Department of Business and Management

The Fourth Industrial Revolution – Metamorphosis of the Business Environment

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Contents

LIST OF ABBREVIATIONS

AI	Artificial Intelligence
CRM	Customer Relationship Management
CMS	Compliance Management Systems
DPD	Data Protection Directive
ERP	Enterprise Resource Planning
EC	European Commission
EDPS	European Data Protection Supervisor
EU	European Union
GDPR	General Data Protection Regulation
ICT	Information and Communications Technology
IoT	Internet of Things
IT	Information Technology
RFID	Radio Frequency Identification Device
MBA	Master of Business Administration
MIT	Massachusetts Institute of Technology
USD	United States Dollar
WEF	World Economic Forum

INTRODUCTION

The first industrial revolution used water power and steam to mechanize the production process. Electricity was the driver of the second industrial revolution and enabled mass production. The third has electronics and information technology at its basis to automate wide parts of production. Now, we are on the brink of a technological and industrial revolution that will change and redefine the way we live, work and communicate with one another. The extent of these changes is currently not very clear but has to be dealt with caution and thoughtfulness and include every individual of our society. In the fourth industrial revolution, new disruptive technologies and innovations are being introduced at a much faster pace than in the previous ones. The scientific breakthroughs that were made in the last years and the new technologies that have emerged seem infinite. Also, they all have the same key feature: the powerful use of digitization and information technology. The digital megatrends are clustered in three groups. The fourth industrial revolution combines physical, digital and biological megatrends. The combination of these technologies allows the emergence of disruptive waves in the business environment. This development has led companies to change their corporate strategies and research agendas as well as putting their focus on the use of these mentioned technological megatrends. Using the advantages of interaction between physical, digital and biological technologies distinguishes this industrial revolution from the ones before.

The fourth industrial revolution implies the transformation of companies on an organizational and operative level as well as achieving digital success to stay competitive and exploit first mover advantages. This digital transformation - characterized by the digitization of horizontal and vertical value chains, the improvement and digitization of product portfolios, shorter innovation cycles as well as new data driven business models – has reached enterprises in all industries around the globe.

RESEARCH QUESTION

This thesis and survey were conducted to explore the opportunities, risks and challenges of the fourth industrial revolution. Further it should highlight key findings on how companies can prepare to guarantee a successful transition from a 3.0 to a 4.0 enterprise. The conducted survey explores the opinions of digital natives on increasing digitization. It gives an indication on how a blueprint for digital readiness can look like and how companies can successfully transform by acquiring and using digital capabilities. Also, regulatory and legal issues that arise with new business models and vast data distribution will be discussed. The Fourth Industrial Revolution will lead to new policies and regulations. Calling for a more agile, faster and perhaps more experimental governance and regulation approach. Concluding, this thesis should answer the following research question:

> ***What are the opportunities, risks and challenges of the Fourth Industrial Revolution and what key findings should companies consider when going from a 3.0 to a 4.0 enterprise?***

Further, the survey indicates a tendency towards great concern of data protection and security threats the last part of the thesis will talk about the current data protection situation and the planned directive for the future, called the General Data Protection Regulation (GDPR). Unsolved data protection concerns and security threats, the commitment of governments and company stakeholders towards sound regulation and protection and the need to establish trust and acceptance towards the digital revolution calls for further elaboration on data protection and laws.

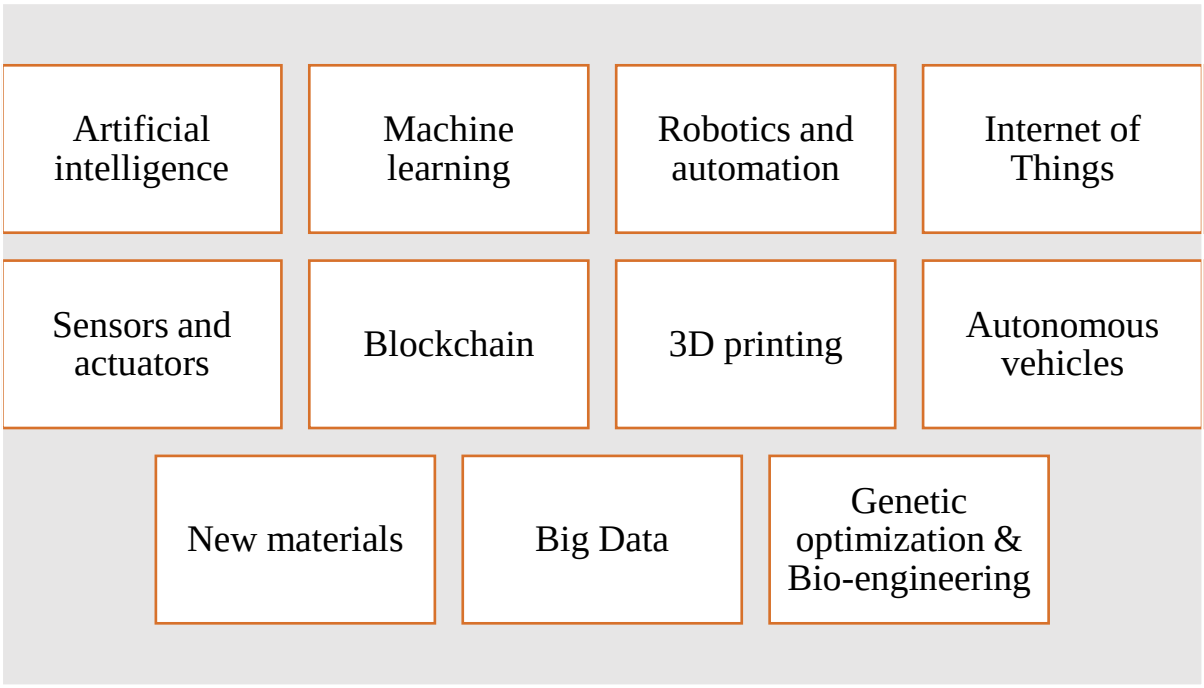
The first chapter of the thesis will give some insight into the Fourth Industrial Revolution, its historical integration and explain the three dimension of trends it is composed of.

The chapters two, three and four will elaborate on the conducted survey. Chapter two will provide an executive summary of go through the obtained data characteristics. Chapter three will go through the survey questions and present the responses and results. Chapter four will present the eight distilled key findings.

The fifth and last chapter will elaborate on the new EU data protection regulation, called the General Data Protection Regulation and will come into effect on May 25th, 2018. This last chapter will explain the structure of the directive and the main obligations companies must adapt to.

1 THE FOURTH INDUSTRIAL REVOLUTION – WHAT IS IT?

Keywords such as Industry 4.0, Logistics 4.0, automation, digitization, digital transformation or the Fourth Industrial Revolution are very present and widely discussed in science, education and by companies worldwide. Leading experts say that the fourth industrial revolution began at the start of the twenty first century and builds on the previous third industrial revolution, that had the advancement of information technology as its main driver. The fourth industrial revolution is driven by a variation of sources, such as the mobile internet, actuators and sensors, advanced machine learning and artificial intelligence. The use of digital technologies (mainly hardware, software and networks) already existed and spurred the previous industrial revolution. What main difference distinguishes them from each other? It is the combination of digital and physical assets with the Internet of Thinks (IoT) connecting both and creating highly sophisticated and integrated technologies that will have the power to change the way we live, act and work together. The main technologies to be acknowledged are shown in the table below:



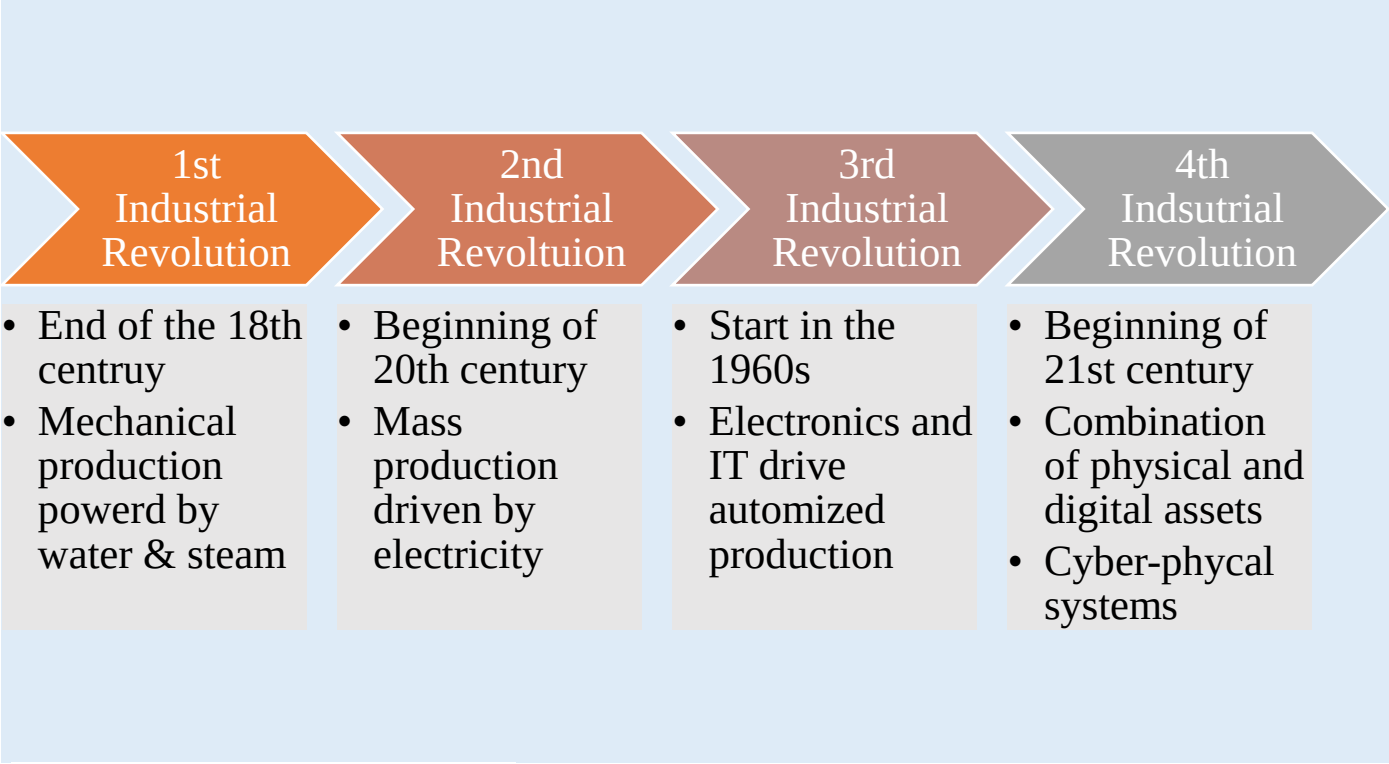
Source: Schwab, 2016

In 2011 the term Industry 4.0 was introduced at the Hannover Fair in Germany. It was used to explain the optimization of organizational value chains through robotics, algorithms, sensors and connected machines. This combination of digital technology will transform the corporate production site into a “smart factor”. But this is not where the future stops. Smart factories with connected machines and autonomous systems are not the end of the scale, rather the beginning. Technological breakthroughs in the digital, physical and biological area will drive quantum leaps in performance and turn traditional industries upside down. The combination and interaction of the three mentioned technological areas is what makes the fourth industrial revolution so fundamentally diverse from the previous ones.

1.1 Historical integration

The term “revolution” usually marks radical changes. Every Industrial Revolution has reshaped and changed our society and economy dramatically. History provides a lot of examples of breakthrough technologies that spurred periods of fundamental and usually exponentially paced change. Turning economic systems upside down and break up current social systems.

The Industrial Revolutions were proceeded by several Agricultural Revolutions, which all meant profound shifts for the human civilization. The first to name is the First Agricultural Revolution (around 10 000 BC), also referred to as the Neolithic Revolution. It marked the transition from hunting and gathering to fixed settlements and farming. The First Industrial Revolution, which was driven by the invention of the steam engine, railways and the start of mechanical production, was set at the end of the 18th century. The Second Industrial Revolution can be dated back to the end of the 19th century and beginning of the 20th century. Its characteristics were the breakthrough technology of electricity, the use of the conveyor belt and the start of mass production. The main icons of this time were Frederick Taylor and Henry Ford, who revolutionized the way of production and corporate organization. The Third Industrial Revolution is set in the 1960s. It is the beginning of the Information Technology era and the start of digital production, with semiconductors, computers and the internet at its core (Schwab, The Fourth Industrial Revolution, 2016). The Industrial Revolution we face today has the digital technologies of the Third Industrial Revolution at its base. In addition, it is driven by a big number of new and emerging technologies, combining the digital and the physical realm. They come in a much faster speed and depth than the previous technological innovations which triggered industrial changes before. The cycle and process of the four Industrial Revolutions is shown in the table below:



Source: Brynjolfsson and McAfee, 2014

1.3 Driving forces and megatrends

1.3.1 Digital

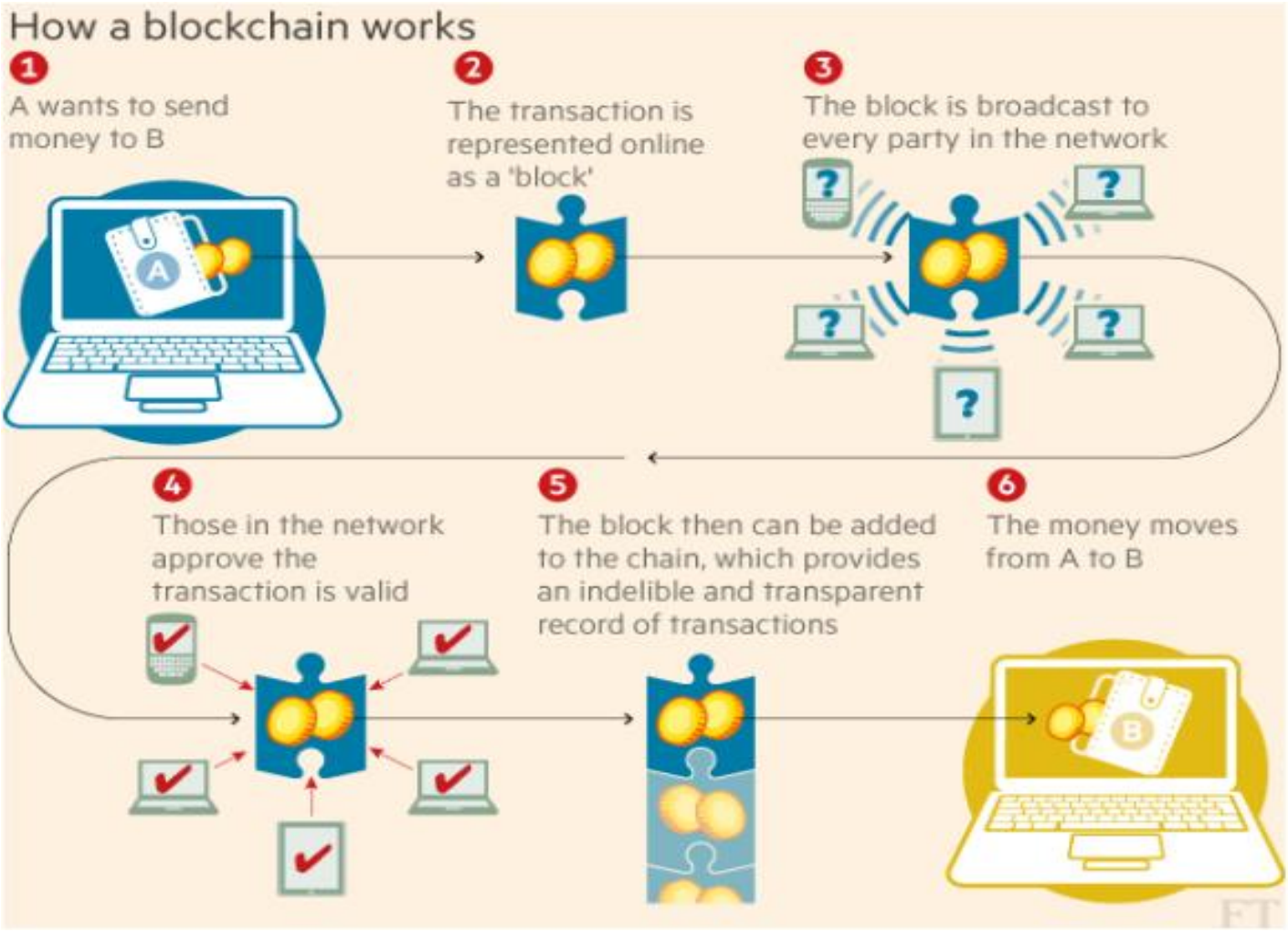
The Internet of Things

By connecting the digital and physical assets, the Fourth Industrial Revolution is also referred to as the cyber-physical phase. One main driver is the Internet of Things (IoT), which can be described as the bridge between things such as products, services, machines or places and the people they are connected to. Sensors are connected by networks to computer systems and monitor the actions of the connected environment. It allows us to manage all the physical objects around us electronically and generate data on behavior and interaction to optimize decision making. The interconnectedness of network is accelerating partly because of the fast development of sensors becoming faster, cheaper and smaller. These can be installed on humans (in the form of wearables), at home, in the retail environment, offices, in production facilities, in vehicles or cities. Already today, billion sensors and actuators are connected to devices such as computers and smartphones and interact using the internet. According to the World Economic Forum (2016) the number of connected devices will increase from several billion today to over one trillion. This indicates a tendency towards big transformations across all business industries, the way we manage our day to day life, and of course the way we interact with each other and the objects we are connected to. One example that already optimized the way we manage and monitor our supply chain through the Internet of Things is the radio frequency identification (RFID) tag. Sensor will be able to generate, distribute and analyze data in real-time. This will allow companies, especially the manufacturing industry, to optimize the production process, error detection and debugging (Matzler et al., 2016). The automobile industry and its supply chain management are a good example to illustrate an efficient and customer oriented production. Car producers use RFID (Radio Frequency Identification) tags. These devices contain all specification details of the respective customer. At the different production steps, the RFID tag communicates details on color of doors, motorization, interior or gear units (Schmidt & Ziemba). Containers, package, parts and products can have such an RFID tag as well. This enable companies to track all parts within the value chain and control production timing. Also, the costumer benefits by exactly knowing where his order is. Everybody ordering via Amazon, Alibaba or Zalando has occasionally used the tracking option to check at what stage of the shipping process his or her product currently is. This shows how manufacturers can decrease costs through more efficient processes. As well as increase customer experience and satisfaction at the same time, through individual production.

Blockchain

The way individuals, companies and institutions collaborate with each other are being revolutionized. Most of use when making transactions rely on a trusted and verified middlemen, for example a bank. This middleman is removed by the blockchain, enabling consumers and suppliers to connect directly with one another. The blockchain is also referred to as “distributed ledger”. This ledger functions as a safe and protected protocol. Also, it can be inspected by anyone calling for maximum transparency. The transaction is verified and

approved by a whole network of computers before being processed any further. In this way trust is built up. People who have not direct connection and therefor do not know each other can engage in a trusted transaction without the need of a fixed central authority. The image below from the Financial Times (2016) explains the blockchain process in a graphical way:



Source: Hutt, 2016

The starting point is a situation where two people want to engage in a transaction with one another. In this example person A wants to send money to person B. The transaction is represented digitally as a "block", containing all the information concerning the underlying transaction. This block can now be viewed by all participants in the network and be verified and approved by every one of them. After the block has been validated it is added to the chain of blocks and the money moves from person A to person B.

This technology holds a lot of great chances to speed up and optimize digital transactions. These types of transactions are not only limited to money. Also, goods or property can be exchanged for example. Or help optimize institutional work, such as tax collection and other bureaucracy processes. The main improvement is the security level that is set and reduce fraud or criminal actions. Every single transaction is recorded and is transparent can be viewed digitally for anyone interested. The most recognizable and widely known blockchain technology at the moment is the cryptocurrency Bitcoin (Hutt, 2016).

Digital platforms

New emerging technologies also transform business models and the way how companies generate revenues. There has been a strong shift towards technology-enabled platforms, pleasing the changing customer needs , what we these days refer to as the "on demand-economy". This new way of goods and services consumption can be used on any connected device, such as computers, tablets and smartphones. Digital platforms enfold dynamics that threaten the traditional businesses across all industries. These dynamics are fast growth, network effects that allow the winner to take it all and zero marginal costs (Matzler, Bailom, Friedrich, & Anschober, 2016).

Fast growth, because most disruptive digital businesses require only a fraction of time then traditional companies needed to reach a market dominating standpoint. Downes and Nunes (2013) referred to this phenomenon as "big bang disruption". This disruption sends competition changing shock waves towards long lasting players in different industries that have difficulties to cope with the pace of the respective disruption.

A winner takes it all effect, because of the creation of powerful networks. These network effects often reach a monopoly position. This triggers a phenomenon called "virtues cycle", meaning that the more users a service or product supplier has the more attractive it will be for other users. This pulls users towards the own offering and creates high barriers for competitor's entry (Matzler, Bailom, Friedrich, & Anschober, 2016). Mentionable examples are Uber, Netflix or one of the various social media sites (Facebook, Instagram and others).

And finally, zero marginal costs because new digital products and services in a lot of cases have marginal costs that go towards zero. In our globalized economy, this economic principle has become the norm as everything is becoming more and more digitized. The scalability in production towards a price close to zero underline the nature of the new business models (Schwab, The Fourth Industrial Revolution, 2016). Some examples are the e-readers Kindle or Tolino. Once in digital form the disruption of literature is not connected to any mentionable costs.

Big Data

The word Big Data describes data sets that have reached an amount which does not allow classical database software to save or process it. It describes the phenomenon of ever growing data sets. According to Matzler et al. (2016), big data can be described in five dimensions. The volume of data, its wide variety, the velocity in processing data, the reach of were the data has originated from and the complexity in analyzing the vast amounts of data generated. The amount of data, that is collected and distributed is growing at an extremely fast pace. This has to do with the fact that the number of devices that we are connected to and that accumulate these sets of data about the individual users are growing rapidly as well. There are various sources that data can be collected from:

- Data generated from mobile devices. Especially whereabout the user is located. This has an incredible value for location marketing of companies.
- Data generated from social media networks. All common social media sites such as Facebook, Twitter, Instagram generate huge amounts of data about preferences, behavior and location of their users.
- Data generated from multimedia sources such as videos or photos. These sources provide vast amounts of data. It is said that one minute of video material contains more data than a written text of 120 000 pages.
- Data generated from Enterprise-resource-planning (ERP). These systems that interface between terminal devices and the connection with other systems can contain valuable information. These data sets can go beyond regular controlling and reporting activities within a corporation. They can identify rule violation more effectively or monitor payment practices more accurately. This leads to possibilities to analyze customer fluctuation or build up rating profiles of customers.
- Data generated from the Internet of Things. As mentioned earlier IoT applications generate huge amounts of data on customers, users and processes with in the organizational value chain. Data analysis can bring forward new services or products that have been distilled from the vast amount of generated information.

The advantages seem clear. Data will help establish the basis for clear decision making, optimize processes, improve risk calculation, increase profitability, optimize price setting, improve customer services and exploit undiscovered market potentials. But threats should not be unmentioned as well. Data privacy and security threats are the main topics companies and government institutions have to deal with in order to make the fourth industrial revolution a success, build trust and accelerate acceptance of digital business models.

