, farm data derived from yield monitors or information from GPS would be worthless without the ability of the farmer to use that data for decision support (Ingram & Maye, 2020). This approach increases the responsibility that each player has towards the farming industry, both nationally and internationally (Rijswijk et al., 2021; Macklean, 2016).

The adoption of the latest digital techniques, such as GPS, drones, phones containing farm data, and robotics, reduces manual and repetitive activities on the farm. To illustrate, GPS can be used to collect live information from a specific location. Agricultural workers can use this data to decide where and how resources should be employed across the farm. Drones and other equipment equipped with cameras are generally used to map or crop spray a field. The use of such tools increases farm efficiency, precision, and productivity (Rijswijk et al., 2021; Lohm & Andersson, 2021; Frankelius, Norrman & Johansen, 2017).

For this process to prosper, cooperation among actors involved within the system will be needed, in addition to other elements (Kenney & Serhan, 2020). This procedure will ensure that boundaries are set for a balance between private and work life. Digitalisation contributes to the understanding of agricultural systems, while providing digital tools to improve the entire industry in the future.

The digital transformation of the farming industry is characterised by two main areas: big data and the Internet of Things (IoT). Big data concerns the electronic storage of information instead of traditional ways (e.g., paper). The quality and quantity of this type of data depends on skills to gather (e.g., Web and digicams), save (e.g., fixed drivers), and manage knowledge. The IoT refers to the advancement of devices, means of transport, and other tools with built-in detectors or electronic components. These options provide professionals with an improved vision, transmission system and real-time data on which to make informed decisions (Jordbruksverket, 2017). The impacts of IoT on agriculture is summarised in Fig. 2, with the actors and services involved in the industry. The opportunities are indicated under '+' and the challenges under '-', thereby showing impacts of IoT (including big data) on the agricultural sector.

The effects (positive and negative) of digitalisation on the farming sector vary according to the party/element of interest: a) Agricultural sector; b) Breeders; c) Trade; d) Inputs, equipment and services; e) Advisors; f) Authorities; g) Organisation's interest; i) Research; and j) Financers.

Agriculture: Digitalisation improves productivity, allows the sharing of farming data throughout the sector, and eliminates/substitutes/improves parts of the digital system without compromising its structure. The negative side of this process is that it creates uniform information for farmers, leading to the same thought process among workers, which can be both positive and negative; it generates individual actor systems rather than cooperative players, where each participant is looking for their gain; and users become technology-dependent, which would affect productivity, efficiency, and farm precision.

Breeders: Agricultural data coming from the industry would help producers to make predictions about raw materials available and plan for future management, increase information exchange, and reduce waste from agricultural systems. Despite those positive inputs, digitalisation also brings negative points such as financial capital needed for IT and equipment or lack of experts within the field.

Trade: Digitalisation is favourable to trade by improving logistics and efficiency as well a greater tracing system. Negative consequences include the promotion of e-commerce and data not solely for food purchases.

Inputs, equipment and services: Farming information improves inputs, equipment, and services through precise product development, resulting in new revenue streams and closer relationships with customers, thereby increasing loyalty. Unwanted effects of this process include suppliers not having access to farm data, leading to potential disruption of their roles within the sector. This transition would present a challenge to an older generation of agricultural players with low digital skills and applying traditional methods.

Advisors: Digitalised knowledge provides advisors with a wider range of products /services to recommend to their customers for each land unit. Advisors can provide this help digitally, instead of being face-to-face on every occasion. Drawbacks include the investments and amalgamation involved in system transformation, which leads to increased competition among consultants. Experts within the field will be required, which would put pressure on advisors to complement their job skills with IT and data analysis.

Authorities: Agricultural data would be used by authorities to improve administration, analysis, and decision-making, with reduced input costs, and up-to-date information. Digitalisation would force the relevant agency to improve skills regarding IoT information for digital material dissemination.

Organisation: Digitalisation promotes improved data and services for members of the respective organisation. Disadvantages include new interests sparking new bodies/entities as suppliers to meet changed expectations, no access to IoT data for those interested, and a lack of experts in the field.

Research: Agricultural data provides new opportunities for analysis, while digitalisation necessitates greater skills to carry out research assignments.

Financers: digital agricultural information gives financers enough data to make financial decisions. However, they do not have direct access to farm information, and it would most likely come from a third party.

