What is Industry 4.0 and what are its implications on HRM Practices?

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ABSTRACT

This research paper seeks to find a holistic European definition of Industry 4.0 and wants to investigate the impact Industry 4.0 has on HR practices. To come up with an answer for the first research question a document analysis was conducted with which a matrix consisting of 38 policy documents of 10 different European Industry 4.0 initiatives was established. With this matrix a European Framework of Industry 4.0 was created. In this framework three main components of Industry 4.0 are described namely technical components, social components and production components with each their own components in them like Smart factories, Cyber-Physical systems and Big Data. To investigate the impact Industry 4.0 has on HR practices interviews were conducted with experts to gain their insights into what their view is of what impact Industry 4.0 will have on HR practices. The outcome of these interviews was that mainly direct impacts in the form of using new technologies like Big Data are foreseen for the HR Practices. The findings of this paper are that there is a high level of uncertainty around the topic of Industry 4.0 and that therefore managers need to take a pro-active stance and try to anticipate the changes that are necessary for HR Practices.

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1. Introduction

The fear that people have of technological unemployment is not a recent phenomenon (Frey & Osborne, 2013). Already in 1589 William Lee invented a stocking knitting machine that was a major technological breakthrough, but a patent was not granted by the Queen of England as she feared what this technological breakthrough would do to the jobs of her citizens (Acemoglu & Robinson, 2012). According to Mokyr (1998), technological breakthroughs will likely be stopped through non-market mechanism or political activism (as in the Queen of England´s case) unless everybody want it to take place.

For this reason, it took another several hundred years for the first Industrial Revolution to take place. In this revolution machines powered by water and steam engines were used. Moreover, this revolution mainly meant "deskilling" in the sense that skills of workers were replaced by the simplification of the tasks that had to be performed (Bravermann, 1974, Hounshell, 1985).

The switch from steam and water-powered engines to electricity made the second Industrial Revolution possible in the late nineteenth century. However in this revolution through the introduction of the assembly line with its batch production the demand for unskilled manual workers decreased, but the demand for skilled workers increased. The demand for skilled blue-collar workers to operate the machinery as well as white-collar non production workers to do the managerial tasks grew and their tasks had increased in complexity and number over the last years (Chandler, 1977; Goldin & Katz, 1998). Moreover, because of the improved infrastructure the transport costs for shipping goods declined leading to domestic and international trade (Atack et al., 2008b).

The story of the twentieth century was one of the race between technology and education (Goldin & Katz, 2009). Although the typewriter was invented in the 1860, office workers did not start using it until the early twentieth century (Beniger, 1986; Cortada 2000),which was when the third Industrial Revolution began. This revolution was also known as the Computer Revolution, because of the introduction of the personal computer in the 1960s and the development of the internet and e-commerce (Frey & Osborne, 2013). The cost of information processing was decreased because of these office machines and the demand for educated office workers was increased (Goldin & Katz, 1995).

The fear people have had of losing their employment to a machine during these revolutions was exaggerated. For a long time economists have already recognized that inventions have an effect on all products and factors in a market and not only on the invented product itself. This is the case as the efficiency for one product rises then its price sinks. This in turn increases the real income of the workers and with the extra money they earn, they will increase demand in other goods (Frey & Osbourne, 2013). Based on this one can conclude that the employment did not disappear but was shifted to other products.

This brings us to the present where a fourth Industrial revolution is upcoming. There is a huge fascination for Industry 4.0 as it is the first time in history that a revolution is predicted before it happened instead of described afterward (Drath & Horch, 2014) On top of that Industry 4.0 is expected to have a huge impact on the economy because of expectations of the creation of entirely new business models, products and services and increased efficiency (Kagermann et al., 2013; Kagermann 2014; Lasi et al, 2014).

The fourth revolution is known as Industry 4.0 in most German speaking countries. Different terms for a similar concept can be found in other countries such as Smart Industry in the Netherlands or Industrial Internet in the United States of America (Davis et al., 2012; Dias, 2014; Evans & Annunziata,2012). For this research paper the term Industry 4.0 will be used. But what exactly is Industry 4.0?

With all the interest gained by the topic, a lot of different definitions with each different components included exist, but with these definitions the term Industry 4.0 became more blurred than concrete (Bauernhansl 2014). Practitioners and academics say it signifies the "convergence of industrial production and information and communication technologies […]" (Hermann et al., 2016 p.3928). Kragermann (2015) came up with a definition which says that Industry 4.0 enables a decentralized production process of smart products through the communication between machines, resources and people. Hermann et al. (2016) also include this aspect, but name it Smart Factories. They also go beyond this aspect and include the Internet of Things (IoT) which is the fusion of the virtual and physical world and Cyber-Physical Systems into their definition.

To do research on the topic of Industry 4.0 however, an overall definition is needed, so that all researchers have a clear understanding of what the term means. If everybody has a different definition they work with, it is very hard to compare the results (Hermann et al, 2016). As there is a lack of an overall definition this research aims to create a common understanding of Industry 4.0 within Europe. The first research question will therefore be: **how can Industry 4.0 be characterized and which components does it have?** This research question will be answered through a document analysis with which an European framework for Industry 4.0 will be created.

The impact that Industry 4.0 is predicted to have on both the economy as well as the labor force is huge. Research conducted by the European Union

says that Industry 4.0 will have an influence on employee roles in terms of health, flexibility, demographics, working time and private life (Smit et al., 2016) Frey and Osbourne (2013) predict that within the next two decades 47 percent of the employment in the United States of America is at high risk to be replaced by automation. All these arguments implicate that Industry 4.0 will have an influence on the workforce, but unfortunately, not much has been investigated thus far on this topic. Vacek (2016) said there has been much research done on Industry 4.0 from a technical point of view, but there has been little research done on what it means for the workforce or society as a whole. As many new and different skills will be needed during production and services in Industry 4.0 (Smit et al, 2016), the accompanying practices should also be adapted. New jobs will have to be created which make new job designs necessary that did not exist before and if many tasks now performed by humans will be replaced by robots, how will we give feedback? This is what I want to research in this paper.

Since not all practices can be in the focus of this paper I will focus on the HR practices as described by Bernadin (2010) who defines five major areas: (1) Organizational design, (2) Staffing, (3) Performance Management and Appraisal, (4) Employee Training and Organizational Development and (5) Reward Systems, Benefits, and Compliance. These are the most commonly performed activities by HRM professionals nowadays (Bernadin, 2010). Organizational Design includes job design, job analysis and human resource planning based on the strategy of the company. Staffing entails recruiting, inductions and employee selection. Performance Management and Appraisal contains management appraisal by strategy execution, productivity programs and multirater systems (360°, 180°). Employee Training and Organizational development includes career planning and development, attitude surveys and employee assistance and counseling programs. Last but not least Reward Systems, Benefits and Compliance includes health and medical services, compensation administration and pension/profit-sharing plans (Bernadin, 2010).

Furthermore, there are two ways of how Industry 4.0 may influence HR Practices. This may on the one hand be an indirect influence through the impact it has on the jobs meaning that the HR Practices need to be adopted or changed in order to support the workers in doing their job. On the other hand, the influence may be direct through the use of new and digital technologies. In this research paper I will be focusing on the latter.