1.3.2 Physical

The main four physical megatrends identified by the World Economic Forum that will transform and optimize value chains and disrupt the whole business environment are:

1. 3D printing
2. Autonomous vehicles
3. Advanced robotics
4. New materials

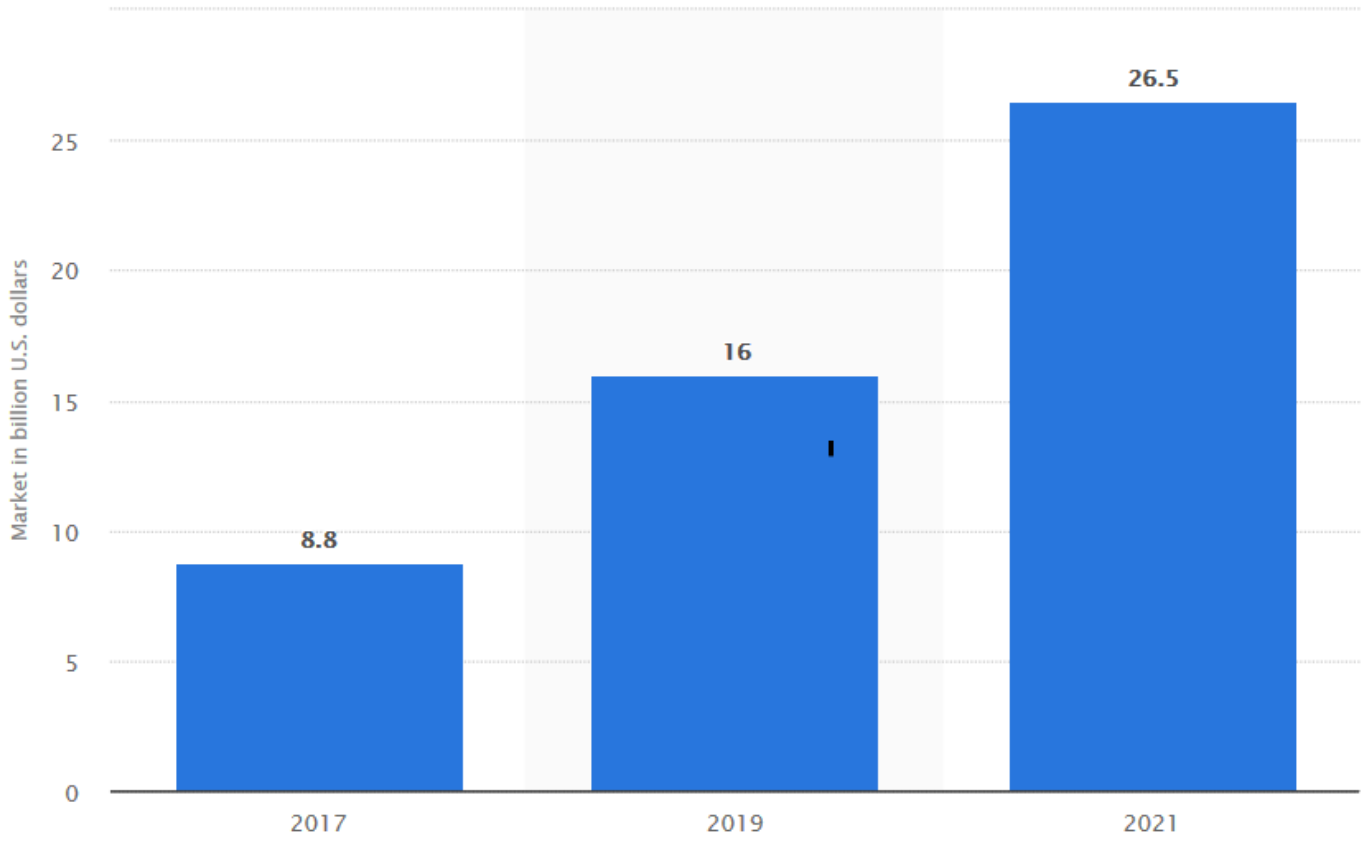
3D printing

In contrast to subtractive manufacturing, additive manufacturing (also referred to as 3D printing) is becoming increasingly popular among manufacturers. It is considered a new futuristic technology but was already first invented in 1983. Back then a man called Chuck hall invented the first 3D printer, called “stereolithography”. 3D printing works, by printing one layer after another using a 3D drawing as a model. Until now the most common way of manufacturing was to remove layers from a piece of metal (or any other material) until the

desired form has been carved out. Before printing a digital 3D file is designed by using a physical object as a template.

This technology can be used across a broad range of industries, starting from large wind turbines for onshore and offshore use to small implants used for medical purposes. The use is still limited to a few applications, especially in the automotive and medical industry. But as sales numbers and future predictions show, this is about to change.

The graph below shows the value of 3D manufacturing market from 2017 to 2021. The estimations predict a market size of 26.5 billion USD in 2021. This would be a growth of over 300% from the market size in 2017, which reached 8.8 billion USD.



Source: https://www.statista.com/statistics/261693/3d-printing-market-value-forecast/

Autonomous driving

The car or vehicle of tomorrow is expected to use less resources, produces less emissions, run quieter and support the sustainable mobility concept of the future. A modern vehicle today already takes over multiple tasks that in the past had to be handled solely by the driver. Systems such as cruise control, automated vehicle distance regulator or parking assistance support and help the driver in difficult situations. The development of the self-driving car takes place in five phases: supportive driving, partly automated driving, highly automated driving, fully automated driving and finally unmanned driving. The driver hands over control and tasks to the car in each step (Schaal, 2018).

1. Supportive driving means that the driver steers, stops and accelerates independently. Systems such as cruise control or vehicle distance regulators support him.
2. The electronic systems adopt more responsibilities and functions such as automated parking assistance or holding the vehicle on the correct path. Still the driver remains responsible for driving.
3. The highly automated driving phase allows cars to drive autonomously to a large extent. The driver will be able to take his hands off the steering wheel but must be ready to actively participate at any time.
4. In the fully automated driving stage has the possibility to actively participate in driving the vehicle but does not have to. Electronic systems can handle all traffic situations automatically.
5. In the unmanned driving phase, cars will not need a steering wheel any more. The whole car or vehicle will be controlled solely over the provided systems.

What do we think of concepts that talk about cars which are able communicate flawlessly with each other? Cars which avoid a cyclist that comes out of nowhere? Logistical concepts that avoid traffic jams and optimizes the distribution of products in less time? Unmanned vehicles in which the passengers can read a book, listen to music or sleep without having to pay attention what is happening around them? These future visions might be far from taking over our streets, but a lot of companies and institutions are working on these concepts extensively. And these plans are not just limited to cars. Other vehicles such as trucks, planes, boats or drones can be run autonomously using technologies such as sensors, artificial intelligence, radars and machine learning.

Until cars will be able to drive fully autonomous will take a substantial period of time. This not only has to do with the technical efforts, also the legal hurdles should not be underestimated. From a legal perspective, already automated parking assistance programs are problematic. Who will be liable for an accident caused by an automated parking assistant?

Advanced Robotics

“My colleague the robot” seems to become a more and more commonly used slogan in manufacturing and production industries. An increasing number of companies recognizes the advantages of artificial intelligence and believe in mixed teams consisting of androids and humans. Artificial intelligence is becoming more and more important in assisting humans in their work in a lot of industries. Smart robotic solutions in production is nothing new and in the medical industry they are of great help to their human colleagues. They are accurate, quick and never fall ill or tire out. Robots are being used across an even bigger range of industries in the next years. Examples are precision farming in the agriculture industry to nursing tasks taken over by intelligent androids. The increasing progress in automated and intelligent robotics will improve collaboration between robots and humans.

According to a McKinsey study (2016) companies are investing increasing amounts in artificial intelligence: In 2015, the major tech companies such as Google and Amazon invested up to 27 billion USD in internal

Research and Development of intelligent androids and self-learning computer systems. The senior executives believe that the key to higher productivity levels are intelligent automation initiatives.

Because of the rapid advances in a lot of technological areas the androids are becoming much more adaptive and flexible. The progress made in areas such as sensors and actuators allow robots to respond to their environment in a better way. Also, they will be able to take over a broader range of tasks and work together with their human colleagues flawlessly.

New Materials

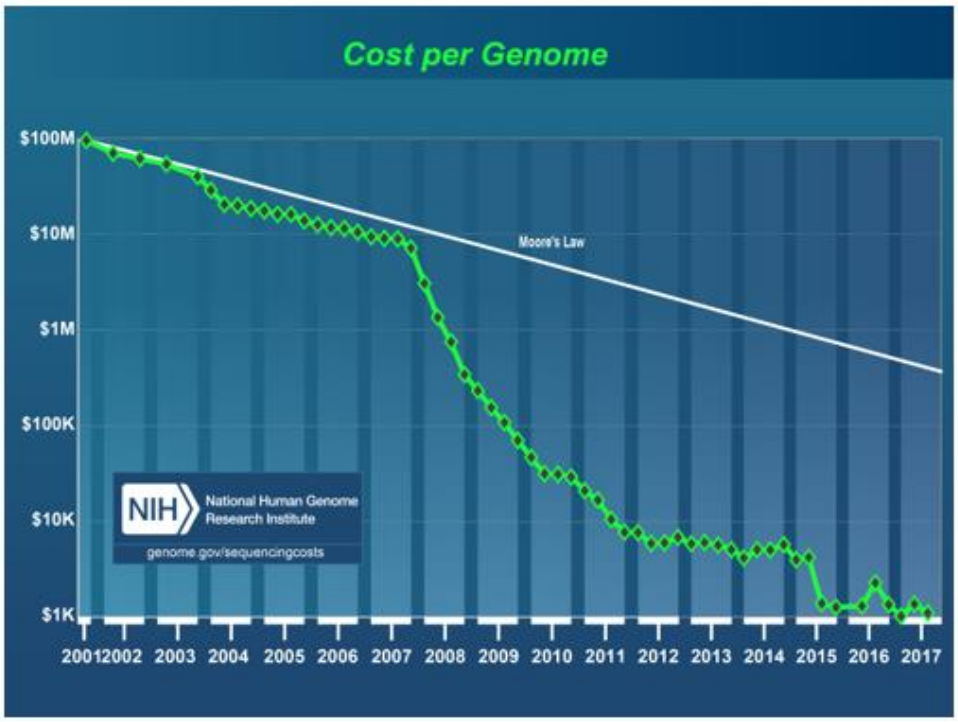
New materials with much improved attributes are being introduced. A lot of them being much lighter, more robust, easier recyclable and more functional. Also, researchers work on materials that are able to clean or heal themselves. Some of which possess a memory of their own enabling them to transform in their original shapes (Schwab, The Fourth Industrial Revolution, 2016).

David Isaiah from the journal 'Automotive World' describes the market for graphene, an extremely light carbon being developed at the moment. A lot of these innovations, their future and their impact are not predictable but their attributes and properties are. The mentioned nanomaterial graphene for example is much thinner than a human hair, a million times thinner to be precise. Also, it is about 200 times stronger than steel, even more robust than a diamond and can be used as an excellent conductor of electricity or heat (Isaiah, 2015). What makes graphene not marketable at the moment is its price point. It is one of the most expensive materials with over $ 1000 for a micrometer-sized patch, making it not price competitive for now.

Another new material that should be mentioned is a polymer referred to as polyhexahydrotriazines (PHTs). This new kind of plastic made it onto the list of the 'Top 10 emerging technologies of 2015' and might play a big factor in fighting one major global risk we face, pollution (Meyerson, 2015).

1.3.4 Biological

A mentionable breakthrough in genetic sequencing and considerable progress in this field have been made possible by the Human Genome Project, which took over 10 years to complete at a total cost of $ 2.7 billion. Nowadays this process of genome sequencing can be done in just a few hours and will cost less than one thousand dollars (National Human Genome Research Institute, 2016). The development of the cost per genome is shown graphically below.



Source: National Genome Human Research Institute, 2016

We have to be aware that it will most likely be the biological advances that will confront us with the greatest challenges, in terms of social norms and regulation. Biological advances will bring up questions that circle around topics such as what it means to be human, data protection of information on our health or what consequences and implications changing genetic codes can have for us and the further generations to come.

1.3.5 Significant digital tipping points identified

One pressing question of course is when these emerging technologies will come into full effect. To give an indication, a World Economic Report called 'Deep Shift – Technology Tipping Points and Societal Impact' published in 2015 identified digital tipping points that should occur until 2025. The research team interviewed over 800 executives and experts from the field of information and communications and distilled the following results showed below.

	%
10 % of people wearing clothes connected to the internet	**91.2**
90 % of people having unlimited and free (advertising-supported) storage	**91.0**
1 trillion sensors connected to the internet	**89.2**
The first robotic pharmacist in the US	**86.5**
10 % of reading glasses connected to the internet	**85.5**
80 % of people with a digital presence on the internet	**84.4**
The first 3D-printed car in production	**84.1**
The first government to replace its census with bid-data sources	**82.9**
The first implantable mobile phone available commercially	**81.7**
5% of consumer products printed in 3D	**81.1**
90% of the population with regular access to the internet	**80.7**
90% of the population using smartphones	**80.7**
90% of the population with regular access to the internet	**78.8**
Driverless cars equaling 10% of all cars on US roads	**78.2**
The first transplant of a 3D-printed liver	**76.4**
30% of corporate audits performed by AI	**75.4**
Tax collected for the first time by a government via a blockchain	**73.1**
Over 50% of internet traffic to homes for appliances and devices	**69.9**
Globally more trips/journeys via car sharing than in private cars	**67.2**
The first city with more than 50,000 people and no traffic lights	**63.7**
10 % of global gross domestic product stored on blockchain technology	**57.9**
The first AI machine on a corporate board of directors	**45.2**

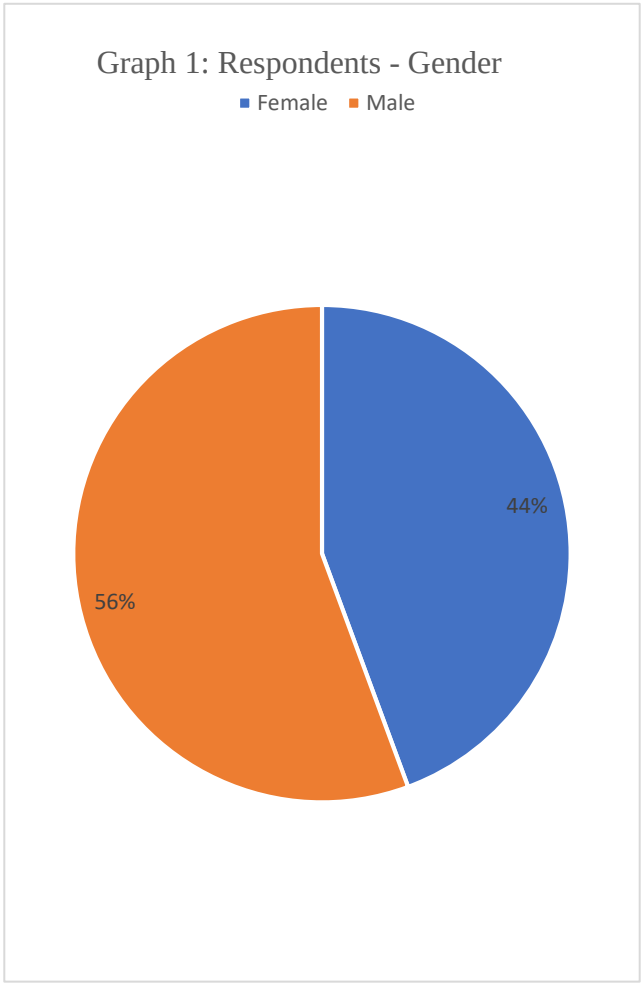
Source: Schwab, 2016

The table presents the survey respondents opinion on what tipping points are most likely to occur until 2025. They indicate that major changes lie ahead of us, not in the far future but most likely in the next 5 to 10 years.

2 EXECUTIVE SUMMARY – SURVEY

We are on the brink of a technological revolution that will change and redefine the way we live, work and communicate with one another. The extent of these changes is currently not very clear but has to be dealt with caution and thoughtfulness and include every individual of our society. The fourth industrial revolution implies the transformation of companies on an organizational and operative level as well as achieving digital success to stay competitive and exploit first mover advantages. This digital transformation - characterized by the digitization of horizontal and vertical value chains, the improvement and digitization of product portfolios, shorter innovation cycles as well as new data driven business models – has reached enterprises in all industries around the globe.

This Work Project and the underlying survey explore the opportunities, risks and challenges of the fourth industrial revolution. Further it should highlight key findings on what companies and employees should take into consideration to guarantee a successful transition from a 3.0 to a 4.0 enterprise. Graphs 1 to 5 and table 1 below show the data characteristics of the survey. These range from gender, age, country of origin, employment status, university education to the faculty or major of the respective respondents. The data characteristics are shown and outlined below.



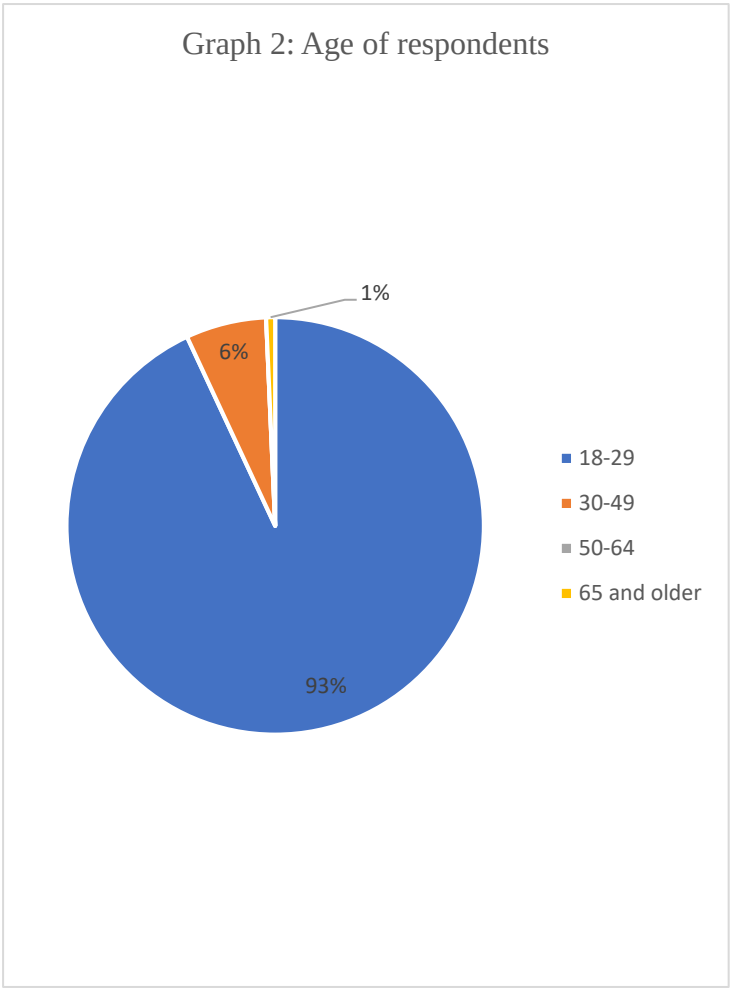
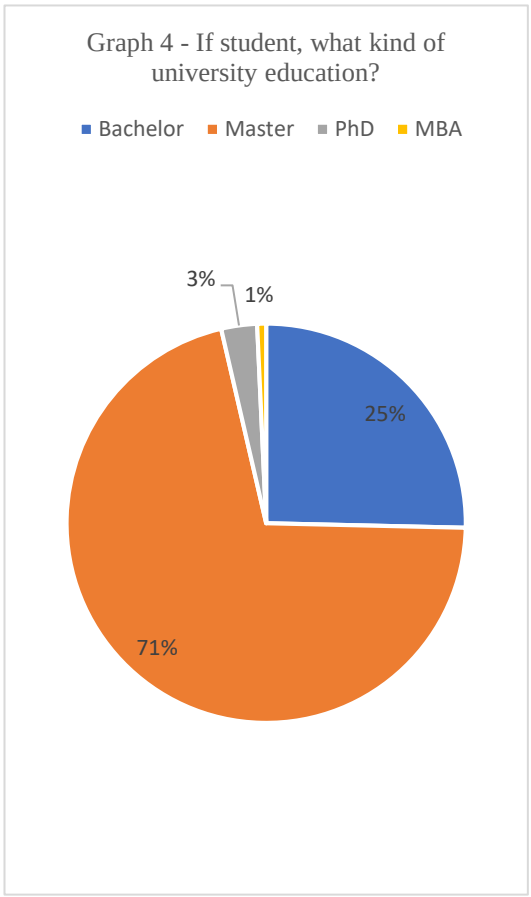
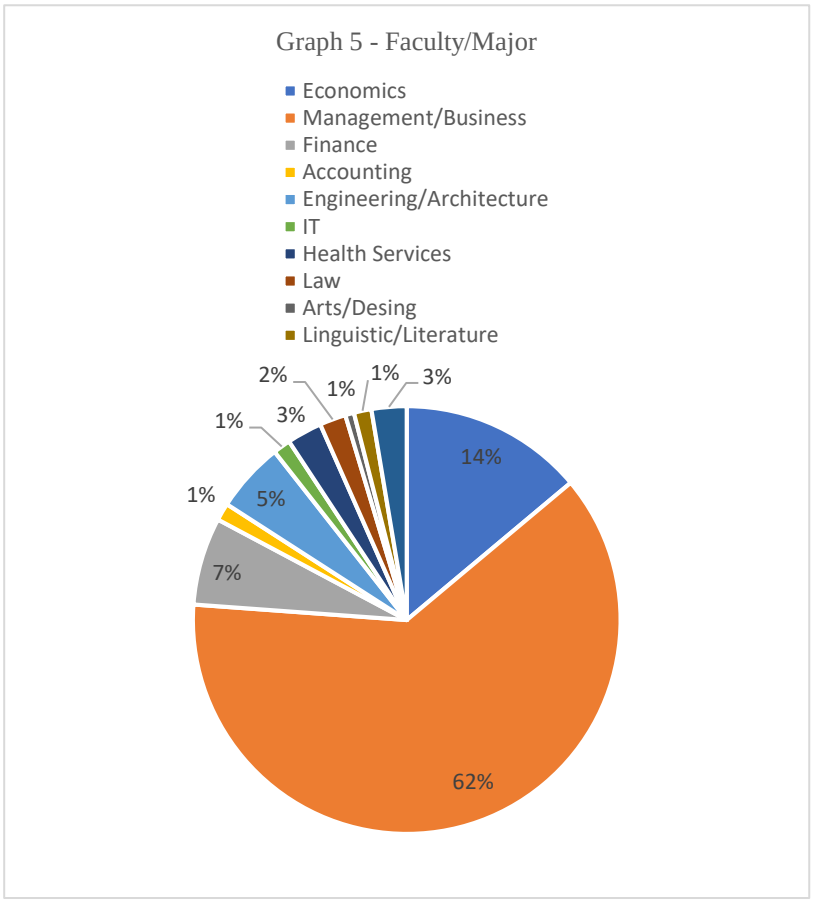


TABLE 1: COUNTRY OF ORIGIN OF SURVEY RESPONDENTS

COUNTRY OF ORIGIN	Number of respondents
GERMANY	70
PORTUGAL	27
ITALY	24
FRANCE	11
SPAIN	4
RUSSIA	2
AUSTRALIA	1
AUSTRIA	1
BELARUS	1
BELGIUM	1
BULGARIA	1
BOLIVIA	1
FINLAND	1
IRAN	1
IRELAND	1
NAMIBIA	1
NORWAY	1
PAKISTAN	1
POLAND	1

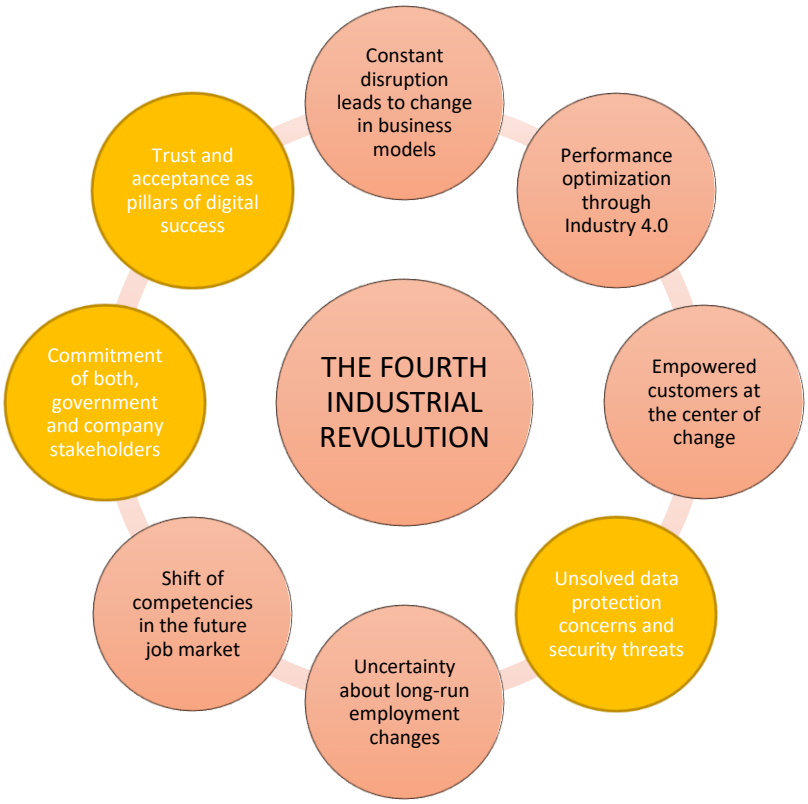




44% of survey participants were female and 56% male. 134 (93%) were between the age of 18 and 29. Another 9 respondents (or 6%) were between the age of 30 and 49 and 1 participant (0,6%) was 65 and older. Most respondents are from Germany (46%). 18% are from Portugal and 16% from Italy (the spread between the remaining countries can be seen in the appendix – table 1). The majority of participants were students (62%), followed by people who are employed for wages (28%), 5 % being self-employed and 2 % being currently out of work and looking for a new job. 71 % of all students are currently doing their master´s degree, 25 % their bachelor´s degree, 3 % their PhD and the remaining 1 % a MBA. Most of them studied in business related fields such as management (62%), economics (14%) and finance (7%).