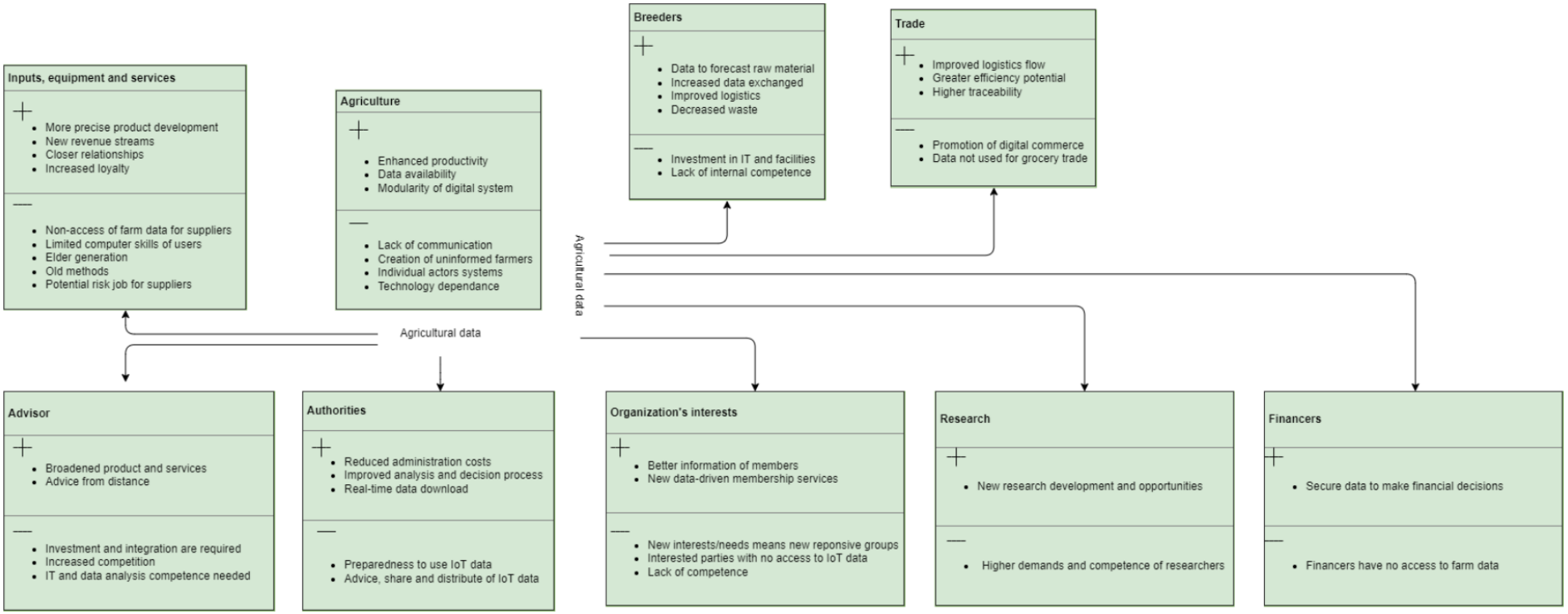

Fig. 2. Opportunities and challenges regarding the effects of IoT on the agricultural sector, from system inputs to actors involved within the process (modified from Tele2, Macklean and LRF, 2017, pp. 15, created using Diagrameditor.com).

Implications for future professional roles in agriculture

Based on the information collected, future professional roles are projected to include the following:

- Agriculture professional expert roles + Data scientist/IT expert/AI expert or translator (McKinsey, 2020a).
- More consultancy roles – experts in fields ranging from agriculture to AI.
- Farmers to oversee agricultural operations with drone farming, self-driving vehicles, and intelligent machinery rather than manage agricultural fields "directly" by driving tractors themselves.
- Farm vehicles may be offered as a service, reducing the farmer's needs for skills in how to repair and maintain vehicles.

