



UNIVERSITETET I AGDER

**The Effects of New Emerging Technologies on
Human Resources:**

Emergence of Industry 4.0, a Necessary Evil?

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DEDICATION

We dedicate this work to our late mother Dulsu Maksumic who gave me her unconditional love and support from birth and through my studies but unfortunately couldn't be part of the success.

We love you

ACKNOWLEDGEMENT

Industry 4.0 is a new phenomenon with conflicting views among researchers. Few studies have been conducted to uncover the dynamics of the industry but seems there is no concrete agreement and the debate is still ongoing. We took up this research to contribute our understanding of the Industry 4.0 to the knowledge required in academics. We are open to suggestions and contribution that will enhance our study. We extend our sincere appreciation to our supervisor, Professor Andreas Wald for his professional and constructive guidance of our work. We appreciate our class mates and colleagues as well as alle the companies and experts who contributed to our research success. Also, we appreciate our family members for their unflinching support for their contribution cannot be underestimated. Our profound gratitude goes to the University of Agder for the privilege accorded us to study in Norway to advance our academic standard.

ABSTRACT

Based on dynamic capability theory and existing literature, the study empirically investigates the effects of new emerging technologies on human resources; to know if the emergence of Industry 4.0 is a necessary evil or not. Descriptive research design with deductive qualitative analysis (DQA) method was used to analyse data obtained from 6 companies in Norway. Consistent with the two hypotheses deduced in our study, results confirmed in the first place that new emerging technologies have positive effect on human resources productivity. Secondly, new emerging technologies have potential negative challenges on human resources in term of unemployment in the future. We identified that the Industry 4.0 is still at the development stage and superficially conflicting. The implication is that Industry 4.0 is a necessary evil and required more research studies.

Keywords: Industry 4.0, Emerging technologies, Dynamic capability theory, Human resources productivity.

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CHAPTER ONE

INTRODUCTION

1.1 The subject-matter

There is no doubt that the face of innovation is changing with the emergence of new technologies associated with industry 4.0. The industry 4.0 is a new production focus otherwise known as fourth industrial revolution or the internet of things. “Industry 4.0” is described as interactive interconnectedness between analogue production and the digital world” (Wolter et al.,2015, p.8), that re-evaluates the entire production process. This means that it involves cyber physical production system (CPPS) whereby there is an interface between man and computer systems in the production process. The much use of computer which characterises this technology is transforming the traditional manufacturing to information environment. Some of these technologies are 3D printing (additive manufacturing), Robotics, Nanotechnology etc.

As new technologies emerge so does new knowledge accumulates. In effect, it translates to the fact that human resources’ technical know-how must change along with new methods of production processes. The specialised skills required to work with these technologies are what we directly emphasized when referring to professionalism. On this perspective, Wolter et al. (2015) believe that one of the effects brought about by industry 4.0 is the change in the structure of occupational fields. They believe that it will results in job reduction or cut in the manufacturing sector, job switching and improvement or change in qualifications. Consequently, it means that the adoption of new technologies associated with Industry 4.0 may pose some potential negative challenges or to a certain extent result in negative outcomes such as future unemployment if what is required are not met. However, the technology will create avenue for new skills acquisition development that leads to specialization, improved innovation, competitiveness etc. In the other way, its potential negative challenges are that it may lead to loss of jobs or create unemployment (in the middle-income section) as it reduces the need for people in many median skill jobs (Rotman,2013).

The effect of the new technologies associated with industry 4.0 as briefly highlighted previously seems to be two faced. First, it is inevitable that the adoption of industry 4.0 will drastically improve the capacity for innovation whether at the industry or at firms’ level if competent or versed employees are engaged. Second, it will reduce the number of employees required for services and make some unprofessional personnel (with median skills like

customer service and administrative workers) jobless. On the positive side, management researchers like (Drucker, Dyson, Handy, Saffo, & Senge, 1997) believe that “It is not technology, but the art of human and humane management” that matter most in the new production and manufacturing era. Also, Smith & Kelly (in Shiri 2012) opinionated that succeeding economic and strategic advantage lies with the organizations that can most effectively engage, develop, and retain professionals in the marketplace to gain competitive advantage. Based on this, we therefore think that competent human resource team manages and gather information about employees and their potentials. Consequently, new technologies which uses information communication technologies (ICT) tend to increase the quality of employees’ information which results in overall effectiveness of organization (Shiri, 2012). In other words, the interaction between new technologies and professional employees are complements to capacity for innovation and improved productivity.

We reemphasize that the emergence of new technologies as related to the industry 4.0 does not only create capacity for innovation which leads to improved productivity, but creates some challenges. Built on these two researchers (Erik Brynjolfsson & Andrew McAfee in Rotman, 2013), the emergence of new technologies is destroying jobs faster than it is creating them. Rotman affirm that it is contributing to the deceleration of middle income earners and growth of inequality in the technologically advanced economies. According to Rotman, these researchers believe that new technologies are getting rid of the need for many types of jobs and making the regular worker lose job opportunities (Rotman 2013). Therefore, our aim in this paper is to investigate how the new emerging technologies affects human resources’ performance or productivity as well as how it is posing potential negative challenges which might lead to potential job loss. The goal is to determine if the emergence of industry 4.0 is truly a necessary evil. Hence we aim to create awareness for mitigating the evil trace.

To accomplish the study aim, we carried out interview to study firms in manufacturing industry, refinery, health industry and a business network in Norway. Primary data was collected in firm level to predict a model found on dynamic capability (DC) theory. DC is the ability to re- focus capacities in order to take advantages in a volatile business environment by manipulating both internal and external resources of the firm (Teece, Pisano, & Shuen, 1997). Based on this knowledge, we view that the use of new technologies will improve human resources’ innovation capacity that generates increased productivity. In contrast, this innovation is also suspected to cause a certain level of challenges that may results in loss of job

opportunities or unemployment in the future, a consequence that seem to paint the Industry 4.0 a necessary evil.

1.2 Motivation of study

It is apparent that few existing studies have established that the application of new emerging technologies is an innovation that will help improve productivity and increase profitability of the firms. Yet, researchers like (Wolter et al.,2015) & (Rotman, 2013) believe that these new technologies have damaging consequences that may lead to unemployment in the labour market. However, it is imperative to know that these technologies will surely bring positive impact on firms' productivity and innovatively increase profitability but if it will also affect employees such that skills and competencies required to gain employment or remain employed will become another challenge to labour, then it is worrisome. The emergence of the use of these new technologies as related to industry 4.0 and according to Wolter et al. (2015) will bring some structural changes (challenges) to the labour market. Accordingly, it will create some jobs and some will be lost within occupational fields. Soon, it seems industry 4.0 may be creating unemployment and increase competitiveness.

Also, Rotman (2013) affirmed that industry 4.0 has the capacity to destroy some jobs and render some employees jobless faster than it is creating the jobs. This is because most median workers who have no technical know-how to work with the emerging technologies and who have not acquired the required skills might lose their job positions. Therefore, if Industry 4.0 will help to increase competitiveness and likely improve productivity and profitability, it seems that major manufacturing firms and service providers will be positive to its emergence. However, if the true position is that the industry may pose potential negative challenges such as loss of job opportunities or unemployment, why then the uproar for this industry? Should Industry 4.0 emerge at all? Or perhaps, what are the necessary things that ought to be done that are not yet done if truly it should emerge and be sustained? Based on these conflicting opinions, this study has been developed to explore the existing knowledge, discover and contribute to the ongoing debate on the business impact of the Industry 4.0 on firms and labour market. The study therefore, aims to show a evidence of the impact of industry 4.0 as to whether it is a dare need phenomenon for firms at the expense of the employee or it is both beneficial to both the firms and the employees. Consequently, the study is developed to determine if the Industry 4.0 is doing better than harm, what might become of the Industry 4.0 in the future with respect to human resources and if truly it is a necessary evil or not an evil at all.

1.3 Definition of the problem

The use of new technologies as related to the industry 4.0 seem to be creating innovation capacity that improves firms' productivity on the part of human resources but seem to have conflicting effects. It seems the unwanted impact is traceable to job cuts due to the nature of the new knowledge required for its operations since it is incompatible with the major practice of the third industrial revolution. Even though many scholars believe that the Industry 4.0 is going to do better than harm, it is still calling the attention of many to the fact that it tends to have some potential negative challenges. Regarding these challenges, Rotman (2013) posit that its consequent effect on employment opportunities is not encouraging. For Rotman, it is creating more unemployment than it is creating jobs. This potential negative challenge (e.g. unemployment effect) has not been agreed by many and therefore needed to be properly investigated to create a counter approach. We therefore develop this study to call the attention of scholars and industry actors to the implication of these conflicting effects to develop the best use of these technologies and guide against the future problems it might bring.

1.4 Purpose and objective of the study

The central purpose of the study is to determine if the use of new technologies as related to the Industry 4.0 have conflicting effects that made it a necessary evil and in effect create awareness for the need for possible best adoption of the industry to mitigate its potential negative challenges. To achieve the main objective of our study, we consider the following objectives:

- (i) Define the concept of the Industry 4.0 and its development
- (ii) Analyse new emerging technologies and their impacts on productivity and human resources
- (iii) Examine the potential challenges brought about by Industry 4.0 as related to human resources

1.5 Research Problem

(1) How does new emerging technologies create conflicting effects on human resources?

To answer the research problem, the problem is further decomposed into the following research questions:

- RQ1: How does emerging technologies shapes productivity and jobs in the Industry 4.0
- RQ 2: How does the Industry 4.0 change HRM?
- RQ 3: How can firms prepare for the challenges of the Industry 4.0 in their HRM?

1.6 Research gap

The emergence of the Industry 4.0 seems to be showing a lot of promise to manufacturing and service firms especially with the use of new emerging technologies. Early adopters believe that the innovation has positive effect on performance and thereby improves human resources productivity and will have direct effect on firms' competitiveness. Nevertheless, among other researchers, if Rotman's (2013) assertion that Industry 4.0 has potential negative challenges such as losing job opportunities or "destroying jobs faster than it is creating them" is true, then it will therefore mean that its overall effect on the economy could lead to a diminishing marginal return to scale. For instance, if more employees lose their jobs due to the use of Robots in the manufacturing sectors or more jobs are lost than created due to inability to acquire required skills for the jobs, the situation may create more unemployed persons. Consequently, this will stress the social benefits provided by many governments.

As in the previous, if governments will need to increase revenue to meet their demands, they might increase company and personal income tax. If this is so, then to whose benefit is the emergence of the industry 4.0? Researcher's view of the Industry 4.0 is polarized. While some researchers think that Industry 4.0 is an innovation toward productivity and human resources' improvement with no pessimism, researchers like Brynjolfsson & McAfee (2012) among others are of the opposite view. To determine whether the Industry 4.0 is a necessary evil to be sustained or not, this study tries to investigate the industry's impact on human resources in term of productivity and labour market. Consequently, the study will contribute to the necessary awareness required by the industry's participants on how to view the negative effects if exists. In effect, this study tries to re-evaluate and enlightened the polarized view of the current debate on the Industry 4.0 and its effect on human resources.

1.7 Research structure

This study is structured to have six chapters. Chapter one as the introduction. The introduction includes the subject-matter, motivation of study, definition of the problem, purpose and objective of study, research problem and research gap. Chapter two as background to the study. It includes development and nature of the Industry 4.0, new emerging technologies and technological progress and the Industry 4.0 and technology enablers. Chapter three as theoretical background. It includes theories and framework, challenges and competence design for Industry 4.0 and review of emerging technologies, potential effects and conceptual model Chapter four is methodology. It includes research design, sample selection, data description, and coding procedure and analysis. Chapter five as findings and interpretation. It includes new

emerging technology - manufacturing capacity and transformation requirement, human resources productivity - the productivity effect of technology, potential negative challenges - potential threats to human labour. Chapter six as discussion and conclusion. It includes, summary and concluding comments, limitations and suggestions for further research.

CHAPTER TWO

BACKGROUND TO THE STUDY

2.1 Introductory comments

This chapter set to discuss the meaning of Industry 4.0 and how it develops. Next, it will identify some technologies associated with the industry with few examples and how these technologies develop over time. Also, it will look at how the industry functions with what is referred to as enablers.

2.2.1 The development and nature of Industry 4.0

According to Africa Industry 4.0 Report, the phrase ‘Industry 4.0’ is expected to become the next developmental stage in the arrangement of the whole value chain process in the manufacturing industry. It is also referred to as the ‘fourth industrial revolution’. The notion of Industry 4.0 was first surfaced by the German government as part of its high-tech strategy to promote the computerisation of its manufacturing industry. Today it is widely used across Europe and has also been adopted in Asia, especially in China. In the US and the English-speaking world, the terms ‘internet of things’ (IoT), the ‘industrial internet’ or the ‘internet of everything’ are always applied alternatively. The central point of these concepts is that traditional manufacturing and production methods are undergoing a digital transformation process. The general adoption by the manufacturing industry of information and communication technology (ICT) is progressively reducing the boundaries between the real world and the virtual world, and is creating new production systems, specifically, cyberphysical production systems (CPPSs) (Pillay, Ori & Merkofer, 2016, p.8).

CPPSs are online networks of social machines that are designed comparable to social networks. In specific, they connect IT with mechanical and electronic parts that then interact with each other via a network. It can be said that radio frequency identification (RFID) technology, which has been in use since 1999, was an earlier form of this technology. CPPSs are not only network machines that relate to each other, the systems also create a smart network of machines, properties, ICT systems, smart products and individuals throughout the whole value chain and the complete product life cycle. Accordingly, sensors and control elements allows machines to be connected to plants, fleets, networks and human beings. Complete footprints in any part of the systems and live product data and customer feedback assures enhance all-inclusive product and service quality. Industry 4.0 centres around smart factories and CPPSs and interact with other smart infrastructures, such as those of smart mobility, the

smart grid, smart logistics and smart homes and buildings. Relative to business and social networks, the business network and the social network also determine a progressive vital role in the digital revolution of manufacturing to industry 4.0 (Pillay, Ori & Merkofer, 2016, p.8).

“Industry 4.0” emerged based on anticipated changes for an expected “fourth industrial revolution” and as a recollection of software versioning. The industry connotes an advanced digitalization within industrial factories; a representation of the combination of internet technologies with expected technologies in the field of “smart” objects i.e. machines and products (Lasi, Fettke, Kemper, Feld, & Hoffmann, 2014). Industry 4.0 describes the fourth industrial revolution as a new step of organization and management of complete supply chains over the life cycle of products (Platform I4.0, 2015). Some assume it to be a mere catchphrase for marketers, describing a pack of emerging technologies. Accordingly, a study of 1,393 persons in Germany showed that 82% had not heard the appellation Industry 4.0 before and of the 18% with prior knowledge of Industry 4.0 more than 33% see ordinarily the internet and communication web as the major aspect of Industry 4.0 while 25% could not identify with the real content of Industry 4.0 (IfD Allensbach) (as cited in Glas & Kleemann)

2.2.2 Industry 4.0, New Emerging Technologies and Technological progress

In the discussion of associated concepts such as the “Internet of Things” or the “Industrial Internet”, it has been said that there is a need to place high importance on digitalization and the internet. Apart from emphasis on digitalization, Industry 4.0 is not expected to be instituted by one separate technology, but by the combination of numbers of technological progress whose measured effects in aggregate create new ways of production (Schmidt et al., 2015). Felser (in Glas and Kleemann 2016) stated that Industry 4.0 is not restricted to the technical depth of digitizing contemporary businesses. In a similar vein, Glas and Kleemann (2016) believe that “Smart Factory”, “Internet of Things and Services” or “Cyber-Physical Systems”, are subsystems or sub-elements of the overall concept of Industry 4.0. However, these researchers (Schuh, Potente, Wesch-Potente, Weber, & Prote, 2014) understood Industry 4.0 from three major perspectives. First, Smart technical and engineering perspective, i.e. “Industry 4.0” is the application of smart products and services within a relevant technical environment. For instance, within industrial internet of things; smart home; smart factory. Second, organizational and transformational perspective, i.e. “Industry 4.0” is the ability to dynamically generate and quickly use organizational interfaces for expertise and capacity networking. Third, economic, value-oriented perspective i.e. “Industry 4.0” recognizes collaboration productivity.

In line with the foregoing, Feldmann (2015) contend that “Procurement 4.0” or a “Supply Management 4.0” is an essential concept of Industry 4.0 for it allows for connection of the different supply chain collaborators and facilitates a dynamic and fast synergy and coordination beyond organizational borders. As related to Germany, “without the procurement and supply chain management functions, Industry 4.0 is not to be successful in Germany” (Feldmann, 2015). The use of twenty- first- century information technology(IT) is another major aspect of the Industry 4.0. The employment of IT in business organizations has been in existence since the 1970s. In this era, the demand for production materials was organized with the use of simple electronic system called “Material Requirements Planning” (MRP). The technology was restricted to the connection of internal departments such as production, material management and or procurement (Menges, Roubanov, & Ernst, 2014; Kuhn & Hellingrath, 2002)(cited in Glas & Kleemann 2016). An improved stage of IT application in procurement was described by cross-company integration of IT systems, referred to as “Enterprise Resource Planning” (ERP). ERP deliver a standard basis for all major business functions across a company, ranging from sales over finance as well as production among others to procurement (Saggau, 2007) (in Glas & Kleemann 2016).

Glas and Kleemann (2016) believe that while the move from MRP to ERP is evolutionary, the development stage to eProcurement is revolutionary. Going by trends such as eBusiness, Internet and Supply Chain Management, the use of IT was more pronounced than it has ever been (Kollmann, 2011; Essig & Arnold, 2001)(in Glas & Kleemann 2016). eProcurement is viewed from different perspectives. For example, Brenner and Wenger (2007b) has viewed eProcurement as the support technology for operative procurement, with a well-defined eSourcing for the tactical or strategic procurement undertakings. eProcurement on the other hand is viewed as the general term for the use of IT in procurement. Robustly, it is defined as the use of Internet technology for making the operative procurement processes easy and possible, such as ordering, as well as sourcing tasks, e.g. web-based supplier search or eAuctions (Koppelman, 2007) (in Glas & Kleemann 2016). Wisner, Tan & Leong (2015) (in Glas & Kleemann 2016) has identified that the technology is used to implement tasks that earlier required burdensome manual work. For example, the interdependence between suppliers and the ordering company by means of electronic data interchange (EDI) systems (Wisner et al.,2015). Bogaschewsky (2015), McCue and Roman (2012) and Roland Berger (2011) (in Glas & Kleemann 2016) conclude that eProcurement has conventionally been widely used in organizations, as in specific tool such as procure-to-pay operations.