The first part of the survey analysis will lead through and explain the seven survey questions and their respective graphs. The second part will pool together the survey answers and describe the 8 key findings that were distilled from the participants responses:

1. Constant disruption leads to change in business models
2. Performance optimization through Industry 4.0
3. Empowered customers at the center of change
4. Unsolved data protection concerns and security threats
5. Uncertainty about positive long-run employment changes through technological innovations
6. Shift of competencies in the future job market
7. Commitment of both, government and company stakeholders
8. Trust and acceptance as pillars of digital success

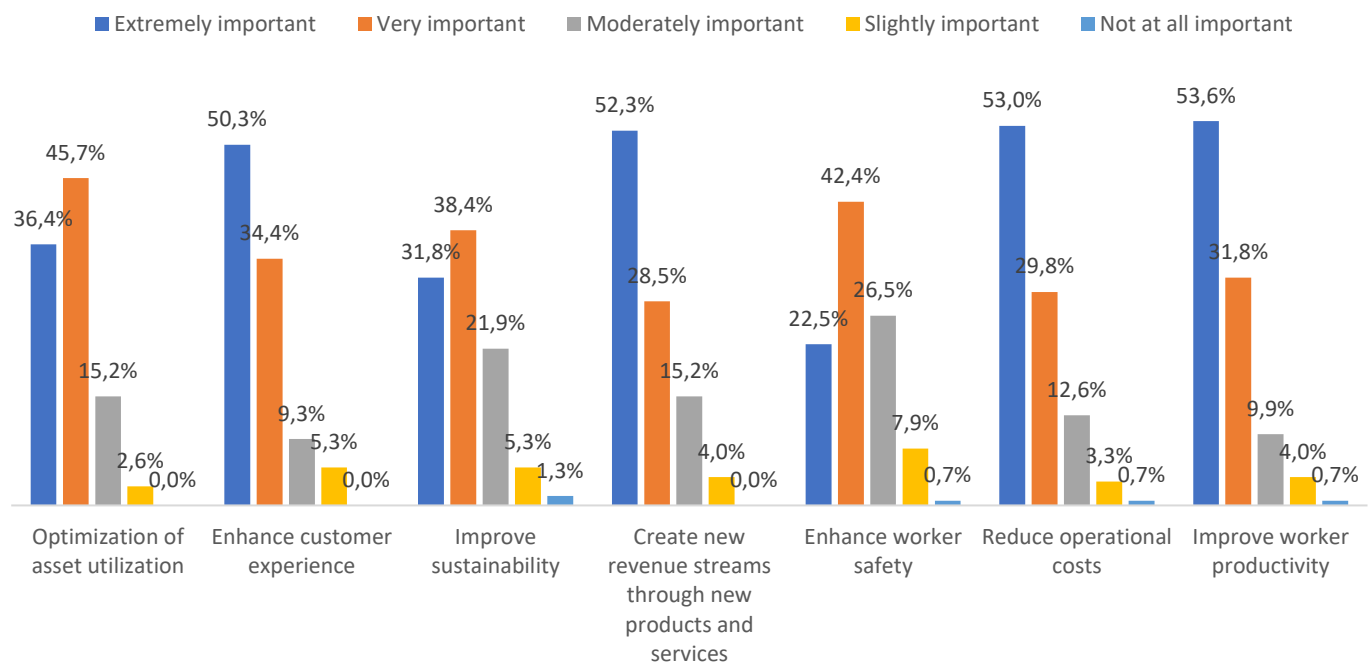


3 SURVEY QUESTIONS AND RESPONSES

3.1 Benefits created through Industry 4.0 initiatives

Graph 6 shows the weighted responses to the question "How important are the following benefits for companies created through Industry 4.0?". Each listed benefit should be categorized by the respondents as either being extremely important, very important, moderately important, slightly important or not at all important.

Graph 6: How important are the following benefits for companies created through Industry 4.0?



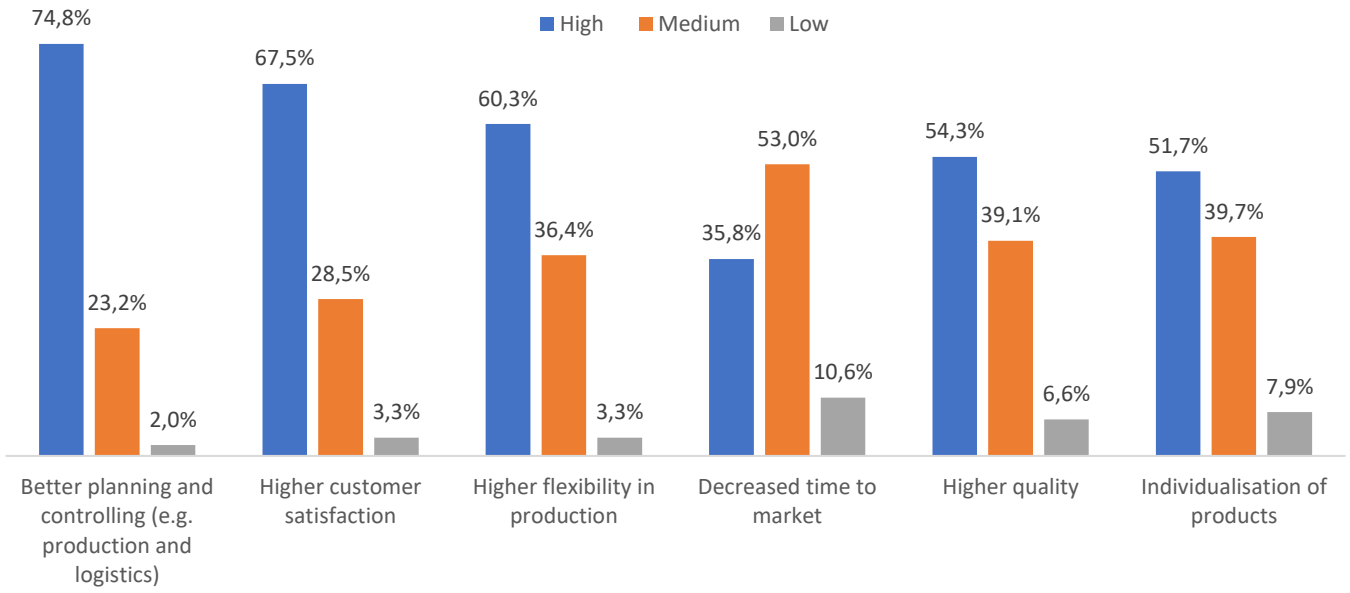
Four listed Industry 4.0-benefits were said to be extremely important by over 50% of respondents. These are, the improvement of worker productivity (53.6%), the reduction of operational costs (53.0%), the creation of new revenue streams through new products and services (52.3%) and the enhancement of customer experience (50,3%). The three remaining benefits which were identified as being very important are the following: The optimization of asset utilization (45.7%), the enhancement of worker safety (42.4%) and the improvement of sustainability (38.4%).

The survey shows that the respondents strongly believe that companies will not only cut costs dramatically and improve productivity, but also generate additional revenue streams. Through the automation of processes using Big Data, algorithms, sensors and artificial intelligence, companies will be able to improve both the bottom and top line. These cost reductions and productivity gains can be reached through better asset utilization in the form of smart manufacturing initiatives.

3.2 Qualitative advantages created through Industry 4.0 initiatives

Graph 8 shows the responses to the question “How high or low will the impact of the following qualitative advantages be for a company?”. The respondents should rate each listed qualitative advantage as either being high, medium or low.

Graph 8: How high or low will the impact of the following qualitative advantages be for a company?



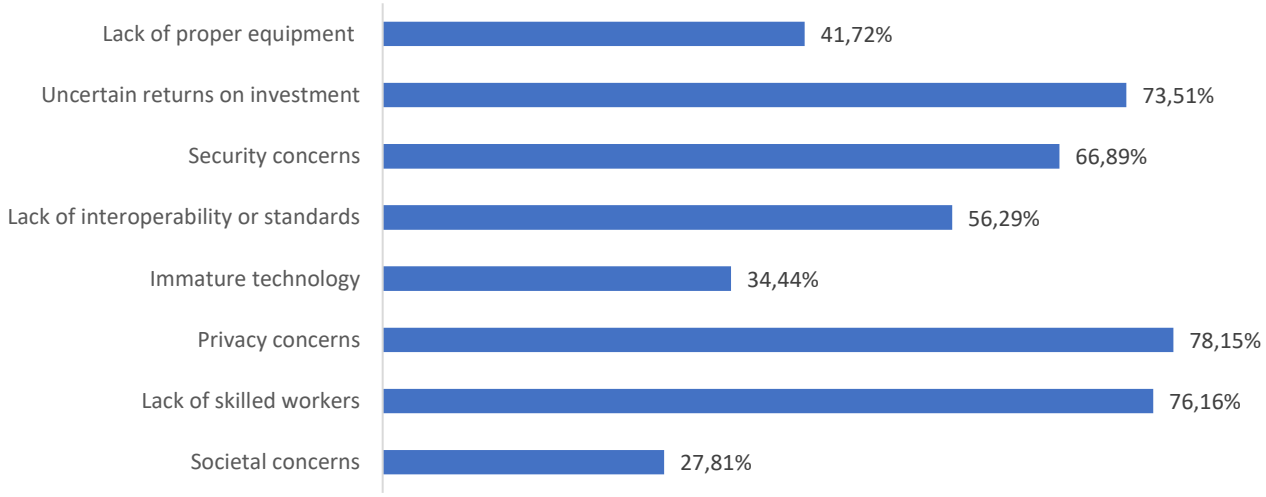
The following qualitative advantages were rated as having a high impact on a company: Better planning and controlling, for example in production and logistics (74.8%), higher customer satisfaction (67.5%), higher flexibility in production (60.3%), higher quality (54.3%) and individualization of products (51.7%). Decreased time to market was rated by 53.0% of respondents as having a medium impact on a company.

These results strongly correlate with the results from graph 6, showing the survey participants opinions on benefits by Industry 4.0 initiatives. Both graphs indicate a tendency towards generating additional revenue, lower costs, higher efficiency and greater customer satisfaction.

3.3 Barriers preventing adoption of digital technologies

Graph 7 shows the responses to the question "What do you think are the biggest barriers that prevent companies from adopting digital technologies. Each participant could choose five main limitations to digital technology adoption.

Graph 7: What do you think are the biggest barriers that prevent companies from adopting digital technologies?

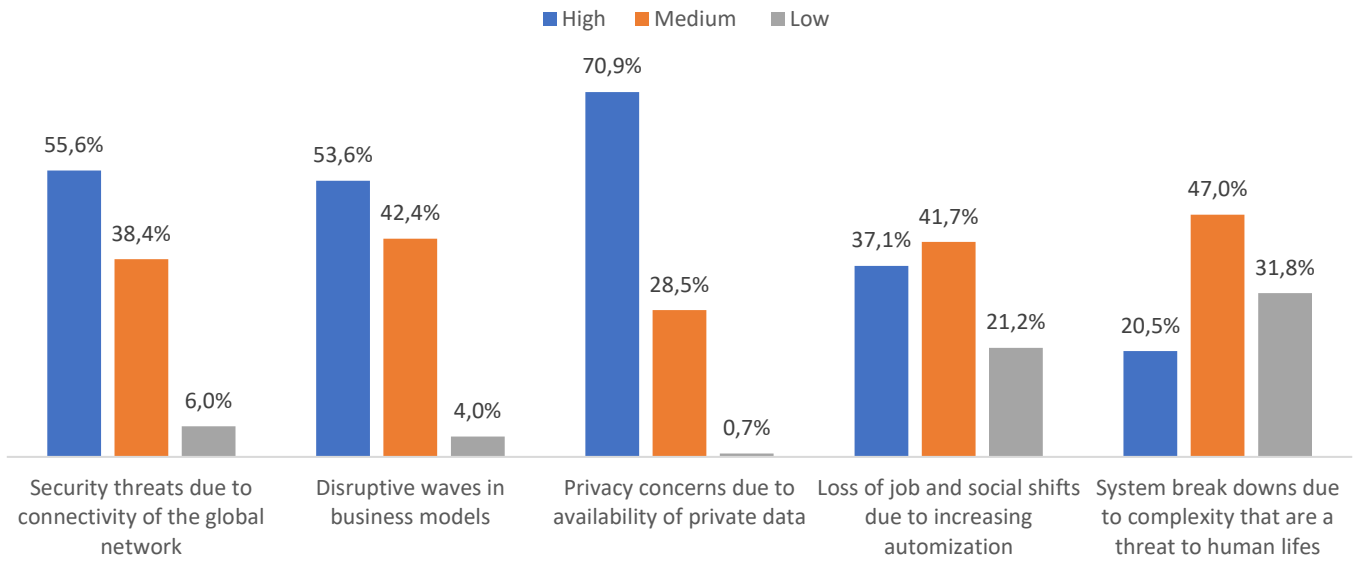


118 survey respondents voted for privacy concerns being the biggest barrier to digital technology adoption. This suggest rising concerns among digital users about their private data. This suggest that the respondents are aware that growing digitalization also shows growing caution on how private data is collected, distributed and protected. Lack of skilled workers was selected 115 times and ranks as the second biggest limitation. This suggests, that respondents are aware of changing skills and job competencies in the future business environment. The third commonly selected limitation are the uncertain returns on investment with 111 responses. This barrier to investing in digital technologies shows that the survey participants know of the difficulties to quantify the impact of digital transformation. This implies that a lot of investments are not based on sound ROI calculations and therefore cannot capture the full impact of the new emerging technologies, making investments seem like more of a risky bet. This point correlates with another highly voted barrier: the lack of interoperability or standards (85 responses). Suggesting that the uncertainty to invest ground on uncertainty of the maturity and soundness of the digital technologies. The fourth biggest barrier with 101 responses are security concerns. This goes hand in hand with the number one limitation, privacy concerns. The limitations that occupied the end of the scale are the lack of proper equipment (63 responses), immature technologies (52 responses) and societal concerns (42 responses).

3.4 Risks associated with the digital revolution

Graph 9 presents the responses to the questions “How likely do you think are the following risks associated with the digital revolution?”. The survey participants evaluated each listed risk as being either high, medium or low.

Graph 9: How likely do you think are the following risks associated with the digital revolution?



Privacy concerns due to availability of private data was identified to have a high risk (70.9% voted high, 28.5% voted medium risk). The second biggest risk identified were security threats due to connectivity of the global network (55.6% voted high, 38.4% voted medium). The third major risk associated with the digital revolution are disruptive waves in business models (53.6% voted high, 42.4% voted medium). The remaining two risks identified as having a medium risk are system break downs due to the complexity (20.5% voted high and 47.0% voted medium) and loss of job and social shifts due to increasing automation (37.1% voted high, 41.7% voted medium and 21.2% voted low).

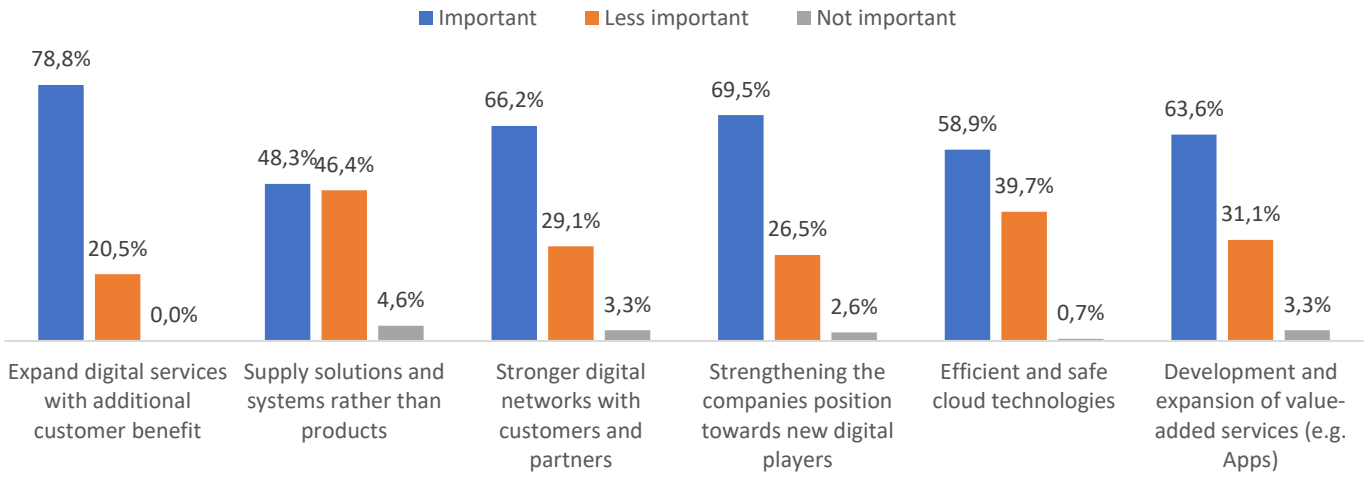
Privacy concerns and security threats highly correlate with the identified barriers and limitations to digital technology adoption (graph 7). Although privacy concerns and security threats were identified as the risks with the highest impact, the survey respondents are not totally convinced that the digital revolution will threaten human lives due to system break downs. This indicates that the participants believe in the maturity and soundness of the new technologies. This highly correlates with immature technologies not being one of the main barriers towards digital technology adoption (identified by graph 7).

The risk of disruptive waves in business models gives an indication that traditional businesses will have to adapt to new waves of doing business and the use of emerging technologies and business models. And the balanced vote on the risk of job losses and social shifts due to increasing automation reflects the current popular-scientific discussion, which are far from agreeing opinions on the long-run impact of automation.

3.5 Aspects of a successful and sustainable business model

A lot of industries are being turned upside down by new entrants that are threatening ore totally driving out traditional businesses. To find answers how to cope with digital business models the respondents should respond to the following question: “How important are the following aspects of Industry 4.0 for a successful and sustainable business model?” (shown in graph 11).

Graph 11: How important are the following aspects of Industry 4.0 for a successful and sustainable business model?

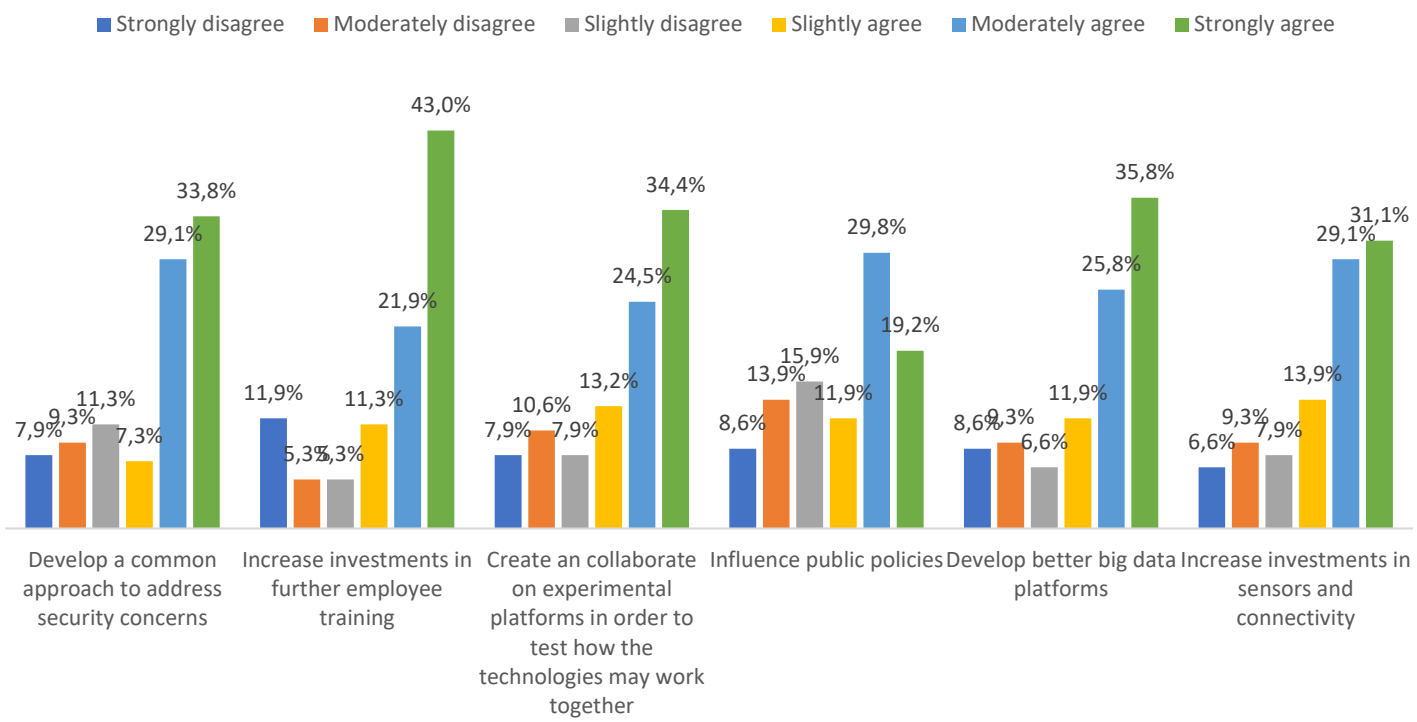


All listed aspects where identified as being important for a successful and sustainable business model. The individual responses on being “important” were weighted as follows: Expand digital services with additional customer benefit (78.8%). Strengthen the company’s position towards new digital players (69.5%). Stronger digital networks with customers and partners (66.2%). Development and expansion of value-added services for example apps (63.6%). Efficient and safe cloud technologies (58.9%) and supplying solutions and systems rather than products (48.3%).

3.6 Company stakeholder actions to accelerate digital adoption

Graph 12 evaluates to what extent the survey participants agree or disagree on each listed action company stakeholders should take to spur digital technology implementation.

Graph 12: To what extent do you agree/disagree with the actions company stakeholders should take in order to accelerate the adoption of digital technolgy?

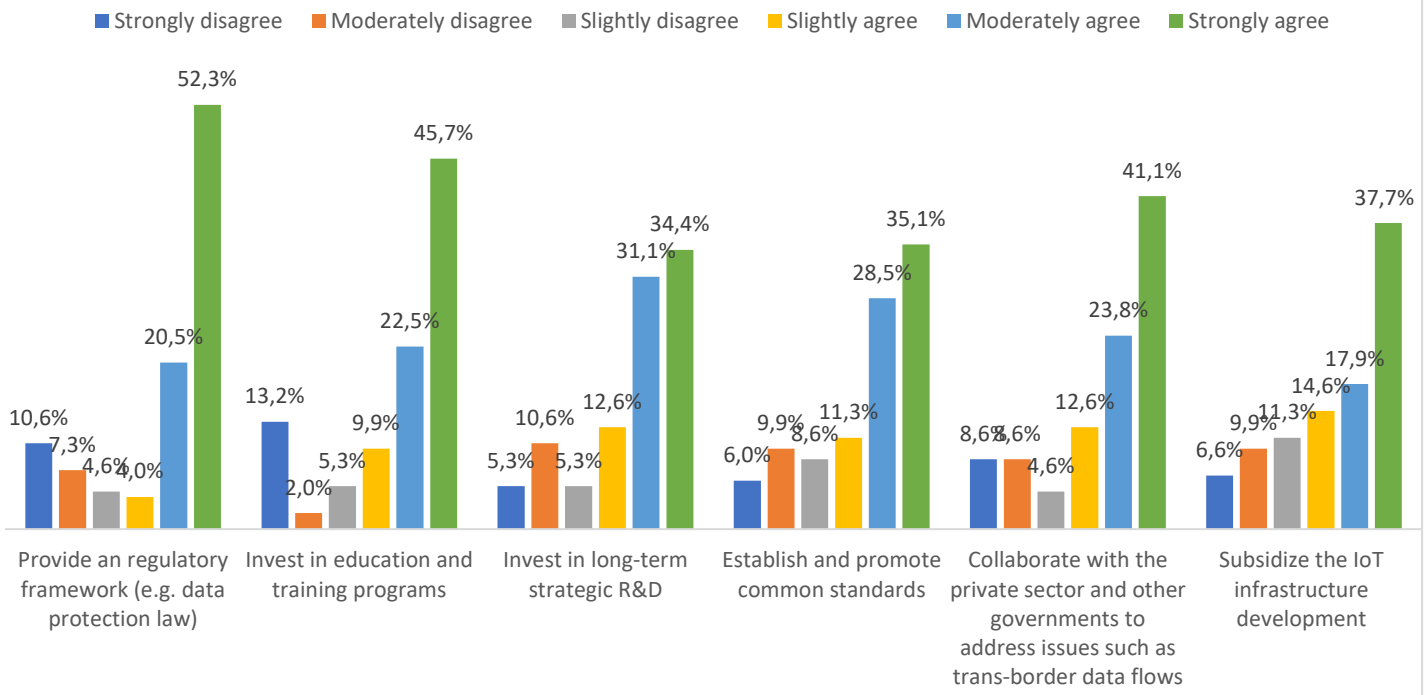


The results are as follows: 43.0% strongly agree with increasing investments in further employee training. 35.8% strongly agree on developing better big data platforms. Over one third (34.4%) of respondents strongly agree that company stakeholders should create and collaborate on experimental platforms to test how the technologies work together. Also, over one third (33.8%) strongly agree with developing a common approach to address security issues was. Increasing investments in sensors and connectivity was as well strongly agreed upon (31.1%). To influence public policies to accelerate the adoption of digital technologies was not seen as important as the other actions. 19.2% strongly and 29.8% moderately agreed with this action.

3.7 Government actions to accelerate digital adoption

In addition to company actions, the survey identified main actions governments should take to accelerate and support the acceleration of digital technologies (shown in graph 13). The survey participants rated each listed action by how strongly they agreed or disagreed.

Graph 13: How strongly do you agree/disagree with tha actions governments should take to accelerate the adoption of digital technology?



The outcome correlates with the previous responses towards security issues, education and training. 53.3% strongly agreed with the provision of a regulatory framework (for example data protection laws). 45.7% strongly agreed with investments in education and training programs. Further, 41.1% strongly agree on government collaborations with the private sector and other government to address issues such as trans-border data flow. The following three governmental actions had less participant agreement: Subsidize the IoT infrastructure (37.7% strongly agreed), establish and promote common standards (35.1%) and invest in long-term strategic R&D (34.4%).