During this research paper the focus will be on these five major areas to look at how Industry 4.0 impacts these practices. It is very important the impact for HR Practices is looked at since the changes in Industry 4.0 will be very fast and require managers to be pro-active and thus the practices they use should also pro-actively be changed. For this reason, my second research question will be: **what direct impact will Industry 4.0 have on HR practices?** This research question will be answered by conducting interviews with HR experts to gain their views of what impact Industry 4.0 will have on HR practices.

2. Methodology

To answer the research questions mentioned above, exploratory research in the form of expert interviews with HR experts and a document analysis will be conducted. Dooley (2001) explains that exploratory research in contrast to confirmatory research begins without any hypothesis. In exploratory research hypothesis are created by the data which then afterwards may be tested. On top of this, explorative research seeks to create a theory rather than test it. This fits to our situation very well as there is not much research conducted on the topic of Industry 4.0 and thus no theory is available on the topic.

Furthermore, this research will be qualitative of nature. Qualitative research is social research that is analyzed without statistics like our document analysis and which is based on observations mainly through direct observations and relatively unstructured interviews in natural field settings (Dooley, 2001).

In this research paper I created a framework for Industry 4.0 in Europe to answer the first research question which focuses on the characteristics and components of Industry 4.0. I chose to focus on the EU for three reasons. First, since the goal is to create an holistic overview of the different European initiatives, the European context is chosen. The second reason is that the European union obviously also regards the importance of Industry 4.0. They established a platform to collect the different initiatives across Europe and predict investments of 140 billion Euros in Europe will be necessary to make manufacturing companies ready for Industry 4.0 (Davies, 2015). The third reason why we focus our research on the EU is the commonalities between European countries due to overarching EU laws and regulations on the one hand and the large differences in terms of culture and economy on the other hand. Therefore, it is worthwhile looking whether there are more commonalities or differences between the countries when it comes to Industry 4.0

The research for this paper will be done in two parts. In the first part I, together with two of my fellow students (Krüger, 2018 and Tekelenburg, 2018). I will conduct a document analysis of the various national initiatives of Industry 4.0 in EU countries. We will do so by analyzing policy documents, articles, papers and websites of the various national initiatives of Industry 4.0 in the EU countries. Consultancy papers will be excluded

from the analysis as they mostly give their own or sponsored view of Industry 4.0. However, if the national government or platform uses consultancy papers as the official source of information, they will be included in our analysis. The countries within the EU that we will focus on are Germany, Austria, Italy, Sweden, Portugal, Belgium, Luxembourg, Denmark, Hungary and Lithuania. We will look at the different kinds of initiatives similar to Industry 4.0 in these European countries, like Industria 4.0 in Portugal or MADE (Manufacturing Academy of Denmark) in Denmark. To make the document analysis more concrete and easier to analyze we created a matrix to compare the different policy documents, articles, papers and websites we found. To fill this matrix, we selected and explored the articles on the basis of their relevance for our research. We did this by first scanning all papers and the ones that either included a definition of industry 4.0, components of Industry 4.0 or links to HRM were included into our matrix (see Appendix A) All together we looked at over 100 policy papers, articles and websites etc., however relevant and included in our matrix are only 38 of those since the others did not have a definition of Industry 4.0 and or links with HRM. Moreover, we will compare which implications of Industry 4.0 each article gives for HR practices. Furthermore, we will also make use of the paper by Habraken, M., & Bondarouk T. (2017) who already analyzed smart industry and the implications on HRM in the Netherlands. I will therefore not analyze the Netherlands in my research paper, as it already has been done.

In the second part of the research I, together with my fellow students, will conduct expert interviews with several HR professors and researchers. These interviews are necessary since there is not enough data available that can answer the question of what implications Industry 4.0 will have on the HR Practices. I will therefore rely on the expertise and practical knowledge of the experts to come up with an answer to my second research question. For sample selection we looked at people who had expert knowledge of the field of HRM, however they did not need to be experts in the field of Industry 4.0. We started contacting experts that are all part of the Dutch HRM network which has representatives from ten Dutch and Belgium universities including the university of Amsterdam, Tiburg, Groningen, Twente, Nijmegen, Ghent and Leuven etc. Six of the experts responded to our email and agreed to participate in our research and answer our questions. We chose HR professors and researchers as our interviewees as they know a lot about the field of HRM at the present time and can give us well informed predictions of what will happen to HR practices in Industry 4.0. For the interviews we will use the framework to create a common understanding of what Industry 4.0 entails and what components it has. With this knowledge and understanding I asked the HR professionals for their expert opinion on what the implications of Industry 4.0 are on HR practices.

The interviews, which lasted about one to one and a half hours, were recorded and later transcribed verbatim by us. With these transcribed interviews I analyzed the predictions of the professionals. For this I first read the whole interview again. Reading it a second time I coded it on the basis of the direct impact of Industry 4.0 on each of the above-mentioned HR Practices. The analysis of this can be found further on in part 3.3 expert interviews.

3. Results

With the help of the created matrix, which consisted of different documents and the definitions of Industry 4.0 the different countries gave, the components they present of Industry 4.0 and the implications for HR practices I was able to create a framework of Industry 4.0 in Europe. In this framework both the main characteristics and components found in the analysis can be seen. This framework can be found in Figure 1. During the analysis of the matrix I could conclude some countries in Europe like Germany, Sweden, Belgium and Luxembourg have invested much more money and time in the introduction and evolvement of industry 4.0 than other countries like Italy or Lithuania who seem to be just starting out. Furthermore, it could be seen that definitions and components differed between but also within the countries. This is a sign that all these countries still do not have a clear vision of what Industry 4.0 is. That is why I will analyze their definitions and components they give to come up with a European Framework that brings all the different components of Industry 4.0 together in a structured way.

3.1 Industry 4.0 components

To start I will answer the first research question I posed before: **how can Industry 4.0 be characterized, and which components does it have?** In order to answer this question, I looked at the column in the matrix which included all the different definitions and components the counties had for industry 4.0. With the use of these definitions and components I came up with three main components Industry 4.0 has namely the technical components, social components and the production components. These components can we found in the framework in figure 1.

The first component is the technical component and it is the most important one as the social and production components come forth and use these technical components. The technical part of Industry 4.0 can be used to make work and life itself easier using the components mentioned and connects the physical with the virtual world. The technical component incorporates several items. The first are self-learning machines. This is also

described as Artificial Intelligence (AI) by Denmark. AI or self-learning machines can describe any device that perceives its environment and can mimic the cognitive functions of humans such as problem solving and learning. (Russell, S.J. and Norvig, P. ,2003, 2009). With the use of these machines work will become easier for the humans to the point where they maybe are not even there anymore due to machine to machine cooperation (Federal Ministry for Economic Affairs and Energy, 2017). This may become the case with the help of the second technical component which are robotics. Robotics was mentioned by Lithuania, Belgium and Denmark. Denmark describes these robots as autonomous robots (Danish Institute of Industry 4.0, 2018), but they are also implied to be used during the mechanization, electrification and automation of the industry (Association Industry 4.0 Austria, 2018). The third technical component is Big Data. This component was named but not described by Belgium, Denmark, Lithuania and Luxembourg. Big Data can be seen data sets that are high in volume, velocity and variety. To make sense of all these Big Data sets they will have to be analyzed through a new method called Big Data analytics. (Russom, 2011). The fourth technical component mentioned are cyber-physical systems. Cyber-Physical Systems are systems that have computers and sensors in them that control the physical production. Usually feedback loops are also in place that improved the faults in the system too (Lee, 2008). The fifth and last technical component is the Internet of Things. The Internet of Things allows objects or "things" like sensors, mobile phones etc. to communicate and interact with each other to reach a common target (Guisto et al., 2010). These five technical components form the basis for the social and production components.