Henke and Schulte (2015)(in Glas & Kleemann 2016) has claimed that procurement at the boundaries of suppliers' technology and production technology presents the opportunity to situate itself as the main propeller of the Industry 4.0 development but also assumed several questions around this assertion. In relation to Industry 4.0, Schmidt et al., (2015) (in Glas & Kleemann 2016) view that "smart" IT systems is one major area to be properly investigated. Glas and Kleemann (2016) believe that smart is a notion for actual automation that encompass the entire procurement processes. They posit that Smart systems spontaneously identifies with demand for a certain material and thereby independently produce an order that is communicated to the specific supplier without any necessary human interference. Therefore, the actual automation is a difference between "Procurement 4.0" and eProcurement. Another consideration for Industry 4.0 in explaining eProcurement IT system suggests the organizational model in Industry 4.0. Even though there is a significant support for exchanging information suppliers in eProcurement (Kollmann, 2011), the technological progress associated with Industry 4.0 have immensely intensified the potential for this development. Accordingly, the main change is the move from "exchanging information" to the "free flow of information" between linked products, services and hence, organizations (Schlick et al., 2014; Wannewetsch, 2005)(in Glas & Kleemann 2016).

According to Schuh et al. (2014), the productivity model in terms of an improved "collaboration productivity" in Industry 4.0 is used to reference the differences between Industry 4.0 and the current approach of eProcurement. The productivity obtained from eProcurement drive is fundamentally caused by reduction in transaction and process costs (Wagner & Essig, 2006) (in Glas & Kleemann 2016). Industry 4.0 completely facilitates short production development processes, capacitates new product-service functions and enhance the organizational supply chain design (Schuh et al.,2014). For Kagermann(2014)(in Glas & Kleemann 2016)., eProcurement focuses ordinarily on process-efficiency but Industry 4.0 potentially has the tendencies to enhance productivity and performance to satisfy extremely customized demands' investments. Schuh et al. (2014) observed that the new ICT enabled technologies associated with Industry 4.0, e.g. sensor technology, robotics, 3D printing etc., are expensive investments. These technologies according to Schuh and his colleagues are still in the development process and have not yet have optimal impact. They believe that Procurement 4.0 shall support the company's Industry 4.0 strategy with suggestions for integrating Industry 4.0 technologies accessible on supply markets (Schuh et al.,2014).

2.2.3 Industry 4.0 and technology enablers

Mobile: Mobile technologies comprise all wireless communication systems, whether cellular connections or Wi-Fi and corresponding technologies. Great amounts of information formerly accessible only at fixed locations are now accessible instantly. As far as Industry 4.0 is concerned, the mobile internet is crucial for a linked production environment. Accordingly, this can be explained using real-time data capturing and accessibility, object tagging and internet-to-object communication (Capgemini Consulting report, 2014, p.12).

Cloud Computing: As a key precondition for value-added mobile services, Cloud Computing is said to be a description of the applications, platform and infrastructure solutions obtained as services over public or private networks on a pay-per-use basis. Cyber Physical Systems (CPS) and CPPS has the potential to produce large amounts of data which should be stored and processed. Results obtained must be accessible worldwide anywhere at any time. According to the Capgemini Consulting report, cloud technology enables this free flow of data as an important part of Industry 4.0. As reported, it will also stop the need for high-end user devices. Ultimately, capacity can be quickly added and high financial risk can be mitigated when taken decisions on infrastructure investment (Capgemini Consulting report, 2014, p.12).

Advanced Analytics: As reported by Capgemini Consulting, Advanced Analytics is determined to create business perceptions from an accumulation of data by pinpointing patterns and interdependencies. As CPS increases in manufacturing and Smart Products on the market, the amount of data accessible to manufacturers will practically trigger. Despite this great promise, it is observed that this important resource is being underestimated. Data analytics has enabling power on manufacturers such that it will help to analyse their operational processes and business implementation, discover and interpret inefficiencies and also forecast future events. Despite its incorrect attribution to only the customer-focused processes, analytics in manufacturing is said to have the capacity to also help attain remarkable enhancements in operations (Capgemini Consulting report, 2014, p.12).

Machine-to-Machine Communication: Predominantly, what drives the shop-floor impacts of Industry 4.0 is Machine-to-Machine Communication (M2M). This is otherwise known as technologies enabling the automated exchange of information between the CPS which constitute the Industry 4.0 production environment. M2M is described as the essential technology of the 'Internet of Things' (IoT). Via advanced implanted sensor and actuator applications technology, the complete production floor can transmit relevant information, forming the connection between the physical and the virtual worlds. This presents a level of

transparency that facilitate massive advancements in manufacturing, from performance management to complete new business designs. As intra-company linking of production assets is determined by the usage forms of M2M, it is also the major facilitator when it comes to cross-company operations (Capgemini Consulting report, 2014, p.12).

Community platforms: Community platforms is noted with its revolutionary effects on everyday lives through the rapid, worldwide communication of one-to-many. Facebook and Twitter are identified as part of this platform. Beyond this, it comprises advanced, enterprise-grade approach which leverage employee collaboration to achieve a more dynamic, content-rich relationship with partners and customers. Accordingly, many other venture applications now also integrate community platforms components. The human-to-human perspective of a networked industrial domain is significantly enabled and enhanced via community platforms. Also, the ‘classic’ social networks, for example, is said to have the capacity to be applied for easier on- demand manufacturing and supply a lot of data about customers (Capgemini Consulting report, 2014, p.13).

3D printing: As published by Capgemini Consulting and in relation with the cloud, the concrete impact of 3D printing is being underestimated by manufacturers. Additive manufacturing as otherwise known, it connotes the production of three-dimensional objects straight from virtual designs. The Industrial use of the technology (3D Printing) has not been widely adopted due to slow production rates, few accessible materials and exorbitant prices. As recent innovations mitigate these weaknesses, it said that there is possibility that the adoption of additive manufacturing will mostly remove the barriers to the efficiencies of producing individually customized products. Capgemini Consulting noted that it will enable quick prototyping and extremely decentralized production processes. The specific process is that the product model could easily be transferred to the ‘printing’ site convenient and close to the customer, putting a stop to middle production manufacturing steps, transportation and warehousing. Therefore, 3D printing is projected to have revolutionary impacts on how, where and by whom products will be manufactured in the future (Capgemini Consulting report, 2014, p.13).

Advanced robotics: Technological innovations have considerably enhanced robotics in the last few years, making robots suitable for work in almost every sector. Particularly, sensors and machine vision coupled with enhanced artificial intelligence enables advanced robots to perform their role in manufacturing as independent productive constituents safely alongside shop-floor employees. Following the view of Capgemini Consulting, the use of advanced

robotics in Industry 4.0 will become a deciding factor for process efficiency and reduce complexity (Capgemini Consulting report, 2014, p.13).

2.3 Concluding remarks

This chapter discusses how Industry 4.0 emerged in Germany and demonstrated that the Industry is at the developmental stages. Different perspectives to the understanding of the industry have been analysed from three dynamics namely (1) Smart technical and engineering perspective (2) organizational and transformational perspective and (3), economic, value-oriented perspective (Schuh et al.,2014). Section 2.2.3 presented different ICT enabled technologies that propelled the industry and are called the “enablers.”

CHAPTER THREE

THEORETICAL BACKGROUND

3.1 Introductory comments

To analyse the objective of the study and answer the three research questions, this chapter is determined to focus on some theories and framework to give deep understanding of how the Industry 4.0 is applicable to the firms and human resources. It will identify the challenges expected or associated with the industry and how to cope or solve the associated problem emanating from the challenges. Following this, new emerging technologies associated with the industry will be reviewed as to identify their potential effects on human resources. Also, this chapter will try to develop a model that can explain the possible effects of the new emerging technologies on human resources.

3.2.1 Theories and framework

Rotefoss (2001) and Dollinger (1999) outlines resource based view (RBV) for the understanding of firms' innovation processes. Researchers like Amit and Schoemaker (1993) and Barney (1995) posit that firm can be perceived as a bundle of resources and capabilities. For Barney and Arikan (2001, p. 138), resources are considered as “tangible and intangible assets that firms use to conceive of and implement its strategies.” Barney and Hesterly (2012) described “resource” as something which an organization can leverage upon to reach its desired objectives. They categorized resource into human, organizational, physical, financial, and all consisting of capabilities. Makodok et al furthers that capabilities are elements of firm's resources which reflect organizational deeply fixed idiosyncratic resource that serves to improve the productivity of other resources that the firm owns. (Makadok 2001,p. 389). According to Teece (1981), much of technological assets are pinpointed to be part of these resources since its know-how is not easily transacted in the various markets.

As in the aforementioned, the Industry 4.0 is a new production system that combined analogue production with digital world; a cyber physical production system with an interface between man and computer systems in the production process (Wolter et al., 2015). The industry entails specialised human resources and their skills to operate the new ICT enabled technologies. However, the interaction of both the technological capability and human resource capability required in the industry 4.0 can be considered as organizational capabilities; for according to (Day 1994; Yang et al. 2009), such an interaction represents the act of using resources with a new ability to create value. So, this study focuses the conceptual model on

dynamic capability theory (DCT) developed by Teece et al. (1997). With DCT, the understanding of the research can be visible in explaining the effect of the Industry 4.0 (the dynamic flow of human resources and new ICT enabled technologies) to affect human resources' performance. Brown (2000) contends that for a firm to remain active, technological investment is a priority. However, the type and extent of operational technological choice will be determined by the capacity of the firm and the nature of production process. Since Industry 4.0 is majorly facilitated by new ICT enabled technologies, we therefore build this study on the theory of dynamic capabilities (DCs) to theorize how the capabilities of new ICT emerging technologies can affect human resources in term of productivity and competencies.

Researchers have differentiated dynamic capabilities from ordinary capabilities. Ordinary capabilities allow an organization to sustain production in the present, while dynamic capabilities improve the production capacity of an organization for sustenance (Helfat & Winter, 2011). Dynamic capabilities empower the firm to augment the resource base, manipulate ordinary capabilities, and effect or bring about change in the organization's external environment (Barrales-Molina, Martinez-Lopez, & Gazquez-Abad., 2014; Helfat & Winter, 2011; Teece, 2007). As noted by Zahra, Sapienza, & Davidsson. (2006, p. 921), 'new routine for product development is a new substantive capability but the ability to change such capabilities is a dynamic capability.' Augier and Teece (2009, p. 418) posit that, dynamic capabilities to a certain extent is about introducing valuable and unique competence into the resource base, and to a reasonable extent, it is about promoting and modifying continuously to transform existing capabilities (Rindova & Kotha, 2001). Synthesizing resource-based and changing strategic logics, the dynamic capability dynamics focuses on capabilities that may bring a competitive advantage by creating unique value for the firm through systematic change, especially in industries with fast technological change (Peteraf, Di Stefano, & Verona, 2013; Teece et al., 1997).

Some researchers have debated that dynamic capabilities may not necessarily create the right resource arrangements or combinations (Ambrosini & Bowman, 2009; Eisenhardt & Martin, 2000) and inherently cost attributed (Pablo, Reay, Dewald, & Casebeer, 2007). Also, some researchers have also claimed that dynamic capabilities tend to be valuable (Peteraf et al., 2013), mainly, because dynamic capabilities are 'idiosyncratic in their details' (Eisenhardt & Martin, 2000, p. 1105). More so, as organizations learned and adjust to their environment (Jacobides & Winter, 2012), it could lead to a significant and hard- to - copy value added to the most experienced firms (Peteraf et al., 2013). Zott (2003) posit that systematic change to firm's'

resource base may result in notable performance differentials because these activities enable the organization to develop knowledge about how to change and with lesser costs, and thus increase conformance with the environment. For instance, there is an implication for procurement IT systems from the organizational model in the Industry 4.0. Despite a quantum active support for both exchanging information and suppliers in eProcurement (Kollmann, 2011) (as in Glas & Kleemann 2016), the technological advancement in Industry 4.0 have tremendously increased the potential for doing this. The fundamental change is the step from “exchanging information” to the “free flow of information” between linked products, services and resultant organizations (Schlick, Stephan, Loskyll, & Lappe, 2014; Wannenwetsch, 2005 (in Glas & Kleemann 2016).

The capabilities approach emerged in a situation where capabilities are regarded as the potential to arrange and manage resources to achieve the firm’s goals and objectives (Amit & Shoemaker, 1993). The implication is that even though resources themselves do lead to performance, the combined effect of other resources (dynamic capabilities) is the major cause of performance differences (Grant, 1991). As defined by Teece et al. (1997), dynamic capability is “the capacity to renew competencies to achieve congruence with the changing business environment” by “adapting, integrating, and reconfiguring internal and external organizational skills, resources, and functional competencies” (Teece et al. 1997, p. 515). Organization's’ dynamic capabilities is not just the ability to sense the likelihood of technological change but to also have the capacity to align with change through innovation (Hill & Rothaermel, 2003).

Technology will strengthen capabilities, innovatively create and integrate many resources and environments which cannot be easily copied and replaced and consequently lead to sustainable competitive advantages (Barney, Wright, & Ketchen, 2001; Tian & Xu, 2015). Studies have shown that HRM in IT should have a positive effect on firm’s performance in supportable development due to firms’ resources or skills improvement capabilities (Liang 2011), which include not only the prevalent technical knowledge, but also the outstanding HRM ability to organise, use and manage those skills (Hulland, Wade & Antia 2007). These imperceptible skills; like knowledge assets or skills exist among a firm’s human resources (Bharadwaj 2000) and technology integration skills (Feeny & Willcocks 1998) are majorly non-transferable, so that they are hard to obtain, trade, imitate and easily replaced (Barney 1991). For instance, information communication technology (ICT) has improved operational activities (Sambamurthy, Bharadwaj, & Grover, 2003), improve workers’ job effectiveness

(Winter & Taylor, 1996; Orlikowski, 2002), and realigned the organizational architecture of the firm (Boynton, Zmud & Jacobs 1994; Pinnseneault & Kraemer, 1997).

From the dynamic capability view of the RBV, these researchers (cf. Barney 1986; Amit & Schoemaker 1993) positioned that unique and tacit human resources' skills should help improve performance to achieve competitive advantages. Explicitly, firms with high level human ICT resources could (1) harmonize ICT and business strategy practices more effectively, (2) expedite strategic management through a reliable and cost effective applications, (3) transform the business process through agility by improving communication and work with business units and (4) Innovatively contribute to the new product features for future needs (Sambamurthy & Zmud 1992; Bharadwaj 2000). Snell, Stueber and Lepak (2002), noted that ICT can potentially lower administrative costs, increase productivity, reduce speed response times, improve decision making and strengthen customer service at the same time. Human resource information system (HRIS), an example of ICT use can assist the human resource function in developing business strategy and consequently intensify organization's performance (Barney & Wright, 1998; Lawler, Levenson, & Boudreau, 2004). HRIS is used to gather, store, shape analyse, retrieve, and appropriate important information that has to do with an organization's human resources (Kavanagh, Gueutal, & Tannenbaum, 1990).

In a study about the role of IT on the HR professional, Gardner, Lepak and Bartol (2003) noted that the much use of IT required that IT-related support activities are provided such as maintaining IT-based HR applications. Consequently, Gardner et al. (2003) contend that HR professionals can optimise their contribution to the organization's' success if they complement their knowledge regarding IT. Consistent with Nelson (1991), they posit that IT is changing the needed skills for HR professionals and increases the requirement for IT training. Delorme and Arcand (2010) debated that organizations start to outsource components of the HR function that are relevant for IT, because HR professionals lack required skills necessary for its operation. A study by Bell, Lee and Yeung (2006) on the impact of e-HRM on professional competence in HRM show that HR professionals need to be strengthened with technologies such as the internet to fully integrate e-HR into the HR role. In the same vein, Suen, Hsiao and Yang (2011) investigated the association between IT competencies, HR competencies and job performance for HR professionals. It was evident that IT competencies are positively associated with HR competencies and job performance. However, IT competencies is identified as a key to enhance HR competencies and job performance (Suenet et al.,2011).

As associated with industry 4.0, a couple of new technologies (ICT enabled) such as Robots, augmented reality, algorithms, machine-to-machine communications, 3-D printing, and autonomous vehicles grows every day and help people with many of different tasks. These technologies are expansive in their scope and momentous in their ability to transform existing businesses and personal lives (West, 2015, p.6). On the contrary, West (2015, p. 7) noted that these new technologies in several sectors is replacing labour, and this has striking consequences for middle class jobs and incomes. Also, Arthur (2011) posit that digital processes majorly explains how productivity has improved without a significant increase in human labour. Arthur noted that “digital versions of human intelligence” are increasingly substituting many jobs that are once thought to require people. Accordingly, it will transform every profession in perspectives we are yet to think about. Brynjolfsson and McAfee (2012) argued that technology boosts productivity and makes societies wealthier, but they think that technological progress is destroying the need for many types of jobs and aggravating the ordinary worker’s situation. For McAfee, as new ICT enabled technologies continue to “their exponential advances”, the pressure on employment and consequent inequality will get worse. Brynjolfsson on the other hand submit that technology is responsible for both the robust growth in productivity and the weak growth in jobs (Brynjolfsson & McAfee,2012).

3.2.2 Challenges and competence design for Industry 4.0

A. The challenges

Industry 4.0 as it is being phrased explains the growing digitization of the complete value chain and the subsequent interconnection of people, objects and systems through concrete time data exchange (Spath, Ganschar, Gerlach, Hämmerle, Krause & Schlund, 2013; Dorst et al.,2015) (cited in Wolter et al. 2015).. The interconnection equipped products, machines and processes with artificial intelligence and get enabled to acclimatize to spontaneous changes of the environment autonomously. Also, smart objects become entrenched in wider systems, which improve the creation of flexible, automated production systems. (Porter & Heppelmann, 2015; Huber & Kaiser, 2015). Relative to Industry 4.0, there are some challenges associated with it. Forschungsunion and Acatech (2013) note that the emergence of Industry 4.0 will bring change in production structure and will eventually have consequences. Considering the working and professional world, Forschungsunion and Acatech assumed further that work will become more challenging, sophisticated and have more informal prerequisite requirements such as the capacity to act independently, allow self-organisation and intellectual thinking-skills (Forschungsunion & Acatech, 2013)(cited in Wolter et al. 2015).