Case study 2 – Effects of digitalisation on mining

A digital transformation is currently taking place in the mining industry, affecting all aspects of the business, from operations to trade of product/service (BCG, 2021). Since 2014, the sector has been able to reverse its downward trend in productivity, increasing output by approximately 2.8% annually during the years 2014-2016. This change can be attributed to two main factors: a) workforce efficiency improvement, which reduced the number of workers, and b) a closely monitored budget for miscellaneous activities. The prime movers of this IT movement were/are:

i.) Technology: incorporating automation, electronics, and analyses throughout the enterprise to address relevant issues related to topics such as consumer satisfaction, security, or cost-effectiveness.
ii.) Monitoring schemes: a switch to modern techniques for schemes such as working procedures could strengthen the company's position.
iii.) Lifestyle and competencies: recondition of these elements to make the organisation flexible and adaptable to advanced techniques (McKinsey, 2018a).

These improvements are enabled by the introduction of tools such as drones, wearables, sensors, or incorporated distant controlled environments (Deloitte, 2017). The impacts of these technologies vary, depending on the mining company. The areas that will be influenced by these new tools will touch upon automation, efficiency, AI, and skillsets for job requirements (Airaksinen, 2020; IISD, GIZ & BMZ, 2019; McKinsey, 2020c; McKinsey, 2019; Clausen et al., 2020). Consequently, the framework of the industry is changing, as summarised in Fig. 3. Digitalisation affects the whole mining sector, including the product and service area, value chain, business models, and customer access. At the core of this transformation are data and analytics, embraced by the industry to make these changes possible. The techniques associated with digitalisation include the adoption of mobile devices, cloud computing, smart sensors, and IoT platforms.

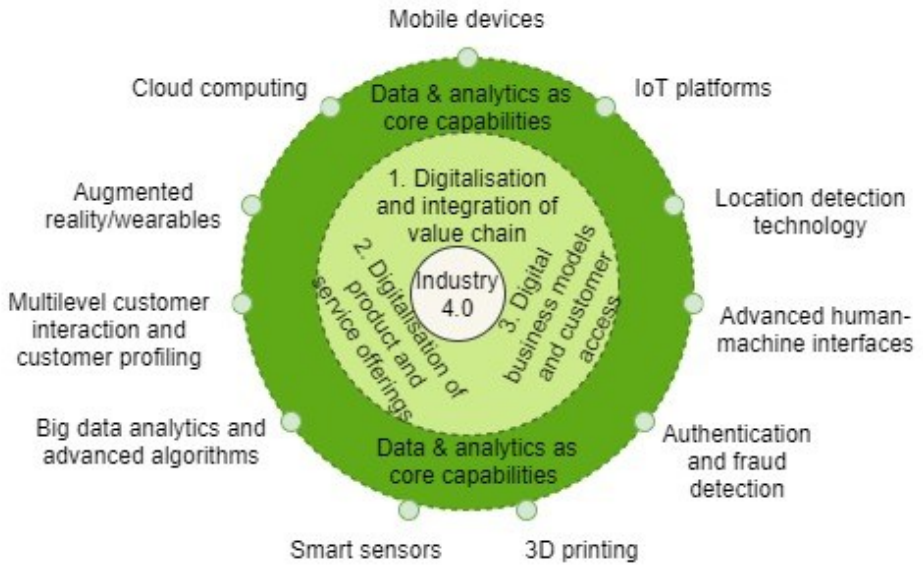

Fig. 3. Effect of digitalisation on mining framework (modified from PWC, 2016, pp. 6, created using Diagrameditor.com).

The effects of introducing new technology in the mining sphere alters the future working environment, which is an important point to consider in new system implementation. As the latest electric equipment is integrated in the workplace, this reduces attention paid to the wellbeing of those who use the technology e.g., handlers and managers. This lack of consideration can manifest itself in the form of risks and/or vulnerability (physical, mental, social), such as putting the worker in a position that could have otherwise been prevented. However, it is equally relevant to state that not all risks are preventable. The implementation of technology cannot be considered as a single event but part of a wider system, which would have a knock-on effect on other parts of the industry. Hence, it is important to understand the implications of digitalisation for the sector, including the effects on labour conditions (Lööw, 2021; Deloitte, 2018; Deloitte, 2021).

Implications for future professional roles in mining

Based on the information collected about the mining sector, future professional roles are projected to include the following:

- "Specially-powered miner" who utilises biomechanical aid systems to enhance arm motion, power, and stamina.
- "Glasses miner" operates his task using augmented reality (AR) to amalgamate digital data into real life.
- "Virtual Reality (VR) miner" whose job is to simulate situations and prepare other miners for unsafe conditions.
- "A condition miner" who adopts wearable detectors to check information concerning health and GPS position.
- "Intelligent miner" who uses smart assistants to interact with devices, electronics, databanks, and other systems.
- "Cooperative miner" who employs collective automation to carry out monotonous and arduous tasks.
- "Social miner" who engages in social web systems separating workers.
- "Methodical miner" who extrapolates valuable material and forecasts pertinent facts through data processing (Lööw, Abrahamsson & Johansson, 2019).