The social components of Industry 4.0 focus more on improvement of work quality for the employees. Not all countries specifically mention these components but it can be seen that Sweden and Germany perceive this as an important component. Of all countries Sweden focuses on the employees the most, but Germany also give some attention to this topic. Germany sees that because of the technological developments employees will be able to interact with intelligent production equipment more easily. Through these developments opportunities will appear for the work to be organized differently, for example through more flexible and family-friendly working arrangements and workplaces that are designed to be more health friendly (Federal Ministry for Economic Affairs and Energy, 2018) Sweden on the other hand mentions attractive workplace and innovation environments based on the workplace improvement technologies so that the supply of skills for the industrial sector is ensured (Government Offices of Sweden - Ministry of Enterprise and Innovation ,2016).

The third and last component of Industry 4.0 are the production components. Smart Factories are mentioned a lot in the literature and are described to incorporate the Internet of Things (IoT) and Cyber-Physical Systems (CPS) in itself. Smart factories were mentioned by Austria, Belgium, Denmark, Germany, Hungary, Luxembourg, and Sweden. Belgium described these factories as being equipped with self-learning machines and robotics (Pagegroup, 2018) while Luxembourg sees it as the digital organization and management of processes and data associated with the value chain in the manufacturing sector (Luxembourg Institute of Science and Technology, 2015) The second production component is customized mass production. This means that the production process will be adapted so that it can more easily apply to the individual wishes of the customers. Here Luxembourg and Hungary describe a growing demand for more individualized products that is going to appear (Luxinnovation Union des Entreprises Luxembourgeoises, 2018, MTA SZTAKI, 2018) where Denmark mentions a fast-developed customer specific mass production (Manufacturing Academy of Denmark, 2018). The Netherlands, which is not analyzed in our matrix since it was already analyzed for Industry 4.0 before mentions a similar concept namely the (fine)tuning to customer needs. (Habraken,& Bondarouk,, 2017) The third production component that I found was the digitalization and integration of the entire value chain. This component is the most mentioned component since it was named by Austria, Denmark, Germany, Portugal and Sweden. With the integration of the entire value chain they mean both the upstream and downstream integration such as suppliers and logistics company as well as internal corporate processes such as procurement, production, sales and maintenance (Association Industry 4.0 Austria, 2018). What these countries mean with digitalization of the value chain is a bit more vague with them saying that more IT will be involved, and that communication will be seamless and wireless (Federal Ministry for Economic Affairs and Energy, 2018).

Having named and described all the technical, social and production components found for Industry 4.0 the following definition can be created:

Industry 4.0 is the production of goods and services with the help of technical components such as Big Data, Cyber-physical systems and the Internet of Things, social components like attractive workplace conditions and production components as smart factories to increase the competitiveness of a country.

3.2 Industry 4.0 and HR Practices

After answering my first research question in the section before, I now want to focus on my second research question which was: **what direct impact**

will Industry 4.0 have on HR practices? In order to answer this question, I will take a look at the column of the matrix that included implications for HR Practices.

First of all it can be said that not many countries had a detailed view about what implications Industry 4.0 would have on HR Practices. Most countries were very general in their implications with Germany, Denmark, Portugal and others saying that education and training is very important so that they will have skilled workers in the future (Federal Ministry for Economic Affairs and Energy, 2018). Austria and Germany said that employees will have to have a range of qualifications and competence requirements in future (Association Industry 4.0 Austria, 2018) and that workers will have to have new and more interdisciplinary knowledge and skills (Lassnig et al., 2016). I expect that these trainings and education may also be given with the help of the internet for example in the form of video training, virtual reality or robots. Some countries also mentioned that there will be an increase in the will of employees to work abroad (Pagegroup, 2018) and thus companies will have to focus on creating jobs in the country they come from for a fair wage (Sirris & Agoria, 2016). Here we need to consider job design and compensation by the EU countries so that it will be attractive for workers to stay and work in their home country.

However, this outcome is not enough to come up with an informed answer to the research question. This is why I decided to do interviews with experts in the field of HRM to gain their knowledge and views on what they think the implication of Industry 4.0 on HR Practices will be.

3.3 Expert interviews

Between the 4th and the 12th of June I, together with my fellow students, conducted our interviews in the Netherlands and Belgium. For these interviews we travelled to these experts and had a face–to-face interview with them. In these interviews they answered question I prepared beforehand which can be found in Appendix B, but I also asked follow-up questions if necessary.

To begin with it can be mentioned that all experts had different views on whether and in what way Industry 4.0 as presented and explained by us would be adopted by the Industry. Some saw it as something in the future while others saw that Industry 4.0 was already here.

"It´s coming. It´s evitable." (respondent 2)

"It is already influencing, so it is not like the future, it is already happening." (respondent 5)

Furthermore, they had different opinions about the extent to which Industry 4.0 would be adopted. Several reasons that hindered the adoption were named such as organizational choice, customer and managerial choice.

"organizations can choose whether or not to use the technologies, whether or not to implement the technologies." (respondent 2)

"So, the managerial choice as it is called in literature is also important. So, you have the choice in automation and those choices have impact on what kind of type of work are substituted or which new tasks are coming." (respondent 1)

"Of course, it also asks for certain customers. Do I want to be divorced by a robot?" (respondent 5)

Having explained the different views the respondents had, I will now analyze the differences and similarities in their answers about the impact of Industry 4.0 on HR Practices. During the interviews I focused on the practices mentioned in the introduction which were organizational design, staffing, performance management and appraisal, employee training and organizational development and reward management.

Organizational design includes job design, job analysis and human resource planning based on the strategy of the company. In this area changes in the way work is being organized were foreseen. With the fast changing environment of Industry 4.0 skills and knowledge of workers may become irrelevant and this means that job design must keep adapting so that it incorporates the right skills of workers.

"because of these technological innovations it will also come to a change in how to organize work and that will have consequences for the competences we ask from employees." (respondent 4)

"some of the experience you have from the past is not relevant anymore" (respondent 3)

Staffing entails recruiting, inductions and employee selection. For both recruitment and selection changes were foreseen. The experts said that whole process of recruitment will be digitalized for the sake of finding the best people for the job and the organization. However, this is nothing new since recruitment has been digitalized for a great part already. For selection the experts saw that it would become more critical and also more expensive since there are less people in the workforce and thus it will be harder to find the right person for the job. However, it is not sure how many of these changes are caused by Industry 4.0 and how many by the demographics we have nowadays. Moreover, they also saw that resumes will be selected by artificial intelligence in the future thus making it fully automated.