Wolter et al (2015, p.14) in an interview conducted discovered that start-up companies utilizing the potentials digitalization within the context of Industry 4.0 has the capacity to manufacture flexible and individualized products which will help them to form and occupy new market niches. Wolter et al. reported that these companies require their specialists to acquire special professional skills, backed by know-how in dealing with digital media and networks, as well as idiosyncratic soft skills in communication and especially in teamwork. Accordingly, skill in problem solving, which is harmonised within the processes among the team but also applied autonomously, is very important for the companies. However, new skills or activities which would result in new job descriptions, are not anticipated but the emphasis is that previous occupations are adequately established and required greater end-to-end IT skills (Wolter et al 2015, p.14).

With the emergence of the Industry 4.0, a decline in the demand for specialists in intermediate skills is anticipated. Even though there is high demand for employees in the growth phase of new processes and products, it is only a short-term shift towards necessitating academic degrees. It is envisaged that this shift will normalise during implementation phase since more people with training qualification would later be required. Nevertheless, the employment opportunities for low-skilled workers would still be difficult in the long run (Wolter et al 2015, p.14). Accordingly, manpower may not be the only thing reduced or restructured in the adoption of Industry 4.0. Real time production will potentially replace material, inventory and movement sequences (BITKOM 2014) (cited in Wolter et al. 2015). According to Hecklau, Galeitzke, Flachs and Kohl (2016), the challenges associated with industry 4.0 are well identified and classified as economic, social, technical, environmental and political, and legal challenges. However, for this study, we shall briefly further discuss only the technical and social challenges.

Technical challenges: As technologies grow in geometric progressions, companies are expected to be able to competently deal with a large amount of data (Huber & Kaiser, 2015). Therefore, all-embracing IT infrastructures, such as communications networks and internet protocols, need to be put in place and implemented (Brühl, 2015; SPD-Bundestagsfraktion, 2015). According to (Dorst et al.,2015; Brühl, 2015; SPD-Bundestagsfraktion, 2015), it is essential to develop consistent boundaries and open designs to guarantee unproblematic exchange of data between collaborators within a network. This accordingly will empower collaborative and organised work on different platforms. The storage of huge amounts of data on external servers is said to have potential risk about cyber security in the sense that data must

be protected from illegal access (Dorst et al.,2015; Huber & Kaiser, 2015; Shahd & Hampe, 2015; SPD-Bundestagsfraktion, 2015) in Heklau et. al. 2016). Therefore, employees are saddled with the business of acquiring the required skills to prepare for the increase in simulated work, e.g. with virtual glasses [BMBF,2014; Stock-Homburg, 2013) (in Heklau et al. 2016)

Social challenges: Stock-Homburg (2013) note that one of the most convincing social challenges is the demographic change. According to Stock-Homburg R. (2013), strategies have to be put in place to attract young people and still retain knowledge from older employees. Also, Stock-Homburg (2013), identified that younger generations express different social values, such as the increasing importance of a good work-life stability. This notion corresponds with the rising employee flexibility due to changes in work organizations. With these occurrences, limits should be set up to check the continuous availability of employees, such that their work life does not affect their private life (BMBF 2014.; Spath et al., 2013). Consequently, these scholars (Brühl,2015; Gronau & Ullrich, 2015) believe that increasing virtual work and flexible work areas requires new forms of lifetime learning(skills). Also, it was noted that processes are becoming more complicated and thereby leading to increase jobs with higher qualifications and a loss in jobs requiring lower qualifications (Spath et al., 2013; Brühl, 2015). Because of these complications, Hecklau et al. (2016) suggests that companies must train their employees to be able to fit to strategic positions, coordinate and create tasks with higher responsibilities.

B. The competence design

To face the challenges of the Industry 4.0 and adapt to the operations of the new economy it is deriving, we view that there are two sides of the coin that must be addressed having combined the notion of Capgemini Consulting (2014) and Hecklau et al. (2016) respectively. First, firms must transform and conform themselves with the technology enablers as indicated by Capgemini Consulting (2014) mentioned above. Second, employees and potential employees must train and develop their skills to adapt to the operations of the Industry 4.0. As noted by Capgemini Consulting (2014), requirements for becoming Industry 4.0-ready from the perspective of the firm requires that ‘Manufacturer’s Digital Transformation (MDT) must be based on a powerful, secure, reliable and scalable Digital Infrastructure (DI)’ (P.14). According to the report, Digital Infrastructure integrates the technology enablers into the firm’s activities. For example, the report noted that fibre-optic cables or the mobile networks operated by private companies as well as intra-firm IT infrastructures are vital integral part of Industry 4.0.

Capgemini Consulting position that manufacturing firms must fulfil four necessities to be able to allow and realise the possibilities and the potentials of Industry 4.0 as in the following:

Making your Digital Infrastructure powerful. With the enormous growth of data traffic over the coming years, there is no doubt that particularly mobile networks need to be expanded in the future. Manufacturers should thus try to rely on the non-licensed mobile spectrum (e.g. Wi-Fi, Bluetooth) whenever possible. Furthermore, firm-specific infrastructure should deliver the computing power necessary for complex processes. Intra and extranets must have connectivity sufficiently powerful to accommodate peak data loads. When implementing new systems, only interfaceable infrastructures and systems designed according to Service Oriented Architecture (SOA) principles can be powerful enough for Industry 4.0 (Capgemini Consulting, 2014, p.24).

Making your Digital Infrastructure secure. In Industry 4.0, manufacturing companies will continue the virtualization of valuable business assets, such as new product designs. Both within companies as well as in the cross-company collaborative environment that firms rely upon, this valuable data must be secured against loss or theft. Data segmentation and communication policies will be essential here, but the Digital Infrastructure also should play its role by employing the latest data protection mechanisms. Staying up to date on the developments in enterprise security is the key recommendation here – and that IT security will not come for free, so investments in this area must be anticipated and planned (Capgemini Consulting, 2014, p.24).

Making your Digital Infrastructure reliable. That manufacturers will often rely on virtualized business processes, their Digital Infrastructure should offer enterprise-grade availability rates (often stated with a target of ‘three nines’, i.e. 99.9% of availability). For individual IT components, this could result in much higher availability requirements – think of ‘single points of failure’. Companies need to focus on the stability of the infrastructure employed. Stringent service level agreements must be made with cloud providers, for example. Minimize the number of single points of failure. Localize critical Digital Infrastructure in areas less prone to disasters or energy insecurity. If there is no standard in your industry or partner network for a technology yet, choose the ones with the most promising outlook of becoming the standard in the future (Capgemini Consulting, 2014, p.24).

Making your Digital Infrastructure scalable. The journey to Industry 4.0 will often be an evolutionary one whereby functions and processes will be ‘virtualized’ at different times. To optimize the trade-off between system performance, i.e. the load and functional perimeter a system is capable of handling, and the associated costs, the infrastructure employed must be scalable. It should enable the flexible adding of capacity and the incorporation of new functions or requirements as needed. Manufacturers should therefore consider the deployment of cloud services over on -premise solutions (Capgemini Consulting, 2014, p.24).

The perspective of the employees’ readiness for Industry 4.0 according to Hecklau et al. (2016) is also categorised into four competencies. These competencies are (1) Technical competencies: It is comprised of state-of-the-art knowledge, technical skills, process understanding, media skills, coding skills, and understanding IT security. (2) Methodological competencies: This encompass creativity, entrepreneurial thinking, problem solving, conflict solving, decision

making, analytical skills, research skills and efficiency orientation. (3) Social competencies: As noted, this include intercultural skills, language skills, communication skills, networking skills, ability to work in a team, ability to be compromising and cooperative, ability to transfer knowledge and leadership skills and (4) Personal competencies: This competency entails flexibility, ambiguity tolerance, motivation to learn, ability to work under pressure, sustainable mindset and compliance.

From the forgoing, the strategy developed by Hecklau et al. is that the competency model will help firms to conduct a competence gap analysis for essential competencies in Industry 4.0. Since the competencies are too definite to be generalised for the whole workforce, firms will be required to assess employees individually with the design. The required scale value for every employees' competence should be adjusted since every job profile corresponds to some extent a dissimilar improvement levels for each competence. Assessment process should be carried out by professionals with consistent competence measure and upgrade the competence model with the outcome of the assessment (Hecklau et al.,2016). To determine if an employee will be able to cope with the challenges of Industry 4.0, Hecklau et al. (2016) assert that emphasis should be placed on employees' largest competence gaps. Consequently, it is identified that this procedure will help firms to plan appropriate training for an employee in case the required scale level for a competence is not met when applying qualification strategies (Hecklau et al., 2016).

3.2.3 Review of emerging technologies, Potential effects and Conceptual model

Researchers like Bell et al. (2006) view that technology has positive effects on the functions of HR in organizations. Bell et al. (2006) posit that e-HRM enables HR staff to go beyond performing traditional functions such as administrative tasks and align them towards being a strategic partner. Hussain, Wallace & Cornelius (2007) note that the ICT enabled HRIS is an enabling technology which HRM professionals progressively use to support strategic decision making. Bell et al. (2006) on the impact of e-HRM on expert competence in HRM discovered that HR professionals should be able to comfortably use the ICT enabled technologies such as the internet to copiously integrate e-HR into the HR role. On the same view, Suen et al. (2011) in a study that connects IT competencies, HR competencies and job performance for HR professionals conclude that IT competencies have positive correlation with HR competencies and job performance. They posit that IT competencies are the enablers of HR competencies and job performance (Suen et al.,2011). It is therefore advocated that if technology is correctly

managed, positive productivity effects from the adoption of new HRM is inevitable (Bloom & Reenen, 2010).

In line with the above, optimists have contended that new digital and other technologies will increase productivity (Brynjolfsson & McAfee, 2014, p.11). OECD (2016) reported that emerging production technologies has the propensity to affect productivity via several machines. The report for example noted that robots have massively increased productivity on assembly lines in the automotive industry because they are faster, stronger, more accurate and reliable than human labour. In the same vein, the report claimed that the integration of new sensors and actuators, big data analysis, cloud computing and the Internet of Things is supporting independent productivity-enhancing machines and intelligent systems. Also, it was advocated that 3D printing (additive manufacturing) can bypass the requirement for assembly in some stages of production by printing a pre-assembled mechanism (p.10). To further demonstrate productivity associated with the use of new emerging technologies, Watson and Rotman (2013) note that in Kiva's large demonstration warehouse and assembly facility, many robots move about with apparently endless energy humans cannot match to perform tasks. It was affirmed that robotic technology has helped retailers (humans) to survive and expand their business e-commerce business.

The new emerging technologies that enables machine-to-human collaboration and cooperative product comprehension, a reflection of advanced manufacturing and industrial processes are the new realities associated with Industry 4.0. The adoption and adaptation to the mechanism of Industry 4.0 will result in extraordinary levels of operational efficiencies and enhanced progress in productivity (Thames & Schaefer, 2016). For example, eProcurement, a technology which was expected to deliver a mere process efficiency is said to have been enhanced by Industry 4.0's goals with better and improved productivity and performance to satisfy extremely tailored demands (Kagermann, 2014). It means that technology enablers and the operational efficiencies within the realities of the Industry 4.0 can strengthen the ordinary capacity of the resources accessible in a firm. Simply put, the emerging technologies associated with Industry 4.0 and their applicability has dynamic impact on the pre-existing technologies. From this view, Industry 4.0 allows radically quick production development processes, enables new product-service functions and enhances the organizational supply chain structure (Schuh et al.,2014).

The emergence of new technologies like Artificial Intelligence (AI) has positive impact on human resource productivity. Artificial intelligence refers to “machines that respond to

stimulation consistent with traditional responses from humans, given the human capacity for contemplation, judgment and intention” (Shukla & Vijay,2013). AI is considered a visionary advanced technology that combines critical reasoning and judgment into response decisions. Its application is found in areas such as finance, transportation, aviation, and telecommunications to create expert systems. These expert systems “make decisions which normally require human level of expertise” (Shukla & Vijay,2013). These systems according to West (2015), assists humans to anticipate problems or analyse them as they emerge. This technology is being used to work in place of humans in many areas of work life such as space exploration, advanced manufacturing, transportation, energy development, and health care. With the use of computers and its high performing processing power, humans can enhance their own skills and improve productivity through artificial intelligence (West,2015). After the enormous contributory efficiencies of new emerging technologies to human resources job performance, we aligned ourselves at this point with technology optimists that the new emerging technologies as associated with Industry 4.0 may have some positive impact on human resources productivity. Therefore, we initiate a hypothesis that:

H1: The emergence of new technologies will increase human resources productivity.

Contrary to the foregoing, the advancement in emerging technologies seems to be having a considerable effect on the workforce (West,2015). In some sectors, it is evident that technology is replacing human resources, and this has negative consequences for middle class jobs and incomes. Subsequently, Lipson in West (2015) posit that “for a long time, the common understanding was that technology was destroying jobs but also creating new and better ones. Now the evidence is that technology is destroying jobs and indeed creating new and better ones but also fewer ones” (p.7). Following this assertion, West followed that with technological progress, the information sector is said to be one of the areas anticipated to shrink in jobs. He further claimed that despite the innovative effect of technology on many businesses, it is observed that it is only transforming operations and not increasing the number of jobs (West 2015). Therefore, it is said that technology can improve productivity and enhance efficiency but these effects are reducing the number of employees required to produce the same or even superior levels of production (West 2015).

Consistent with the foregoing, Arthur in 2011 saw a down side of the emergence of new technologies. Arthur calls the operations of the new technologies in the Industry 4.0 the second economy where there is a shift from producing prosperity to distributing prosperity. He posits

that jobs are disappearing into the second economy. From Arthur's view, digital transformation is shrinking jobs and in future it might be only few people who will have white collar business process jobs which he saw as a problem (Arthur, 2011). According to Shukla and Vijay (2013), Artificial Intelligence has become sophisticated and improved automation process but has the potential to destroy, if not change many professional jobs. It means that with the continuous progress in the advancement of emerging technologies, unemployment is not far fetch for many employed professionals or the middle-class workers. Ford in 2015 believe that soon, machines will be able to perform the duties found with many jobs of many the 'average' people in different sectors, and these people will not be able to secure new jobs (Ford, 2015). This indicates that the economy which the fourth industrial revolution is bringing about might pose a big challenge and might create unemployment problems if not properly managed.

In another development, West (2015) believe that it is difficult to be certain about the evolving trends of the fourth industrial revolution because one cannot be sure of how new technologies will affect different jobs. Frey and Osborn (2013) believe technology will change many sectors of life. According to a study conducted by Frey and Osborn in an analysis based on 'improving levels of computerization, wage levels, and education required in different fields', results indicate that "47 percent of U.S. workers from 702 occupational groupings have a high possibility of seeing their jobs automated over the next 20 years. They analysed that jobs within these areas: telemarketers, title examiners, hand sewers, mathematical technicians, insurance underwriters, watch repairers, cargo agents, tax preparers, photographic process workers, new accounts clerks, library technicians, and data-entry specialists have a 99 percent possibility of being having computerized. On the other hand, recreational therapists, mechanic supervisors, emergency management directors, mental health social workers, audiologists, occupational therapists, health care social workers, oral surgeons, supervisors of fire fighters, and dieticians have less than a one percent chance of having their tasks computerized (Frey & Osborn, 2013). It means that with the emergence of the new technologies, professions will witness a shake up such that workers might need to train for other jobs to remain employed. A failure to upgrade and train to acquire new skills may render many people unemployed.

With the current debate on the impact of emerging technologies on job creation or destruction, Brynjolfsson and McAfee (2014) have argued that technology is creating major changes in the workforce. According to Brynjolfsson and McAfee: "technological progress is going to leave behind some people, perhaps even a lot of people, as it races ahead. In their words, there's never been a better time to be a worker with special skills or the right education

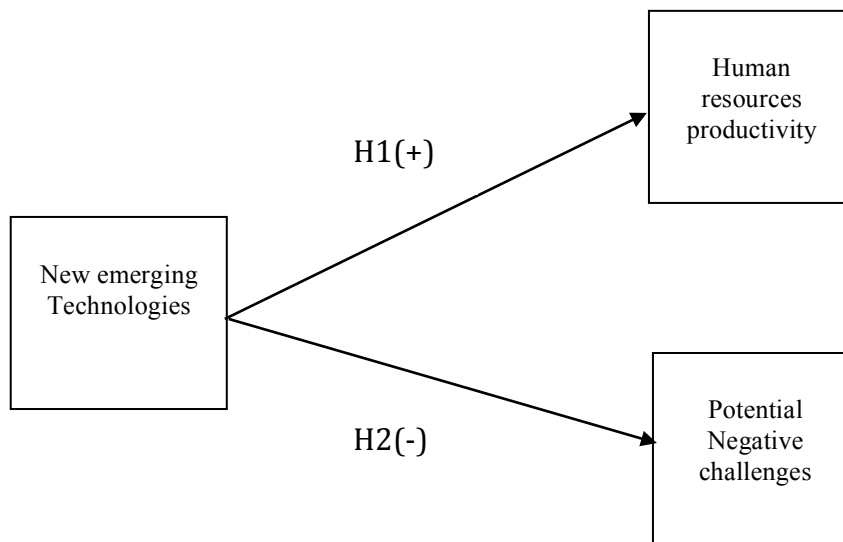
because these people can use technology to create and capture value. However, there's never been a worse time to be a worker with only 'ordinary' skills and abilities to offer, because computers, robots, and other digital technologies are acquiring these skills and abilities at an extraordinary rate (Brynjolfsson & McAfee, 2014).

On the same page with Brynjolfsson and McAfee, Summers in 2014 argued that "if current trends continue, it could well be that a generation from now, a quarter of middle-aged men will be out of work at any given moment." From his perspective, "providing enough work" will be the major economic issue the world will contest (Summers, 2014). West in his writing presumed that emerging technologies might shrink job opportunities in the advanced economies. He summarised his view such that, if developed economies requires fewer workers to complete desired tasks, maybe because few employments of Artificial Intelligence could do these jobs, and benefits are derived primarily through full-time jobs, then there is a danger that many people will find it difficult to get health care, pensions, and the income maintenance required for sustainability(West,2015). Based on these arguments, one could deduce that the adoption of the emerging technologies could positively transform the workforce as well as pose negative challenges around required skills and competences of employees which may lead to unemployment problem in the future. We therefore seconded another hypothesis:

H2: The adoption of new emerging technologies has potential negative challenges.

From the foregoing, review suggests the effects of the new emerging ICT enabled technologies on human resources in term of productivity and potential negative challenges. As conceptualised in Figure 1, the new emerging technologies seems to have positive relationship with human resources' productivity as well as potential negative challenges.