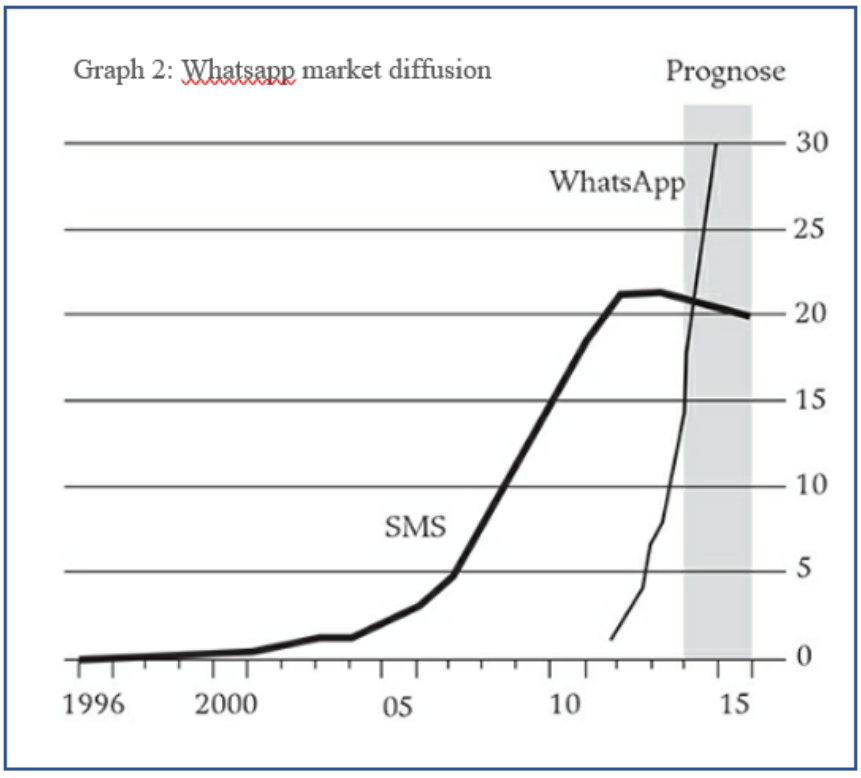
4 KEY FINDINGS – SURVEY

4.1 Constant disruption leads to change in business models

The survey reveals that 53.6% of respondents think that disruptive waves in business models is a high risk to businesses associated with the digital revolution. This is shown in graph 1 which shows risks that are rated on how likely they are associated with the digital revolution. Privacy concerns due to availability of private data (70.9% consider this as being a high risk) and security threats due to the connectivity of the global network (55.6% consider this as being a high risk) will be outlined in more detailed later.

There are plenty of examples that show the dynamics that originate from digital and disruptive business models. Disruptive ideas and the transformation and enhancement of existing industries with new digital technologies has ruined some of the most successful companies and is turning whole sectors upside down.

WhatsApp is a good example to illustrate the speed and extent of disruptive digital business models. The company was founded in California in 2009 and was acquired by Facebook for 19 billion US dollars five years later. Back in 2015 more than one billion users sent about 42 billion messages, 1.6 billion photos and 250 million videos per day – with 57 engineers working for them. WhatsApp destroyed the hundred-billion-dollar Short Message Service (SMS) industry in a short period of time (Economist, 2015). This is illustrated by graph 2, that shows the corresponding market diffusion below.



Source: Matzler et al., 2016

Further, according to Matzler et al. (2016) WhatsApp and other examples such as Netflix, Uber, Airbnb or Spotify show many similarities:

- **Fast growth**

  The market diffusion graph shows that WhatsApp only required one tenth the time the SMS needed to reach a volume of 20 billion messages per day. This phenomenon is referred to as 'big band disruption', sending shock waves towards long lasting players in different industries that have difficulties to cope with the pace of disruption (Downes & Nunes, 2013).

- **Network effects that allow the winner to take it all**

  A typical characteristic is the network effect. A lot of new digital business models take advantage of it to reach a monopoly position. This means the more users a service or product supplier has the more attractive the offer is for other users and creates barriers of entries for competitors (Hagiu, 2016).

- **Zero marginal costs**

  Digital products and services usually have marginal costs that go towards zero. Once they are produced the cost of producing any additional amount is nearly nothing. This economic principle has become the norm as the economy becomes more and more digitized. Scalability in production towards a price close to zero underlines the new digital business models. To put it in the words of Jeremy Rifkin (2014), *"Zero marginal cost is the most sustainable state because it allows us to produce goods and services with the minimum input of energy, labor time and capital, and optimize the output".*

  Take the book as an example. Once in digital form the distribution is not connected to any mentionable costs. The logical consequence is that the digital transformation of the economy also forces digital companies to seek for new revenue drivers.

The fourth industrial revolution will lead to disruptive waves in products and business models. Emerging new technologies will make companies change at a faster pace. Due to the mass of provided information, faster moving processes and constant innovation, companies have a gradually decreasing lifespan. Also, the time that competitors need to acquire a dominant role in the market has become much shorter (Schwab, The Fourth Industrial Revolution, 2016). This will force companies to adopt changes efficiently and rethink their current business models.

The conducted survey shows that 52.3% of respondents believe that creating new revenue streams through new products and services is an extremely important benefit of the fourth industrial revolution (shown in appendix 4). This can be done either through disruptive or evolutionary products and services (Matzler et al., 2016). Further, the respondents identified the three most important aspects for a successful and sustainable business model being the following:

4.1.1 Expand the digital services (extend the current product portfolio)

78.8% consider expanding digital services with customer benefit the most important aspect for a successful and sustainable business model. Companies can either place new innovative products in their current portfolio. Or they add so called evolutionary innovations to their current product and service setting. The first named innovative products create either an entirely new market or transform to expensive products into affordable

ones to reach a bigger customer base. Newly created markets would be the tablet or smart-watch. And products turned from unaffordable for the average consumer are for example Fords` Model T or the PC (Matzler et al., 2016). The second way of expanding the product portfolio are the evolutionary innovations which improve and further develop existing products. In the digital era, this is done through connected devices. The expansion through digital services can nicely be illustrated by breaking down the various steps of digital value chain. This is done by the example of Nest, a home automation company that was bought by Google and is known for its programmable thermostats (Curtis, 2014):

a) Step 1: The physical product is that is the basis of the value chain are thermostats. Usually thermostats are manually adjusted through a setting wheel. The value generated for the customer is the manual regulation of the temperature.
b) Step 2: The thermostat is being equipped with sensors and actuators to make an analog product into a smart appliance. Now the thermostat can learn through data generation, can be programed by its users, is connected to the internet and adjusts the temperature inside automatically to the corresponding temperature outside.
c) Step 3: In this step, the smart thermostat is further developed and upgraded with IP enabled sensors. Via the internet the product can now communicate and exchange data with other devices. Also, huge amounts of data can be collected and stores.
d) Step 4: This accumulated data can now be constantly analyzed to produce valuable information. Data collected can for example be consumption habits. It can be used to provide consumption forecasts and optimize domestic energy use. This information can prepare a basis for new services to generate further revenue.
e) Step 5: Based on the data collected new digital services can be created or the data can be connected to other sectors to generate more value. For example, the partnership between Nest and Whirlpool, a producer of home appliances. Through the integration of the Nest thermostat with the Whirlpool mobile app it is possible to increase efficiency and customer utility. One example is the automated start of the washing machine during a period of low network utilization and lower electricity rates (Whirlpool, 2017).

The fourth digital revolution and its sensory capabilities are generating opportunities of business growth for companies. By expanding the current products with digital services, especially through connected devices, corporations can start building new and sustainable business models.

4.1.2 Stronger digital networks with customers and partners

66.2% consider this aspect as being important for a successful future business model. Networks must be established and expanded to generate new customers and retain the current ones. Fast growth of digital products and services can be explained by the network effects (Schwab, The Fourth Industrial Revolution, 2016). It develops when the utilization changes because of a changing number of customers. This effect can

go both ways. A positive network effect increases the utility for the user with increasing customers that use the product or service. According to Shapiro this phenomenon is referred to as a "virtuous cycle" (Zobel, 2005). Examples are social media channels like Facebook, Twitter, WhatsApp and other services such as Airbnb or Uber.

The virtuous cycle can be perfectly shown with the example of Uber:

a) A higher number of Uber drivers (partners) makes the service more attractive for the potential users (customers). More drivers, shorter waiting times, higher satisfaction for customers, growing user base and therefore increasing recommendations to other people.

b) A higher number of Uber users (customers) makes the service more attractive for potential drivers (partners). They expect higher capacity and more business.

c) Data generated and provided within the service enhances positive network effects. Algorithms can predict hot spots with a lot of users and high capacity. The more drivers provide data the more precise the hot spot prediction will get. This will lead to more Uber drivers penetrating the areas with a high number of customers. The more drivers are present the more attractive the service gets for the customers and positive feedback will increase.

This example shows that big and extensively developed networks will spur growth and keep a business in the game.

4.1.3 Strengthen the company's position towards new digital players and disruptors

69.5 % consider this aspect as being important for a company to succeed in the long-run. This point summarized the actions taken by the two aspects explained before. The expansion of the product portfolio through digital services and the extension of networks with customers and suppliers will help adapt to the pace of disruption and innovation. Other actions taken by companies are the integration of start-up incubators

It is important that companies do not underestimate the digital era, its technological advantages and disruptive nature. Digital business models have major advantages in scalability because of increasing automation, zero marginal costs and fast growth. Mr. Chui a lead researcher on the impact of information technologies innovation on the society, businesses and the economy at McKinsey and Company provides a great example to understand digital scalability. He describes digital companies as hyperscale businesses. These hyperscale businesses can optimize economies of scale through automation and process optimization. To illustrate his statements, he compares Detroit and Silicon Valley, respectively in 1990 and 2014. According to Chui the top three corporations in Detroit had revenues of $250bn. These revenues where reached with 1.2 million employees and a market value of outstanding shares of $36bn. In contrast, the top three corporations in Silicon Valley had similar revenues of about $247bn. This was achieved with much less employees and a much higher market capitalization. Namely 137 000 employees and a market cap of $1.09tn (Michael & James, 2014).

4.2 Performance optimization and cost reduction through Industry 4.0

Industry 4.0 will lead to cost minimization and productivity maximization within a company's production process. Therefor performance optimization will result in increased revenues per annum and keep companies competitive within the changing business landscape. The survey highlights that respondents expect performance optimization through the digital transformation, more precisely through Industry 4.0. Graph 6 shows the weight of respective benefits created by Industry 4.0 initiatives. 52.9% think it is extremely important that companies benefit from a reduction of operational costs. Also, 36.4% of respondents consider the optimization of asset utilization being an extremely important benefit created through the fourth industrial revolution. And another 45.7% think this aspect is very important. Further, 53.6% of respondents think that worker productivity improvement is extremely important for companies.

Through the automation of processes using Big Data, algorithms, sensors and artificial intelligence, companies will be able to improve both the bottom and top line. These cost reductions and productivity gains can be reached for example through better asset utilization in the form of smart manufacturing initiatives. A report by Gerbert et al. (2015) from the Boston Consulting Group found that the fourth technological revolution will have significant impact on productivity. For their study, they used Germany as and example and quantified their results as followed: The manufacturing sector for example will increase their productivity by €90 billion to €150 billion. This means that productivity will improve by 15 to 25 percent in conversion costs (excluding material costs) and 5 to 8 percent including material costs. These improvements are intended to be met in the next five to ten years. Also, it should be considered that the mentioned benefits can vary significantly between industries.

For comprehensive reasons, it is important to mention the following two areas. They will enhance performance optimization and cost reduction in the future:

- **Process optimization**:

  Sensor will be able to generate, distribute and analyze data in real-time. This will allow companies, especially the manufacturing industry, to optimize the production process, error detection and debugging (Matzler et al., 2016). The automobile industry and its supply chain management are a good example to illustrate an efficient and customer oriented production. Car producers use RFID (Radio Frequency Identification) tags. These devices contain all specification details of the respective customer. At the different production steps, the RFID tag communicates details on color of doors, motorization, interior or gear units (Schmidt & Ziemba). Containers, package, parts and products can have such an RFID tag as well. This enable companies to track all parts within the value chain and control production timing. Also, the costumer benefits by exactly knowing where his order is. Everybody ordering via Amazon, Alibaba or Zalando has occasionally used the tracking option to check at what stage of the shipping process his or her product currently is.

This way of digitization shows how manufacturers can decrease costs through more efficient processes. As well as increase customer experience and satisfaction at the same time, through individual production. These key benefits of Industry 4.0 were also identified by the respondents of the survey. It is underlined by 74.8% of survey respondents agreeing on better planning and controlling (for example in production and logistics) to be the most important qualitative important. Further, 69.5% of people asked, think that enhancing customer satisfaction is the second most important qualitative advantage when introducing Industry 4.0 initiatives.

- **Predictive maintenance**:

  By uniting digital and physical assets, smart factories will become more and more important to manufacturers around the world. Through real-time data analysis maintenance procedures will change. Waiting until an error or damage occurs is part of the past. Today the key word is 'predictive maintenance', meaning forecasting and preventing damages before they occur (Coleman, Damodaran, Chandramouli, & Deuel, 2017). The workflow of machines is tracked automatedly and analyzed for patterns. This will allow predictions on when parts could fail or a damage might occur. Knowing this beforehand will allow companies to proactively exchange parts and predictively maintain the machines. Higher capacity utilization and shorter downtimes will lead inevitably to higher productivity.

4.3 Empowered customers at the center of change

The fourth industrial revolution will lead to increasing empowerment and change the relationship between companies and customers. As the new digital era fosters transparency, customers gain power and the traditional way of pushing out products to the market will decrease. Instead, customers rather pulling products they want and need towards them will become the norm in the future. Further, digital peer-to-peer comparison is increasing, putting companies under pressure by making them take responsibility for bad quality products or services (Schwab, The Fourth Industrial Revolution, 2016). This peer-to-peer comparison increases customer demand, shown by a report of the Institute of Customer Service. According to them, the percentage of customers who have problems with their product or service has decreased from 17% in 2008 to 11.7% just four years later. In the same period, the customers that took active steps to make a complaint increased from 72% to 76% (Hoong, 2013). Customer experience and satisfaction will be at the core of customer service. This means that products and services will be increasingly customized towards consumer needs – whether it is on a B2C or B2B basis.

One of the main benefits for companies created through Industry 4.0 is to enhance customer experience. 50.1% of the respondents see this as an extremely important benefit the can be created through the digital revolution. In addition, 67.5% mentioned higher customer satisfaction as a main qualitative advantage of the digital revolution. This correlates with the 51.7% saying that individualized products are a high qualitative advantage for a 4.0 enterprise. And 52.3% considering the creation of new products and services an extremely important benefit for the company and its revenue drivers. Summarized the survey sketches out an empowered customer

that wants to increase his or her experience, satisfaction and benefits through new individually and digitally upgraded products.

Therefore, to roll out a successful customer centered approach the enterprise should meet the following points that the survey identified. They will help deepen the digital relationship with their customers:

- Improve customer interaction going from multi-channel to omni-channel
- Improved user experiences for better relationships
- The development of stronger digital networks with customers and partners
- Increased individualization and quality of products to enhance customer experience
- Increasing revenue streams through expansion of digital services with additional customer benefits

4.4 Unsolved data protection concerns and security threats

The fourth industrial revolution also creates controversy and risks. The respondents are most concerned about their private data. 70.8% of respondents think that privacy concerns due to the availability of private data is the most probable risk created through the digital revolution. The vast collection of sensitive data, to both consumers and companies, raise concerns about privacy and confidentiality (Manyika & Chui, 2015). The McKinsey Global Institute (2015) identified the following data security issues that have the potential to destroy trust towards digital initiatives and business models if not assessed appropriately:

- Loss of control over private data because data that has been given to companies cannot easily be detected or deleted.
- An information imbalance is created. Companies accumulate huge amounts of data and detailed information about their customers. In contrary, the corporations themselves are not very transparent. This fact does not build trust between customer and company.
- Data analytics can also be flawed and may create wrong data forecasts on customers which can cause discriminating acts against the user. Underwriting companies may for example raise rates on certain insurances or completely terminate insurance contracts.
- There is also a threat of illegal use of data through criminals. Flaws in security systems or hacked gateways may allow criminals to exploit generated data illegally.

This is where public policy must interfere to ensure the protection of privacy rights of customers as well as companies. Regulatory frameworks will have to set limits on how private data is distributed throughout the global network. In addition, security threats within a company and a society are strongly associated with the digital revolution. These security threats must be contained to establish digital trust and make everybody profit from the fourth industrial revolution (Schwab, The Fourth Industrial Revolution, 2016).

4.5 Uncertainty about positive long-run employment changes through technological innovations

Back in 1930 John Maynard Keynes published his short essay 'Economic Possibilities for our Grandchildren' and warned about the negative effects of technological innovation on the job market. He said that *"(…) we are being allected with new diseases of which some readers may not yet have heard the name, but of which they will hear a great deal in the years to come – namely, technological unemployment".* He further explained his theory, saying that *"(…) this means unemployment due to our discovery of means of economizing the use of labour outrunning the pace at which we can find new uses for labour"* (Keynes, 1930). Keynes predictions turned out to be wrong, back then. These days we are already able to see how computers and advanced robotic solutions take over professional activities carried out by humans. The recent developments have led to new discussions on how the long-run employment will change through technological innovations.

The survey identifies the respondents' uncertainty whether the fourth digital revolution will create more opportunities then jobs it will displace. According to the survey only 26.4 % highly agree with the statement predicting more opportunities created than job displacement (shown in graph 10). This reflects the concerns of the public opinion and current popular-scientific discussions, stating that the fourth digital revolution drives 'the end of work' and will have a devastating impact on employment. Still, most economists these days argue that the increase of labor automation will raise incomes, which will lead to demand for new products and services and in the follow up generate new jobs for workers who have been displaced (Bonin, et al., 2015). An exception which should be mentioned in this context, is the study by Carl Benedikt Frey and Michael A. Osborne called "The Future of Employment: How Susceptible are Jobs to Computerization?". Frey and Osborne examine the automation potential of jobs in the USA. According to this survey, 47% of US workforce can be taken over by computers and algorithms. Therefore, they first reason why technological innovations can lead to job loss and unemployment. According to their study this has to do with the rapid developments in the field of machine learning, artificial intelligence and robotics. This will lead to loss of jobs in fields that were solely done by humans, not only restricted to manual tasks but also tasks that include creative thinking and social intelligence. Afterwards they characterize tasks that are threatened by automation and those that are not. And eventually calculate their results based on expert estimates the automation probability of jobs in the USA. Frey and Osborne assume that businesses and their employees will be faced with two waves of automation in the future. The first and major wave in the next 10 to 20 years, where jobs with a high automation risk are substituted step-by-step. Especially affecting jobs in the manufacturing industry with a high degree of manual handling and routine activities. 47% of the American workforce is expected to be affected. During the second wave jobs will be substituted in a much slower pace touching jobs with a medium and low risk of automation. This second wave will automate an estimated 33% of the workforce (Frey and Osborne, 2013). It is important to mention that Frey and Osborne do not take the capitalization effect into account. They only take potential job losses through technological substitution and creative destruction into account and do not counterbalance their results with new jobs that are created through the fourth industrial and technological

revolution. Never the less, these findings are concerning and call for discussion about implications by governments, businesses and employees. Examples are to support workers which have a higher risk of being substituted by automated processes. They should be reinforced to cope with the changes in the working environment. Employers should provide further training and continuing educational programs. These programs should enable the workforce to successfully handle the use of new technologies. Their labor power should be used complementary instead of substitutive to increase the worker productivity. This point was identified to be one important qualitative advantages reached through Industry 4.0 initiatives (shown in graph 8 of the appendix). Further remarks on this topic are made in the next point 'Shift of competencies in the future job market'.

4.6 Shift of competencies in the future job market

The survey anticipates that Industry 4.0 and the digital transformation of companies will require additional as well as new models of training and education. According to the survey 76.1% of respondents highly agree with this statement.

This is closely correlated to the statement that the increased use of digital labor will change the skills that are required from the future workforce. 65.6% of the respondents highly agree with this statement.

The World Economic Forums 'Future of Jobs Report' evaluates the dynamics of the fourth digital revolution on the workforce, the skills demand and future job competencies (Schwab, The Fourth Industrial Revolution, 2016). The questioned chief human resource officers from the leading global companies think that cognitive abilities, complex problem solving and social competencies will be much more needed than physical and technical competencies. The report outlines the change in demand for core work-related skills from 2015-2020 in all industries. Further the 'Future of Jobs Report' identifies the following ten skills to be the most important in 2020:

1. Complex Problem Solving
2. Critical Thinking
3. Creativity
4. People Management
5. Coordinating with Others
6. Emotional Intelligence
7. Judgment and Decision Making
8. Service Orientation
9. Negotiation
10. Cognitive Flexibility

The WEF Report states that about 35% of skills that are very important for the workforce in 2015 will have changed by 2020. The current digital revolution will have introduced advanced robotics, autonomous driving,

artificial intelligence, machine learning and advanced materials. Businesses should make sure that the workforce is able to adapt to the new emerging technologies that will be integrated into the business environment. And provide support to the workforce for them to learn the new skills that are needed to complementary the new technologies and avoid lay-offs. We must keep in mind that this process of adaptation will be different between the different employee groups. Studies suggest that the pressure of adjustment will be higher for low-paid and low-skilled workers (Bonin, et al., 2015). Specific training and qualification measures should be introduced to support the workforce that has the highest potential of being substituted by automated machines and processes. 45.7% of the respondents strongly agree on increased investments in employee training and skill development.

It is proven that additional training programs have a long-term positive impact on participants (Card, et al., 2010). Especially for low-skilled workers (Schwab, The Fourth Industrial Revolution, 2016). These training activities should not only be borne by businesses. Governments have the obligation to help finance such programs and should help reform the school agenda to prepare the future employees for the digital job environment.

4.7 Commitment of both, government and company stakeholders

The fourth industrial and technological revolution calls for the commitment of both, government and company stakeholders. They must deliver actions to accelerate the adoption of digital technologies, prioritize employee development during the change process and spur digital culture and trust. Also, governments should work out a policy framework that will make the digital transformation work for the different industry sectors, their firms and employees. The survey identified the following actions government and company stakeholder should take to eventually foster well-being and growth in the future:

4.7.1 Subsidize technologies and digital infrastructure development

37.7% of respondents strongly agree on subsidizing technologies and digital infrastructure development. This is a crucial point because to advantage of the benefits that are connected to the digitalization we must make sure that affordable and reliable access to digital infrastructure is in place. The expansion of high-speed networks, accessible broadband communication networks, appropriate software and hardware is extremely costly and exceeds the financing capabilities of most companies. Especially those of small and medium enterprises which are the economic back bone of most OECD countries. The governments must set budgets to support the funding of the digital infrastructure individually, because the starting condition for the digital transformation differs widely from country to country (OECD, 2017).

4.7.2 Increase investments in employee training and skills development

Having access to digital infrastructure, its networks and services will not ensure effective use. 45.7% strongly agree on increased investments in employee training and skill development. Every individual will have to be equipped with the skills to use these technologies. With additional investments in employee training and skill

development, governments and corporations can make sure that the information communication technologies in place are used efficiently.

4.7.3 Find a common approach to address security concerns

Companies and governments will have to streamline their approaches towards security concerns to avoid taking different directions and implementing counterproductive regulations. A way companies can collaborate with each other is vis open architecture platforms. A mentionable example is the OpenPOWER Foundation. According to the MIT Technology Review (2015) is a technology collaboration spanning over 170 technology companies (for example Google, Mellanox Technologies and NVIDIA). This open architecture platform enables companies to work together on solutions and products. It also helps companies to rethink their technology approach as well as enhance collaboration on security and privacy concerns.