"And so for recruitment and selection you need to adjust your recruitment and selection tools in order to find the right people for the job you have in the organization" (respondent 2).

"the whole process of recruitment will be digitalized." (respondent 4)

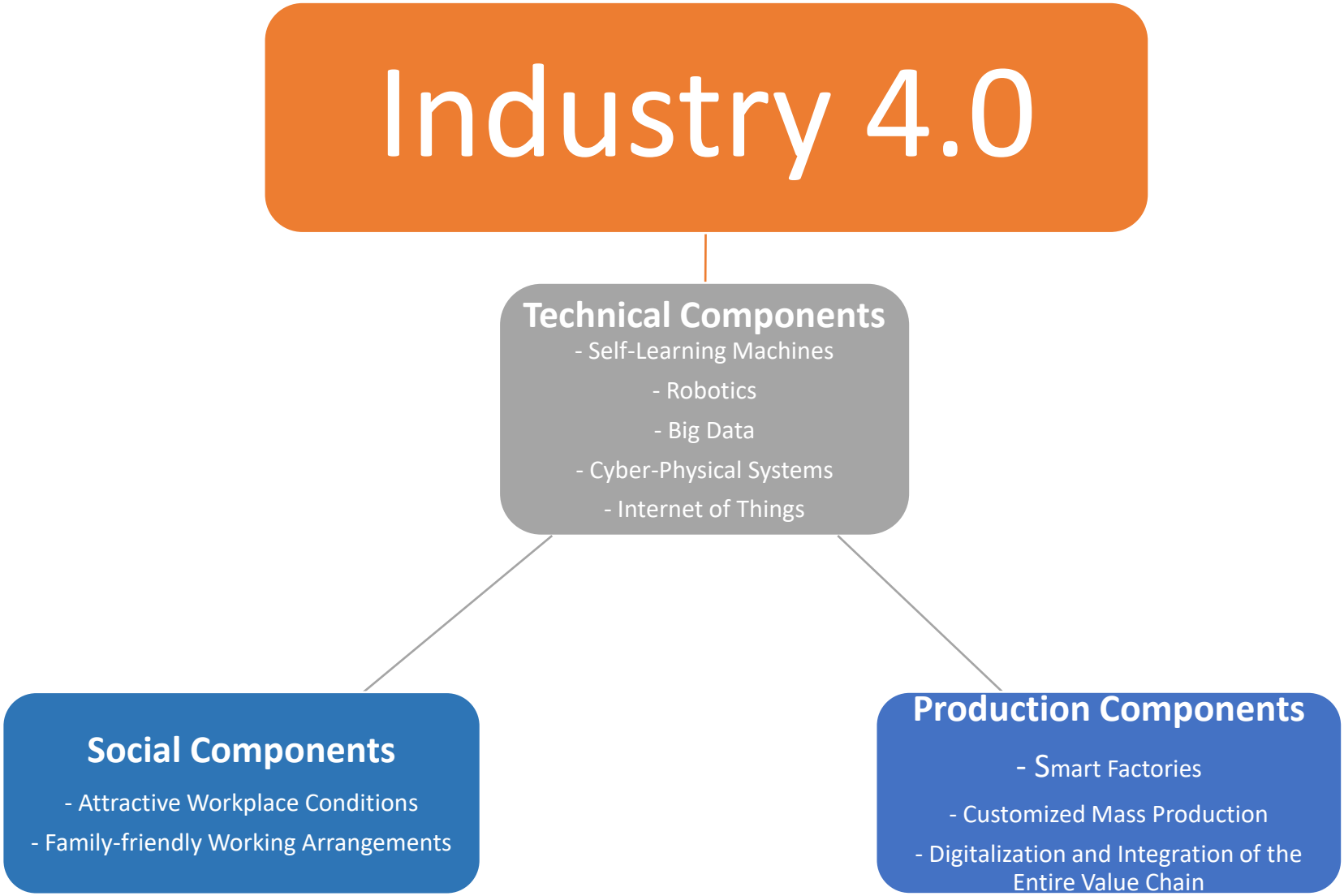

Figure 1 Industry 4.0 Components

"so selection becomes more critical and also more expensive" (respondent 1)

"Selection of available resumes online for example. You can easily go through robotization, artificial intelligence if you like." (respondent 5)

Performance management and appraisal contains management appraisal by strategy execution, productivity programs and multi-rater systems. Almost none of the respondents mentioned changes in the way performance management would be done. It is predicted that performance management will become very data driven, analyzing data via biomedical data through smart watches and technical data received through machines.

"because you have big data, you have much more qualified information about performance of people but also about the social network of people. And I guess more and more it will be used for data driven HR decision making." (Respondent 5)

Employee training and organizational development includes career planning and development, attitude surveys and employee assistance and counselling programs. About this topic all respondents had a view for the future. For education they saw that there will be differences between what students are taught at university and in school and what knowledge and skills companies expect them to have. With the fast changes happening in Industry 4.0 these differences will become bigger very fast which is way training and development is predicted to become more important and influential.

"On the other hand, we have our educational system which is not changing with such as fast slope as the technical innovation. So, I guess that at one point there will be some sort of mismatch between what organizations are looking for and what the educational system teaches them" (respondent 4).

"Who is responsible for the level of knowledge and skills for young people who leave schools or universities What do they need to know? If schools are responsible with the fast changes that we see now, it´s hardly impossible to develop a curriculum that is that flexible that you can change it every time, so that the students get a proper education." (respondent 2)

"If you don't know what skills are needed in order to get there, let alone that we can start organizing training programs in order to train them because we don't know what to train." (respondent 3)

"We know the best thing to do is to train these people on the job." (respondent 6)

"So I will have to design the work so that you get trained while doing it." (respondent 6)

" So the work of the higher educated evolves very quickly and you have to stay in front, you have to continuously learn." (respondent 1)

Reward management includes health and medical services, compensation administration and pension/profit sharing plans. This topic was not really mentioned by the experts. Only one expert mentioned the moved towards more individualized rewards and the use of cafeteria points, but this is not a new concept.

"Employees can make choices in terms of what they want. If they want a particular amount of money or if they want to have holidays or a car." (respondent 4)

When asked whether they saw any new HR practices to be established they all mentioned Big Data being used in the new practice. Along with that they also mentioned that people should learn how to analyze this Big Data.

"You have this Big Data, big HR Data, is also an area that is developing in large organizations. They use all kinds of HR data to finetune or develop HR Practices." (respondent 2)

"what they should learn is data analysis. And they should learn it a bit fast. Being able to make sense of a lot of data" (respondent 6)

All in all, they all mentioned different views, that sometimes overlapped but also sometimes contradicted and gave me good overview of what they thought would happen to the HR Practices.

To answer the second research question which was: **what impact will industry 4.0 have on HR Practices** it can be said that this overall depends on choice to what extent to adopt it. Assuming it will be adopted the documents and experts foresaw the biggest impacts for the practices of staffing, including recruitment and selection, and for education and training. In addition, it can be said that the Big Data component of Industry 4.0 is also expected to have an impact on HR Practices in the form of Big Data analysis.