Figure 1 Hypothesized effect of Industry 4.0 on human labour



However, “Industry 4.0” is a convergence of readiness and technologies with promises to restructure the way things are done or produced. This is the next phase in the digitization of the manufacturing sector, propelled by four disruptions: the surprising rise in data volumes, computational power, connectivity, and improvements in transferring digital instructions to the physical world, such as advanced robotics and 3-D printing (emerging technologies) (Baur & Wee, 2015). For Arthur (2011), these emerging technologies have opposing impact on human resources. Accordingly, productivity is increasing such that more output for each person is obtained in the economy, but general output, nationally, requires less people to produce it. As shown in Figure 1 above, it therefore means that as new emerging technologies are improving human resource’s productivity, these technologies are also posing some challenges such as requirements for necessary skills and competencies to operate them and the possibility of taking over some jobs. Failure to meet up with these challenges may mean that some people may lose their jobs and in future, some emerging technologies (AI) might take over some jobs and thereby create unemployment.

3.3 Concluding remarks

To accomplish the main objective of study and answer the research questions to a reasonable extent, this chapter has presented theories to explain how Industry 4.0 functions. The theories such as DC theory was used to analyse the understanding of Industry 4.0 such that the technologies and the enablers of the industry are resources that have capabilities that can improve human resources productivity. Subsequently, some challenges are identified with the

industry. It was established that the use of emerging technologies attributed to Industry 4.0 will bring some structural changes to labour (human resources). It was admitted that it will improve productivity but required skills or competencies for job will change. However, if these challenges are not met, it was noted that it could lead to some potential negative challenges in the future such as loss of job opportunities or unemployment. Nevertheless, review of studies in this chapter have been employed to develop two hypotheses to verify the effect of new emerging technologies and modelled that these technologies will both improve human resources productivity and have potential negative challenges.

CHAPTER FOUR

METHODOLOGY

4.1 Introductory comment

This chapter focuses on the methods used for the study. To conduct a good research, the method used must be suitable and fit for the overall objectives of the study. This is to ascertain the reliability and validity of the outcome of the research. Therefore, this chapter aims at presenting the methods used to collect data and the process of analysis for the research within the framework of Industry 4.0. However, the chapter is set to discuss the research design, the sample selection, data description and coding procedure and analysis.

4.2 Research design

The research strategy adopted in this study is qualitative we adopted qualitative design because the topic area is new and there are no much studies on the research area that could support adequate quantitative data. However, qualitative research comprises the studies' use and gathering of various empirical materials - case study, personal experiences, introspective, life story, interview, observational, historical, interactional, and visual texts- that describes regular and difficult moments and meanings in individuals lives (Denzin & Lincoln, 1994; Patton, 2002). We chose a semi-structured interview for our study and we used interviews to explore and identify developments within the Industry 4.0. Our study concentrates on how new emerging technologies is creating conflicting effects on human resources. Therefore, we used interview method to investigate how emerging technologies shapes productivity and jobs in Industry 4.0, how the emergence of industry 4.0 is changing HRM and how firms can prepare for the challenges of Industry 4.0 in their HRM.

4.3 Sample selection

To pick out participants for this research, we need people that have an idea or versed experience with Industry 4.0, technology and its developments. Therefore, we had to consider sectors that are affected by technological growth. We already know some companies from different collaborations with academic researches through our study program and some companies are commonly known. We start by contacting some companies who further connected us to others they think were relevant. We talked to a managing director of a cluster who gave us internal reports and the different industries in the cluster and their level of Industry 4.0 adoption. We then continued by contacting the different companies. We sampled six

companies in different occupational fields in Norway which are deemed to be operating within the Industry 4.0. They are within manufacturing, refinery, health and an expert. For confidentiality, we coded the six companies as ABC, DEF, GHI, JKL, MNO and XYZ. Among the interviewees includes a professor of ehealth who is an expert in electronic health and healthcare, chief executive officer, R&D managers, engineers and HR managers. However, we believe that the outcome of this investigation is a reasonable representation of the perception of the Industry 4.0. Nevertheless, the idea of Industry 4.0 originated in Germany but we chose to conduct our study in Norway because we believe that Industry 4.0 is ICT enabled with emerging technologies which are also obtainable in Norway.

4.4 Data description

Existing research indicate that new emerging technologies associated with the emergence of the Industry 4.0 have some effects on human resources productivity and efficiency. It is also pointed that these technologies will reshape how human resources will be managed in organizations such as demand for higher competencies as well as potential threats in unemployment. To ensure thoroughness and develop a consistent understanding of Industry 4.0, we reviewed scientific papers as scoping study to identify several developments and related concepts on Industry 4.0. Also, it was specifically used to develop an insight into the effects of emerging technologies within Industry 4.0 on the human resources management. We therefore inspired our interviewees in our main study to report similar developments in their organizations as related to these effects. As related to our research questions, we initiated an interview guide that comprise 29 guiding questions with focus on the following areas:

- Emerging technologies
- Human resources productivity
- Human resource challenges

At first we listed about 15 different companies that we think could have relevance to this topic. We most often start by making calls to their reception and ask for someone that can give us relevant information to this topic. Where the receptionist is unclear, we make specific requests to speak to managers in either IT, R&D or HR departments. In some instances, we search through the company's website to find a person with relevant knowledge to our research. Some companies meant they were either not suitable or too far behind with respect to technological development, some just didn't have the time at all, some came to dead ends, but we succeeded in getting some that were interested willingly or through persuasion. Due to convenience issues

on the part of the interviewees, 2 of the interviews were carried out through the phone while the rest were on site. Nevertheless, Interviewees were briefed ahead of the personal interviews.

We used the interview guide for 6 interviews in 5 days between 21/03/2017 and 29/03/2017 excluding weekends. The interview was spread over few days because we studied organizations from different sectors and therefore it requires that we pre- arrange our interview schedule at different time at different locations. More so, to conduct the interviews, we went through a lot of challenges. It was difficult to book appointment with the interviewees. To do this, we had to send several mails and put many calls across. In some cases, when we arrive at the companies for interview at the scheduled time, the interviewees are not available. We had to make special calls to confirm if the interview will take place or needed to be postponed. Also, an interviewee accepted to be questioned in English but preferred answering in Norwegian. Finally, we could conduct all interviews within the reported time frame, transcribed it and got it ready for analysis.

4.5 Coding procedure and analysis

The collected and transcribed data were analysed using NVIVO software which allows coding statements and deriving new ideas. Using software to code in qualitative research has been popularly used in research (Corbin & Strauss, 2015) to develop an efficient data reduction and increase reliability. First, we conducted data cleaning by extracting useful data for the analysis after transcription. We then uploaded the data into NVIVO to reorganize the data using automatic coding into sentences and paragraphs. Before proper analysis, we used query command to conduct data exploration before coding relevant information in the data into themes.

The deductive qualitative analysis (DQA) approach was used for the study. Creswell and Plano Clark (2007) posit that the deductive researcher “works from the ‘top down’, from a theory to hypotheses, to data to add to or contradict the theory” (p.23). Therefore, to confirm or contradict the proposed hypotheses, we deductively coded data in relation to themes along our theorised research questions to support or reject the hypotheses. We decomposed the interview into data and deductively developed coding statements into sentences and paragraphs. We therefore labelled the paragraphs with close codes from the list of existing themes and we examined the themes to check for ideas and develop sub-themes (axial coding). We then identified how each sub-theme are related to each other (selective coding). We later constructed

narratives from our codes and themes (i.e. quotes from interview to support relationship between ideas). See details in appendix.

Figure 2 Data exploration

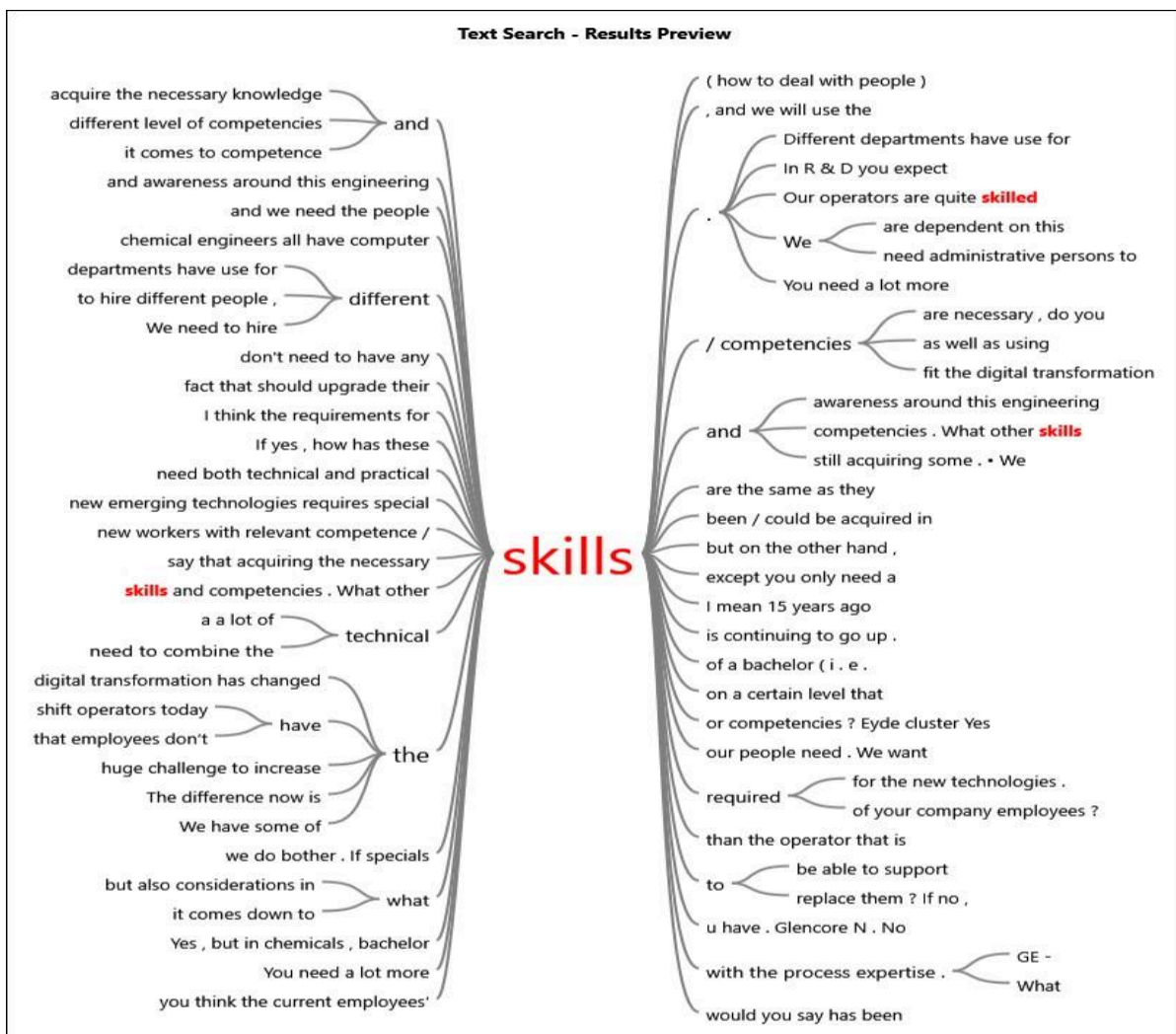


Figure 3 Coding map for coding process

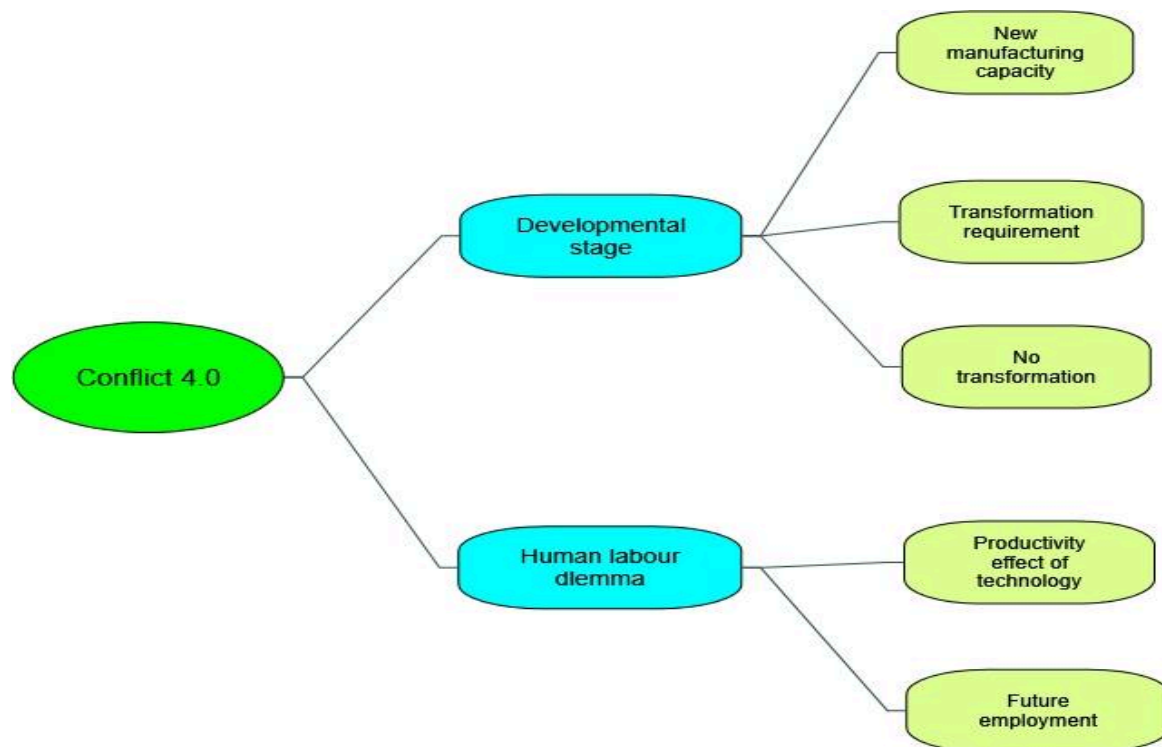


Figure 4 Coding example - Selective code based on Axial codes

Axial codes	Selective code
<p>GHI “To an extent. We are not deep into industry 4.0. We are on the way taking baby steps. We have its strategies that will tell us if we need cloud computing and if we need to change our strategies.”</p> <p>GHI “The robot we have in packaging was put in place in 2014 and it replaced five employees.”</p> <p>XYZ “For certain jobs, we would see that it could exchange some workers. Other jobs it’s hard to see that AI or mathematical models will be better I can’t see that. Certainly, for some jobs.”</p> <p>JKL “I don’t think it has a big effect on jobs yet.”</p> <p>XYZ “We have not reduced employees, but we have more than doubled the productions. So, the output per employee has doubled.”</p>	<p>Superficial conflict</p>

4.6 Concluding remarks

This chapter has considered the methodology used for the study. Experts from 6 companies have been used for the interview and these companies are within manufacturing, refinery, education and health sectors and were all based in Norway. The study used qualitative method with DQA approach for the study. NVIVO software was employed to organize the data and coding process followed. The codes applied are close, axial and selective codes to support or reject the study hypothesis.

CHAPTER FIVE

FINDINGS AND INTERPRETATION

5.1 Introductory remarks

The Industry 4.0 is a system that uses cyber-physical production system such that there is an interphase between human resources and emerging technologies for manufacturing and production of good and services. It uses ICT enabled technologies such as 3D printing, cloud computing, advanced analytics etc. According to this study, we developed a conceptual framework based on theories and literature. We hypothesized that new emerging technologies, the phenomenon of Industry 4.0 will have a positive impact on human resources productivity and at the same time it will have some potential negative threats such as change in job structure and loss of job opportunities. We conducted interview in 6 different companies to investigate our hypotheses and the data provided in the interview described different approaches and views to the developed framework. The next section is focused on each variables of the developed framework for explanation of our findings.

5.2 New emerging technology - Manufacturing capacity and transformation requirement.

The Industry 4.0 is characterised by new technologies combined with human resources technical-knowhow for production or manufacturing of goods and services. The Industry 4.0 operates differently from the traditional manufacturing system and the technology has changed the way human resources managers approach their operations. The response from the companies where we conducted our interviews support this view that Industry 4.0 use modern technologies and these technologies have changed the requirements and capacity for manufacturing and production.

Quotation: ABC *“Everything happens in the computer and it gives you more information than traditional process of what we used to know before.”*

Quotation: ABC *“Some extent. Some of the companies are typically collecting and systemizing data in much broader than they used to do before.”*

Quotation: ABC *“Technology is growing so fast so if u don't prepare your staff for the changes you may be left behind and it is a big risk for most companies.”*

Most companies agree that Industry 4.0 works with new approach and this new orientation is yet to be fully acquired in most organizations. This suggest that the Industry 4.0 is still at the preliminary stage and the Industry is yet to be mature to its full operation. One of the reasons

for these claims is that most organisations do not have the technologies required to enable the digitization process of the Industry 4.0. Therefore, it appears that some organizations have not even started what is called Industry 4.0 or the fourth industrial revolution.

Quotation: JKL *“when you look at the experts and consultants, there are many of them together with companies that are talking about this Industry 4.0 but they don’t understand it. At Least they are not able to convert the theoretical technology part into practical solution.”*

Quotation: GHI *“To an extent. We are not deep into Industry 4.0. We are on the way taking baby steps. We have its strategies that will tell us if we need cloud computing and if we need to change our strategies”.*

Our study suggests that some companies believe that some of the activities of Industry 4.0 will only be achieved in the future.

Quotation: MNO *“Not a lot today but in the future, everything will be based on that.”*

In summary, our findings show that while some companies have attained the operations of Industry 4.0, most organizations have not even started. Our study revealed that many consultants have been hearing and talking about the Industry in theory but they have not operated in practice. It is evident in our study that the industry 4.0 has not been in operation in full as most people will think. It shows that it is an Industry to come into full operation in the next couple of years. While some companies have not understood the industry let alone operating in it, it is evident that few companies understood the industry and have been operating in its dynamics. They have experienced its positive impact on human labour in term of productivity and potential threats which will be discussed in the next two sections.

5.3 Human resources productivity - The productivity effect of technology

According to our study, most of the companies that granted interview with us confirmed that the technologies within the Industry 4.0 have positive impact on human resources productivity. It means that with the use of the new technologies within the Industry 4.0, work is easier done at a faster pace than what is obtainable in the traditional manufacturing or the third industrial revolution.