4.8 Trust and acceptance as pillars of digital success

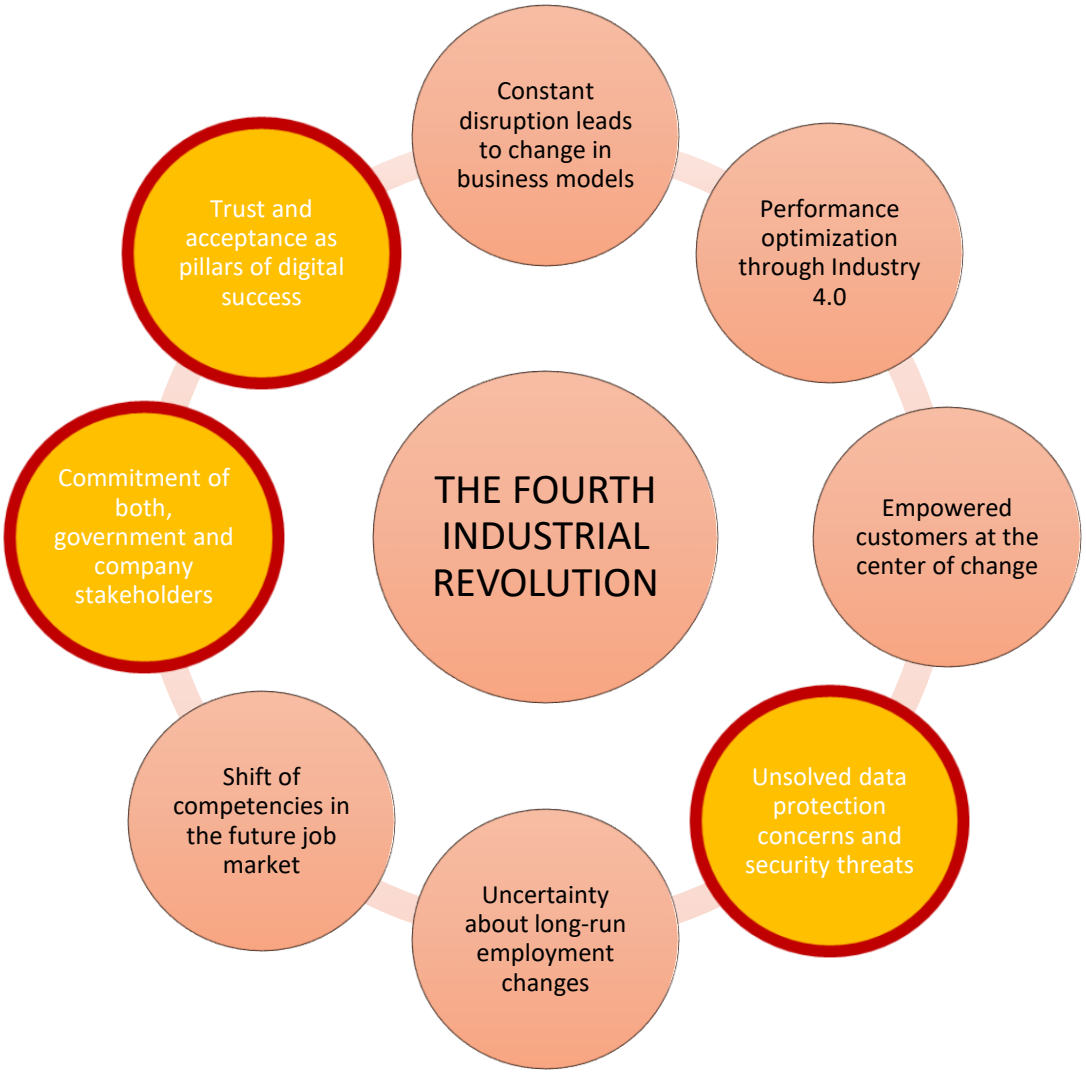
According to the survey outcome, over 50% of respondents think that analytics and digital trust will be the foundation of the digital revolution. Also, the survey respondents indicate a strong tendency towards issues such as data protection, data security and cyber security concerns.

Most of us know that trust is key to any successful endeavor. Consumers are aware of how important and valuable their data is for corporations. According to Accenture, a consultancy, eight out of ten consumers will refuse to do business with a company that is not able to keep their data safe or process it in a lawful way. Further, only five out of ten consumers think that profiling and the tracking of consumption behavior or selling personal data to other parties will benefit them (Barton, 2016). The amount of personal data that companies are able to collect seems infinite. The growing interconnectedness of the global system will impose a challenge towards digital trust. If confidence in a company is not given and if consumers believe the responsible party is collecting, storing and processing personal data in a way that harms them, digital trust cannot increase. Any lack of privacy, security, integrity and accountability will hinder a successful unfolding of the Fourth Industrial Revolution.

5 REGULATORY AND LEGAL ISSUES CONCERNING DATA PROTECTION

5.1 The Fourth Industrial Revolution and its responsibility towards consumer information

The survey indicates a tendency towards great concern of data protection and security threats. Shown below, unsolved data protection concerns and security threats, the commitment of governments and company stakeholders towards sound regulation and protection and the need to establish trust and acceptance towards the digital revolution calls for further elaboration on data protection and laws. This last part will focus on the current personal data protection situation in the EU and explain the new EU data protection reform that is on its way.



There is no doubt that the digital revolution is in full progress and will be unfolding with dramatic changes and consequences in the future. In the course of the Fourth Industrial Revolution everything will become intelligent. Starting with the smart phones several years ago, to smart homes, smart factories and smart cities unfolding today. The accumulation of personal data is extremely lucrative for corporations but also holds a societal explosive force. Explosive in the terms of a threat towards creating a jesters licence for companies around the globe as well as the creation of a programmable society or individual. Search engines and social

media platforms provide us with personalized suggestions of products and services. These have personal and meta data at its basis, accumulated from previous searches, internet movement and consumption behavior. Algorithms that process and analyze the data collected, and can tell us what we do, think or feel with extreme precision. This also leads to the assumption that the more one knows about us the more unlikely it will be that we make decisions based on our own free will.

In the future the cloud will be the key to a successful and efficient big data era. Although the analysis of these big amounts of data is a great challenge, problems already occur long before that. The main challenge will be to set up a legal framework to protect the consumer and figure out how his privacy and rights are protected. A thoughtful and effective personal data protection regulation will be key to a safe and successful digital future. The following chapter will outline the new General Data Protection Regulation as well as the main obligations for companies and rights of the consumer when it comes to working with personal data.

5.2 Current situation of EU data protection rules

The current legal framework regarding personal data protection is regulated in the Data Protection Directive (DPD), also referred to as Directive 95/46/EC (Rouse, 2008). This regulation is now 23 years old and does not interact with a lot of new technologies and far reaching innovations. From Proposal for a "Regulation of the European Parliament and of the Council" by the European Commission, several problems can be distilled that show that the current directive (DPD) is outdated: The EC thinks that *"(...) the current fragmentation of personal data protection in the Union, in particular by economic stakeholders who asked for increased legal certainty and harmonization of the rules on the protection of personal data"* [1] is a major setback for the current directive and must be changed. Also, the individual should be put into a stronger position by building a *"(...) stronger and more coherent data protection framework in the EU*" in order to *"(...) put individuals in control of their own data and reinforce legal and practical certainty for economic operators and public authorities"* [2]. (European Parliament, 1995)

The new regulation that was proposed by the European Commission in 2012 and should come into force on May 25th 2018 is called General Data Protection Regulation (GDPR). This European data protection reform will be explained in depth in the next chapters.

5.3 European data protection reform

The Data Protection Directive (DPD) from 1995 is a milestone within data protection. Nevertheless, critics have always highlighted the difficulties of the DPD to regulate free flow of data and especially the protection of people's personal data. The DPD has been outdated by the fast scope of the fourth digital revolution and the spread of data driven business models and make the European Commission take action in order to prepare and introduce a new framework. This framework was introduced on January 25th, 21012 by the commission.

[1] EC Proposal C7-0025/12; page 4
[2] Also distilled from EC Proposal C7-0025/12; page 4

Back then the vice-president of the European Commission Viviane Reding referred to the new framework as being a "necessary step, presenting and updated and modernized" directive with the DPD as its basis. Further, the EU wanted to overcome the fragmentation caused by the different national data protection laws of the different EU member states, causing unequal protection, extremely high costs, bureaucratic and administrative challenges, and there for creating a very business unfriendly environment.

On May 4th, 2016 the European Union introduced the final form for the General Data Protection Regulation (GDPR), which has been negotiated on since 2012. The GDPR will regulate and control the processing of personal data starting from May 25th, 2018. The new Data Protection Directive will suspend the official directive 95/26/EC (Rouse, 2008).

This directive will regulate and protect personal data in a uniform and comprehensive way throughout the whole European Union. Meaning that an implementation into national law of the member states is not necessary. The European Union wants to standardize data protection and lead to uniform economic conditions which should strengthen the internal European market.

The new European data protection law will introduce a wide range of new requirements and produce serious consequences and challenges for companies. Companies will be confronted with claims for damages and penalties that can amount up to four percent of the global corporate revenues. Further, involved managers, data protectionists and other stakeholders must expect personal penalties of up to 20 million Euros if directives are violated. Also, the new requirements will be very high affecting all resorts from IT, to human resource, compliance, internal revision and sales (European Comission, 2012).

5.3.1 Goals of GDPR

The GDPR has the purpose to unify the data protection law on a EU level. The level of protection of the rights and freedoms of the personal data for every person should be consistent in the whole European Union. The application of just one EU directive should enable companies to structure and execute their data processes in all 28 member states equally. This standardization should strengthen the internal EU market by streamlining regulations and processes. With this regulation the European Commission want to suspend the regulatory patchwork provided by the Data Protection Directive (DPD).

Never the less the regulation also includes a whole range of opening clauses. This will allow the member states to create national special laws concerning data processing. One example is the employee data protection. The suitable recital 155 of Article 88 (Processing in the context of employment) implies that the opening clauses grant member states possibilities to mold the employment data protection to fit their needs. Recital 155 states that:

"*Member State law or collective agreements, including 'works agreements', may provide for specific rules on the processing of employees' personal data in the employment context, in particular for the conditions*

under which personal data in the employment context may be processed on the basis of the consent of the employee, the purposes of the recruitment, the performance of the contract of employment, including discharge of obligations laid down by law or by collective agreements, management, planning and organisation of work, equality and diversity in the workplace, health and safety at work, and for the purposes of the exercise and enjoyment, on an individual or collective basis, of rights and benefits related to employment, and for the purpose of the termination of the employment relationship" [3]

This recital gives the member states the possibility that companies can process personal data of employees with their consent individually, which is also stated in Article 4(11) of the GDPR.

These exception rules must comply with the specifications of the GDPR. In the above example this is stated in Article 88 paragraph 2, stating that the specific rules must

"(…) include suitable and specific measures to safeguard the data subject's human dignity, legitimate interests and fundamental rights, with particular regard to the transparency of processing, the transfer of personal data within a group of undertakings, or a group of enterprises engaged in a joint economic activity and monitoring systems at the work place" [4]

This indicates that the opening clauses have the potential to restrict a uniform EU Data Protection Directive. In a lot of areas, it remains to be seen if and in what manner the member states enact their own special laws.

5.3.2 GDPR – coming into effect

The GDPR was passed by the European Parliament on May 14th, 2016. The directive was published in the official journal of the European Union on May 4th, 2016 and came into force 20 days later. After a transitional period of two years the General Data Protection Regulation will become applicable law on May 25th, 2018 (Rouse, 2008). The GDPR will go far beyond the legal requirements of most EU member states current national data protection laws. The new directive creates a lot of new processes which should be implemented by companies.

According to Wybitul, the transitional period of two years is very limited for an effective implementation of the necessary processes and structures of the GDPR. To achieve a successful implementation companies must have completed all necessary target-performance comparisons and budget planning for the time after the new data protection directive comes into effect. Most advisers call for a timely and well-prepared consultation of the management team on all new requirements and liability risks. In principle, companies must check which consequences the new EU directive has for their work.

[3] Recital 155 of Art. 88 of GDPR
[4] Art. 88 (2) of GDPR

5.3.3 Scope of Application – What and Where?

The GDPRs scope is divided into a material and territorial side, determined by Articles 2 and 3 of the General Data Protection Regulation. (European Parliament, 2016)

5.3.3.1 Where does the directive apply?

The directive applies to the handling of personal data for those responsible for processing and distribution of data sets, with subsidies within the European Union. This is not restricted to whether the processing is done within the European Union or not. Article 3 establishes the territorial scope of the GDPR:

"*This Regulation applies to the processing of personal data in the context of the activities of an establishment of a controller or a processor in the Union, regardless of whether the processing takes place in the Union or not"* [5]

This residence principle defines the scope of action of a subsidy or processor within the European Union. As mentioned before it does not matter whether the data is processed within the EU or not. It is decisive whether the subsidy of the responsible company or processor is located in the European Union or not.

Further, Article 3 defines the market principle by stating that the *"(...) regulation applies to the processing of personal data (...) where the processing activities are related to:*

> *a) the offering of goods or services, irrespective of whether a payment of the data subject is required, to such data subjects in the Union, or*
>
> *b) the monitoring of their behavior as far as their behavior takes place within the union"* [6]

The first mentioned category covers the offering of goods and services. The second category refers to the `monitoring of behavior`. This category is further clarified by saying that an activity can be declared 'monitoring of behavior' it must *"(...) be ascertained whether natural persons are tracked on the internet including potential subsequent use of personal data processing techniques which consist of profiling a natural person, particularly in order to take decisions concerning her or him of for analyzing or predicting her or his personal preferences, behaviors and attitudes"* [7]

Companies such as Google or social media networks (Facebook, Instagram and many more) are targeted by this recital. These companies often "profile" the individuals on the internet, which is often done by the digital marketing departments. Their main purpose is to accumulate the data and sell the valuable information to advertisers.

[5] Art. 3 (1) of GDPR
[6] Art. 3 (2) of GDPR
[7] Art. 3, Recital 24 of GDPR

5.3.3.2 What data will be affected?

The directive is directed towards the automated processing of personal data. Article 2 defines the material scope and what kind of data is affected:

"This regulation applies to the processing of personal data wholly or partly by automated means and to the processing other than by automated means of personal data which from part of a filing system or are intended to form part of a filing system" [8]

It is not important whether the processing of the data sets is totally or just partly automated. Also, the regulation is applicable to data which has already been stored or is planned to be stored in a filing system. Thereby the material scope is broadly formulated. Companies will usually not collect data that they will not store or process in any other way. Even data collected and processes automatically (for example through means of observation, questioning, listening and any other process of perception that is not supported through technology) will be stored if economically relevant.

Paragraph 2 of the respective article states the exceptions, which are not affected by the GDPR. According to the General Data Protection Regulation the *"(...) regulation does not apply to the processing of personal data:*

a) in the course of an activity which falls outside of the scope of Union law,
b) by the Member States when carrying out activities which fall within the scope of Chapter 2 of Title V of the TEU,
c) by natural person in the course of a purely personal or household activity,
d) by competent authorities for the purposes of the prevention, investigation, detection or prosecution of criminal offences or the execution of criminal penalties, including the safeguarding against the prevention of threats to public security. "

Sub c of the Art. 2(2) will be relevant for corporate practice. According to the legal text the regulation will not be applicable if natural persons use personal data only for their personal and household activities. It will be difficult what actions and activities will be classified as personal, for example when a supervisor asks an employee for her or his well-being. Can this be classified as a purely personal process? Or does this happen in the context and boundaries of the employment relationship?

[8] Art 2 (1) of GDPR

5.3.4 Structure of the GDPR

The GDPR is composed of 11 chapters with 99 articles and respective recitals. The structure of the body is shown below.

Source: European Parliament, 2016

5.3.4.1 Chapter 1 – Article 1 to 4

The first chapter of the General Data Protection Regulation the objectives as well as the territorial and material scope of the new regulation. It also includes all relevant definitions (Article 4).

Chapter 1- General Provisions

- Article 1: Subject matter and objectives
- Article 2: Material scope
- Article 3: Territorial scope
- Article 4: Definitions

Source: European Parliament, 2016

Article 1 determines the objectives and goals of the GDPR, saying that it *"(…) lays down the rules relating to the protection of natural persons with regard to the processing of personal data and rules relating to the free movement of personal data"* [9]. The right of every natural individual to have her or his data protected is defined in this part. Without having the *"(…) free movement of personal data within the Union (…) restricted nor prohibited (…) with regard to the processing of personal data"* [10].

The articles 2 and 3 define the material and territorial scope of the law as mentioned in the chapter before. The fourth article contains all important definitions for the application of the regulation. Starting from the definition of personal data which is according to the GDPR *"(…) any information relating to an identified or identifiable natural personal; an identifiable natural person is one who can be identified, directly or indirectly, in particular by reference to an identifier such as a name, an identification number, location data, an online identifier or to one or more factors specific to the physical, physiological, genetic, mental, economic, cultural or social identity of that natural person"* [11]. And other definitions ranging from "processing", "restriction of processing", "profiling", "filing system" and many more in order to make the GDPR applicable within a well-defined scope.

[9] Art. 1 (1) of GDPR
[10] Art. 1 (3) of GDPR
[11] Art. 4 (1) of GDPR

5.3.4.2 Chapter 2 – Article 5 to 11

Chapter 2- Principles

- Article 5: Principles relating to processing of personal data
- Article 6: Lawfulness of processing
- Article 7: Conditions for consent
- Article 8: Conditions applicable to childs consent in relation to information society services
- Article 9: Processing of special categories of personal data
- Article 10: Processing of personal data relating to criminal convictions and offences

Source: European Parliament, 2016

Article 5 of contains the most important principles of the regulation and the main requirements of the GDPR. This part is responsible for the interpretation of the main legal concepts. The following principles are listed in the mentioned article which describe the appropriate handling of personal data [12]:

- lawfulness in processing
- good faith in processing
- transparency in processing
- earmarking means
- data minimization
- storage limitation
- integrity of data sets
- accountability

Article 7 regulates the several conditions for consent towards the further processing of data. According to the article the controller or processers must *"(...) be able to demonstrate that the data subject has consented to processing of his or her personal data"* [13]. Also, the consent must be *"(...) freely given*" [14].The data provider has the "(…) right to withdraw his or her consent at any time" which should *"(...) be as easy to withdraw as to give consent"* [15].

Article 9 of chapter 2 defines special categories within data processing. The processing of data shall therefor be prohibited if it reveals information on racial or ethnic origin, genetic data, biometric data or religious beliefs.

[12] Distilled from Art. 5 of GDPR
[13] Art. 7 (1) of GDPR
[14] Art. 7 (4) of GDPR
[15] Art. 7 (3) of GDPR

5.3.4.3 Chapter 3 – Article 12 to 23

This chapter takes care of rights of the affected person. It regulates the following points:

- transparent information and communication towards the data subject (Article 12)
- obligation to provide information when collecting personal data (Article 13 and 14)
- right of the data subject to be informed about access their personal data that has been collected (Article 15)
- the right of correction of collected and processed data (Article 16)
- the right to have personal data erased, also referred to as the right to be forgotten [16] (Article 17)
- the right of the data subject to restrict processing of personal data (Article 18)
- the right of the data subject to receive his or her personal data stored (Article 20)
- the right of the data subject to oppose data collected (Article 21)
- the right to object any kind of automated decision making including profiling (Article 22)
- and finally, the right of member states to restrict the above mentioned to *"(...) safeguard: a) national security; b) defence; c) public security; d) the prevention (...) of criminal penalties (...) and the prevention of threats to public safety; e) other important objectives of general public interest of the Union or of a Member state (...); f) the protection of judicial independence (...); and the j) enforcement of civil law claims"* [17].

5.3.4.4 Chapter 4 – Article 24 to 43

Chapter 4 contains regulations of controllers and processors. The Articles 24 to 39 scale the duties of the responsible controllers and processors. The following general obligation items and points are covered in the Articles 24 to 31:

- implementation of appropriate technical and organizational measures *"(...) to ensure and to able to demonstrate that processing is performed in accordance with this Regulation*" [18] (Article 24)
- data protection through technical and data protection friendly defaults (Article 25)
- proper organization of duty allocation between controllers, if there are two or more of them. In detail they must *"(...) determine their respective responsibilities for compliance with the obligations under this Regulation, in particular as regards the exercising of the rights of the data subject (...)"* [19] (Article 26).

[16] This right has its roots in French law, where criminals have *"the right of oblivion"*. This is stated by Rosen (2012, p.88) as follows: *"(...) a right that allows a convicted criminal who has served his time and ben rehabilitated to object to the publication of the facts of his conviction an incarceration"*.
[17] Art 23 (1) (a-j) of GDPR
[18] Art. 24 (1) of GDPR
[19] Art. 26 (1) of GDPR

- processing requirements to be obeyed by the controller (Article 28 to 31).

Articles 32 to 34 several points on the security of personal data. These are points concerning data security (Article 32), notifications of supervisory authorities (Article 33) and notification of the data subject (Article 34) in case of a data leak. Further, the articles 35 and 36 are very important when it comes to assessing the impact of data protection (Article 35) and in case of high risks for the private person, the consultancy of the supervisory authorities (Article 36). This passage states that one must *"(...) carry out an assessment of impact of the envisaged processing operations on the protection of personal data",* if *"(...) processing, is likely to result in a high risk to the rights and freedoms of natural persons"* [20]. If the impact assessment of the responsible party "(…) indicates that the processing would result in a high risk" [21], they must consult the supervisory authority and have them identify if the controllers have mitigated all risks sufficiently.

The designation, position and tasks of a data protection officer is regulated in the articles 37 to 39. This officer must be installed if *"(...) the processing is carried out by a public authority or body*" [22] and under further circumstances stated in sub a-c in article 37. Further, the responsible parties must make sure that the data officer is *"(...) involved, properly and in a timely manner, in all issues which relate to the protection of personal data"* [23], and manage the following tasks:

- perform advisory and informational tasks towards the controllers and processors as well as the employees who are involved in data processing
- take care of compliance tasks involved in the GDPR, such as responsibility allocation, raising awareness as well as training of the parties involved in processing operations
- perform advisory tasks during the impact assessment mentioned in article 35 before
- collaboration on all levels of the supervisory authorities

The last four articles of the chapter (40-43) define the code of conduct and supervise the certification mechanisms of processing operations.

5.3.4.5 Chapter 5 – Article 44 to 50

Article 44 of the General Data Protection Regulation is cited below and represents the wording of the general principle for cross border data transfers:

"Any transfer of personal data which are undergoing processing or are intended for processing after transfer to a third country or to an international organisation shall take place only if, subject to the other provisions of this Regulation, the conditions laid down in this Chapter are complied with by the controller and processor, including for onward transfers of personal data from the third country or an international

[20] Art. 35 (1) of GDPR
[21] Art. 36 (1) of GDPR
[22] Art. 37 (1) (a) of GDPR
[23] Art. 38 (1) of GDPR

organisation to another third country or to another international organisation. All provisions in this Chapter shall be applied in order to ensure that the level of protection of natural persons guaranteed by this Regulation is not undermined."

Combined, the seven articles of this chapter regulate the data transfer into third countries. In principle the mechanisms of the Data Protection Directive remain the same. Which is, that the transfer of personal data across borders into third countries or to international organizations is only permitted if all stated regulations of this chapter are met [24].

According to article 45, adequacy decisions of the European Commission can approve of the level of protection in a third country in order to permit cross border data transfer. If this is done, *"(...) Such a transfer shall not require any specific authorisation"* [25]. If a third country was assessed and has been declared as having a sufficient level of protection the commission must *"(...) provide for a mechanism for a periodic review, at least every four years (...)"* [26]. The span of possibilities to authorize a data transfer is broadened by article 46. It states that data transfer can be permitted on the basis of appropriate guaranties, such as binding company internal data protection regulations also referred to as Binding Corporate Rules (BCR) [27]. Article 50 outlines important steps that should be taken in order to intensify the international cooperation towards the protection of personal data. Such as installing cooperation mechanisms to enforce legislation, the provision of international assistance on a mutual basis, trigger discussion and activities between relevant stakeholder so raise awareness and the promotion of different legislation and protection practices across the European Union.

5.3.4.6 Chapter 6 – Article 51 to 59

Articles 51 up to 59 regulate the status, competences and tasks of the supervisory authority. Every member state of the European Union is there for obliged to install one or more public authority (Article 55 of GDPR). This is done to protect the rights of people in terms of the processing of her of his personal data and information. It is important to note that *"Each supervisory authority shall act with complete independence in performing its tasks and exercising its powers (..)"* [28]. This includes points such as remaining *"(...) free from external influence (...) nor take instructions from anybody"* [29], making sure that the installed supervisors are *"(...) provided with the human, technical and financial resources, premises and infrastructure necessary for the effective performance of its tasks"* [30], and remaining independent by being able to *"(...) choose and has its own staff"* [31]. Articles 51 to 55 set a framework to guarantee the independence of the supervisory board as

[24] Outlined in Art. 44 of GDPR
[25] Art. 45 (1) of GDPR
[26] Art. 45 (3) of GDPR
[27] Mentioned in Art. 46 (2) (b) of GDPR
[28] Art. 52 (1) of GDPR
[29] Art. 52 (2) of GDPR
[30] Art. 52 (4) of GDPR
[31] Art. 52 (5) of GDPR

well as define conditions and rules on the establishment of the supervisory authority by each EU Member State.

The articles 55 to 59 set a framework for the competences, tasks and powers of the supervisory authority. The territorial scope of the supervisory board is defined by the recital 122 (of article 55) mentioned below:

"Each supervisory authority should be competent on the territory of its own Member State to exercise the powers and to perform the tasks conferred on it in accordance with this Regulation. This should cover in particular the processing in the context of the activities of an establishment of the controller or processor on the territory of its own Member State, the processing of personal data carried out by public authorities or private bodies acting in the public interest, processing affecting data subjects on its territory or processing carried out by a controller or processor not established in the Union when targeting data subjects residing on its territory (...)" [32]

This gives back a certain amount of sovereignty on the judiciary and legislative level to each member state on processing of personal data. Keeping the identified territorial scope in mind, the tasks of every supervisory authority (on its respective territory) are regulated by article 57 and are the following: First, monitoring and enforcing all applications of the regulation. Also, increasing the promotion of public awareness as well as all connected risks in relation to data processing especially *"(...) activities addressed specifically to children shall receive specific attention"* [33]. As well as reminding controllers and processors of their obligations under GDPR, providing any information required to data subjects and put emphasis on transparency when it comes to sharing information and aiding the supervisory authorities of the other member states. Every authority must prepare reports on their work on an annual basis. These reports *"(...) may include a list of types of infringement notified and types of measures taken in accordance with Article 58 (2)"*. Also, these repots must be *"(...) transmitted to the national parliament, the government and other authorities as designated by Member State law"* and be *"(...) made available to the public, to the Commission and to the Board*" [34].