4. Discussion

4.1 Theoretical implications of the Industry 4.0 framework

In this section I will look at the predictions the documents gave and the predictions that the experts gave and compare them. As said before in the documents not many countries have a detailed view of what implications Industry 4.0 will have on HR Practices. The documents saw education and training being very important to have skilled workers in the future. We found that education and training is the most important for the same reason but also mentioned that we think there will a mismatch between the education system and the skills required by organizations as the education cannot keep up with the fast changes. Other than this practice and the focus on creating job at home, the documents mentioned no implications. This is where the experts had a much broader view of what might happen to the other practices.

4.2 Theoretical implications for HR Practices

HR Practices	Changes due to Industry 4.0
Organizational design	skills and knowledge of workers may become irrelevant and this means that job design must keep adapting so that it incorporates the right skills of workers i.e. more technical skills as required for the machines they control or create.
Staffing	More technical tools will be used in recruitment and selection like for example artificial intelligence to select applications, some also expect full automation of selection.
Performance management	More use of Big Data to assess people´s performance for example with biomedical data or from the machines they control. This requires managers to have knowledge of HR analytics.
Training and education	Mismatch of education and job requirements leads to the necessity of more training on the job to gain the right knowledge for the function.
Reward management	More flexibilization and individualization of rewards through for example cafeteria points

Figure 2 Implications of Industry 4.0 on HR Practices

In the table above a short summary of the main implications of Industry 4.0 on each HR Practice can be found. It can be noticed that all implications are direct implications of Industry 4.0. For organizational design it can be said that the main findings of the experts are very general and does not explicitly say which actions will have to be taken. I expect that in the future work will have to be created around the new technologies that are employed in the organization and that thus more technical skills will be required of the employees For staffing it can be seen that the direct implications of Industry 4.0 are predicted such as more use of technical tools like selecting applications with artificial intelligence. However, it can be said that the process of using more technical tools has already been going on for some years for example through online selection of applications in the first rounds of selection or interviews via skype etc., and thus is not new. For Performance management one of the technical components of Industry 4.0 mentioned in the framework above, namely Big Data, is seen to become important. This very probable to become true as more and more data is gathered in companies today, both biomedical and technical data. However, for this to be successful managers must know how to analyze and make sense of all this data. For training and education, a mismatch of education and job requirements is predicted. If this has to be overcome schools and universities will have to work together to align their expectations and duties to create a skilled workforce. For reward management more flexibilization and the cafeteria points systems was envisioned to become more important, but this has already been established for quite some time.

4.3 Practical implications

In this section I will discuss what these implications for HR Practices mean in practice. For one it can be said that the changes mentioned before are happening in a very fast pace which means that managers and employees will need to take a pro-active stance during these changes and anticipate what knowledge and skills are going to be needed from them in the future. With this stance they need to look at the practice they use or design and incorporate these changes into the practices. As mentioned before decisions made by management will become much more data-driven so managers also need to learn how to analyze and make sense of all these different sources of data.

5. Limitations and future research

Naturally, there were also some limitations to this research. The first limitation this research had was that it only focused on the European Union and here also only ten countries within the European Union were looked at. The second limitation is that other factors that might influence the HR Practices were given no attention. Examples of these factors may be changing demographics and changing labor markets. Changing demographics entail that there are increasingly more older people and less children born. Because of this a lot of labor shortages will appear on the labor market, mainly in the care taking industry. The second factor is that there is and increasingly changing labor market. This change comes from the flexibilization of work so that there are more flex workers and freelancers. Moreover, there is a migration crisis

going on in Europe at the moment because of the refugees from the middle east. They form a huge potential workforce but have to be educated and trained before they can become active in the labor market.

For future research I would recommend looking at a similar trend as Industry 4.0 in either South-East Asia or in North-America using the same kind of methodology as used in this research paper.

6. Conclusion

This research paper sought to answer two research questions. The first was **how can Industry 4.0 be characterized, and which components does it have?** which can be answered by the following definition: *Industry 4.0 is the production of goods and services with the help of technical components such as Big Data, Cyber-physical systems and the Internet of Things, social components like attractive workplace conditions and production components as smart factories to increase the competitiveness of a country.* The second research question was **what direct impact will Industry 4.0 have on HR Practices?** and can be answered by saying said that this overall depends on choice to what extent to adopt it. Assuming it will be adopted the documents and experts foresaw the biggest impacts for the practices of staffing, including recruitment and selection, and for education and training. In addition, it can be said that the Big Data component of Industry 4.0 is also expected to have an impact on HR Practices in the form of Big Data analysis.

7. Acknowledgement

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8. Appendix A

The Matrix

Number	Country	Article	Definition of Industry 4.0	Sources of Infomation/Definitions	Components of I4.0	Implications for HRM Practices
1	Austria	Association Industry 4.0 Austria (n.d.), *What is Industry 4.0?*. Retrieved on 16.05.2018, from: http://plattformindustrie40.at/was-ist-industrie-4-0/?lang=en	Industry 4.0 is defined as the digitalization and integration of the entire value chain and follows the mechanization, electrification and automation as the fourth industrial revolution. the change is taking place at all stages of the production process (value chain). Industry 4.0 refers to both upstream and downstream integration such as suppliers or logistics company as well as internal corporate processes such as procurement, production, sales and maintenance. Therefore, Industry 4.0 leads to higher productivity and flexibility, more innovation and resource preservation	Association Industry 4.0 Austria - the Platform for Smart Production	- Smart factories - Improving the organization and control of production processes - Deeper integration of upstream and downstream activities (internal and external) - Increasingly multidisciplinary and overall acceleration of research and development	- Change of qualification and competence requirements of employees - Increased importance of education and training
2	Austria	Lassnig et al. (2016) *Industrie 4.0 in Österreich. Kenntnisstand und Einstellung zur digitalen Transformation durch Industrie 4.0 und neue Geschäftsmodelle in österreichischer Unternehmen In: Report from the Bundesministerium für Verkehr, Innovation and Technologie.* Retrieved on the 12.05.2018, from: http://plattformindustrie40.at/wp-content/uploads/2016/03/I40-	Industry 4.0 is not a revolution in the perception of Austrian companies, but an Evolution - but with far-reaching effects on competitiveness. The assessment as pure evolution, however, is also a greatly shortened view and carries the risk, not in the (future) innovation leaders in digitization.	Federal Ministry of Transport, Innovation and Technology	- transformations are advances in sensor technology and in information and communication technology 1) Cyber-physical systems (CPS) 2) Internet of Things , Industrial Internet	- workers have to have new and more interdisciplinary knowledge and skills
3	Belgium	Sirris & Agoria (2018), *Made Different - Enabling Factories of the Future.* Retrieved on 10.05.2018, from: http://www.madedifferent.be/en		Association 'Made Different Belgium'	7 transformations: 1. World Class Manaufacturing Technologies 2. End-to-end Engineering 3. Digital Factory 4. Human Centered Production 5. Production Network 6. Eco Production	
4	Belgium	Pagegroup (10.01.2018), *Industry 4.0 will make Belgium an attractive destination for engineers* Retrieved on 16.05.2018, from:	Smart Factory = equipped with self-learning machines and robotics, all of which requires different ways of working	Consulting company with relationship to European Union	IoT, Manufacturing execution systems (MES), Self-learning machines	High demand for candidates with knowledge about MES software