Quotation: DEF *“Yes, it made people more productive”*

Quotation: MNO *“Yes, save more time, and increase efficiency.”*

We conducted interview with different types of companies and as such, we got a bit of different perspectives of responses on the impact of emerging technologies on human labour. Some companies with the manufacturing orientation believe that Robots have a better working ability than human labour and have the potential to do more jobs than humans.

Quotation: DEF *“It is more efficient to do Robotic tasks which is highly programed.”*

Quotation: GHI *“Machines are cheaper than human labour.”*

In the health sector, it seems the technology required to improve productivity was not understood as Robots. It was generally understood as modern technology. The response in this sector confirmed that modern technologies would make nurses more productive at work.

Quotation: MNO *“Yes, then one nurse can attend to many patients at the same time and now we are much involved in using modern technology to improve productivity.”*

Quotation: MNO *“There is growth in aging population so we need the advancement in technology to make nurse more efficient.”*

Our results show that the emerging technologies as related to the Industry 4.0 has a positive productivity effect on human resources. What we identified from our study correlates with the notion of Shukla and Vijay (2013). In their assertion, the development of new technologies like Artificial Intelligence (AI) has positive impact on human resource productivity. They believe that Artificial Intelligence refers to “machines that respond to stimulation consistent with traditional responses from humans, given the human capacity for contemplation, judgment and intention” (Shukla & Vijay 2013). We found that the level of technological input required in the Industry 4.0 demand sophisticated human resources skills that enables what Robots or Artificial Intelligence required. In summary, we found that the Industry 4.0 has the capacity to improve on human resources productivity but its operations requires the use of technologies that warrants new skills. These requirements in human resources seems to be disruptive in the sense that as its attainment will bring fulfilment of the Industry, the inability to attain it poses a potential threat to human resources. In the next section, we shall present and discuss our results on how the Industry 4.0 warrants new operational needs and poses potential threats to human labour.

5.4. Potential negative challenges - Potential threats to human labour

One major reason why our study was conducted is to investigate whether Industry 4.0 is truly a development which has more positive contribution or its unwanted effects will render it unnecessary. Our study indicates that there are different views on the industry as it affects human labour. We identified that there are few things that looks like threats to the Industry:

- Necessary skills
- Future employment problem

5.4.1 Necessary skills

Although our study suggest that Industry 4.0 has positive contributions. The technologies associated with the industry have been said to have positive impact on human labour in term of efficiency and effectiveness. Yet, the use of these technologies does not come automatically. There are necessary skills required of the human labour found within the industry. Our study show that for Industry 4.0 to be achieved, the necessary skills required to operate or work with the ICT enabled technologies must be acquired. It means that without the skills required by the employees in organizations in the industry, Industry 4.0 is unachievable.

Quotation: GHI *“The person taking care of our robots was working here before and lately in the last few years got the assignment to be able to handle these machines. So, this person had to acquire the necessary knowledge and skills.”*

Quotation: XYZ *“We upskill existing engineers.”*

In the above quotes, our study evidently show that the Industry 4.0 came with skill requirement threat. From interviewee’s responses, it is affirmed that even though employees who have already been working in their organizations will need to learn new ways of handling the emerging technologies associated with Industry 4.0. It means that failure to acquire these skills may not enable them to fit in to the organizations’ operations. It means for the organizations involved to minimise their spending on hiring new staffs and save time, existing staffs or workers should be trained.

Quotation: ABC *“People with 30yrs of seniority are not versed with these new technologies, so you can’t just push them to the side. You should retrain them and re-educate them.”*

To train these employees, our study indicates that there are different requirements to be met. Some companies think that education in term of higher qualification is necessary and some believe that new employees are required at the expense of the incompetent ones. It is also evident that the threat is not limited to the decision of the organizations’ management but also the employees have their choice to make if they think that acquiring the needed skills is cumbersome. Some of these employees leaves their jobs to do other things and some decides to remain with their organizations and get the required training.

Quotation: JKL *“We both employ new people and retrain the ones we have. We also connect to partners that we have in the industry with suppliers that specializes on this.”*

Quotation: DEF *“Generally, yes we demand a higher qualification than before but not specifically qualification in terms of degrees.”*

XYZ *“You can utilize general engineers and teach these guys into the new subjects if they have the motivation.”*

Quotation: XYZ *“Yes, some people change and do other things. Most workers are updated.”*

We discovered that the Industry 4.0 is a threat to human labour when it comes to acquiring the necessary skills either to remain in job or find appropriate job within the industry. From our study, we realized that employees in some organizations cannot just meet up with the required skills due to their level of knowledge acquisition. Therefore, they rather leave their present job and move to another profession entirely. To an extent, it seems some job applicants might find it difficult to get themselves a job to do because they could not meet up with what is required. To these group of people, what the Industry 4.0 brought is a threat.

Quotation: ABC *“They evaluate what they have as competence gap and what is it that is missing for them to achieve those goals in a way that they know that they cannot fulfil their goals if they don't have the competence to do it.”*

Quotation: ABC *“It must be a good match between the education that is given to the new people who is coming into the job market to find new ways.”*

Quotation: JLK *“We need to combine the technical skills with the process expertise.”*

5.4.2 Future employment problem

Our results suggest that there are two dimensions to the understanding of the potential threat which the Industry 4.0 poses on the human labour in term of future employment debate. First, a set of companies we interviewed believe that there is no threat (skill requirements) brought about by the industry when it comes to job opportunities for now but in the future, it might be so. Second, the other set of companies think that the emergence of the Industry 4.0 has had effect as of today, has been creating and will create employment problem in the future if the necessary requirements are not met by the employees as well as the organizations themselves. Going by the first notion, some interviewees indicate that the Industry 4.0 has not affected or effect any change. They think that as it stands, Industry 4.0 has no significant effect on human labour and may not still affect anything in the future:

Quotation: DEF *“I don't think I need to have special competence to understand the technology, I just need to update myself and find what i need and learn it.”*

Quotation: JKL *“I don't think it has a big effect on jobs yet.”*

Quotation: XYZ *“We have not reduced employees, but we have more than doubled the productions. So, the output per employee has doubled.”*

Contrary to these responses, the second notion according to our results indicate that some companies believe that Industry 4.0 is already in operation and has had significant effect on human labour in term of unemployment. Also, results show that while some companies believe that the impact is much, some believe that it is still at the minimum. Results indicate that those companies which understood the operations of Industry 4.0 or have been operating in the industry could tell their story better than those who have not operated in the industry. The companies understood what Robots mean and what it could do. They identified that it is cheaper to produce with these machines than using humans.

Quotation: GHI *“The robot we have in packaging was put in place in 2014 and it replaced five employees.”*

Quotation: ABC *“Even if the value of the company is growing, it decreases the number of people in the company.”*

Quotation: DEF *“We had 1700 people but today it is 550. In the next 15 years, it might reduce to 400. We using more machines in place for humans in areas that are dangerous to work.”*

In addition to the two main dimensions from which the interviewed companies viewed the potential threat to human labour, results also show that the companies admit that not all jobs will be affected by the threat posed by Industry 4.0 in term of unemployment. We found that while some jobs will be affected using the emerging technologies, some jobs will still need people with their natural ability.

Quotation: XYZ *“For certain jobs, we would see that it could exchange some workers. Other jobs it’s hard to see that AI or mathematical models will be better I can’t see that. Certainly, for some jobs.”*

Quotation: JKL *“In general, we would need people more in many areas. For example, the people with Fagbrev will be needed for maintenance.”*

Going by the results, we identified that some companies don’t understand the operations of the industry yet. Some of the companies we interviewed were guessing the operation and could not talk specifically about what the industry entails. They think that most of their suspicions will take place in the future. On this case, we deduce and summarise that the Industry 4.0 is not at full operation and still developing.

Developmental stage

Quotation: GHI *“To an extent. We are not deep into industry 4.0. We are on the way taking baby steps. We have its strategies that will tell us if we need cloud computing and if we need to change our strategies.”*

Quotation: JKL *“I don’t think it has a big effect on jobs yet.”*

Furthermore, we identified that these companies had opposing views on the impact of emerging technologies on human labour. While some companies affirmed that the emergence of Industry 4.0 has improved labour productivity and reduced number of employees, some companies claimed that it has improved productivity but has not reduced the employees in their organization. We also found that while some companies claimed that the industry has not affected employment in their organizations, they agreed that it has affected employees in some job areas and in some companies. Our results show that while some jobs will be needing employees, some jobs will be laying them off. We found that it is not only because the organizations will employ machines in place of human labour but because the employees will be required to acquire necessary skills to operate. Results indicate that motivated employees might be willing to get trained and remain with their organizations while unmotivated ones might decide to look for another profession. It is also evident that when the competence gap in the employees could not meet with the required skills, it would make employees look for another profession since they cannot cope with the pace required by the operations of Industry 4.0. The results indicate that whether an organization will retrain and retain an employee depends on employee’s motivation, competence gap and the readiness of the organization itself. We therefore abridged and deduce that the Industry 4.0 with its associated technologies may pose threat on labour employment and might throw labour into dilemma.

Human Labour Dilemma

Quotation: GHI *“The robot we have in packaging was put in place in 2014 and it replaced five employees.”*

Quotation: XYZ *“For certain jobs, we would see that it could exchange some workers. Other jobs it’s hard to see that AI or mathematical models will be better I can’t see that. Certainly, for some jobs.”*

Quotation: XYZ *“We have not reduced employees, but we have more than doubled the productions. So, the output per employee has doubled.”*

In summary, we identified that the Industry 4.0 requires that employees can upgrade themselves to the requirements of the new emerging technologies. Also, we found out that while some companies are already operating in the Industry 4.0 and has experienced the major effects of the industry on human labour in term of improved productivity and potential threat (future employment problem), some companies are opposed to this development. For instance, companies XYZ and JKL think that Industry 4.0 has not reduced the number of employees in

their organizations while companies: ABC, GEF and GHI says it does reduce the number of employees in their organizations. In this situation, we condensed both ‘developmental stage’ and ‘human labour dilemma’ and we deduce that the Industry 4.0 is not fully understood today and believe it is ‘conflicting’.

Superficial conflict

Quotation: GHI *“The robot we have in packaging was put in place in 2014 and it replaced five employees.”*

Quotation: JKL *“I don’t think it has a big effect on jobs yet.”*

Quotation: XYZ *“We have not reduced employees, but we have more than doubled the productions. So, the output per employee has doubled.”*

Consequently, our results indicate that the Industry 4.0 operates with modern technologies like advanced Robots and it is cheaper than human labour. Results show that the use of these technologies improves labour productivity and has penitential threats. From the results, we identified that the industry is still developing and embedded in it disharmony and we construe that the Industry 4.0 is superficially conflicting.

5.5 Concluding remarks

This chapter has presented, analysed and interpreted the study results. In section 5.2, it analysed the understanding of the new emerging technologies in term of manufacturing capacity and transformation requirements of the Industry 4.0. In section 5.3, it analyses how the associated technologies in the Industry 4.0 affects human resources productivity. The section further analysed the industry requirements and future employment effect. The results indicate that the Industry 4.0 is still at the developing stage as well as threatening to human labour. In summary, this chapter concludes that the Industry 4.0 is superficially conflicting.

CHAPTER SIX

DISCUSSION, SUMMARY AND CONCLUDING COMMENTS, LIMITATIONS AND SUGGESTIONS FOR FURTHER RESEARCH

6.1 Introductory remarks

After the analysis of data and interpretation of results in chapter five, this chapter presents the discussion of the study, summary and concluding comments, and limitations and suggestions for further studies.

6.2 Discussion

We offer the logical analysis of the effect of the new emerging technologies as associated with Industry 4.0 on human resources. In section 5.2, our results showed that the Industry 4.0 is characterized by new technologies combined with human resources technical-knowhow. It shows the impact of emerging technologies on human resources productivity and the potential negative challenges to human resources. The proposed hypothesis, H1 states that the emergence of new technologies will increase human resources productivity is confirmed by our study result in section 5.3. Our results show that the emerging technologies as associated to the Industry 4.0 has a positive productivity effect on human resources. Also, hypothesis H2 states that the adoption of new emerging technologies has potential negative challenges is confirmed in section 5.4. We identified that the necessary skills required of employees and the future employment problem if the required skills are not met may constitute a potential threat to human resources.

The analysis of our results indicate that the Industry 4.0 combines the use of modern technologies with human resources skills to produce or manufacture and deliver goods and services to the consumers. The sampled companies in our study revealed that the operations of the Industry 4.0 happen within the ICT enabled platforms and these technologies has changed the requirements and the capacity for manufacturing and production. Accordingly, Industry 4.0 is not a system operated by one separate technology, but by the combination of numbers of technological progress whose measured effects collectively create new ways of production (Schmidt et al., 2015). Our results indicate that the Industry 4.0 is still at the preliminary stage because most companies have not been able to acquire and put in place necessary technologies. For example, company GHI sampled in our study in section 5.2 confirmed that they are not yet matured into the Industry 4.0 because they are yet to acquire technology enabler called cloud

computing. Based on this assertion, our result correlates with Schuh et al. (2014) who observed that the new ICT enabled technologies associated with Industry 4.0, e.g. sensor technology, robotics, 3D printing etc., are expensive investments, still in the development process and have not yet have optimal impact. Based on these opinions, we believe that the Industry 4.0 is still in progress and not yet matured.

As predicted in hypothesis, H1, our results supported the notion that new emerging technologies increases human resources productivity. The companies in our sample confirmed that these modern technologies made people more productive. In some cases, the companies claimed that the use of these technologies save work time and increase efficiency. Going by these stand points, we identified with literature that the emergence of ICT enabled technologies as linked with Industry 4.0 have positive effect on human resources productivity. We support this claim based on Thames and Schaefer (2016) with the notion that the new emerging technologies that empowers machine-to-human collaboration and supportive product comprehension, a reflection of advanced manufacturing and industrial processes are the new realities connected with Industry 4.0. Therefore, the adoption and adaptation to the operations of Industry 4.0 will result in extraordinary levels of working efficiencies and enhanced progress in productivity (Thames & Schaefer, 2016). Based on our results and literature, we posit that the Industry 4.0 has a positive and improved productivity effect on human resources.

Although, our results indicate that Industry 4.0 has positive effect on human resources yet, we identified that there are potential threats with negative impact on human resources. From our results in section 5.4.1, the level of technological involvement in the Industry 4.0 demand sophisticated human resources skills that enables what Robots or Artificial Intelligence required. Most companies sampled in our study provide evidence that the Industry 4.0 came with skill requirement threat. They noted that for their existing employees to fit into the operations of the Industry 4.0, required skills for operating the ICT enabled technologies must be acquired. Failure to train or be trained for these skills threatens the job positions of the employees who could not meet up. This implies that the employee who is not motivated to train for these skills will move to other jobs to remain employed. This according to Frey & Osborn (2013) indicate that with the emergence of new technologies in the Industry 4.0, professions will experience a shift such that workers might need to train for other jobs to remain employed. However, whether an employee will train or not depends on how well the employee is motivated either by his or her organization or self-motivated. Nevertheless, getting another job by moving to other profession has never been easy and automatic. It therefore

means that the skill requirement effect of the emerging technologies may threaten human resources.

As noted that the operations of the Industry 4.0 required special skills and might become a threat to human resources if not met, we also identified that there are dichotomies among the companies we sampled. Some companies believe that there is no threat brought about by skill requirement while some companies think that failure to meet with the required skills will affect employees on the job. On one hand for example, company JKL in section 5.4.2 think that no potential threat is associated with skill requirement attributed to the Industry 4.0 and has not affected human resources in terms of reduced job opportunities. On the other hand, companies: ABC, DEF and GHI in the same section of our results confirmed that the use of new technologies with its required skill requirements as linked with the Industry 4.0 have significantly affected human resources negatively. They claimed that even though company value increases, these technologies have reduced the number of employees and will continue to do so in the future. Company XYZ in our result believe that associated technologies in the Industry 4.0 will only affect some jobs while other jobs will not be affected. From the forgoing, our result is synonymous to a vague argument found with West (2015) who believe that it is difficult to be certain about the evolving trends of the Industry 4.0 because one cannot be sure of how new technologies will affect different jobs. Based on West's opinion and the analysis of our results, we believe that the true operation of Industry 4.0 is yet to be accomplished.

In line with literature, we established in our study that the Industry 4.0 operates with expansive and new ICT enabled technologies (West, 2015). Conforming to our first hypothesis we confirmed that new emerging technologies as attributed to the Industry 4.0 have positive impact on human resources (Brynjolfsson & McAfee, 2014; Rotman,2013). Our study indicates that the associated technologies in the Industry 4.0 improves human resources productivity and is cheaper to use than using human beings. Second, we hypothesized that the new emerging technologies found with Industry 4.0 have potential negative effects on human resources. Accordingly, we confirmed the second hypothesis as put forward. Although, our results show that there is no unanimous opinion that the technologies linked with Industry 4.0 have negative threat. We identified that while some employees in some job areas would experience it as a threat, our study confirmed that some companies in our sample did not foresee any threat. Even though we tend to support the second hypothesis that the use of new emerging technologies in the Industry 4.0 have potential negative effect, our judgement is that the Industry 4.0 as a phenomenon is at a development stage and superficially conflicting. It seems while the Industry

4.0 is still under investigation, there are indications that it has both positive and negative impact on human resources. Like Shukla and Vijay (2013), Artificial Intelligence has become sophisticated and enhanced automation process but has the potential to destroy, if not change many professional jobs. Based on these assumptions, we believe that the dynamics of Industry 4.0 could be likened to a ‘necessary evil’.

6.3 Summary and concluding comments

The Industry 4.0 is a new phenomenon and still attracting more research interest. Even though there are few research in this area, we developed an empirical study on the phenomenon to contribute to the existing knowledge of the industry. We built on the prevailing literature to investigate the effect of new emerging technologies on human resources as associated with Industry 4.0. We conducted a semi structured interview on six companies from different sectors to collect data for our study. With NVIVO, we coded and analysed our data into coding statements. We showed that new emerging technologies have positive effect on human resources productivity. Also, our results indicate that new emerging technologies have a potential negative threat to human resources in term of job opportunities in the future. Our results suggest that the dynamics of the Industry 4.0 is still at the development stage and conflicting.