Case study 3 – Effects of digitalisation on transportation of both individuals and goods

Similar to the agricultural and mining sectors, the transportation field is undergoing changes due to digitalisation. Systems such as AI, automation, and electronic devices bring both opportunities and challenges. On the one hand, this implementation can improve the relationship between customers and buyers, promote collaborative planning among workers, and enhance productivity and environmental impact. On the other, digitalisation increases risks associated with this transformation. This situation results in a call for transparency to provide users with adequate information for the decision-making process. Thus, the digitalisation of transportation affects all aspects of the industry (PwC, 2016; Leviäkangas, 2016; PwC, 2016b; McKinsey, 2018a).

Views coming from the truck industry, such as Scania Trucks, Volvo Trucks and Trucks in Canada, can provide further explanation concerning the current changes in the transportation sector due to digitalisation. According to Scania Trucks, digitalisation represents one of the main operating factors transforming the industry, after sustainability and urbanisation. With these components set to change tomorrow's transportation, Scania foresees the future in four realms: automation, connectivity, electrification, and renewable fuels (Scania, 2020). Volvo Trucks also believe in these future trends, where techniques such as digitalised loading or digital services like Volvo Connect are aimed at improving the sector (Scania, 2019; Scania, 2018). The advantages of digitalised cargo carriage are better usage rates, minimised management, and enhanced client satisfaction (Volvo Trucks, 2019). Trucks in Canada are also incorporating new technology in with a technique named truck platooning. This consists of a minimum of two trucks or more connected (through computers, cameras, GPS etc.), travelling close together. This system would potentially reduce costs of transportation by 17%, but also tackle problems relating to a severe labour shortage (Gaudet & Pekilis, 2020).

The impacts of digitalisation on transportation are through a) IoT, b) AI and automation, c) the rise of new business models and competition, and d) less dependence on location. The collection and use of big data have become part of businesses' agenda, as they see an increased use of this information necessary for the company's improvement. Automated systems and robots are increasingly incorporated in business systems. This development goes together with the IoT and could culminate in an integration of both advancements, where devices are unified with the ability to reflect and articulate ideas. New business models and competition through digitalisation changes both supply and demand relating to products/services as well as the work environment. While customers' preferences mutate regarding products/services, workers have to adapt to a new system that includes digital tools, e.g., the use of smart phones, data, and other digital tools.

Accessibility to the digitalised world is expanding, reducing the dependence on location. Tasks can be performed irrespective of location, which opens the door for future development of machines that are remotely controlled, such as remotely controlled forwarders (Skogforsk, 2021a). The framework for transportation in relation to digitalisation is shown in Fig. 4. Digital disruption originates from technical structure, formed by infrastructures and equipment. This disturbance affects a society's social framework, composed of organisations, industries, markets, and stakeholders (Trafikverket, 2018; Pernestål et al., 2020; Davidsson et al., 2016; Leviäkangas, 2016, pp. 4).

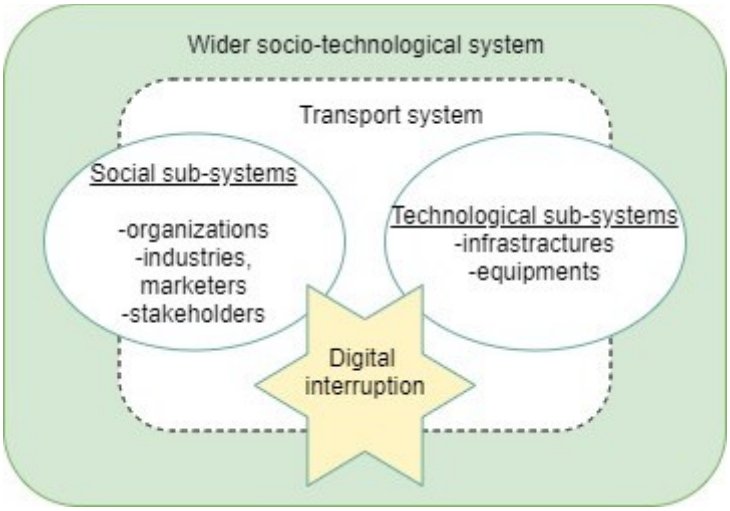

Fig.4. Transportation framework with disruption caused by digitalisation (modified from Leviäkangas, 2016, pp. 4, created using Diagrameditor.com).