5.3.4.7 Chapter 7 – Article 60 to 76

Regulations for the cooperation between the supervisory authorities are contained within chapter 7. Further, this chapter is broken down into 3 sections, being cooperation, consistency and the European data protection board. It is important to note that extent of the cooperation by several paragraphs in transparency, scope and time.

In terms of cooperation the legal body requires that the lead supervisor authority must *"cooperate with the other supervisory authorities (...) to reach a consensus"* [35]. Also, they are obliged to *"provide mutual*

[32] Art. 55 Recital 122
[33] Art. 57 (1) (b) of GDPR
[34] Art. 59 of GDPR
[35] Art. 60 (1) of GDPR

assistance" and *"may conduct joint operations (...) for carrying out investigations"* [36]. If one party demands information on the matter of personal data protection the lead supervisory authority should *"(...) without delay, communicate the relevant information on the matter to the other supervisory authorities"* [37].

In terms of consistency the legal body requires that the lead supervisor authority *"cooperate with each other (...) through the consistency mechanism"* [38]. The core aim of this mechanism is to make sure that every EU Member State enforces the EU data protection law uniformly. The matters, that must be consistent across the European Union, are:

1. to communicate the draft decisions to the board and have them formulate an opinion on the matter (Article 64 of GDPR)
2. implement dispute resolutions by the board (Article 65 of GDPR)
3. install an urgency procedure (Article 66 of GDPR)
4. and increase the exchange of information between the board and the supervisory authority (Article 67 of GDPR)

The third section on the European data protection board is composed of 8 articles explained below. Starting, we must define what the European Data Protection Board is. According to Article 68 of the GDPR the European Data Protection Board (EDPB) is *"(...) established as a body of the Union and shall have legal personality"* [39]. Further the EDPB is composed of "(…) the head of one supervisory authority of each Member States" [40]. The mentioned members of the EDPB can also be substituted by the respective representatives. The before mentioned board must act independently [41], create annual reports on the protection of personal data and data processing in the EU and after being *"made public (...) be transmitted to the European Parliament, to the Council and to the Commission"* [42].

The main tasks of the EDPB are the monitoring and assurance the correct application [43], give advice to the Commission on any data protection topic required [44], advice on format and procedure of information exchange [45], give best practice recommendation on data deletion [46] as well as *"maintain a publicly accessible electronic register of decisions taken by the supervisory authorities and issues handled in the consistency mechanism"* [47].

[36] Art. 60 (2) of GDPR
[37] Art. 60 (3) of GDPR
[38] Art. 63 of GDPR
[39] Art. 68 (1) of GDPR
[40] Art. 68 (3) of GDPR
[41] Art. 69 (1) of GDPR
[42] Art 71 (1) of GDPR
[43] Art. 70 (1) (a) of GDPR
[44] Art. 70 (1) (b) of GDPR
[45] Art. 70 (1) (c) of GDPR
[46] Art. 70 (1) (d) of GDPR
[47] Art. 70 (1) (y) of GDPR

5.3.4.8 Chapter 8 – Article 77 to 84

Chapter 8 explains the rules on issuing complaints, lodging a judicial review on the decision of the supervisory authority and how to take legal actions against processors and controllers. An overview of chapter 8 is shown below.

Chapter 8- Remedies, liability and penalties

- Article 77: Right to lodge a complaint with a supervisory authority
- Article 78: Right to an effective judicial remedy against a supervisory authority
- Article 79: right to an effective judicial remedy against a controller or processor
- Article 80: Representation of data subjects
- Article 81: Suspension of proceedings
- Article 82: Right to compensatoin and liability
- Article 83: General conditions for imposing administrative fines
- Article 84: Penalties

Source: European Parliament, 2016

Every individual has the right to issue a complaint *"(...) if the data subject considers that the processing of personal data relating to him or her infringes this Regulation"* [48]. If done so, the person who issued the complaint must be informed on her or his *"(...) progress and the outcome of the complaint"* [49]. Article 78 states the right of every individual to *"(...) remedy against a legally binding decision of a supervisory authority concerning them"* [50]. Also, every complaint that is not taken care of or of which the individual is not informed of has the right to an effective remedy and must *"(...) be brought against the courts of the Member State where the supervisory authority is established"* [51]. Not only the supervisory authorities of each respective Member State are subject to remedies. These steps can also be taken in proceedings against a controller of processor as stated in Article 78 of the General Data Protection Regulation.

If legal steps are taken by the data subject, they *"(...) have the right to mandate a not-for-profit body, organisation or association".* These bodies must be *"(...) active in the field of the protection of data subjects´ rights and freedoms with regard to the protection of their personal data to lodge the complaint of his or her behalf*" [52].

After successful legal action, individuals have the right to compensation and liabilities as well as administrative fines and penalties imposed on the respective company responsible for the data proceeding [53].

[48] Art. 77 (1) of GDPR
[49] Art. 77 (2) of GDPR
[50] Art. 78 (1) of GDPR
[51] Art. 78 (3) of GDPR
[52] Art. 80 (1) of GDPR
[53] Outlined in Art. 82, 83 and 84 of GDPR

5.3.4.9 Chapter 9 – Article 85 to 91

Chapter 9 is about provision which are related to specific situations in respective articles, outlined in the table below.

Chapter 9 - Provisions relating to specific processing situations

- Article 85: Processing and freedom of expression and information
- Article 86: Processing and public access to official documents
- Article 87: Processing of the nationa identification number
- Article 88: Processing in the context of employment
- Article 89: Safeguards and derogations relating to processing for archiving purposes in the public interest, scientifif or historical research purposes or statistical purposes
- Article 90: Obligations of secrecy
- Article 91: Existing data protection rules of churches and religious associations

Source: European Parliament, 2016

There are several exemptions that should be granted. If processing is needed for journalistic reasons or for academic, artistic or literary expression then:

"(…) Member States shall provide for exemptions or derogations from Chapter II (principles), Chapter III (rights of the data subject), Chapter IV (controller and processor), Chapter V (transfer of personal data to third countries or international organisations), Chapter VI (independent supervisory authorities), Chapter VII (cooperation and consistency) and Chapter IX (specific data processing situations) if they are necessary to reconcile the right to the protection of personal data with the freedom of expression and information" [54].

Due to territorial differences and modifications in exemptions from one country to another it is important to mention that the respective laws that apply are those of the country to which the controller is subject to [55]. Further, public access to any kind of official documents that contain personal data may be granted if carried out in public interest [56]. The processing of a national identification number will be subject to the respective Member State. They must determine specific measures and conditions on their own [57]. The opening clause of Article 88 will be relevant for corporate practice. It allows every Member State to regulate the data protection within the employment relationship through national law. Further provisions are listed under Chapter 9 of the General Data Protection Regulation and will not be subject of further discussion.

[54] Art. 85 (2) of GDPR
[55] Art. 85 Recital 153 of GDPR
[56] Art. 86 of GDPR
[57] Art. 87 of GDPR

5.3.4.10 Chapter 10 – Article 92 and 93

Chapter 10 regulates the competences of the Commission towards issuing delegated legal acts. It is important to mention that this part of the GDPR targets die rights of the European Commission and is not relevant for the practical implementation of the General Data Protection Regulation in corporations.

5.3.4.11 Chapter 11 – Article 94 to 99

The last chapter of the GDPR contains final provisions such as an article on the closure of the current Data Protection Directive (95/46/EC) and one on the coming into effect of the discussed directive on the 25th of May 2018. Until this date companies should have implemented all the necessary requirements outlined in the GDPR.

5.3.5 Practical consequences and important changes

5.3.5.1 New obligations for companies

The General Data Protection Regulation introduces a lot of obligations that companies must adapt to. The following paragraph will elaborate on the most important and extensive obligations companies will be obliged to, after the coming into effect of the GDPR.

5.3.5.1.1 Extended obligations towards documentation and burden of proof

In terms of documentation practices and burden of proof the GDPR will extend such practices. All processors have to comply with article 5 (1) of GDPR in order to be held accountable. They must process all personal data *"(...) lawfully, fairly and in a transparent manner in relation to the data subject"* [58]. If not done so and the principles of article 5 are violated, the responsible processor may be subject to penalties stated by article 83 (5) (a) shown below:

"*Infringements of the following provisions shall, in accordance with paragraph 2, be subject to administrative fines up to 20 000 000 EUR, or in the case of an undertaking, up to 4 % of the total worldwide annual turnover of the preceding financial year, whichever is higher"*[59].

Further, any processor or controller must, as mentioned before in point 5.3.4.4, take her or his responsibilities seriously and *"(...) ensure and be (...) able to demonstrate the processing is performed in accordance with this Regulation"* [60]. A burden of proof must be always be verified in accordance with the GDPR. Also, all information must be given to the party responsible in order for them to be able to show that they have met all regulations to deliver the required obligations. These requirements are stated in articles 32 to 36 in the chapter 4 (Controller and processor) of the GDPR.

The obligations below indicate that companies must be able to proof, when it comes to a legal dispute, that they implemented the requirements of the General Data Protection Regulation. This will force the responsible

[58] Art. 5 (1) (a) of GDPR
[59] Art. 83 (5) (a) of GDPR
[60] Art. 24 (1) of GDPR

parties to show and proof that they have implemented the regulation correctly within their corporate boundaries.

5.3.5.1.2 Data protection and risk mitigation

As the processing of personal data of individuals has a high risk of violating the rights and freedoms of the data subject, companies must focus on risk based approached when it comes to the new regulation. Usually companies follow this risk based approach in various other resorts using so called compliance management systems (CMS).

5.3.5.1.3 Obligation to inform on data processing

Individual must be informed much more extensively than under the DPD. They have to be informed about if and in what way their data will be stored and processed. Article 5 (1) mentioned before displays the transparency principle of the new regulation. Further, article 12 calls for appropriate measures to make sure every individual receives information on her or his account *"(…) using clear and plain language"* [61]. All rights of the individual, also referred to as data subject, are set down in chapter 3 of the GDPR.

These strict information regulations call for measures companies have to undertake within their IT infrastructure. All necessary information that a data subject can request are stated in article 13 of the General Data Protection Regulation and are compiled below. According to article 13 the controller must provide:

- their (the controllers) and his or her representative´s contact details and if necessary contact details of the data protection officer
- information on the purpose of data processing and on what legal basis the data processing is built on
- the intended recipient's information of the personal data
- information if there is any intent to forward personal information to any third country or international organization
- the time period of data storage
- information on the possibility to request access to personal data, to have personal data erased and the right to lawfully lodge a complaint against the supervisory authority

These points show the extent to which users and data subjects have to be informed about data accumulation, processing, as well as the individuals rights and the right to lodge complaints and lawsuits. Therefor company functions such as IT, project management, project controlling as well as the data protection and law department have to work together closely. This must be done to ensure that all requirements of the GDPR are met and violation and penalties can be avoided.

[61] Art. 12 (1) of GDPR

5.3.5.1.4 Obligation to carry out an impact assessment

Article 35 (1) of GDPR states that if the rights of the individual is at high risk of being violated *"(…) the controller shall, prior to the processing, carry out an assessment of the impact of the envisaged processing operations on the protection of personal data"* [62]. This impact assessment must contain information on the processing that should be conducted, the main purpose of the data processing and where it might be applicable. Further, the new regulation states that the impact assessment must explicitly address the risks that might occur for the data subject. This should include *"(…) safeguards, security measures and mechanism to ensure the protection of personal data"* [63], with which a company can mitigate risks and comply to the requirements of the GDPR.

If the impact assessment comes to the conclusion that the data processing holds a high risk for the individual the supervisory authority must be informed. This must be done if the controller does not take measures himself to lessen the risk. Should an impact assessment not be conducted by the responsible party, the following penalties may be imposed: *"(…) administrative fines up to 10 000 000 EUR, or in the case of an undertaking, up to 2% of the total worldwide annual turnover of the preceding financial year, whichever is higher"* [64].

5.3.5.1.5 Strict obligation to delete and erase personal data

Article 17 of the GDPR contains the regulations towards the right of the data subject to have her or his information erased. This article is one of the most important and one of the most heavily discussed on (Gottlieb, 2017). This is also referred to as the 'right to be forgotten'. Several reasons that may apply in order to have data erased are shown below.

Article 17 – Right to be forgotten and to erase

"The data subject shall have the right to obtain from the controller the erasure of personal data concerning him or her without undue delay and the controller shall have the obligation to erase personal data without undue delay where one of the following grounds applies: (…)" [65]

- if the data is not needed by the controller anymore
- if one withdraws from the agreement made previously on data processing
- if an individual uses her or his rights (stated in article 21 of GDPR) to object
- if the data has been processed unlawfully
- if it is being legally required to erase data
- and if the person was a child (under the age of 16 years) when the data has been collected, making data collection an unlawful act.

[62] Art. 35 (1) of GDPR
[63] Art. 35 (7) (d) of GDPR
[64] Art. 83(4) (a) of GDPR
[65] Art. 17 (1) of GDPR

There are exceptions to the right of data deletion. These are, complying with the right of freedom and expression, when the controller is bound to legal compliance (for example banks having to keep data for at least 7 years), complying with public interest and in order to help with legal crimes.

5.3.5.1.6 Obligation to inform in the case of data violation

If there have been violations towards the personal data regulations or a data breach occurred, the controller is obliged to inform the supervisory authority about it.

A personal data breach is defined by the GDPR in article 4 as follow:

"'personal data breach' means a breach of security leading to the accidental or unlawful destruction, loss, alteration, unauthorised disclosure of, or access to, personal data transmitted, stored or otherwise processed;"

Informing the supervisory authority has to be done without delay and within 72 hours after such a data breach has been revealed. The notification directed towards the supervisory authority has to contain several items. Such being, *"(...) the categories and approximate number of data subjects concerned and the categories and approximate number of personal data records concerned"* [66]. The point of contact must also be named. These are the contact details of the responsible data protection officer. Further, consequences and risks of the data violation should be descried as well as *"(...) the measures taken or proposed to be taken by the controller to address the personal data breach, including, where appropriate, measures to mitigates its possible adverse effects"* [67].

If not done so, the responsible company may be subject to a fine of up to 2 % of the annual global turnover (GDPR Art. 83 (4)).

5.3.5.1.7 Prepare IT systems to cope with the new requirements

Companies must make sure that *"(...) appropriate technical and organizational measures"* are in place. These measures should make sure that *"(...) necessary safeguards into the processing in order to meet the requirements of this Regulation and protect the rights of data subjects"* [68] are put into place in order to meet all legal requirements stated in article 5 of GDPR.

Also, IT systems should be default in a way that *"(...) only personal data which are necessary for each specific purpose of the processing are processed"* [69].

[66] Art. 33 (3) (a) of GDPR
[67] Art. 33 (3) (d) of GDPR
[68] Art. 25 (1) of GDPR
[69] Art. 25 (2) of GDPR

5.3.5.1.8 Obligation to keep a record of all processing activities

It is important for companies to keep a record of all data processing activities. According to the General Data Protection Regulation, the following information must be part of this record: First, the point of contact of the controller. This includes the controllers name and their complete contact details. Second, the reasons for the processing of the individual's data. Third, a list of categories referring to the data subject, including all relevant personal data that has been collected. Fourth, all categories and relevant information of the data recipients (domestic as well as international recipients). Fifth, the time period that has to be taken into account during data deletion and finally information on *"(...) the technical and organizational security measures referred to in Article 32 (1)"* [70].

A record of all processing activities will allow the supervisory authority to successfully and effectively control if companies meet their obligations stated in the GDPR. If data subjects file complaints the supervisory authority will demand the recorded processing activities in order to proof if a wrong doing was done or not. Any mistakes or violations towards the recording regulation may be subject to penalties with up to 2 % of the global annual turnover (stated in article 83 (4) (a)).

[70] Art. 30 (1) (g) of GDPR

CONCLUSION

The digital transformation of companies triggered by the fourth industrial revolution is a continuous process based on new and emerging technologies. Organizational structures, processes and employees will be heavily affected by these changes. These major changes that will be unfolding with even faster speed and greater scope in the future triggered the following question: What are the opportunities, risks and challenges of the Fourth Industrial Revolution and what key findings should companies consider when going from a 3.0 to a 4.0 enterprise?

To answer this question, one should have insights in what the Fourth Industrial Revolution is. The first chapter explains the historical integration of the Fourth Industrial Revolution as well as its three main driving forces: The digital, physical and biological megatrends that will shape the world we live in. The essential trends will range from cloud computing, IoT, Big Data, Artificial intelligence, Robotics, Genome sequencing to machine learning, autonomous driving and the integration of the blockchain technology into several processes and transactions.

The digital revolution we are currently in will dramatically change the way we work, interact and live. To get an understanding on the main challenges, risks as well as opportunities of the Fourth Industrial Revolution a survey with over 150 participants was conducted. The chapters two, three and four go through the data characteristics, the questions and finally the key findings of the survey. The questions ranged from benefits and qualitative advantages created through Industry 4.0 initiatives, over barriers and risks associated with the digital revolution to actions company and government stakeholders can take to accelerate the digital adoption. Eight key findings were distilled from the survey. These are the constant disruption leading to a change in business models, performance optimization and cost reduction objectives, empowerment of the customer, unsolved data protection and security concerns, uncertainty about positive long-run employment changes, shift of competencies in the future job market, the commitment of governments as well as companies and finally the notion that trust and acceptance are the pillars of digital success.

As the future economy will be more and more data driven and most companies will rely on the accumulation and processing of personal data the fifth chapter is dedicated to the EU data protection reform that should come into effect on May 25th, 2018. The current and outdated EU data protection situation is explained. Afterwards the chapter goes through the goals, scope and structure of the General Data Protection Regulation. The last part of chapter five is dedicated towards the main obligations companies after the GDPR comes into effect. These are extended obligations towards documentation, extended data protection and risk mitigation, further obligations to inform individuals on data processing, the obligation to carry out impact assessments, strict obligations towards data deletion, information requirements in case of data violations, the preparation of internal IT systems to cope with the new requirements and the obligation to keep a record of all processing activities of personal data. These points indicate that the European legislator could improve the data protection rights of every individual and help to build trust towards a successful digital future.

SUMMARY THESIS

THE FOURTH INDUSTRIAL REVOLUTION – METAMORPHOSIS OF THE BUSINESS ENVIRONMENT

This thesis and survey were conducted to explore the opportunities, risks and challenges of the fourth industrial revolution. Further it should highlight key findings on how companies can prepare to guarantee a successful transition from a 3.0 to a 4.0 enterprise. The conducted survey explores the opinions of digital natives on increasing digitization. It gives an indication on how a blueprint for digital readiness can look like and how companies can successfully transform by acquiring and using digital capabilities. Also, it should show and evaluate legal and regulatory issues concerning personal data protection through emerging and advanced technologies.

THESIS KEY WORDS

DIGITAL TECHNOLOGIES

INDUSTRY 4.0

DATA PROCESSING & DATA PROTECTION

DISRUPTION

COST AND PRODUCTIVITY OPTIMIZATION

CUSTOMER EMPOWERMENT

CHANGING SKILLS

TRAINING AND EDUCATION

1 The Fourth Industrial Revolution - Introduction

The first industrial revolution used water power and steam to mechanize the production process. Electricity was the driver of the second industrial revolution and enabled mass production. The third has electronics and information technology at its basis to automate wide parts of production. Now, we are on the brink of a technological and industrial revolution that will change and redefine the way we live, work and communicate with one another. The extent of these changes is currently not very clear but has to be dealt with caution and thoughtfulness and include every individual of our society. In the fourth industrial revolution, new disruptive technologies and innovations are being introduced at a much faster pace than in the previous ones. The scientific breakthroughs that were made in the last years and the new technologies that have emerged seem

infinite. Also, they all have the same key feature: the powerful use of digitization and information technology. The digital megatrends are clustered in three groups. The fourth industrial revolution combines physical, digital and biological megatrends [71]. The combination of these technologies allows the emergence of disruptive waves in the business environment. This has led companies to change their corporate strategies and research agendas and put their focus on the use of these mentioned technological megatrends. Using the advantages of interaction between physical, digital and biological technologies distinguishes this industrial revolution from the ones before.

The fourth industrial revolution implies the transformation of companies on an organizational and operative level as well as achieving digital success to stay competitive and exploit first mover advantages. This digital transformation - characterized by the digitization of horizontal and vertical value chains, the improvement and digitization of product portfolios, shorter innovation cycles as well as new data driven business models – has reached enterprises in all industries around the globe.

2 Executive Summary - Survey

This Work Project and the underlying survey explore the opportunities, risks and challenges of the fourth industrial revolution. Further it should highlight key findings on what companies and employees should take into consideration to guarantee a successful transition from a 3.0 to a 4.0 enterprise. Graphs 1 to 5 and table 1 in the appendix show the data characteristics of the survey. These range from gender, age, country of origin, employment status, university education to the faculty or major of the respective respondent.

44% of survey participants are female and 56% male. 134 (93%) are between the age of 18 and 29. Another 9 respondents (or 6%) are between the age of 30 and 49 and 1 participant (0.6%) is 65 and older. Most respondents are from Germany (46%). 18% are from Portugal and 16% from Italy (the spread between the remaining countries can be seen in the appendix – table 1).

The majority of participants are students (62%), followed by people who are employed for wages (28%). 5 % are self-employed and 2 % are currently out of work and looking for a new job. 71 % of all students are currently doing their master´s degree, 25 % their bachelor´s degree, 3 % their PhD and the remaining 1 % a MBA. Most of them studied in business related fields such as management (62%), economics (14%) and finance (7%).

The first part of the Work Project will lead through and explain the seven survey questions and their respective graphs. The second part will pool together the survey answers and describe the 5 key findings that were distilled from the participants responses.

[71] Schwab (2016) clusters the emerging and disruptive technologies as followed:
Physical megatrends include autonomous vehicles, advanced robotics, 3D printing and new materials.
Digital megatrends include the Internet of Things, Big Data, algorithms and blockchain technology.
Biological megatrends include optimized gene sequencing, synthetic biology and gene modification.

3 Survey questions and responses

Benefits created through Industry 4.0 initiatives

Graph 6 shows the weighted responses to the question “How important are the following benefits for companies created through Industry 4.0?”. Each listed benefit should be categorized by the respondents as either being extremely important, very important, moderately important, slightly important or not at all important. Four listed Industry 4.0-benefits were said to be extremely important by over 50% of respondents. These are, the improvement of worker productivity (53.6%), the reduction of operational costs (53.0%), the creation of new revenue streams through new products and services (52.3%) and the enhancement of customer experience (50,3%). The three remaining benefits which were identified as being very important are the following: The optimization of asset utilization (45.7%), the enhancement of worker safety (42.4%) and the improvement of sustainability (38.4%).

The survey shows that the respondents strongly believe that companies will not only cut costs dramatically and improve productivity, but also generate additional revenue streams. Through the automation of processes using Big Data, algorithms, sensors and artificial intelligence, companies will be able to improve both the bottom and top line. These cost reductions and productivity gains can be reached through better asset utilization in the form of smart manufacturing initiatives.

Qualitative advantages created through Industry 4.0 initiatives

Graph 8 shows the responses to the question “How high or low will the impact of the following qualitative advantages be for a company?”. The respondents should rate each listed qualitative advantage as either being high, medium or low. The following qualitative advantages were rated as having a high impact on a company: Better planning and controlling, for example in production and logistics (74.8%), higher customer satisfaction (67.5%), higher flexibility in production (60.3%), higher quality (54.3%) and individualization of products (51.7%). Decreased time to market was rated by 53.0% of respondents as having a medium impact on a company.

These results strongly correlate with the results from graph 6, showing the survey participants opinions on benefits by Industry 4.0 initiatives. Both graphs indicate a tendency towards generating additional revenue, lower costs, higher efficiency and greater customer satisfaction.

Barriers preventing adoption of digital technologies

Graph 7 shows the responses to the question “What do you think are the biggest barriers that prevent companies from adopting digital technologies. Each participant could choose five main limitations to digital technology adoption. 118 survey respondents voted for privacy concerns being the biggest barrier to digital technology adoption. This suggest rising concerns among digital users about their private data. This suggest that the respondents are aware that growing digitalization also shows growing caution on how private data is collected, distributed and protected. Lack of skilled workers was selected 115 times and ranks as the second biggest

limitation. This suggests, that respondents are aware of changing skills and job competencies in the future business environment [72]. The third commonly selected limitation are the uncertain returns on investment with 111 responses. This barrier to investing in digital technologies shows that the survey participants know of the difficulties to quantify the impact of digital transformation. This implies that a lot of investments are not based on sound ROI calculations and therefore cannot capture the full impact of the new emerging technologies, making investments seem like more of a risky bet. This point correlates with another highly voted barrier: the lack of interoperability or standards (85 responses). Suggesting that the uncertainty to invest ground on uncertainty of the maturity and soundness of the digital technologies. The fourth biggest barrier with 101 responses are security concerns. This goes hand in hand with the number one limitation, privacy concerns. The limitations that occupied the end of the scale are the lack of proper equipment (63 responses), immature technologies (52 responses) and societal concerns (42 responses).