Number	Country	Article	Definition of Industry 4.0	Sources of Infomation/Definitions	Components of I4.0	Implications for HRM Practices
5	Belgium	Sirris & Agoria (24.02.2016), *What is Factory of the Future 4.0?* Retrieved on 10.05.2018, from: http://www.madedifferent.be/en/what-factory-future-40		Association 'Made Different Belgium'	-digitised production processes 2 main areas 1. Technological Innovation 2. Social Innovation	
6	Belgium	Sirris & Agoria (24.02.2016), *About Made Different* Retrieved on 10.05.2018, from: http://www.madedifferent.be/en/about-made-different	The possibility to stop jobs from moving abroad and to produce mass customized products on a social- and environmental friendly basis. Smart factories are having the potential of outperforming new competitors by entering new markets with new technologies , while at the same time meeting new social standards	Association 'Made Different Belgium'	- mass customization - environmently friendly technologies	Focus on creating jobs in home countries for a fair price
7	Belgium	Sirris (n.d.), *IBN Digitising Manufacturing* Retrieved on 20.05.2018, from: https://www.sirris.be/nl/ibn-digitising-manufacturing	The digitalization of production processes, and introduction of new competition based new technologies	Member of the Belgian Research Platfrom	6 Main topics 1. managing increased complexity 2. enabling fast response 3. supporting operators in their tasks 4. enabling first time right production 5. making the shop floor transparent 6. creating a manufacturing network	
8	Belgium	Sirris (n.d.), *Digital Journes Tracker* Retrieved on 20.05.2018, from: https://www.sirris.be/nl/digitaljourneytracker	Digitalization of 1. Physical products 2. Digital Products 3. Services	Member of the Belgian Research Platfrom	Digitalization of 1. Physical products 2. Digital Products 3. Services	
9	Belgium	EWI Vlaanderen (02/2017), *Startnota - Transitie - 'De sprong maken naar industrie 4.0'* Retrieved on 20.05.2018, from: https://ewi-vlaanderen.be/sites/default/files/bestanden/startnota_sprong_maken.pdf	Industry 4.0 is a nexus for new technologies and concepts within the economy. It especially includes the digitalization of the industry which is taking place right now	Paper of Research Institution	- Factories of the future - transition from product to service companies - mass customization - hypercompetition - Fast internet access	focus on decreasing costs high probability of changing business models

Number	Country	Article	Definition of Industry 4.0	Sources of Infomation/Definitions	Components of I4.0	Implications for HRM Practices
10	Belgium	Belgiian Government (06/2017), Digital Belgium Retrieved on 20.05.2018, from: http://digitalbelgium.be/wp-content/uploads/2017/07/compressed_Brochure_DB_FINAL.pdf		Governmental research association	- Fast internet access - Better informed customers with possibility to easily switch - New Digitial Job Boom - Open Data & Data Management - Safe & Privacy friendly online environment - Cyber Security 5 "priorities" - Digital Economy - Digital Infrastructure - Digital Skills and Jobs - Digital Government	
11	Belgium	Walloon Government (n.d.), Digital Wallonia - We are transforming Wallonia Retrieved on 20.05.2018, from: https://www.digitalwallonia.be/en		EU financed research based on the 'Made Different' association	5 major topics of strategy - Digital Sector - Digital Economy - Skills&Jobs - Open public Services - Smart&Connected territory	
12	Belgium	Deliége (16/01/2017), *Made Different Digital Wallonia. Moving towards the industry of the future* Retrieved on 21.05.2018, from: https://www.digitalwallonia.be/en/posts/made-different-digital-wallonia	Smart processs creating smart products within smart business models, influencing the professions of the future and humans at the heart of the company, challenging and depending on business	EU financed research based on the 'Made Different' association	- Internet of Things - Artificial intelligence - Big Data - The Cloud - Product personalisation	
13	Belgium	Butera (04/05/2018), *Digital Wallonia @ DES 2018* Retrieved on 21.05.2018, from: https://www.digitalwallonia.be/en/posts/digital-wallonia-des-2018		EU financed research based on the 'Made Different' association	- Cloud Computing - Security - IoT - ERP/CRM - Digital Marketing - Big Data & Analytics - Block Chain - Artifical Intelligence	

Number	Country	Article	Definition of Industry 4.0	Sources of Infomation/Definitions	Components of I4.0	Implications for HRM Practices
14	Denmark	Manufacturing Academy of Denmark (n.d.), *MADE SPIR* Retrieved on 16.05.2018, from: http://en.made.dk/spir/	Fast developped customer specific mass production	Own source	high speed product development, modular production platforms, 3d print and new production processes, model based supply chain development, digitalisation of supply chains, lifelong product customization, "new" manufacturing paradigm, hyper flexible automation, sensors and quality	
15	Denmark	Danish Institute of Industry 4.0 (n.d.), Industry 4.0 Retrieved on 03.05.2018, from: https://www.dii4.dk	An increasingly digitisation and interconnection of value chains and business models. Industry 4.0 creates Smart Factories and is based upon cyber-physical systems allowing the manufacturer to control the entire production from one platform.	Website	3 fundamental enablers: costs, technological sophistication and the internet. more specific:autonomous robots, simulation, additive manufacturing, augmented reality, horizontal and vertical integration, internet of things, cyber security, the cloud, big data and analytics, computational power, AI and machine learning, mobile devices, scanning technology, camera technology, software	shift in workforce from production,assembling, handling, processing, fabricating etc. to IT, data science, engineering.
16	Denmark	Rajkumar, Madsen & Skov (2017), *Industry 4.0 in Danish Industry* Retrieved on 22-05.2018, from: http://www.efnms.eu/wp-content/uploads/2017/06/Stentoft-Rajkumar-Madsen-2017-Industry_4_0_in_Danish_Industry.pdf	a construct of materials and manufacturing smart technologies, connectivity smart technologies and data handling and big data	Own source	materilals and manufacturing smart technologies consists of: 3d printing, 3d scanning, robotics, iBin, advanced materials and augmented reality and simulation. connectivity smart technologies consists of: mobile internet, advanced sensors, remote control and enterprise resource planning, data handling and big data	(s