Implications for future professional roles in transportation

Based on the information collected about the transportation sector, future professional roles are projected to include the following:

- Transportation professional expert roles + Data scientist/IT expert/AI expert or translator.
- Increase of jobs relating to remote controlled vehicles jobs (trains, cars, trucks, buses).
- Supervision jobs such as remotely controlled traffic jam operations, thanks to vehicles exchanging information with one another.
- Transportation as a service – different roles for purchase.

Common threads among the industries

The three sectors (agriculture, mining, transportation) show similar results from digitalisation. On the positive side, the IoT, cloud services, big data, and automation are set to improve the industries in various ways, e.g., from organisational, financial, and environmental perspectives. Professional roles are changing as a consequence, with increased digital awareness among traditional professionals in each industry. For instance, the future development in the mining industry would see different sorts of miners, specialising in particular areas, such use of AR, the ability to forecast certain mining events, or the use of biomechanical arms to improve work efficiency. On the negative side, the inclusion of these digital means within each system exposes users' points of vulnerability (mental, physical, social). Professionals may find it difficult to separate their work environment from their life environment, as lines between those two states are blurred.

How would these tendencies and prime movers affect future operations? There is a pressing need to discuss both utopian and dystopian views of technological adoption. Technological utopianism believes that science would guide humankind towards an improved state (Tundo, 2020). As an illustration, it is widely believed that production would improve drastically with the implementation of automation, AI, and robotics. However, at the same time we are removing the human component (social and living

creatures) from the work environment and replacing it with inanimate machines. To what extent would this change benefit industry in the long run? Related to this question is a technological dystopian concept, which believes that science will bring an end to civilization instead. For instance, would giving computers consciousness lead to them overpowering human beings? (Lööw et al., 2019; Signorelli, 2018). These are relevant points to consider when examining digitalisation in any sector.

Conclusion: implications for professional roles in forestry

The implications of digitalisation on the forest sector seem to indicate an enhanced transition of forest operations towards a more automated system (which includes advanced decision support systems for supply chain planning, AI, robots, and big data). Development of a more AI-based forest system is on the way, resulting in a change of professional roles needed in the industry and creating new roles, such as data analysists, AI- engineers and specialists (Skogsstyrelsen, 2021; McKinsey, 2020; McKinsey, 2018). Together with expectations of forest professionals to upskill both their knowledge and abilities for a successful future forest development by 2030 (Macklean, 2016), this creates a vision of the forthcoming changes in the Swedish forest sector.
Companies/organisations, and thereby professionals in general, should be prepared to plan for the new skills needed.

Future professional roles in forestry are expected to include the following digital enablers and roles:

Digital enablers

- Advanced decision support systems for integrated supply chain planning.
- Improved digital communication services, including the use of mobile apps, and pro-active activities to improve everyday work.
- Self-driving machines, remotely controlled or fully automated.
- Digitised forest data.
- Equipment integrated with ultra-sensors for real-time data collection and decision-making.
- Wearable goggles for field and operative tasks.
- Interconnected vehicles and personnel through various platforms to improve communication and planning.
- Virtual- and Augumented Reality (VR and AR).

Future professional roles

- Virtual reality forest planners to prepare crew and forest owners for future scenarios.
- Digital forest advisor, buyer or seller.
- Forest professional expert roles + Data scientist/IT expert/AI expert.
- Forest supervisors overseeing operations (cutting, plantation, cleaning and transporting) conducted by intelligent and autonomous machines.

- Forest worker with goggles that have inbuilt multispectral-laser scanning, GPS, GIS, and other technologies to assess forest areas.
- Social forest worker in charge of the engagement of digital social platforms for forest owners or other clients.
- Fewer medium-income jobs relating to administrative, mechanical, and manufacturing work.
- If forest machinery is offered as a service, this will reduce the need for contractors to have skills in how to repair and maintain vehicles.

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