Risks associated with the digital revolution

Graph 9 presents the responses to the questions "How likely do you think are the following risks associated with the digital revolution?". The survey participants evaluated each listed risk as being either high, medium or low. Privacy concerns due to availability of private data was identified to have a high risk (70.9% voted high, 28.5% voted medium risk). The second biggest risk identified were security threats due to connectivity of the global network (55.6% voted high, 38.4% voted medium). The third major risk associated with the digital revolution are disruptive waves in business models (53.6% voted high, 42.4% voted medium). The remaining two risks identified as having a medium risk are system break downs due to the complexity (20.5% voted high and 47.0% voted medium) and loss of job and social shifts due to increasing automation (37.1% voted high, 41.7% voted medium and 21.2% voted low).

Privacy concerns and security threats highly correlate with the identified barriers and limitations to digital technology adoption (graph 7). Although privacy concerns and security threats were identified as the risks with the highest impact, the survey respondents are not totally convinced that the digital revolution will threaten human lives due to system break downs. This indicates that the participants believe in the maturity and soundness of the new technologies. This highly correlates with immature technologies not being one of the main barriers towards digital technology adoption (identified by graph 7).

The risk of disruptive waves in business models gives an indication that traditional businesses will have to adapt to new waves of doing business and the use of emerging technologies and business models. And the balanced vote on the risk of job losses and social shifts due to increasing automation reflects the current popular-scientific discussion, which are far from agreeing opinions on the long-run impact of automation.

[72] According to Schwab (2016), leading global companies' think that cognitive abilities, complex problem solving and societal competencies will be much more needed than physical and technical competencies.
Also, Bonin et al. (2015) suggest that the digital transformation will highly affect the job structure in the future, especially repetitive tasks that require a low-skilled and low-income work force.

Aspects of a successful and sustainable business model

A lot of industries are being turned upside down by new entrants that are threatening ore totally driving out traditional businesses. To find answers how to cope with digital business models the respondents should respond to the following question: “How important are the following aspects of Industry 4.0 for a successful and sustainable business model?” (shown in graph 11). All listed aspects where identified as being important for a successful and sustainable business model. The individual responses on being “important” were weighted as follows: Expand digital services with additional customer benefit (78.8%). Strengthen the companies´ position towards new digital players (69.5%). Stronger digital networks with customers and partners (66.2%). Development and expansion of value-added services for example apps (63.6%). Efficient and safe cloud technologies (58.9%) and supplying solutions and systems rather than products (48.3%).

Company stakeholder actions to accelerate digital adoption

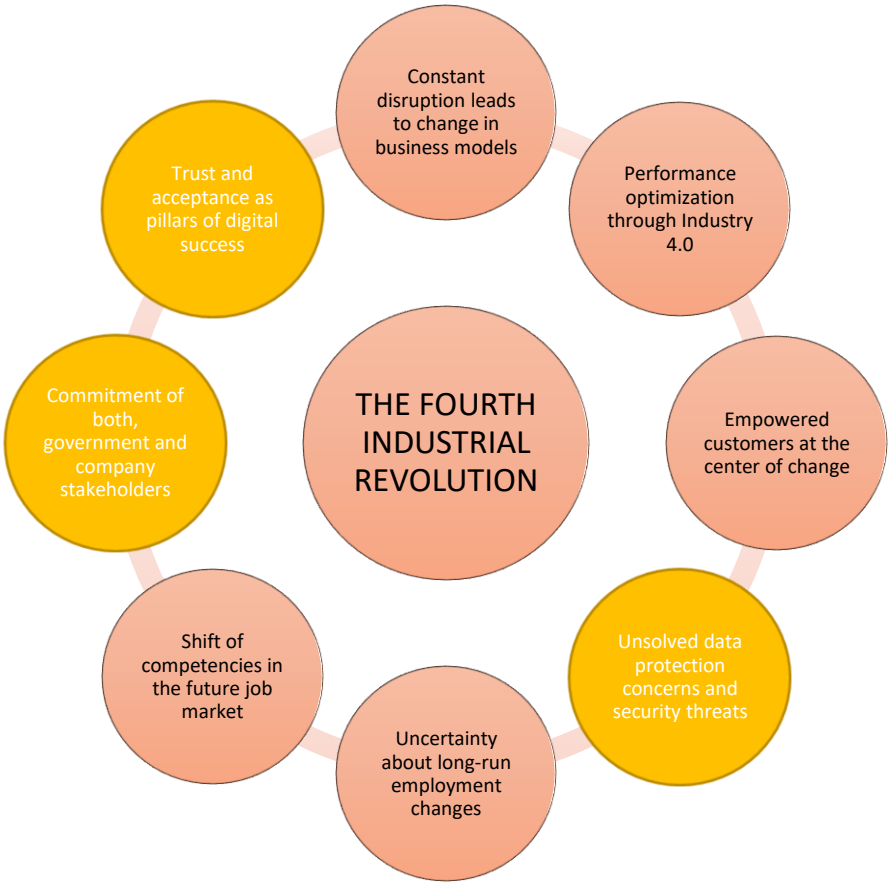
Graph 12 evaluates to what extent the survey participants agree or disagree on each listed action company stakeholders should take to spur digital technology implementation. The results are as follows: 43.0% strongly agree with increasing investments in further employee training. 35.8% strongly agree on developing better big data platforms. Over one third (34.4%) of respondents strongly agree that company stakeholders should create and collaborate on experimental platforms to test how the technologies work together. Also, over one third (33.8%) strongly agree with developing a common approach to address security issues was. Increasing investments in sensors and connectivity was as well strongly agreed upon (31.1%). To influence public policies to accelerate the adoption of digital technologies was not seen as important as the other actions. 19.2% strongly and 29.8% moderately agreed with this action.

Government actions to accelerate digital adoption

In addition to company actions, the survey identified main actions governments should take to support the acceleration of digital technologies (shown by graph 13). The survey participants rated each listed action by how strongly they agreed or disagreed. The outcome correlates with the previous responses towards security issues, education and training. 53.3% strongly agree with the provision of a regulatory framework (for example data protection laws). 45.7% strongly agree with investments in education and training programs. Further, 41.1% strongly agree on government collaborations with the private sector and other government to address issues such as trans-border data flow. The following three governmental actions had less participant agreement: Subsidize the IoT infrastructure (37.7% strongly agreed), establish and promote common standards (35.1%) and invest in long-term strategic R&D (34.4%).

4 Key Findings – Survey

The Work Project highlights key findings on what companies and employees should take into consideration to guarantee a successful transition from a 3.0 to a 4.0 enterprise. The conducted survey, with over 150 respondents, explores the opinions of digital natives on increasing digitization. It gives an indication on how a blueprint for digital readiness can look like. The survey responses can be pooled together and distilled into 8 key findings:



Constant disruption leads to change in business models

According to graph 6, 52.3% of respondents see the creation of new revenue streams through new products and services to be very important. In addition, 53.6% of respondents think that disruptive waves in business models are very likely to occur in association with the digital revolution (seen in graph 9). The fact that the survey participants are aware of disruptive waves in business models that threaten whole industries and the need for companies to create new revenue streams through new products and services implies the following: Constant disruption leads to change in business models. WhatsApp is a good example to illustrate the speed and extent of disruptive digital business models [73].

[73] The company was founded in California in 2009 and was acquired by Facebook for 19 billion US dollars five years later. Back in 2015 more than one billion users sent about 250 million videos, 42 billion messages and 1.6 billion photos per day – with 57 engineers working for them. WhatsApp destroyed the hundred-billion-dollar Short Message Service (SMS) industry in a short period of time (Economist, 2015). According to Matzler et al. (2016) WhatsApp and other examples such as Netflix, Uber, Airbnb or Spotify show many similarities:

- Fast growth

The survey identified the respondents' opinions on a successful and sustainable business model (shown in graph 11). The three most important aspects identified are the expansion of digital services with additional customer benefits, the creation of stronger digital networks with customers and partners and the strengthening of one's position towards new digital players.

78.8% consider expanding digital services with customer benefit the most important aspect for a successful and sustainable business model. Companies can either place new innovative products in their current portfolio. Or they add so called evolutionary innovations to their current product and service setting. Innovative products create either an entirely new market or transform to expensive products into affordable ones to reach a bigger customer base. Newly created markets would be the tablet or smart-watch. And products turned from unaffordable for the average consumer are for example Fords` Model T or the PC. The second way of expanding the product portfolio are the evolutionary innovations which improve and further develop existing products. In the digital era, this is done through connected devices. The expansion through digital services can nicely be illustrated by breaking down the various steps of digital value chain. An excellent example is Nest, a home automation company that was bought by Google and is known for its programmable thermostats [74].
66.2% consider stronger digital networks with customers and partners important for a successful future business model. Networks must be established and expanded to generate new customers and retain the current ones. Fast growth of digital products and services can be explained by the network effects. It develops when the utilization changes because of a changing number of customers. This effect can go both ways. A positive network effect increases the utility for the user with increasing customers that use the product or service.

The market diffusion graph shows that WhatsApp only required one tenth the time the SMS needed to reach a volume of 20 billion messages per day. This phenomenon is referred to as 'big band disruption', sending shock waves towards long lasting players in different industries that have difficulties to cope with the pace of disruption (Downes & Nunes, 2013).

- Network effects that allow the winner to take it all
  A typical characteristic is the network effect. A lot of new digital business models take advantage of it to reach a monopoly position. This means the more users a service or product supplier has the more attractive the offer is for other users and creates barriers of entries for competitors (Hagiu, 2016).
- Zero marginal costs
  Digital products and services usually have marginal costs that go towards zero. Once they are produced the cost of producing any additional amount is nearly nothing. This economic principle has become the norm as the economy becomes more and more digitized. Scalability in production towards a price close to zero underlines the new digital business models.

[74]According to Curtis (2014) the value chain breaks down as follows: **Step 1**: The physical product is that is the basis of the value chain are thermostats. Usually thermostats are manually adjusted through a setting wheel. The value generated for the customer is the manual regulation of the temperature. **Step 2**: The thermostat is being equipped with sensors and actuators to make an analog product into a smart appliance. Now the thermostat can learn through data generation, can be programed by its users, is connected to the internet and adjusts the temperature inside automatically to the corresponding temperature outside. **Step 3**: In this step, the smart thermostat is further developed and upgraded with IP enabled sensors. Via the internet the product can now communicate and exchange data with other devices. Also, huge amounts of data can be collected and stores. **Step 4**: This accumulated data can now be constantly analyzed to produce valuable information. Data collected can for example be consumption habits. It can be used to provide consumption forecasts and optimize domestic energy use. This information can prepare a basis for new services to generate further revenue. **Step 5**: Based on the data collected new digital services can be created or the data can be connected to other sectors to generate more value. For example, the partnership between Nest and Whirlpool, a producer of home appliances. Through the integration of the Nest thermostat with the Whirlpool mobile app it is possible to increase efficiency and customer utility. One example is the automated start of the washing machine during a period of low network utilization and lower electricity.

This phenomenon is referred to as a "virtuous cycle". Examples are social media channels like Facebook, Twitter, WhatsApp and other services such as Airbnb or Uber [75]

The next most important aspect of a sustainable and successful business model is to strengthen the company's position towards new digital players with 69.5% of participants valuating this aspect as being important.

Performance optimization through Industry 4.0

The combination of responses from graphs 6 and 8 which evaluated the questions "How important are following the benefits for companies through Industry 4.0?" and "How high or low will the following qualitative advantages be for a company?" lead to the following assumption: The survey respondents believe that the fourth industrial revolution will lead to performance optimization. Over 80% of respondents believe the following benefits created from Industry 4.0 initiatives are extremely or very important for a company: The optimization of asset utilization, reduced operational costs and worker productivity improvement. Also, the majority of respondents consider the following qualitative advantages to have a high impact on the company: Better planning and controlling for example in production and logistics (74.8%) and higher flexibility in production (60.3%).

These survey results imply that top and bottom line optimization can be made through automation of processes using Big Data, algorithms, sensors and artificial intelligence. For comprehensive reasons, it is important to mention the following two areas. They will enhance performance optimization and cost reduction in the future:

Process optimization

Sensors will be able to generate, distribute and analyze data in real-time. This will allow companies, especially the manufacturing industry, to optimize the production process, error detection and debugging. The automobile industry and its supply chain management are a good example to illustrate an efficient and customer oriented

[75] The virtuous cycle and positive network effect of Uber can be explained as follows:

1) A higher number of Uber drivers (partners) makes the service more attractive for the potential users (customers). More drivers, shorter waiting times, higher satisfaction for customers, growing user base and therefore increasing recommendations to other people.

2) A higher number of Uber users (customers) makes the service more attractive for potential drivers (partners). They expect higher capacity and more business.

3) Data generated and provided within the service enhances positive network effects. Algorithms can predict hot spots with a lot of users and high capacity. The more drivers provide data the more precise the hot spot prediction will get. This will lead to more Uber drivers penetrating the areas with a high number of customers. The more drivers are present the more attractive the service gets for the customers and positive feedback will increase.

production. Car producers use RFID (Radio Frequency Identification) tags. These devices contain all specification details of the respective customer. These smart manufacturing initiatives enable companies to track all parts within the value chain and control production timing. Also, the costumer benefits by exactly knowing where his order is, thus increasing customer experience.

Predictive maintenance

By uniting digital and physical assets, smart factories will become more and more important to manufacturers around the world. Through real-time data analysis maintenance procedures will change. Waiting until an error or damage occurs is part of the past. Today the key word is 'predictive maintenance', meaning forecasting and preventing damages before they occur. The workflow of machines is tracked automatedly and analyzed for patterns. This will allow predictions on when parts could fail or a damage might occur. Knowing this beforehand will allow companies to proactively exchange parts and predictively maintain the machines. Higher capacity utilization and shorter downtimes will lead inevitably to higher productivity.

Empowered customers at the center of change

The fourth industrial revolution will lead to increasing empowerment and change the relationship between companies and customers. As the new digital era fosters transparency, customers gain power and the traditional way of pushing out products to the market will decrease. Instead, customers pulling products they want and need towards them will become the norm in the future and as well as an increasing digital peer-to-peer comparison [76]. Customer experience and satisfaction will be at the core of customer service. This means that products and services will be increasingly customized towards consumer needs – whether it is on a B2C or B2B basis.

One of the main benefits for companies created through Industry 4.0 is to enhance customer experience. 50.1% of the respondents see this as an extremely important benefit the can be created through the digital revolution (shown in graph 6). In addition, 67.5% mentioned higher customer satisfaction as a main qualitative advantage of the digital revolution. This correlates with listed advantages of Industry 4.0 (shown in graph 8): First, 51.7% saying that individualized products are a high qualitative advantage for a 4.0 enterprise. And second, 54.3% of respondents stating that higher quality will be reached through digital technology initiatives.

Summarized the survey sketches out an empowered customer who wants to increase his or her experience, satisfaction and benefits through individually produced and digitally upgraded products.

[76] According to Schwab (2016) increasing peer-to-peer comparison will put companies under pressure by making them take responsibility for bad quality products or services. Also, products will go from push to pull. This peer-to-peer comparison increases customer demand, shown by a report of the Institute of Customer Service. According to them, the percentage of customers who have problems with their product or service has decreased from 17% in 2008 to 11.7% just four years later. In the same period, the customers that took active steps to make a complaint increased from 72% to 76% (Hoong, 2013).

Unsolved data protection concerns and security threats

The McKinsey Global Institute (2015) identified data security issues that have the potential to destroy trust towards digital initiatives and business models if not assessed appropriately [77].

The survey participants also expressed their concerns, calling for increased data protection and the mitigation of security threats. Graphs 7 and 9 prove the tendency towards increasing privacy and security concerns within the digital future. When asked what the biggest barriers are that prevent the adoption of digital technology, privacy concerns and security concerns where at the top of the scale (with 118 and 101 responses respectively). This relates to the outcomes identified in graph 9, which identified the risks associated with Industry 4.0. Privacy concerns due to the availability of vast private data and security concerns due to the connectivity of the global network were identified as being the two most likely risks connected to the fourth industrial revolution. This implies that if not assessed correctly, these issues will greatly inhibit the successful realization of digital technology initiatives.

This is where public policy must interfere to ensure the protection of privacy rights of customers as well as companies. Regulatory frameworks will have to set limits on how private data is distributed throughout the global network. In addition, security threats within a company and a society are strongly associated with the digital revolution. These security threats must be contained to establish digital trust and make everybody profit from the fourth industrial revolution. The survey identified company and government actions that should be taken to make the digital transformation work (seen in graph 12 and 13). In graph 12, survey participants call for company stakeholder to create and collaborate on experimental platforms to test how the technologies may work together. This idea of an open architecture system can help to spur innovation, identify system risks and help optimize technological systems of various companies. A mentionable example is the OpenPOWER Foundation [78]. This leads to the second important company action: creating common security approaches to address user and customer concerns. Within an open platform system, companies can also address cybersecurity issues together and accumulate a pool of ideas on how to successfully mitigate security and

[77] The following privacy and security issues were identified by Manyika & Chui (2015):

1) Loss of control over private data because data that has been given to companies cannot easily be detected or deleted.

2) An information imbalance is created. Companies accumulate huge amounts of data and detailed information about their customers. In contrary, the corporations themselves are not very transparent. This fact does not build trust between customer and company.

3) Data analytics can also be flawed and may create wrong data forecasts on customers which can cause discriminating acts against the user. Underwriting companies may for example raise rates on certain insurances or completely terminate insurance contracts.

4) There is also a threat of illegal use of data through criminals. Flaws in security systems or hacked gateways may allow criminals to exploit generated data illegally.

[78] According to the MIT Technology Review (2015) is a technology collaboration spanning over 170 technology companies (for example Google, Mellanox Technologies and NVIDIA). This open architecture platforms enables companies to work together on solutions and products. It also helps companies to rethink their technology approach as well as enhance collaboration on security and privacy concerns.

privacy threats. Further, the public institutions should work together with the private sector to ensure sufficient protection and gain digital trust. In graph 13, the survey participants identified three main government actions that should be considered. First the provision of a regulatory framework, mainly data protection laws. Second, the collaboration with the private sector and other governments to address such issues. And finally, the establishment of common standards to streamline regulations and provide a firm legal framework.

Shift of competencies in the future job market imply further education and training

The survey identified opinions towards changing job competencies and skills, newly required models of education and a possible lack of skilled workers. Also, the respondents call for corporate and governmental actions to provide further training and investment in education programs. Graph 7 identified the lack of skilled workers (111 responses) as being the second biggest barrier towards the adoption of digital technologies. This correlates with the two statements in graph 10, which reached the highest approval ratings among survey participants: 76.2% highly agree (agreement options high, medium or low) that new models of education and training will be required to meet the talent demand in the future digital job market. And 65.6% highly agree with the statement that the increasing use of digital labor will transform the mix of skills that are required from the future workforce.

Corporations and governmental institutions must respond immediately to approach the worries towards mismatching job competencies and possible technological unemployment. Graph 12 and 13 recommend the following measures to mitigate such risks: Companies must increase investments in further employee training and governments must invest in education (starting from formal school education) and training programs. The World Economic Forums 'Future of Jobs Report' should be mentioned, which evaluates the dynamics of the fourth digital revolution on the workforce, the skills demand and future job competencies [79]. It is important to mention that training activities should not only be borne by businesses. Governments have the obligation to help finance such programs and must help reform the school agendas to prepare the future employees and the domestic economy for the future digital job environment.

Uncertainty about positive long-run employment changes through technological innovations

The survey identifies the respondents' uncertainty whether the fourth digital revolution will create more opportunities then jobs it will displace. According to the survey only 26.4 % highly agree with the statement predicting more opportunities created than job displacement (shown in graph 10; Appendix). This reflects the concerns of the public opinion and current popular-scientific discussions, stating that the fourth digital

[79] The WEF Report states that about 35% of very important skills for the workforce in 2015 will have changed by 2020. The current digital revolution will have introduced advanced robotics, artificial intelligence (AI), autonomous driving, machine learning and advanced materials. Businesses should make sure that the workforce is able to adapt to the new emerging technologies that will be integrated into the business environment. And provide support to the workforce. They must learn the new skills that are needed to complementary the new technologies and avoid lay-offs. We must keep in mind that this process of adaptation will be different between the different employee groups. Studies suggest that the pressure of adjustment will be higher for low-paid and low-skilled workers (Bonin, et al., 2015). Specific training and qualification measures should be introduced to support the workforce that has the highest potential of being substituted by automated machines and processes.

revolution drives 'the end of work' and will have a devastating impact on employment. Still, most economists these days argue that the increase of labor automation will raise incomes, which will lead to demand for new products and services and in the follow up generate new jobs for workers who have been displaced (Bonin, et al., 2015). An exception which should be mentioned in this context, is the study by Carl Benedikt Frey and Michael A. Osborne called *"The Future of Employment: How Susceptible are Jobs to Computerization?"*. Frey and Osborne examine the automation potential of jobs in the USA. According to this survey, 47% of US workforce can be taken over by computers and algorithms. Therefore, they first reason why technological innovations can lead to job loss and unemployment. According to their study this has to do with the rapid developments in the field of machine learning, artificial intelligence and robotics. This will lead to loss of jobs in fields that were solely done by humans, not only restricted to manual tasks but also tasks that include creative thinking and social intelligence

Commitment of both, government and company stakeholders

The fourth industrial and technological revolution calls for the commitment of both, government and company stakeholders. They must deliver actions to accelerate the adoption of digital technologies, prioritize employee development during the change process and spur digital culture and trust. Also, governments should work out a policy framework that will make the digital transformation work for the different industry sectors, their firms and employees. The survey identified the following actions government and company stakeholder should take to eventually foster well-being and growth in the future:

1. Subsidize technologies and digital infrastructure development
2. Increase investments in employee training and skills development
3. Find a common approach to address security concerns

Trust and acceptance as pillars of digital success

According to the survey outcome, over 50% of respondents think that analytics and digital trust will be the foundation of the digital revolution. Also, the survey respondents indicate a strong tendency towards issues such as data protection, data security and cyber security concerns. Most of us know that trust is key to any successful endeavor. Consumers are aware of how important and valuable their data is for corporations. According to Accenture, a consultancy, eight out of ten consumers will refuse to do business with a company that is not able to keep their data safe or process it in a lawful way. Further, only five out of ten consumers think that profiling and the tracking of consumption behavior or selling personal data to other parties will benefit them (Barton, 2016). The amount of personal data that companies are able to collect seems infinite. The growing interconnectedness of the global system will impose a challenge towards digital trust. If confidence in a company is not given and if consumers believe the responsible party is collecting, storing and processing personal data in a way that harms them, digital trust cannot increase. Any lack of privacy, security, integrity and accountability will hinder a successful unfolding of the Fourth Industrial Revolution.

5 Regulatory and legal issues concerning data protection – Current situation and EU Reform

Shown below is the structure of the General Data Protection Regulation (GDPR) that will come into force on May 25th, 2018 and repeal the current Data Protection Directive (DPD) from 1995.

Source: European Parliament, 2016

The General Data Protection Regulation consists of 11 chapters and 99 articles. The GDPRs structure is shown by the graph above. The GDPR has the purpose to unify the data protection law on a EU level. The level of protection of the rights and freedoms of the personal data for every person should be consistent in the whole European Union. The application of just one EU directive should enable companies to structure and execute their data processes in all 28 member states equally. This standardization should strengthen the internal EU market by streamlining regulations and processes. With this regulation the European Commission want to suspend the regulatory patchwork provided by the Data Protection Directive (DPD).

Scope of the GDPR – What and Where

Territorial scope

The directive applies to the handling of personal data for those responsible for processing and distribution of data sets, with subsidies within the European Union. This is not restricted to whether the processing is done within the European Union or not. Article 3 establishes the territorial scope of the GDPR:

"*This Regulation applies to the processing of personal data in the context of the activities of an establishment of a controller or a processor in the Union, regardless of whether the processing takes place in the Union or not"* [80]

This residence principle defines the scope of action of a subsidy or processor within the European Union. As mentioned before it does not matter whether the data is processed within the EU or not. It is decisive whether the subsidy of the responsible company or processor is located in the European Union or not.

Material scope

The directive is directed towards the automated processing of personal data. Article 2 defines the material scope and what kind of data is affected:

"This regulation applies to the processing of personal data wholly or partly by automated means and to the processing other than by automated means of personal data which from part of a filing system or are intended to form part of a filing system" [81]

It is not important whether the processing of the data sets is totally or just partly automated. Also, the regulation is applicable to data which has already been stored or is planned to be stored in a filing system. Thereby the material scope is broadly formulated. Companies will usually not collect data that they will not store or process in any other way. Even data collected and processes automatically (for example through means of observation, questioning, listening and any other process of perception that is not supported through technology) will be stored if economically relevant.

Consequences and important changes for companies under GDPR

The General Data Protection Regulation introduces a lot of obligations that companies must adapt to. The following part will introduce the most important and extensive obligations companies will be obliged to, after the coming into effect of the GDPR:

1. Extended obligations towards documentation and burden of proof
2. Data protection and risk mitigation
3. Obligation to inform on data processing

[80] Art. 3 (1) of GDPR
[81] Art 2 (1) of GDPR

4. Obligation to carry out an impact assessment
5. Strict obligation to delete and erase personal data
6. Obligation to inform in the case of data violation
7. Prepare IT systems to cope with the new requirements
8. Obligation to keep a record of all processing activities

Further elaboration and a more detailed description on the new and extended obligations can be found in chapter five in the main body of the thesis.