Finally we believe that paper contributes to existing studies in the following ways. First, we analysed the Industry 4.0 to determine its operations. We identified that the industry is associated with new ICT enabled technologies and we developed hypothesis from literature to investigate the effects of these technologies by providing empirical views that enable us to identify the dynamics of the Industry 4.0. Secondly, we conducted interview in six companies to gain practical understanding of the dynamics of the Industry 4.0 in regards to the extent to which the industry could be qualified. We identified that even though the Industry 4.0 has significant positive contributions, there are potential negative challenges associated with it. In summary, our study helped to identify that the Industry 4.0 could best be described as a ‘necessary evil’.

6.4 Limitations and suggestions for further research

In an ideal situation, we think that this study would best be conducted in a country like Germany where the idea of the Industry 4.0 is more popular to understand. Hence, we feel that

carrying out our research in Norway could be a weakness since the best of understanding of the Industry 4.0 may not be attained. As it was a hassle finding the right companies, we therefore think it is possible that the data collected during our interview may not be one hundred percent reliable. Also, we believe that change is inevitable and therefore, time and new developments is a limitation to our study. It means that in future, other research may prove that our result did not hold. Despite the suspected weaknesses, the strength associated with our study is that we have focused our interview on the appropriate companies within the Industry 4.0 and process our data with the right software to ascertain the validity of our study. Subsequently, we have not incurred significant expenses to collect our data. Also, we have interpreted our results and analysed the interpretation to avoid biases. Based on our results and the limitation of the study, we suggest that a similar research should be carried out in a country or countries well known for the practices of the Industry 4.0 to authenticate our results. We suggest that larger population of companies within Industry 4.0 should be sampled to increase the reliability of our study results. Also, if the Industry 4.0 is truly a necessary evil, more research studies should be carried out on how to turn its evil trace around to take advantage of innovation.

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APPENDIX

REFLECTION NOTE – Andy Cerika

Discussion of the findings

We offer the logical analysis of the effect of the new emerging technologies as associated with Industry 4.0 on human resources. In section 5.2, our results showed that the Industry 4.0 is characterized by new technologies combined with human resources technical-knowhow. It shows the impact of emerging technologies on human resources productivity and the potential negative challenges to human resources. The proposed hypothesis, H1 which states that the emergence of new technologies will increase human resources productivity is confirmed by our study result in section 5.3. Our results show that the emerging technologies as associated to the Industry 4.0 has a positive productivity effect on human resources. Also, hypothesis H2 which states that the adoption of new emerging technologies has potential negative challenges is confirmed in section 5.4. We identified that the necessary skills required of employees and the future employment problem if the required skills are not met may constitute a potential threat to human resources.

The analysis of our results indicate that the Industry 4.0 combines the use of modern technologies with human resources skills to produce or manufacture and deliver goods and services to the consumers. The sampled companies in our study revealed that the operations of the Industry 4.0 happen within the ICT enabled platforms and these technologies has changed the requirements and the capacity for manufacturing and production. Accordingly, Industry 4.0 is not a system operated by one separate technology, but by the combination of numbers of technological progress whose measured effects collectively create new ways of production (Schmidt et al., 2015). Our results indicate that the Industry 4.0 is still at the preliminary stage because most companies have not been able to acquire and put in place necessary technologies. For example, company GHI sampled in our study in section 5.2 confirmed that they are not yet matured into the Industry 4.0 because they are yet to acquire technology enabler called cloud computing. Based on this assertion, our result correlates with Schuh et al. (2014) who observed that the new ICT enabled technologies associated with Industry 4.0, e.g. sensor technology, robotics, 3D printing etc., are expensive investments, still in the development process and have not yet have optimal impact. Based on these opinions, we believe that the Industry 4.0 is still in progress and not yet matured. Although there are positive impacts of industry 4.0, we have indications of negative impacts. Human resources skills are necessary for the enabling of

Robots and artificial intelligence. We see the threat of skill requirement while the present employees need to update.

Conclusion

Our study focuses on companies at the firm level as unit of analysis. Our findings indicate that a dynamic relationship between modern technologies and human resources are very essential for improved productivity. Nevertheless, our findings cannot be divulged from internationalization process of the firms. Going by our discussion, the industry 4.0 operates with expansive ICT enabled technologies which enhances connectivity between or among firms within and outside an environment. For instance, the use of 3D or additive manufacturing allows a buyer to customise a product from a different geographical location and produce without physical presence at the manufacturing plant. In this case, we identified that Industry 4.0 is a phenomenon that can improve the internationalization process of firms. The internationalization process of the firm itself is an innovation for the firm. Besides this, if according to our results, as claimed by some firms in our study that the associated technologies within Industry 4.0 reduces the number of human labour input and increase company value in term of improved productivity, then it is logical and proper to say this is an innovation for the firm to compete and sustain competitive advantage. Our findings also indicate that to fit into the operations of the Industry 4.0, companies or firms must acquire technology enablers (ICT enabled) and train employees to acquire necessary skills. In some cases, firms would have to employ new qualified workers to be able to meet the demand of the operations of the Industry 4.0. This innovative response is both self-motivation for the organization and a motivation for the employees and this is nothing but accountability or responsibility on the part of the companies we have studied.

In summary, we identified that unmotivated firms or employees would find it a challenge to adapt to the operations of the Industry 4.0. Nevertheless, if the Industry 4.0 has the potential to reduce the increasing need for human labour and can still help to improve productivity, then the question is that what happens to the displaced workers? If the argument is that the industry will make employees move to other jobs, can those jobs continue to accommodate them? On this note, we identify that there is a gap to fill. Our concern is that truly, the Industry 4.0 will improve internationalization process, increase innovation and enable accountability or responsibility but left a gap open. We assume that if technology could continue to replace human labour in some jobs and make employees to move to other

professions, then a time is coming when those jobs will not be able to accommodate the displaced workers any more. Ethically, one could argue that as much as it is an innovation that modern technologies have positive effect on business, it also has negative impact on human labour as well as the environment. For instance, the amount of energy released to the environment has certain green effect. We therefore think that studies should be conducted on this development to provide solution to the potential negative effect of the Industry 4.0 to find a balance.

In addition to the above, we can specifically identify that companies we looked into as mentioned in the codes are all operating in the international arena. Our central aspect here is the emerging technology which does not only affects all these companies in terms of growth and productivity but also the level and quality of human resources they require. To remain sustainable, companies need to focus acquiring the required competence while some are constantly upgrading employees. In another aspect, we could ask the question of what do we do with the people that will loss their jobs to robots in the future? In Finland, the government has started to put in place what we call the minimum wage rate for all their citizens though it is still under political debate. Government policies are also going to be central on how to create new and sustainable jobs. Governments have to also build on a school system that will give the right tools to the youths to be able to approach the future demand from employers.

As technologies continue to emerge, so are companies searching for more innovative ways of going about with their businesses. In order to be innovative, companies need the innovative capacity which involves having the right design for their framework and the necessary technical know how for their operations. The gap is the issue that is slowing down the emergence of the term industry 4.0. There is lack of the right infrastructure and skills required to embrace this technology. We identify a gap analysis that companies need to carry out in order to know employees competence, what needs to be done and how they can be allocated so as to improve efficiency and productivity.

We looked into dynamic capability theory in relation to resources based view that enhances the aspects of firms thriving to continuously improve and gain competitive advantage. In this study, we talked with a digital director who emphasized on the importance of continuous improving and updating to keep up with latest trends and demands. He furthers that it is his responsibility to make sure that the firms digital strategy is implemented and failure to do so we leave slow and backwards and consequently out of business in the fast pace technological era.

Interview Questions

Section 1

About company

- a) Industry
- b) Company/organizational size
 - (0-10), (11-50), (51-100), (101-500), (1001-5000), (5001+)

About participant

- a) Highest qualification
- b) Current position/profession
- c) Number of years of work experience in the position
- d) Number of years of work experience in total
- e) Other positions

Section 2

1. Questions about emerging technologies as related to industry 4.0

- a) What is your understanding of the new emerging technologies?
- b) How would you describe a company operating within industry 4.0?
- c) What is the relevance of information communication technology(ICT) within the industry 4.0?
- d) Would you say human resource information management system (HRIMs) is part of the emerging technologies?
 - If yes, explain
 - If not, why?
- e) What other technologies do you think could be regarded as emerging technologies within industry 4.0?
- f) Has digital transformation taken place in your company?
- g) What is your understanding of Artificial Intelligence such as Robotics etc
- h) Have you employed the use of Artificial Intelligence/sophisticated ICT enabled technologies in your company?
- g) What level of automation or digital transformation has taken place in your company?
 - 25% automated
 - 50% automated
 - 75% automated
 - 100% automated
 - Not at all
- i) What would you say enables a company to function in the industry 4.0 environment?

2. Questions about Human Resources Productivity in industry 4.0

- a) Do you think that HRIMs/other ICT enabled technologies (digital transformation) will improve employees' productivity?
 - If yes, how?
 - If not, why?
- c) Would you say that the use of the new emerging technologies requires special skills or competencies?
 - If yes, how has these skills been/could be acquired in your company?
 - If not, why are the skills not required?
- d) If special skills/competencies are necessary, do you think this will have contributory (dynamic capability effect) impact on employees' productivity?
- e) Would you say that acquiring the necessary skills/competencies as well as using the ICT enabled technologies make your company industry 4.0 ready?
 - If yes, explain
 - If not, why do you think so?

3. Questions about human resource challenges as related to industry 4.0

- a) Do you think digital transformation has changed the skills required of your company employees?
- b) If answer to question "a" is yes, do you think the current employees' skills/competencies fit the digital transformation in your company?
- c) From your own experience, would you say that the employment of new technologies demands higher qualifications from your employees?
- d) What other skills would you say has been required of your employees to adapt to the effect of digital transformation in your company?
- e) Do you think Artificial Intelligence is more job efficient than humans?
 - If yes, how?
 - If not, justify your opinion.
- e) If answer to question d is yes, has automation/digital transformation reduced or increased the number of employees in your company?
- f) Can you say automation/digital transformation is creating more job positions or eliminating some job positions in your company?
 - If yes, how?
 - If no, explain this basis.
- g) Has digital transformation taken away some jobs in your company?
 - If yes, do you employ new workers with relevant competence/skills to replace them?
 - If no, what do you do to keep them in their job positions?
- h) If digital transformation has been making some employees irrelevant in some job positions,
would you say it has also been making them change their job roles?
- i) In general, how do you think digital transformation (use of emerging technologies) is

affecting job opportunities/employment in your company?

- It has been creating job opportunities more than it is destroying them and thereby creating employment.
- It has been destroying job opportunities more than it is creating them and thereby causing unemployment.
- It has neither created nor destroyed job opportunities as well as no effect on employment and unemployment.
- Can't really say.
- Additional comment.....

j) Do you foresee emerging technologies such as Robots taking over many jobs in the future?

k) If the answer to the question above is yes, how do you think these emerging technologies will make you look at employment opportunities?

l) Do you think full automation is achievable in the future?

m) If the answer to the question above is yes, do you think there is hope for human labour?

If

you think there is no hope, what do you think will happen? Do you also agree with the technology guru, Elon Musk that there will be universal basic income in the future?

Automatic coding for Interview on Industry 4.0

EMERGING TECHNOLOGIES

What is your understanding of the new emerging technologies?

ABC Whether you call it 4th industrial revolution or u call it digitalisation. For me it is still sort of a part of evolution. From my understanding, it is sort of technological change but the change is faster than before. This is also what we call disruptive technology which changes the whole value chain in businesses and that is seen to happen much faster than expected. What we see here is the pace and how the change is coming.

DEF It is technologies in markets which are growing fast, like batteries for instance emerging technologies could be something inside fish farming. There is a lot of technology in fish farming, but it is not industry 4.0

GHI With respect to my practice, that will be considering human relations systems and the salary systems. They are developments of these systems very much connected to rules and regulations.

JKL As we are talking about Industry 4.0, I think at least in our industry, there are evolving some potentials to increase the precision in our production and to reduce cost and to increase safety which is a major part of our focus.

MNO New technologies and how these new technologies can be used in health-related situations. The use of modern technologies to become more efficient using internet of things and coming up with brilliant ideas to see if it will improve patients' lives.

XYZ New development of technologies and technologies that is not existed before.

How would you describe a company operating within industry 4.0?

ABC It is very difficult. It depends so much on the type of business they do and the technology level they working at.

DEF For me emerging technologies is not the same as industry 4.0. Industry 4.0 is more about robots making productions without people. Where robots communicate with each other.

GHI Robotic packing, we are thinking of making new production processes that will be much 4.0 oriented.

JKL There would be some indicators, that would tell if they are making use of the industry 4.0. Like Efficiency production (just in time principle/lean production). If lean production is clearer when it comes to that you can see that is is lean when it comes to efficiency and spare parts and maintenance and so on, then you can say that Industry 4.0 is a part of it.

MNO A company in health operating in industry 4.0 or internet of things is plug and play sensors and functionalities. Some of them are based on industry standards.

XYZ The main thing is the focus on keeping up to date on the different types of techniques/technologies it could be additive manufacturing, Cloud systems, type of apps. The main thing is to take on board the new technology within the digital area that will benefit the company to increase customer value and company value. Whether better customer support, increase efficiency.

What is the relevance of information communication technology(ICT) within the industry 4.0?

ABC Yes, it is very relevant for industry 4.0. You can see that in business dealing with services, everything can be fixed via the telephone and these types of platforms and are becoming more and more automatic as well. This mostly happens in a way that the sorting on your mobile phone or what is seen on your display is due to the choices you made before. It happens without us taking an active choice.

DEF Response not relevant.

GHI Yes. we now have a new position where we looking for a content manager to take care of communication between internal workers and the external environment and tap through different social media platforms that we are a part of.

JKL I would say it's very relevant. I think that to be able to utilize to potential of Industry 4.0, you need to have good communication technologies because all

the components are collaborating with each other and on a much higher advanced level than earlier.

MNO Absolutely. When sensors register data at a patient, this data be seen and understood by the doctor or the nurse so they can understand what is going on and take actions if needed. We need important data security and we need to be able to store and analyse data.

XYZ That is a part of the Industry 4.0. Some would see this as the infrastructure. It's the servers, it's the wifi system, it's the pcs, it's the programs with the latest functionality, the infrastructure and the basis to be able to utilise the industry 4.0. Therefore, it is relevant.

Would you say human resource information management system (HRIMs) is part of the emerging technologies?

If yes, explain

If not, why?

ABC I think that the way businesses handle human resources as this change emerge is a very crucial part and two levels. (1) to always be aware that there are new opportunities where they can take new technology into account and be more competitive so that your business survives (2) risk that technology is growing so fast so if u don't prepare your staff for the changes u maybe left behind and it is a big risk for most companies.

DEF Response not relevant.

GHI Yes

JKL Yes Absolutely. Because it is part of the same thing we talked about in the previous question, when it comes to assets management, I mean like lean production, the human resources are also a part of it.

MNO Yes I think this is related to ICT which are important to get information from one end to the other and well stored and secured.

XYZ No response.

What other technologies do you think could be regarded as emerging technologies within industry 4.0?

ABC Big data, intelligent sensors, traditional type automation such as robotics, technical security (cyber security) and he referred to these as the main ones. Computer capacity (machine vision), this is a form of artificial intelligence.

DEF Robotics, I have a narrow view of it. Look at the technologies used in the hospital. If they can build a heart using the computer, that is industry 4.0.

GHI Robotics, cloud technology, sensors, Artificial intelligence.

- JKL** I will relate it to our industry, where we have more advanced censoring technologies. We are doing some mapping here on how new technologies can be useful for us. We see a lot of potential already and different things that can be used to give us a benefit compared to only 5 years ago. This is about sensors, measurements systems and intelligence systems and so on. clouding might be part of the phrase Industry 4.0. it's a part of our company, but it feels more like old technology because we are not considering any new exciting technology within clouding.
- MNO** There is a lot of products available in the market to collect medical data. Here the regulations are very important. Absolutely every type of technology has been used by vendors so we have quite advanced products but the issue is if they abide to regulations and security.
- XYZ** I said additive manufacturing/3d printing, data collection/big data analytics which someone call every data, advanced mathematics, advanced statistics, visualization, individualization (customization).

Has digital transformation taken place in your company?

- ABC** To a little extend. So far, we are still at the preparation phase.
- DEF** No relevant answer
- GHI** A little bit yes.
- JKL** Yes absolutely. We are employing the use of digital transformation and we are in the middle of it.
- MNO** Companies in the health sector don't have these competences within this domain. They will need people with high competences and people with medical technology expertise and will need to contact a clearinghouse to have the technologic equipment certified as a product. There is a clear and secured network that is digital in Norway. So yes, we have a lot of digital transformation but it is still growing.
- GE-Healthcare** Big question, it's more a journey and we are on it. We are in this transformation and we have been there for 10 years and we have 10-15 more years in the journey.

What is your understanding of Artificial Intelligence such as Robotics etc.

- ABC** You can by collecting, systemising and using data that you collect. You can put this into algorithms that consisting of more than the traditional physics or chemistry model that you making, you can make a more like mathematical and sophisticated where you can use the data that can use the data that you collecting which is not necessarily directly linked to your process. Everything happens in the computer and it gives you more information than traditional process of what we used to know before.
- DEF** Making robots talk to each other in a framework. What they use in IBM. what insurance companies using to find out about their clients when clients call. They people didn't want to be disturbed when they were having dinner to discuss insurance so they had to make a computer to do that. Today it is used

to find out things we know. This artificial intelligence mostly used to find the answers to obvious questions and the get obvious answers.

GHI

A computer that thinks for me

JKL

To say it simple, I would say: I call it collaborating systems or machinery that either teach themselves things like improving models and soft control and so on. Or maybe utilises resources based on models that are created in the process of production.

MNO

Its smartness, its reasoning. Today we have a lot of sensors that can measure something that push through the value to you. A physical activity, a medical element etc. in the future, the equipment itself will have artificial intelligence and smartness which will report information from its observation. That's something we are highly working on right now.

XYZ

For me it's kind of mathematical model that could be made or developed as it goes along, but the AI can take a unit/computer that has some sort of mathematical model that you can feed with data so that you would be handled to get out sensible and usable information. Flex IBM Watson Like you ask questions and the more info it gathers, the better it can utilise and give answers.

Have you employed the use of Artificial Intelligence/sophisticated ICT enabled technologies in your company?

ABC

To some extent. Some of the companies are typically collecting and systemizing data in much broader than they used to do before. We have two companies that are quite advanced in collecting data for this.

DEF

No. that is as far as I know.

GHI

The robots that packs our products I think they have AI.