Number	Country	Article	Definition of Industry 4.0	Sources of Infomation/Definitions	Components of I4.0	Implications for HRM Practices
17	Germany	Federal Ministry for Economic Affairs and Energy (n.d.), *What is Industrie 4.0?* Retrieved on 12.05.2018, from: https://www.plattform-i40.de/I40/Navigation/EN/Industrie40/WhatIsIndustrie40/what-is-industrie40.html;jsessionid=F782F8ED43F6B87E00A7BE0D0268DC6E	Industrie 4.0 combines production methods with state-of-the-art information and communication technology. The driving force behind this development is the rapidly increasing digitisation of the economy and society. It is changing the future of manufacturing and work in Germany: In the tradition of the steam engine, the production line, electronics and IT, smart factories are now determining the fourth industrial revolution.	German governmental site for Industry 4.0	- smart factories --> digitalised industrial process, new security concepts, norms and standards: a common language for Industry 4.0 technologies, legal framework: between data protection and supporting innovation, research and innovation: exchanging knowledge for the products of tommorrow	
18	Germany	Adamczyk et al. (2016), *Industrie 4.0 security in vocational and advanced training. New issues for business organisation and expertise*. Retrieved on the 13.05.2018, from:		"Security of networked systems" Platform Industrie 4.0 working group.	- mastering security know-how in accordance with target group requirements and roles - security/trust	Digital transformation, new business models and Industrie 4.0 require new ways of thinking, of working, of cooperating and ultimately of
19	Germany	Federal Ministry of Economic Affairs and Energy (n.d.) *German industry launches standardization initiative for Industrie 4.0:Standardization Council I4.0" founded by Federal Ministry of Economic Affairs and Energy.* Retrieved on the 13.05.2018, from:	The comprehensive networking of technical systems and processes taking place with the digitalization of industry and infrastructure is leading to an increasing merger of the physical and virtual worlds	Federal ministry of Economic Affairs and Energy	1) Internet of Things and Services 2) Standardization	- More standardized practices
20	Germany	Federal Ministry for Economic Affairs and Energy (06/2017), *Industrie 4.0 Plug-and-Produce for Adaptable Factories: Example Use Case Definition, Models, and Implementation* Retrieved on 16.05.2018, from: https://www.plattform-i40.de/I40/Redaktion/EN/Downloads/Publikation/Industrie-40-			order controlled production, adaptable factories, self-organizing adaptive logistics, value based services, transparency and adaptibility ofdeliver products, operator support in production, smart product	

Number	Country	Article	Definition of Industry 4.0	Sources of Infomation/Definitions	Components of I4.0	Implications for HRM Practices
21	Germany	Federal Ministry for Economic Affairs and Energy (n.d.), *Work 4.0 - How will digitised industrial processes affect work? by platform Industrie 4.0* Retrieved on 16.05.2018, from: https://www.plattform-i40.de/I40/Redaktion/EN/Standardartikel/areas-of-action-work.html	The fundamental change will occur in the way these products and services are manufactured and delivered in the future. In the future, communication in factories will often be seamless and wireless, enabling employees to interact more efficiently with intelligent production equipment. This development will open up opportunities for work to be organised differently, for example with workplaces that are designed to be health-friendly, and more flexible and family-friendly working arrangements	Federal ministry of Economic Affairs and Energy		-At the same time it is important to test standards, e.g. in education and training, and to adapt them to new requirements. -The flexible manufacturing that Industrie 4.0 enables will require employees to have a much broader range of skills in upstream and downstream processes. Skilled employees will be in greater demand in the future to make the decisions that no algorithm ever could. At the same time, employees must be trained and qualified for new roles. - new skills are needed
22	Germany	Federal Ministry for Economic Affairs and Energy (06/2017), *Relationships between I4.0 Components – Composite Components and Smart Production* Retrieved on 16.05.2018, from: https://www.plattform-i40.de/I40/Redaktion/EN/Downloads/Publikation/hm-2018-	machine to machine cooperation(instead of human to human-human to machine)	own source		
23	Hungary	MTA SZTAKI (n.d.), *The Industry 4.0 National Technological Platform Association (I4.0 NTP)* Retrieved on 16.05.2018, from: https://www.i40platform.hu/en/about_us	integration of the physical and virtual worlds, and represents a new level of organising and controlling the entire value chain across product lifecycles. This cycle focusses on increasingly personalised customer wishes and extends from the concept to the order, development, production, and shipping of a product to the end customer and ultimately to its recycling, including all associated services	- https://www.i40platform.hu/sites/default/files/2017-08/Industrie%204.0_Definition_0.pdf	horizontal integration, vertical integration, smart products, humans as drivers of added value.	
24	Hungary	European Commision (12/2017), Digital Transformation MonitorHungary:"IPAR 4.0 National Technology Platform" Retrieved on 16.05.2018, from: https://ec.europa.eu/growth/tools-databases/dem/monitor/sites/default/files/DTM_IPAR_HU_v4.pdf			1. StrategicPlanning 2. Employment,Education and Training 3. ProductionandLogistics 4. ICTTechnologies 5. Industry4.0Cyber-PhysicalPilot Systems 6. InnovationandBusinessModel	

Number	Country	Article	Definition of Industry 4.0	Sources of Infomation/Definitions	Components of I4.0	Implications for HRM Practices
25	Italy	Ministero dell'Economia e delle Finanze (n.d.), *Italy's national plan Impresa 4.0 - Resutls from 2017-Actions for 2018* Retrieved on 16.05.2018, from: http://www.sviluppoeconomico.gov.it/images/stories/documenti/impresa_40_risultati_2017_azioni%202018_rev_eng.pdf		Own source: Ministry of Finance, economy of Italy	Impresa 4.0 objectives 2017-2020: innovative investments, skills, enabling infrastructures, other support measures	Challenges of Industry 4.0 «The 10 professions in highest demand on the market did not exist 10 years ago» «Employment will increase in the very countries that have invested in digital skills, and will reduce in those where such skills were not adequately acquired by the labour force»Investments in human capital Schools, Universities and Research Innovate study curricula to train student on new digital skills and Industry 4.0 Labour: manage the risk of technological unemployment and maximise new employment opportunities spurred by the 4 th Industrial Revolution, developing new digital skills Investments in human capital *Schools, Universities and Research* Innovate study curricula to train student on new digital skills and Industry 4.0 *Labour:* manage the risk of technological unemployment and maximise new employment opportunities spurred by the
26	Lithuania	Silkroad 4.0 (2017), *Lithuania* Retrieved on 16.05.2018, from: https://www.silkroad40.com/lithuania/	repatriation of production from east asian countries to Europe and the establishment of a digital innovation hub	Own source	Big Data, Cloud computing, IoT, Robotics, Autonomous systems	
27	Luxembourg	Luxinnovation Union des Entreprises Luxembourgeoises (UEL) (06.11.2017), *Luxembourg gets serious about Industry 4.0* Retrieved on 12.05.2018, from: https://www.luxinnovation.lu/news/luxembourg-gets-serious-about-industry-4-0/	Industry 4.0 is considered one of the key technologies necessary to secure the future competitiveness of industrial companies in the western world. If you were to ask what the ultimate vision of Industry 4.0 is, I would say that it would be to produce high-added value products at the cost of the mass production	National Agency for Innovation and Research, and the Ministry of the Economy	Mass customization	new decision support tools and services to significantly increase Overall Equipment Effectiveness
					Role of Business in Smart	