Conclusion

The digital transformation of companies triggered by the fourth industrial revolution is a continuous process based on new and emerging technologies. Organizational structures, processes and employees will be heavily affected by these changes. These major changes that will be unfolding with even faster speed and greater scope in the future triggered the following question: What are the opportunities, risks and challenges of the Fourth Industrial Revolution and what key findings should companies consider when going from a 3.0 to a 4.0 enterprise?

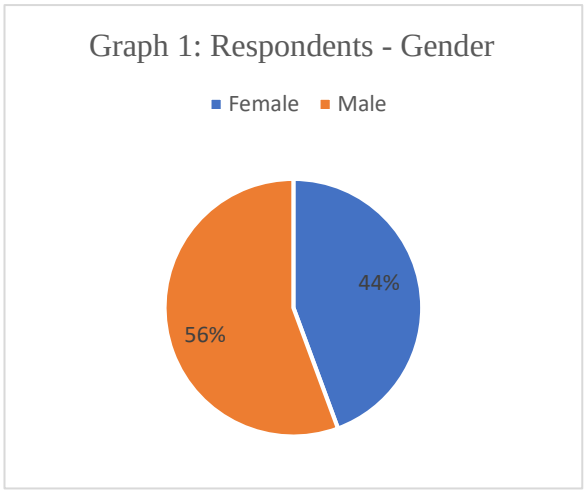
To answer this question, one should have insights in what the Fourth Industrial Revolution is. The first chapter explains the historical integration of the Fourth Industrial Revolution as well as its three main driving forces: The digital, physical and biological megatrends that will shape the world we live in. The essential trends will range from cloud computing, IoT, Big Data, Artificial intelligence, Robotics, Genome sequencing to machine learning, autonomous driving and the integration of the blockchain technology into several processes and transactions.

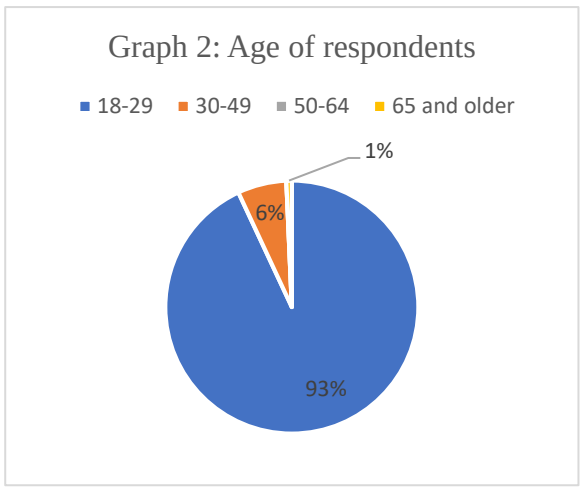
The digital revolution we are currently in will dramatically change the way we work, interact and live. To get an understanding on the main challenges, risks as well as opportunities of the Fourth Industrial Revolution a survey with over 150 participants was conducted. The chapters two, three and four go through the data characteristics, the questions and finally the key findings of the survey. The questions ranged from benefits and qualitative advantages created through Industry 4.0 initiatives, over barriers and risks associated with the digital revolution to actions company and government stakeholders can take to accelerate the digital adoption. Eight key findings were distilled from the survey. These are the constant disruption leading to a change in business models, performance optimization and cost reduction objectives, empowerment of the customer, unsolved data protection and security concerns, uncertainty about positive long-run employment changes, shift of competencies in the future job market, the commitment of governments as well as companies and finally the notion that trust and acceptance are the pillars of digital success.

As the future economy will be more and more data driven and most companies will rely on the accumulation and processing of personal data the fifth chapter is dedicated to the EU data protection reform that should come into effect on May 25th, 2018. The current and outdated EU data protection situation is explained.

Afterwards the chapter goes through the goals, scope and structure of the General Data Protection Regulation. The last part of chapter five is dedicated towards the main obligations companies after the GDPR comes into effect. These are extended obligations towards documentation, extended data protection and risk mitigation, further obligations to inform individuals on data processing, the obligation to carry out impact assessments, strict obligations towards data deletion, information requirements in case of data violations, the preparation of internal IT systems to cope with the new requirements and the obligation to keep a record of all processing activities of personal data. These points indicate that the European legislator could improve the data protection rights of every individual and help to build trust towards a successful digital future.

APPENDIX – SURVEY GRAPHS





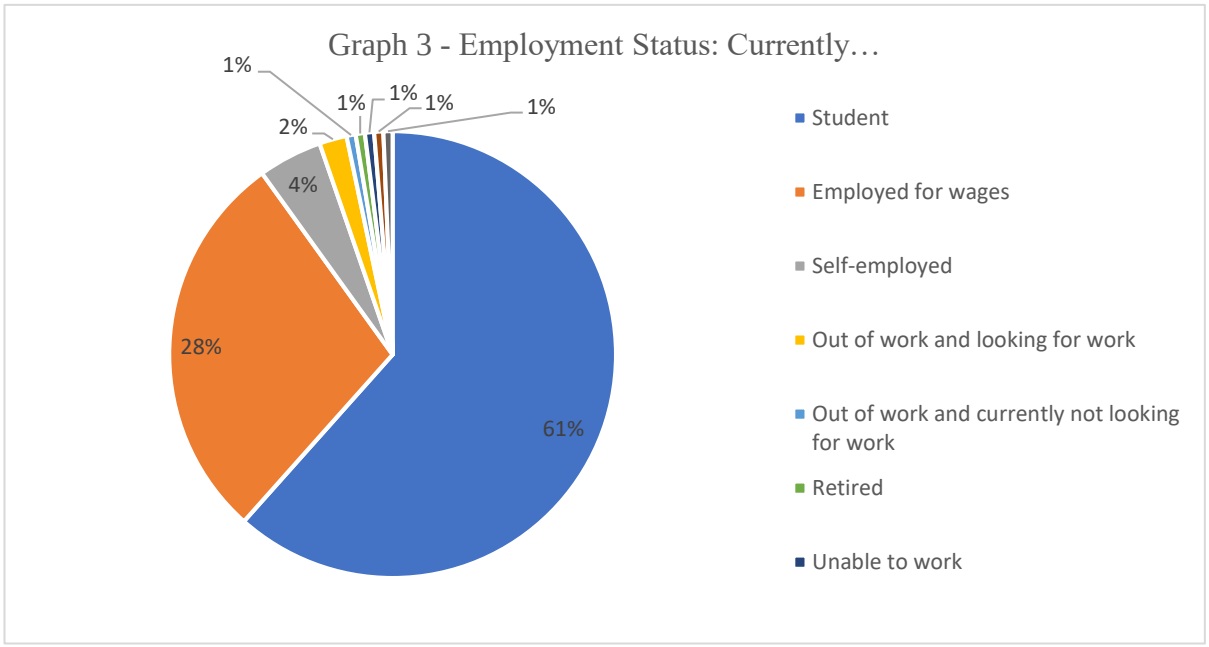
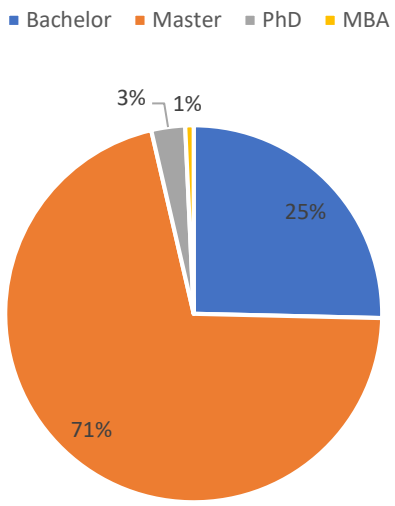


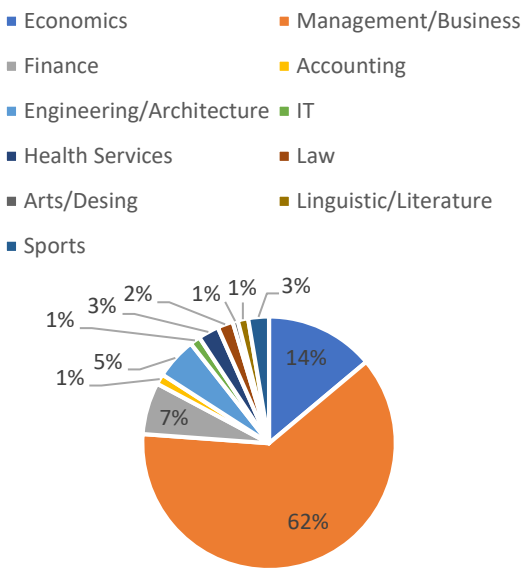
TABLE 1: COUNTRY OF ORIGIN OF SURVEY RESPONDENTS

COUNTRY OF ORIGIN	Number of respondents
GERMANY	70
PORTUGAL	27
ITALY	24
FRANCE	11
SPAIN	4
RUSSIA	2
AUSTRALIA	1
AUSTRIA	1
BELARUS	1
BELGIUM	1
BULGARIA	1
BOLIVIA	1
FINLAND	1
IRAN	1
IRELAND	1
NAMIBIA	1
NORWAY	1
PAKISTAN	1
POLAND	1

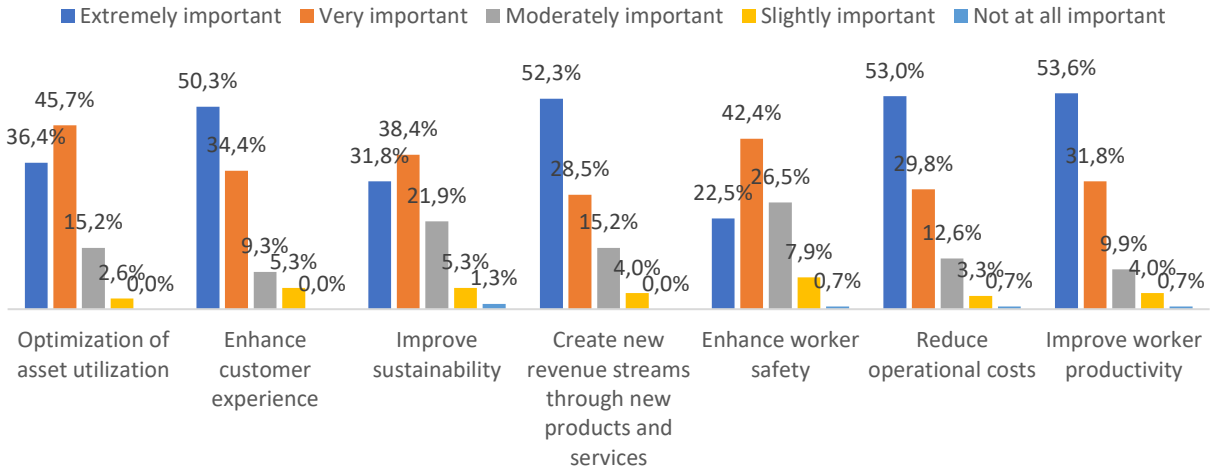
Graph 4 - If student, what kind of university education?



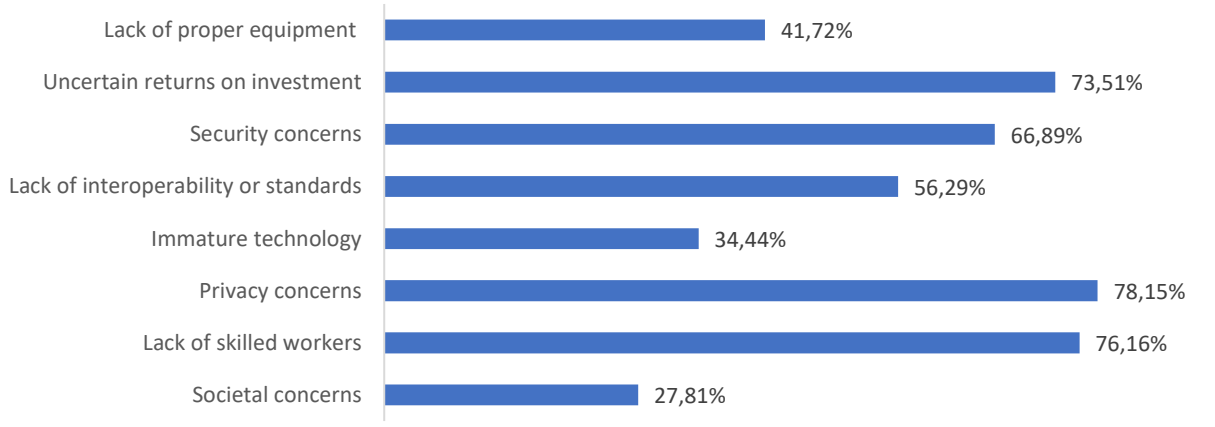
Graph 5 - Faculty/Major



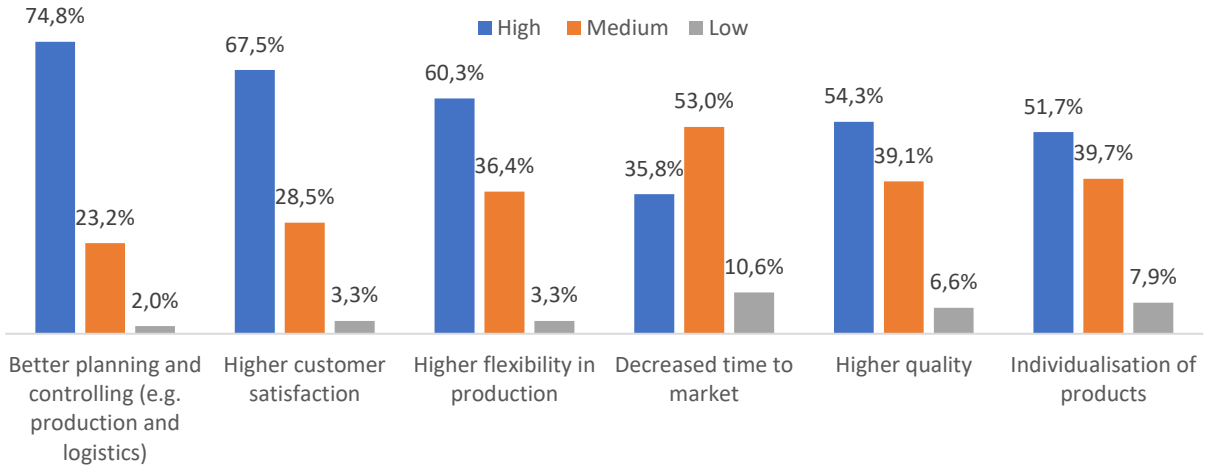
Graph 6: How important are the following benefits for companies created through Industry 4.0?



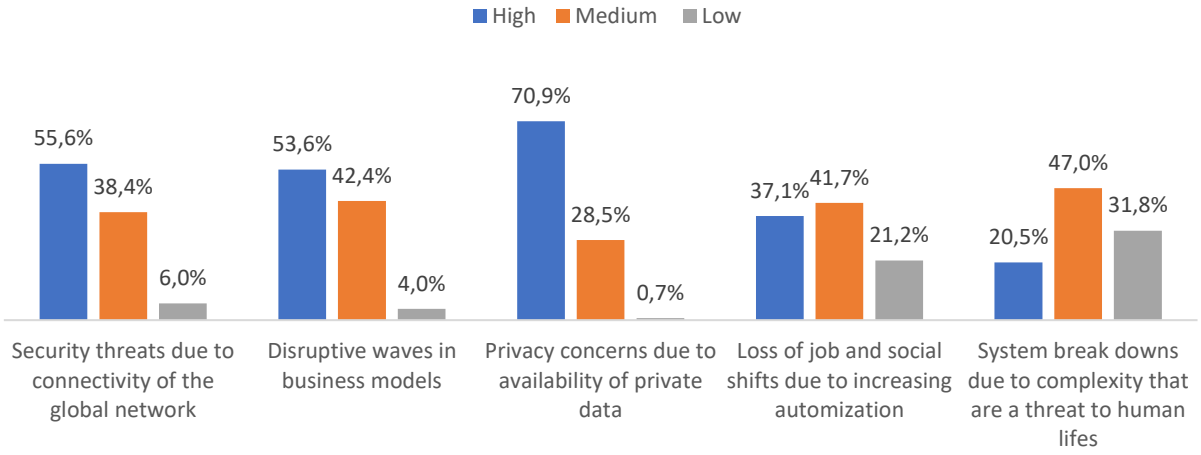
Graph 7: What do you think are the biggest barriers that prevent companies from adopting digital technologies?



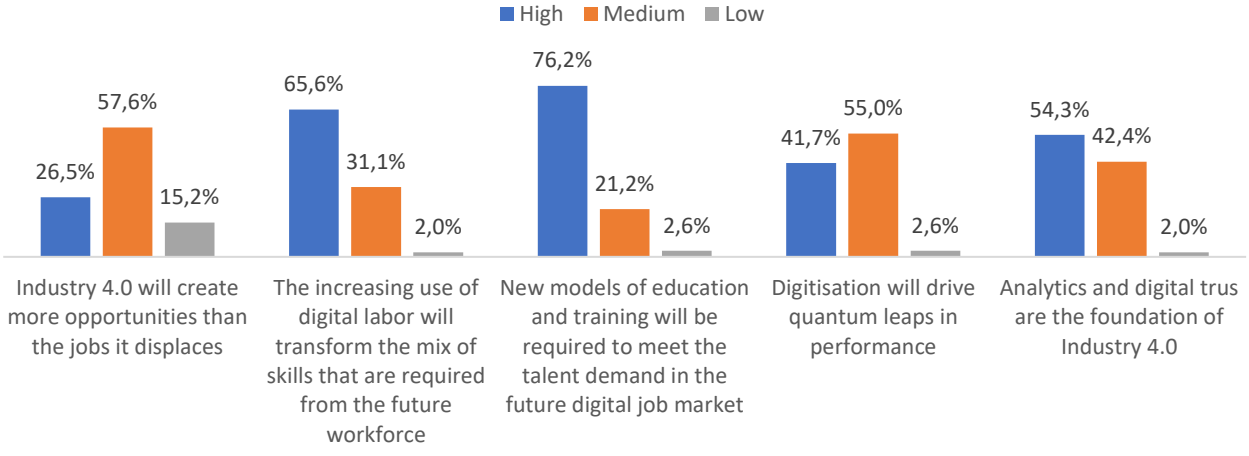
Graph 8: How high or low will the impact of the following qualitative advantages be for a company?



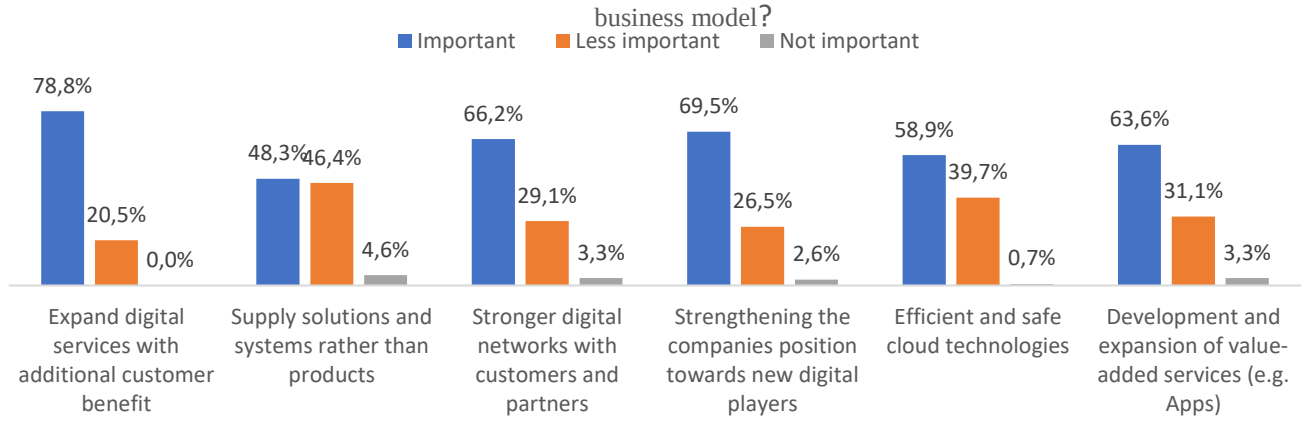
Graph 9: How likely do you think are the following risks associated with the digital revolution?



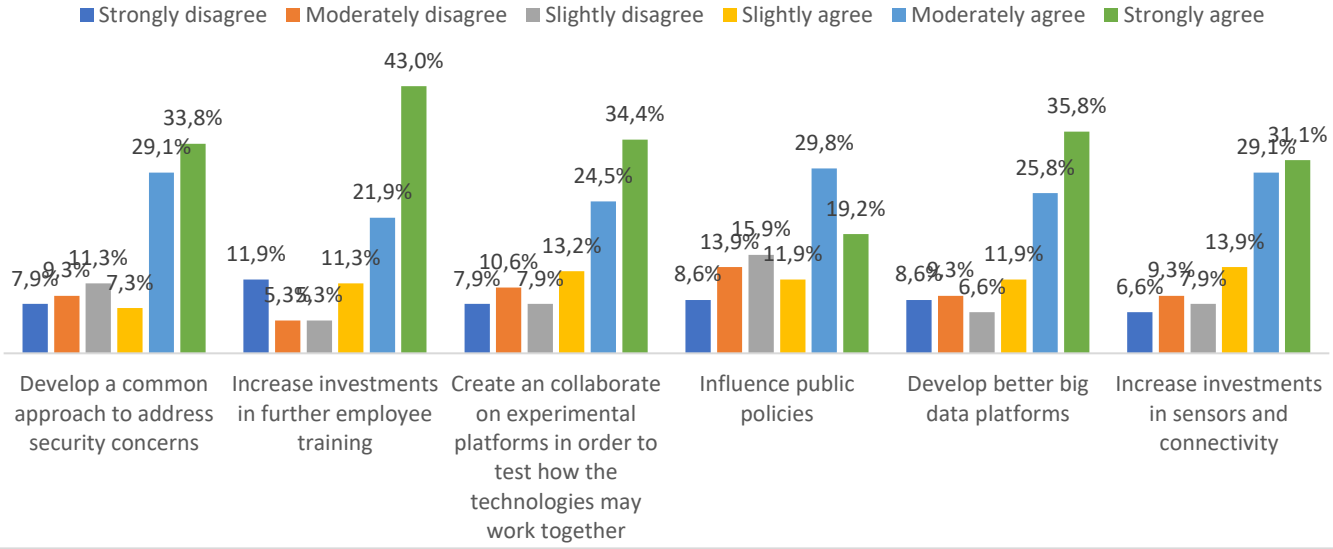
Graph 10: To what extent do you agree with the following statements?



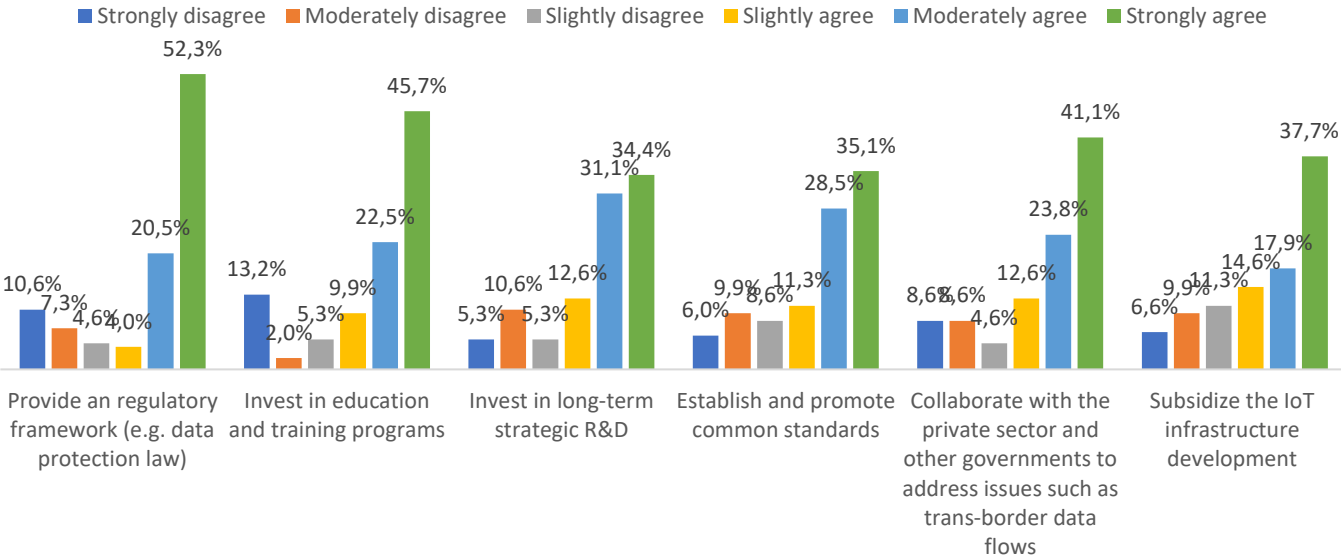
Graph 11: How important are the following aspects of Industry 4.0 for a successful and sustainable business model?



Graph 12: To what extent do you agree/disagree with the actions company stakeholders should take in order to accelerate the adoption of digital technolgy?



Graph 13: How strongly do you agree/disagree with tha actions governments should take to accelerate the adoption of digital technology?



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