JKL

Yes we are

MNO

Not a lot today but in the future, everything will be based on that.

XYZ

We have a model at the site, where we have centres that give info into a model and the computer take this numbers and bring out sensible information.

What level of automation or digital transformation has taken place in your company?

25% automated

50% automated

75% automated

100% automated

Not at all

JKL

Its hard to say. If we talk about the whole area of industry 4.0 i would say maybe 10%. We have done a lot and benefited very distinctly from it, but we have a

lot of potential to develop further, but we need is the development competence. We need to combine the technical skills with the process expertise.

XYZ It's hard to put a number because you need to have a base. For example, we have doubled the production in 6-7 years and we have used quite a lot of automation to do that. So I couldn't put a figure on it.

What would you say enables a company to function in the industry 4.0 environment?

ABC I think we should compare b2b and it's also a matter of being aware. It is also important to be forward leaning in that case. It depends and varies from country to country but it is much important to use new technology to the processes to be better. If one of the companies are advancing in a technology, I urge them to share with other companies that are not so advanced so they can improve.

DEF No response

GHI In the production department i think there is much out there that we can get into our company.

JKL No response

MNO For now, most companies in the health sector are using database connected high tech.

XYZ Keeping up to date with different type of techniques like additive manufacturing and having the necessary type of technologies that I mentioned before.

HUMAN RESOURCES PRODUCTIVITY

Do you think that HRIMs/other ICT enabled technologies (digital transformation) will improve employees' productivity?

If yes, how?

If not, why?

ABC Yes. I think it is one of the basic things we have been working on for several years what we call lean technology. Try to be as efficient as possible. Part of lean technology is to get the people are the workshop to bring a culture where you are becoming more productive instead of one manager trying to decide. In a way to use the experience of the people to find solutions.

DEF All information has always been available to everyone but not on the cell phones but on their computers and it has been so for more than 20years. So, that is not very new. Yes, it made people more productive. And we are still getting new sensors and improving them but I think it's the quality of the information which counts and not that we get it at the same time. It doesn't matter if Donald Trump tweeted bullshit and we saw it at the same time. It is the quality of the information that matters.

GHI Yes.

- JKL** Yes I would say so. Because I believe in “The Toyota production model”, which have been bases for a lot of production philosophies in most of the big companies in the world. It is a core principle there, about releasing the individual potential in human beings. I’m talking about the guys on the floor that benefits from their potential of being intelligent human beings. And i think that the evolving technology within I4.0 is a good tool to facilitate that principle.
- MNO** Not the technology itself. Technology will allow me to push forward data. But this is going to be overload of information, that's why we need a smartness in the sensor. We will also need smartness in what i call backend services in the healthcare perspective. We have a software that u just press on your finger, it measures your pulse value and the oxygen concentration in the blood. Then this information is transmitted to a tablet, and then to a telemedical central database. And the central, a dedicated nurse will be watching the values. And will translate the information. The nurse will need to look at the value and have a video conference with the nurse every day. The nurse will use about half an hour to consider the electronic data, medical data and evaluate the patient and write down medicals.
- XYZ** Yes, the machines can do more. We remove manual transaction to give the people more complex work. That is kind of the automation side, but also we gather quite a lot of data into data basis and we apply statistics and mathematics and visualisation of the data for people to do less and different things to give more efficiency and customer output.

Would you say that the use of the new emerging technologies requires special skills or competencies?

- ABC** Yes I think so, even if you have artificial intelligence, you still need intelligence of the people that are working there.
- DEF** There are many things I don't understand with new technologies. It is a lot more specialised, it is getting many more niches and it is more and more impossible to follow up. I don't think I need to have special competence to understand the technology, I just need to update myself and find what i need and learn it. We have people working in a plant that I think are the world’s best. They have travelled and learn and are specialised in what they are doing. They have learned ethical and theoretical aspects that i can say they are better than veterans.
- GHI** Yes, partly we need better competencies for those that will program these machines.
- JKL** I think we see difference in the generations. The older operator is not as adaptable to the new era. We have talked a lot about that in our company on how we should support the older generation of operators and maintenance people. But the younger ones are even maybe pushing this technology even further, and they gladly accept to work with this new technology that we provide.
- MNO** Yes it does.
- XYZ** Yes it does. But You can utilize general engineers and teach these guys into the new subjects if they have the motivation.

If yes, how has these skills been/could be acquired in your company?

- ABC** First I think it is a very difficult balance the company itself must be aware what sort of competence do we need to bring to our employees to be sure that they adapt to this change smoothly. Since in my view, it is an evolution, it's not a huge change overnight that you don't need the employees. I think the employees are going to be critical for the change. And, to mature the change all the time, and I think that companies need to focus on the company needs of the employees
- DEF** No response.
- GHI** The person taking care of our robots was working here before and lately in the last few years got the assignment to be able to handle this machines. So, this person had to acquire the necessary knowledge and skills. We are dependent on this person that the robots are working because the robots have different functions and he should program them accordingly.
- JKL** Yes if we are talking about the ability to put into use new possibilities. But there is a lot of challenges when it comes to competence and skills. You need a lot more skills than the operator that is using it. It's a huge challenge to increase the skills and awareness around this engineering skills to be able to support a development here and achieving the potential here. Also, when you look at the experts and consultants, there are many of them together with companies that are talking about this Industry 4.0 but they don't understand it. At Least they are not able to convert the theoretical technology part into practical solution. We have some of the skills and still acquiring some. • We both employ new people and retrain the ones we have. We also connect to partners that we have in the industry with suppliers that specializes on this. We also work with Universities like NTNU in Trondheim. Lastly we also have these industry platform cooperation networks that we work with, even UiA. We have gained a lot, but we are unsure of what we should do next with the cluster. Because we shouldn't just continue doing the same thing repeatedly.
- MNO** But that's not the thing for us. It's the smart that can bring out all this information through a device. There will be a health care person behind the scenes that can read this information and take contacts when needed. Here their workload will be reduced and the smartness will take most of their work load. So, in a way I think the nurse will be more productive. There is growth in aging population so we need the advancement in technology to make nurse more efficient. The goal is that the patient can be independent by using artificial intelligence without needing a doctor and the doctor can only come into play when special needs arise. You as the health care personnel will attain to more people because what you can see will be tailored to your preferences and needs.
- XYZ** We buy from computer consulting companies; we upskill existing engineers. So, we do bother.

If special skills/competencies are necessary, do you think this will have a contributory (dynamic capability effect) impact on employees' Productivity?

- ABC** Yes. from my experience in Norway there is a strong bond between the employees and company politics and you need to be sure that you are in the same boat with the employees and the owners of the company.
- DEF** No response.
- GHI** The guy with these competencies is not necessarily more productive but the whole value chain is more productive with the use of robots.
- JKL** I don't think it's enough to be I4.0 ready. When we consider the potential of Industry 4.0, we quickly realized that there are kind of a significant difference between our industry (metal and mining) and other basic manufacturing industries further down the value stream like car industry. For them it's possible to automate everything, and not many people are needed. We have some of that in our company too, BUT, we have a lot of different processes that are open and very manual. We have a great need for people to operate our processes and to use the brain to decide how to change and control the process.
- MNO** Yes, then one nurse can attend to many patients at the same time and now we are much involved in using modern technology to improve productivity. We also want the patients to be as independent as possible.
- XYZ** Yes, Yes, Yes.

Would you say that acquiring the necessary skills/competencies as well as using the ICT enabled technologies make your company industry 4.0 ready?

If yes, explain

If not, why do you think so?

- ABC** Yes, I think company awareness of itself and how to re-educate your people and what sort of competence you can bring in the company is crucial but it is also the fact that it is important that employees are being re-educated. People with 30 years of seniority are not versed with these new technologies, so you can just push them to the side. You should retrain them and re-educate them.
- DEF** Well we have some departments that are industry 2.0 and some industry 4.0. Some parts of the company have a lot of people which looks like industry 1.0.
- GHI** To an extent. We are not deep into industry 4.0. We are on the way taking baby steps. We have its strategies that will tell us if we need cloud computing and if we need to change our strategies.
- JKL** We need more than just competencies. We need to develop technology with elements of Industry 4.0 and that is a huge challenge for us. We do some of it. What we need is the development competence. We need to combine the technical skills with the process expertise. What we do is very complicated processes and it has never been automated in the whole world. You cannot just go to a supplier and ask for a more intelligent system, because it is not possible. We spend a lot of time on measuring technologies and sensors.

MNO Yes, save more time, and increase efficiency
XYZ Yes but in combination with the right technologies.

HUMAN RESOURCE CHALLENGES

Do you think digital transformation has changed the skills required of your company employees?

ABC Yes. it is happening faster and faster. It has been the problem in the last 10yrs in that employees don't have the skills required for the new technologies. You need to hire some people that knows this technology but at the same time you need to train the current employees.

DEF Yes, the shift operators today have the skills of a bachelor (i.e. what a bachelor knew 10-20 years ago).

GHI Not yet, but I think it will happen, especially within the production department. If we want to acquire a new employee, we have different requirements that we had before. Not only that the potential employee is knowledgeable able the food industry but also that you have a special technical competence because these machine and robots need more understanding that normally.

JKL I would say it has changed in the last 10 years. Both when it come to the actual defined tasks that the operators are doing but also considerations in what skills our people need. We want to have people that are technically enabled and they can harvest the potential of new technology when we provide it. We are clear on when we decide competence requirements.

MNO I'm not sure. Because the current nurses and doctors have already have updated technological knowledge. Everything in medicine is very high tech. So, the doctors and nurse constantly update themselves to the present equipment. The challenge is the user friendliness of the data and accumulating data is most important.

ZYZ I have been working for more than 30 years and it has been a continuous change through all these years. This is because technology has changed. I took my master thesis 35 years ago and it was to construct a computer. So, it has been a continuous upskilling all the time.

If answer to question "a" is yes, do you think the current employees' skills/competencies fit the digital transformation in your company?

ABC No I don't think so. We have made two programs that creates awareness of new technologies and we are training our middle management to be aware of these new technologies. We are also working on programs that will give after education to the employees of the companies.

DEF Not all, some will retire, some will quit, some need to need on their way. Sometimes we should employ others.

- GHI** Both yes and no. I think our younger employees are more ready to tackle digitalisation challenges than the older.
- JKL** I see it from two perspectives. We can talk about the people in the production like the main people like operators and process responsible and maintenance people. On the other side, we have the engineering environment and the chain that are developing and installing these technologies. I would say yes for the both perspectives.
- MNO** Yes. but then also need to constantly update themselves with respect to speed of technology and if there is a new equipment.
- XYZ** No, we need to upskill. And we need to hire some new ones as well.

From your own experience, would you say that the employment of new technologies demands higher qualifications from your employees?

- ABC** In general yes, in traditional sense yes. I think the requirements for skills is continuing to go up. People from the old educational systems don't have the capability to adapt to this new technology and therefore there is a gap between the young people that are more available of the technology that is happening and people with seniority that are used to doing the traditional work. I also agree that we have an older mass of people that will slow implementation of the technology to some extent.
- DEF** Yes, but in chemicals, bachelor skills are the same as they were 20 years ago to some extent. For me the point with having a master or a PhD is not the qualification but the ability to learn. You are not working with the things you had in school. What is required to run an operation today is not the same as the requirements 20 years ago. Generally, yes we demand a higher qualification than before but not specifically qualification in terms of degrees.
- GHI** Yes. the requirements we need before and those now are not the same. Yes, we also need higher qualifications than before. We have workers in the production department that don't have any form of qualification. So, their competency must be improved.
- JKL** From the first perspective I don't think we have higher formal requirements but we are clearer defining higher competence requirements that we did not have before. We also look for people that have mindset to convert the new technology into actual working systems. In our industry, we need people that are smart because of the complicated processes. It's not like the car manufacturing. We need people to contribute with their knowledge. It is a lot of technical skills. Our operators are quite skilled and have very high competencies. On the other side, the engineering side. We require more competence in this area now than we did before. I am very clear on what competence I am looking for when hiring someone. This has changed significantly the last 10 years. We have other engineering departments in this company that are not looking for industry 4.0 requirements but we have high requirement when it comes to formal (education) and competence experience.
- MNO** Yes absolutely. Medicine is high tech and it has been like that since 1980 and has only grown ever since.

XYZ We have been after master and doctors and bachelors all the time. We need to hire different skills I mean 15 years ago we didn't have the same education as we have today. In Norway, we need to hire different people, different skills but on the other hand, many of the engineers we had 20 years ago have taken up to study and upgrade themselves about computerised systems so they are able for example mechanical and chemical engineers all have computer skills on a certain level that before. So, it is still the same but for the fact that should upgrade their skills and competencies.

What other skills would you say has been required of your employees to adapt to the effect of digital transformation in your company?

ABC When you asked the question I turn to think of the technical part of it. It is difficult to answer. We made a program where a group of young workers and students will try to find out for us what sort of knowledge and capabilities we need to have that we are not aware of today. Today we are very much focused on technical aspects but I agree that probably through time we will be more focused on other factors in human resource than what we have done traditionally. Over time, we will value more factors within the human resource then we did traditionally. It probably also because the reactions to the changes in technology will be more disruptive so it requires a new mindset of managers.

DEF Ability to follow the rules, work safely which is more important today as nobody cared about it 25 years ago. Ability to work together with other people is more important today (interpersonal communication, team work) not all jobs but most, ability to be versatile, know how to do many different jobs. Like operators need to understand theory so if something goes wrong they will understand what is wrong. They need both technical and practical skills. Different departments have use for different skills. In R&D you expect more creativity that in operations. But we don't need everyone to be creative. It would be chaotic if we have 10 creative people going around.

GHI We are looking more for attitude and personality depending on what kind of job you want to do. Now we want to employ a content manager, we are looking for someone that is good at considering social platforms in different arenas where we will market the company. We need someone that is good in writing and is also good in finding tales in the company and publishing them out. Generally, it depends on where you will work, and what attitude or values you have.

JKL I think this is different from production and the engineering people. But for the production people I think it is a lot about the phrase "curiosity". If you are curious, you would try to improve things and understand things. If you don't have it, you are most likely not a good operator here. On the other side (engineering), we look for people that can identify the potential and define and decide the tasks to do. We need them who can do this but also convert this down to one specific task. We like them who can start something, but also finish something.

MNO I think there will be more teamwork in the health sector. The nurses will need to get the information but they will need to be in contact with a research team to translate what it means and what to do in future and make decisions. The

technical competence added too. Nurses must be good in analysing the complicated and coded information. They must also be able to communicate well with the patients. Ability to have a good overview and can use new technologies. There was talk if we need a technical nurse. Yes, we might need someone with a technical skill to put the equipment in place and repair but that's is just most of the as the equipment and its reading will do the rest. Sometimes this equipment need reprogramming. Something we don't need top management to do. There is also upgrading that is needed by the technical personnel.

XYZ In our company we have always needed creativity. We have the dedication, the systematic guys and the creative guys. We also need the entrepreneurial guys and we need the people skills (how to deal with people). We need you to be able to communicate between employees. Because normally we get results from relations. Without relations between people, we don't get results (team). So, if you have people that are low on communication and people building, it is tougher to get good results.

Do you think Artificial Intelligence is more job efficient than humans?

If yes, how?

If not, justify your opinion.

ABC No clue. What we see is that in some technical areas it will do it faster and better than humans. But I solving task that are made specifically for some people may be harder (many customized tasks).

DEF It will be in many cases in the future. But I think it is very limited. It is more efficient to do robotic tasks which is highly program. Someone has made the programs. But it depends on the activity.

GHI Yes and no. we have departments that should deal with people like HR department and we have manufacturing areas that should deal with people and machines. So, it is a combination of the two. In some places, it could be easier to have machines than humans. Machines are cheaper than human labour. We must also have people that can carter for the machines and run them. The robot we have in packaging was put in place in 2014 and it replaced five employees.

JKL In our industry it helps us a lot. Our processes are complicated chemically. Lean production i our industry is about getting the processes under control and it's very difficult because it's very dangerous and we cannot automate it at this point. AI can be used to support our decisions better at the right time. We must take the decisions, not the system because the system cannot decide the mix of raw materials. It would be more efficient for the processes. It not the same in our industry compared to the manufacturing. Out target is not to reduce the workforce, but to increase precision. But in our manufacturing facilities one goal is to reduce manning, which means that AI is more efficient there.

MNO Yes, in the future and you can see right now when you are doing big data and so on. The system analyses use large amount of information and make it useful and I believe it can do it better than the doctors. If technology can be smarter

than humans we still need humans to use this information in different time and space.

XYZ Yes and no. For certain jobs, we would see that it could exchange some workers. Other jobs it's hard to see that AI or mathematical models will be better I can't see that. Certainly, for some jobs.

If answer to question d is yes, has automation/digital transformation reduced or increased the number of employees in your company?

ABC Yes, over time we should, to be more competitive. Even if the value of the company is growing, it decreases the number of people in the company.

DEF We have not laid off people for 10 years. Over the last 30 years, we had 1700 people but today it is 550. In the next 15 years, it might reduce to 400. We using more machines in place for humans in areas that are dangerous to work.

GHI It has reduced the number of employees

JKL I don't think it has a big effect on jobs yet. At least not in production. In engineering environment, we have more people now that are working with technology related to I4.0. It has created more job positions in our company for now. Maybe it will be different in the future. In manufacturing in our company, I don't think we have reduced many/any jobs. But it's a possibility in the future when we benefit from it. I have been around in companies around in Germany and Europe. I have been looking in factories and plants, car industries and manufacturing industry for spare parts for different purposes. And, many of the biggest companies that need to benefit from the lean production. My personal observation is that the suggestion that I4.0 will reduce many jobs is wrong. It reminds me a lot on the time in the 80s and 90s where internet came, where everybody said work would be lost. But now we see more work than ever. I think I4.0 will need people more than ever before. The difference now is the skills, and we will use the people in a different way. We will challenge them more.... But we need them. In general, we would need people more in many areas. For example, the people with Fagbrev will be needed for maintenance. We need to be better to plan and reduce risk when it come to the spare parts. People are a cost element but there are many other processes that are much costlier.

MNO In the health sector technology has not reduced the number of jobs. In the health sector, the challenge is to more efficient. There is becoming older people. The health sector is needing more people than ever before therefore the challenge is to be more efficient.

XYZ We have not reduced employees, but we have more than doubled the productions. So, the output per employee has doubled

Can you say automation/digital transformation is creating more job positions or eliminating some job positions in your company?

If yes, how?

If no, explain this basis.