Number	Country	Article	Definition of Industry 4.0	Sources of Infomation/Definitions	Components of I4.0	Implications for HRM Practices
28	Luxembourg	Luxembourg Institute of Science & Technology - LIST (2015), *Smart Manufacturing - Carrying out the industrial revolution.* Retrieved on 10.052018, from: https://www.list.lu/en/cooperations/innovation-programmes/smart-manufacturing/	Smart manufacturing = the digital organisation and management of processes and data associated with the value chain in the manufacturing sector	Research Institution serving the national and European economy and society	Role of Business in Smart manufacturing = remain innovative in an increasingly competitive economic environment, increase their productivity while reducing the costs, provide highly customized products, and have ever shorter time-to-market and delivery times. In order to develop new products and associated services, manufacturing companies need to understand new business models, reduce their impact on the environment and natural resources, integrate digital technologies to enhance yield and manufacturing processes, and, of course, comply with increasingly	
29	Luxembourg	Luxinnovation Union des Entreprises Luxembourgeoises (UEL) (n.d.), *Industry 4.0* Retrieved on 10.05.2018, from: https://www.fedil.lu/en/topics/industry-4-0/		National Agency for Innovation and Research, and the Ministry of the Economy	1. Big Data 2. Internet of Things (IoT) 3. Cloud	Hire people with the knowledge of Data management and that are capable of inventing new technology
30	Luxembourg	Luxinnovation Union des Entreprises Luxembourgeoises (UEL) (n.d.), *Visit of the smartfactory in Kaiserslautern* Retrieved on 10.05.2018, from: https://www.fedil.lu/en/events/visit-of-the-smartfactory-in-kaiserslautern/	No clear definition given but, description of economy of the 21st century is characterized as: "global competition, ever shorter innovation and product life cycles, as well as a growing demand for individualized products"	National Agency for Innovation and Research, and the Ministry of the Economy	Less components than more effects of the new industry: - global competition - indiivudalized products - shorter product life cycles Components 1. Modern communication technology 2. Wireless Sensors 3. Semantic product memories 4. mobile interaction 5. Internet of Things	

Number	Country	Article	Definition of Industry 4.0	Sources of Infomation/Definitions	Components of I4.0	Implications for HRM Practices
31	Luxembourg	Larosse (10.10.2017), Analysis of national initiatives on digitising european industry - *Luxembourg: Digital4Industry.* Retrieved on 12.05.2018, from:		Country analysis on behalve of European Union		Problematic of political, regulation and law changes
32	Luxembourg	European Comission (2016) -*Digital Scoreboard 2016 and other information relevant for decisions about Digital Innovation Hubs - Luxembourg* Retrieved on 12.05.2018, from: https://ec.europa.eu/futurium/en/system/files/ged/luxembourg_211117.pdf		Information document from European Union based on: https://cohesiondata.ec.europa.eu/countries/LU and https://ec.europa.eu/futurium/en/content/report-wg1-digital-innovation-hubs-mainstreaming-digital-innovation-across-all-sectors-final	Not real components but areas Industry 4.0 has an impact on: 1. Connectivity 2. Human Capital 3. Use of Internet 4. Integration of Digital Technology 5. Digital Public Services	Not only taking own employees into account when planning introduction of industry 4.0 but also the whole society/customerss
33	Luxembourg	Luxinnovation Union des Entreprises Luxembourgeoises (UEL) (12.05.2016), *Industry 4.0 Platform Luxembourg*				See column 'Important remarks'
34	Portugal	Republica Portugesa & Cotec Portugal (n.d.) *i4.0- Industria 4.0 - About.* Retrieved on 10.05.2018, from: https://www.industria4-0.cotec.pt/en/about/		Website of the Protugese Government and other govenrmental institutions		

35	Portugal	European Commission (05/2017), *Digital Transformation Monitor - Country:Portugal"Industria 4.0".* Retrieved on 10.05.2018, from: https://ec.europa.eu/growth/tools-databases/dem/monitor/sites/default/files/DTM_Ind%C3%BAstria%204.pdf	Industria 4.0 = a strategy to develop industry in the digital area and to identify the real needs of the Portugese industry	Website of the Protugese Government and other govenrmental institutions	3 axes: Digitalisation Innovation Training 6 pillars: human qualification, technological cooperation, start-up i4.0, financing and investment incentives, internationalisation and standards and regulation.	Need for special training and educational systems
36	Sweden	Government Offices of Sweden - Ministry of Enterprise and Innovation (2016), *Smart Industry - a strategy for new industrialisation for Sweden.* Retrieved on 10.05.2018, from: http://www.government.se/498615/contentassets/3be3b6421c034b038dae4a7ad75f2f54/nist_statsformat_160420_eng_webb.pdf	Smart Industry is defined as innovative and sustainable industrial production that is digitally connected, flexible, resource-efficient, environmentally friendly and provides the conditions for an attractive workplace	Swedish government site for Industry 4.0	4 Focus areas of Smart Industry: Industry 4.0 – Exploit the potential of digitalisation • Sustainable production – Improve the industrial sector's capacity for sustainable and resource-efficient production • Industrial skills boost – Ensure the supply of skills to the industrial sector • Test bed Sweden – Create attractive innovation environments - sustainable / environmental friendly production - digitally connection	

Number	Country	Article	Definition of Industry 4.0	Sources of Infomation/Definitions	Components of I4.0	Implications for HRM Practices
37	Sweden	Business Sweden - The Swedish Trade & Investment Council (n.d.), *Smart Industry - The big rethink: Manufacturing in a digital world* Retrieved on 13.05.2018, from: https://www.business-sweden.se/en/Invest/industries/Manufacturing/smart-industry/	Smart Industry = a strategic initiative launched by the Swedish government to strengthen Sweden's capacity for change and competitiveness in a shifting landscape for manufacturing and production. The emerging, data-driven industrial age promises to unlock vast opportunities for innovation. But the transition also presents some real threats	Definition retrieved from: http://www.government.se/498615/contentassets/3be3b6421c034b038dae4a7ad75f2f54/nist_statsformat_160420_eng_webb.pdf	1. Industry 4.0 - Companies in the Swedish industrial sector are to be leaders of the digital transformation and in exploiting the potential of digitalisation 2. Sustainable production - Increased resource efficiency, environmental considerations and a more sustainable production are to contribute to the industrial sector's value creation, job creation and competitiveness. 3. Industrial skills boost - The system for supplying skills is to meet the industrial sector's needs and promote its long-term development 4. Test bed Sweden - Sweden is to lead research in areas that contribute to strengthening the industrial production of goods and services in Sweden	
38	Sweden	Telefonaktiebolaget L. M. Ericsson (n.d.), *Welcome to the smart factory* Retrieved on 13.05.2018, from: https://www.ericsson.com/en/cases/2017/smartfactory	Industry 4.0 = merging operational, information and communication technologies with cyber-physical systems, enabled by advanced wireless communication and Industrial Internet of things (IoT) services. Manufacturing companies are betting on 5G to deliver ultra low latency, high bandwith and reliable communication to realize the smart factory.	Company Website (company works in close clearance with European government (see following link)) http://s3platform.jrc.ec.europa.eu/documents/20182/221302/Industry+4.0+draft+agenda+Budapest_in+Save+the+date.pdf/25943edf-f62b-4806-96c6-f20d0c418f30	CPS, wireless communication, IoT,	

8.2 Appendix B

Interview Questions HR practices

1. In what way do you think Industry 4.0 will have an impact on HR practices?
2. What practices will be most influenced by Industry 4.0 and why?
3. What practices need to be changed /adapted most in your opinion and why?
4. In what way do you think new practices will be established and why?
5. Which practices will become more important and which will become superfluous and why?
6. In what way do you think the practices are impacted for different sectors?
7. In the Industry 4.0 documents most countries talked about education and training being important. In what way do you see this?