- ABC** To some extent yes. But not necessary in the company itself. I think what is more typical is that you require more and more competent suppliers. Instead of having all the knowledge inside the company, you will be able to get some special knowledge from the suppliers. We need to work with Universities and innovation companies that is helping you to develop the new products. The value that you creating for a company is broader in the circumference today compared to earlier. But the value creation may be bigger in total even there is less people inside the company.
- DEF** Yes. it has created new needs. Industry 4.0 needs a lot more maintenance of dealing with the process and the machines. The maintenance crew increases, those who look after electricity, cables, network increases but in total the number of jobs will reduce.
- GHI** It is eliminating jobs
- JKL** No response
- MNO** I don't think so. There are a lot of biomedical and technical engineers in the health sector today. When I start in the 70s there were very few biomedical engineers but today there are many of them. The municipalities don't have the competencies but the vendors do. So, they need to consider them for competencies.
- XYZ** Yes, like my position. We made a digital department with 7 people starting 1st of march and heading that.

Has digital transformation taken away some jobs in your company?

If yes, do you employ new workers with relevant competence/skills to replace them?

If no, what do you do to keep them in their job positions?

- ABC** From earlier, it has been to train the people that are there. It depends a little bit on the technology as well. For example, one of our companies have a goal for the next five years. They then do a gap analysis of the employees to see what they lack. They evaluate what they have as competence gap and what is it that is missing for them to achieve those goals in a way that they know that they cannot fulfil their goals if they don't have the competence to do it. Then it's a matter of evaluating the type of competence. Is it something that they bring from outside or something that the build inside. Most often it is to train the people that they have. I think to be systematic and build on the competence of what they already have is very important. I did not start my job inside digitalisation. So, through time, my job has changed. Now i am looking at this in a much broader perspective. The job change, is a lot of learning for me.

- DEF** We do both (employ new and retrain old).
- GHI** Yes, it has also created new positions. Like now we have a new position for a content manager. Both. we train some and we acquire some new workers. We don't just fire people like that. Most people make efforts to acquire the necessary additional competencies with respect to their jobs.
- JKL** No response
- MNO** No I don't think so. Workers just need to update themselves with new technology. Sometimes we need a technical nurse in special equipment instalments. Like I said healthcare has always been high-tech.
- XYZ** I guess so but I can't remember... we have removed some jobs because functions have changed. The technology has changed but I don't remember anyone right now.

If digital transformation has been making some employees irrelevant in some job positions, would you say it has also been making them change their job roles?

- ABC** Interesting question. Because it is more what the employee would like. But it is very often the employee that does not want to change.
- DEF** Yes, this happens all the time. And they are willing to change.
- GHI** No, here it's not a lot of people that are changing job roles.
- JKL** Yes I would say so, but it's hard for me to connect it to Industry 4.0.
- MNO** Most people are specialised in different functions and at the same time the know the most. Nurses don't just change position. The can only with upgrade of their competence. So yes, there is a shift to higher requirement or competence from nurses but very little.
- XYZ** Yes some people change and do other things. Most workers are updated

In general, how do you think digital transformation (use of emerging technologies) is affecting job opportunities/employment in your company?

It has been creating job opportunities more than it is destroying them and thereby creating employment.

It has been destroying job opportunities more than it is creating them and thereby causing unemployment.

It has neither created nor destroyed job opportunities as well as no effect on employment and unemployment.

Can't say.

Additional comment...:

- ABC** Being a little bit optimistic, i believe that we are creating more jobs in a more sustainable manner, but there is always a risk that you don't need all the workforce available. It must be a good match between the education that is

given to the new people who is coming into the job market to find new ways. The more traditional way was that you did educate yourself to go into a certain job where you would use the knowledge for some time, now the change is going so much faster that I think you need to look on the education as well. Make the system more robust and flexible so that you can adapt to changes in a better way. I think that Universities also need to look at to give more flexibility to the students. The study must be combined with some experience with the related work life through the study time. So, that when you go through your education, you have spent some time in real industries or banks etc. To learn how the business is developing as well as you fill in the academic theory. It is very important to make a gap between what is happening in business and what is happening on the academic side. The ideal way is that every year, students are being involved with companies to get a broader understanding of what is happening in real life. The link between companies and Universities is much more necessary now than before.

DEF No response

GHI No response

JKL No response

MNO No response

XYZ It has not destroyed opportunities in our company. It has created some positions but I can't say it took away some jobs. We have always needed skilled people at different levels.

Do you foresee emerging technologies such as Robots taking over many jobs in the future?

ABC I think robots will continue to take more jobs since now we are still in the starting phase. But it will depend on how fast it is growing and how quick we manage to create other types of jobs.

DEF No response

GHI Yes.

JKL Not in our company.

MNO Not in the health sector. We still need many hands. Technology has been highly used by use for many years now but despite that we have always needed hands and nurses to interpret and manage and even make the right decisions with the information. We can also use technology to advance research.

XYZ Yes. Robots and mathematical models (AI). Today it's more mathematical models, in the future we will call it artificial intelligence.

If the answer to the question above is yes, how do you think these emerging technologies will make you look at employment Opportunities?

ABC It will depend on how fast it is growing and how quick we manage to create other types of jobs.

DEF No response

GHI There will be lesser people being employed

JKL No response

- MNO** In the health sector, there is less focus on reducing workers. It's more focus on making them more efficient with use of technology.
- XYZ** Yes. If you go back in time, when Ford made his car factory the employment increased hugely. When technology changes, those who become down skilled get difficulties in the job market. But if you see uber, you down skill work position as we don't need any taxi specifications as u have and app. With uber you just should be nice guy, you don't need to have any skills except you only need a driver's license. Before they needed to know all the maps and everything in their heads. But now all that is in the apps. So, you get down skilling and there are still a lot of jobs on that and u get upskilling and u get jobs too. So, it is tough to say whether we will have jobs.

Do you think full automation is achievable in the future?

- ABC** Not as long as I am working here. I think even in 30 years, may be misunderstood
- DEF** Yes, I think full automation is achievable within 20 years. For me full automation means humans overseeing the machines.
- GHI** No. we will always need to have departmental managers and different human related functions
- JKL** No I don't think so. For some manufacturing industries that have minimum stress on the equipment, they could be close to it, but not fully.
- MNO** Yes. a lot is fully automated. A lot of companies are pushing on robotic technology. But like I said, it depends on the place and the type of use. In some places, full automation is needed and it is achievable.
- XYZ** No...if you are going to develop things, you can't just get a robot to have new things to do. Ideas creativity and you must see things a couple them in a human brain as you must consider all sorts of things. Today i don't foresee that we have any mathematical artificial intelligence models that will have the possibility of being creative on that level. Not yet anyways. I don't see that there will be models and machines that can be creative. So, we need the human brains.

If the answer to the question above is yes, do you think there is hope for human labour?

- ABC** Yes there is hope for human labour. Politics will play a major part and especially in taxing. In Norway, a big political dilemma arises when the unemployment rate reaches 5%. I don't think Norway is ready for a society with unemployment rate at 20% if that happens in the future.
- DEF** Yes. because as i said it needs maintenance, it needs operating, it needs programing, it needs troubleshooting, it needs control and bureaucracy. It's a natural cycle. Some quit and retire while we employ new. Typical 30-40 people quit a year. I think jobs inside games, entertainment, tourism, health, mathematics.
- GHI** There is hope for human labour.
- JKL** Absolutely

- MNO** Yes. in the health sector, we need different levels of support and different levels of competence.
- XYZ** I think there is. There is a lot that mathematical models cannot do that human labour is doing.

Do you also agree with the technology guru, Elon Musk that there will be universal basic income in the future?

- ABC** It's a little about what I said about taxing robots and so on. It is very difficult to say this on a global level but typically for a company like Norway "Borgelønn" (basic income), which has been tested in Finland as well, ensures that people still have a living. Ideally I think we should not separate people that are unemployed from people that are highly paid with top jobs. We should find a balance. The financial system must change. We will also have to give a creative foundation to people so they must do something.
- DEF** I don't know, it sounds nice. You get a basic income if u doing something or not because the machine is doing it. Taxes is one aspect although people aspire to become richer.
- GHI** I am not sure.
- JKL** I'm not sure, theoretically it has a potential. But I don't know if it is possible. Because if you don't have anything to do, you would become depressed etc. but if it is socially acceptable to be unemployed, then it can be possible. You are touching in some moral challenges. Looking at the society in total, Elon Musk may be right when it comes to the total use of people (it will go down). Then it can be a solution.
- MNO** In the healthcare sector. I don't think so. We need people with different level of competencies and skills. We need administrative persons to take different decisions at different levels. The challenges for the health sector is the bureaucracy that should be reduced.
- XYZ** "Venstre" have been arguing for this for 30 years. It might be a good thing to do. Instead of having 10-15% social welfare, we could have a basic salary to everyone. So, that is a possibility. Also, if we consider the people that are unable to work or the disabled, we can generally say this could be a good idea.

What is your future educational/job advice?

- ABC** Today some jobs are more secure than others like in healthcare, teaching. But at the end of the day it comes down to what skills u have.
- DEF** No response
- GHI** We need to be creative. If you consider the numbers you see that many unemployed have got new and creative things to do. People who lost their jobs last year have different things they are doing right now. So, there is a circulation in the job market. First you should find something you are passionate about. But to be on the safe side, do something inside health, or study mathematics, IT, physics. We must follow the law. By law pension age is 70. We cannot send a person away when the person is not retired yet. But

this is a business so if your position needs and additional competence then you should get it.

JKL

I have done that, and I usually say that you should follow your interest to a level of where you can become an expert. We want people with master's degrees and PhD. Being a specialist to a certain level is good. There is a huge difference between a bachelor and a master degree holder. However, we are talking about the human aspects. There is one thing that I observed and it seems like people tend to forget it when talking about Industry4.0. You should make an argument around the supporting industries. One thing is the companies, but all the consultant, experts and supplier that are in the market, they are very important to develop this and convert it from theory to practice. Germany have had a huge development in the supporting industries. There is an increasing need for people in the supporting industries. Remember that implementing everything is more challenging and costly. That is something to consider.

MNO

No comment

XYZ

I am holding lectures in this at different secondary and high schools. I have done these 4 times and that is where I am today. Stay if you can at school to skill you up. But on the other hand, you need to follow your dreams, but education is very important. You should also have a plan B if that doesn't work without it you are done. It is possible to be a musician and artist but it takes enormous amount of energy and dedication than to go to school and it is only a few that does that. Stay in school if you can afford or take a fagbrev (certified skill). Without education, you are very likely to be unemployed. Today there are 7 times the number of applicants for unskilled jobs in Norway than they are for skilled jobs. So, get a skill or fagbrev, if you don't do that you are open for not having a job.

B. Coding Results

Close codes for RQ1

Close codes	Properties	Participants words
Productivity effect Of Technology	New technology improved human labour performance	DEF "Yes, it made people more productive" MNO "So, in a way I think the nurse will be more productive" MNO "There is growth in aging population so we need the advancement in technology to make nurse more efficient." MNO "Yes, save more time, and increase efficiency." DEF "It is more efficient to do robotic tasks which is highly program."

		MNO “Yes, then one nurse can attend to many patients at the same time and now we are much involved in using modern technology to improve productivity.”
Future employment	Potential threats to human labour in term of job opportunities	<p>JKL “We have a great need for people to operate our processes and to use the brain to decide how to change and control the process.”</p> <p>GHI “Machines are cheaper than human labour.”</p> <p>GHI “The robot we have in packaging was put in place in 2014 and it replaced five employees.”</p> <p>ABC “Even if the value of the company is growing, it decreases the number of people in the company.”</p> <p>DEF “We had 1700 people but today it is 550. In the next 15 years, it might reduce to 400. We using more machines in place for humans in areas that are dangerous to work.”</p> <p>GHI “It has reduced the number of employees.”</p> <p>XYZ “For certain jobs, we would see that it could exchange some workers. Other jobs it’s hard to see that AI or mathematical models will be better I can't see that. Certainly, for some jobs.”</p> <p>ABC “Even if the value of the company is growing, it decreases the number of people in the company.”</p> <p>JKL “In general, we would need people more in many areas. For example, the people with Fagbrev will be needed for maintenance.”</p>

Close code for RQ2

Close codes	Properties	Participants words
New manufacturing capacity	How Industry 4.0 works	JKL “We need people to contribute with their knowledge. It is a lot of technical skills. Our operators are quite skilled and have very high competencies.”

		<p>ABC “Technology is growing so fast so if u don't prepare your staff for the changes u maybe left behind and it is a big risk for most companies.”</p> <p>ABC “Everything happens in the computer and it gives you more information than traditional process of what we used to know before.”</p> <p>ABC “Some extent. Some of the companies are typically collecting and systemizing data in much broader than they used to do before.”</p> <p>JKL “It is a core principle there, about releasing the individual potential in human beings.”</p> <p>GHI “Yes, partly we need better competencies for those that will program these machines.”</p> <p>MNO “The goal is that the patient can be independent by using artificial intelligence without needing a doctor and the doctor can only come into play when special needs arise.”</p> <p>JKL “I would say it has changed in the last 10 years. Both when it come to the actual defined tasks that the operators are doing but also considerations in what skills our people need.”</p> <p>ABC “People from the old educational systems don’t have the capability to adapt to this new technology and therefore there is a gap between the young people that are more available of the technology that is happening and people with seniority that are used to doing the traditional work.”</p> <p>DEF “Yes. it has created new needs. Industry 4.0 needs a lot more maintenance of dealing with the process and the machines.”</p> <p>DEF “Ability to follow the rules, work safely which is more important today as nobody cared about it 25 years ago.”</p> <p>ABC “Yes. I think it is one of the basic things we have been working on for several years what we call lean technology. Try to be as efficient as possible. Part of lean technology is to get the people are the workshop to bring a culture where you are becoming more productive instead of one manager trying to decide.”</p>
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Close codes for RQ3

Close codes	Properties	Participants words
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<p>Transformation and requirements</p>	<p>What Industry 4.0 has effected and its operational input</p>	<p>XYZ “You can utilize general engineers and teach these guys into the new subjects if they have the motivation.”</p> <p>GHI “The person taking care of our robots was working here before and lately in the last few years got the assignment to be able to handle this machines. So, this person had to acquire the necessary knowledge and skills.”</p> <p>JKL “We both employ new people and retrain the ones we have. We also connect to partners that we have in the industry with suppliers that specializes on this.”</p> <p>XYZ “We upskill existing engineers.”</p> <p>ABC “People with 30yrs of seniority are not versed with these new technologies, so you can’t just push them to the side. You should retrain them and re-educate them.”</p> <p>JLK “We need to combine the technical skills with the process expertise.”</p> <p>DEF “Generally, yes we demand a higher qualification than before but not specifically qualification in terms of degrees.”</p> <p>ABC “They evaluate what they have as competence gap and what is it that is missing for them to achieve those goals in a way that they know that they cannot fulfil their goals if they don't have the competence to do it.”</p> <p>XYZ “Yes, some people change and do other things. Most workers are updated.”</p> <p>ABC “It must be a good match between the education that is given to the new people who is coming into the job market to find new ways.”</p> <p>ABC “I think that Universities also need to look at to give more flexibility to the students. The study must be combined with some experience with the related work life through the study time. So, that when you go through your education, you have spent some time in real industries or banks etc.”</p>
<p>No transformation</p>	<p>How Industry 4.0 has been exaggerated</p>	<p>MNO “Not a lot today but in the future, everything will be based on that.”</p> <p>DEF “No. that is as far as I know.”</p> <p>DEF “I don't think I need to have special competence to understand the technology, I just need to update myself and find what i need and learn it.”</p> <p>JKL “when you look at the experts and consultants, there are</p>

		<p>many of them together with companies that are talking about this Industry 4.0 but they don't understand it. At Least they are not able to convert the theoretical technology part into practical solution."</p> <p>GHI "To an extent. We are not deep into industry 4.0. We are on the way taking baby steps. We have its strategies that will tell us if we need cloud computing and if we need to change our strategies."</p> <p>JKL "I don't think it has a big effect on jobs yet."</p> <p>GHI "Not yet, but I think it will happen, especially within the production department."</p> <p>XYZ "We have not reduced employees, but we have more than doubled the productions. So, the output per employee has doubled."</p>
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Axial codes based on close codes

Close codes	Axial codes
<p>ABC "Yes. I think it is one of the basic things we have been working on for several years what we call lean technology. Try to be as efficient as possible. Part of lean technology is to get the people are the workshop to bring a culture where you are becoming more productive instead of one manager trying to decide."</p> <p>GHI "To an extent. We are not deep into industry 4.0. We are on the way taking baby steps. We have its strategies that will tell us if we need cloud computing and if we need to change our strategies."</p> <p>GHI "Not yet, but I think it will happen, especially within the production department."</p> <p>JKL "It is a core principle there, about releasing the individual potential in human beings."</p> <p>JKL "I don't think it has a big effect on jobs yet."</p> <p>DEF "Yes. it has created new needs. Industry 4.0 needs a lot more maintenance of dealing with the process and the machines."</p>	<p>Developmental stage</p>
<p>GHI "The robot we have in packaging was put in place in 2014 and it replaced five employees."</p>	<p>Human Labour Dilemma</p>

<p>XYZ “For certain jobs, we would see that it could exchange some workers. Other jobs it’s hard to see that AI or mathematical models will be better I can’t see that. Certainly, for some jobs.”</p> <p>DEF “We had 1700 people but today it is 550. In the next 15 years, it might reduce to 400. We using more machines in place for humans in areas that are dangerous to work.”</p> <p>JKL “In general, we would need people more in many areas. For example, the people with Fagbrev will be needed for maintenance.”</p> <p>XYZ “We have not reduced employees, but we have more than doubled the productions. So, the output per employee has doubled.”</p>	
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Selective code based on Axial codes

Axial codes	Selective code
<p>GHI “To an extent. We are not deep into industry 4.0. We are on the way taking baby steps. We have its strategies that will tell us if we need cloud computing and if we need to change our strategies.”</p> <p>GHI “The robot we have in packaging was put in place in 2014 and it replaced five employees.”</p> <p>XYZ “For certain jobs, we would see that it could exchange some workers. Other jobs it’s hard to see that AI or mathematical models will be better I can’t see that. Certainly, for some jobs.”</p> <p>JKL “I don’t think it has a big effect on jobs yet.”</p> <p>XYZ “We have not reduced employees, but we have more than doubled the productions. So, the output per employee has doubled.”</p>	<p>Superficial conflict</p>