



LUT University

School of Engineering Science

Industrial Engineering and Management

Kajal Bhandari

The changing demand of digital skills in Finnish Industries: Industrial Engineering and Management discipline

Master's Thesis, 2019

1st Supervisor: Professor Ville Ojanen

2nd Supervisor: Associate Professor Lea Hannola

ABSTRACT

Author:	Kajal Bhandari
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Digitalization is a growing phenomenon that is changing the way organizations, people and societies operate. It influences on the products and services along with the activities inside the organization. Digital transformation is challenging companies as well as people to be digitally advanced and as a result, the skills industries require from their employees have changed to be more dynamic in nature. The change of skills demands investigation of the required digital skills and their integration in the universities' curriculum. This study realizes the shift of demand in skills and explores the organizational changes as well as the digital skills that are in demand in the Finnish industries.

The study follows qualitative method of collecting data from company experts and academics using open-ended interviews. The result suggests that the organizations are highly invested in digitalization and integration of digital skills in their companies. With increased interest in digitalization in companies, the skills gap between the company's demand and the availability in the workforce is widening. Results also revealed that the companies look for candidates with hard digital skills as well as cognitive skills in digital environment. From Industrial Engineering and Management perspective, the study emphasis on the digital skills for IEM discipline along with the approaches and importance of including them in the program.

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Past two years in LUT has been amazing in every way. Studying and working in LUT, has given me the sense of individuality and has guided me towards discovering a meaningful life. My aim to take this thesis was to challenge myself with the topic and experience the work life in LUT.

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List of abbreviations

<i>Abbreviations</i>	<i>Full Forms</i>
3D Printer	3-Dimensional Printer
5G	5 th Generation
AI	Artificial Intelligence
AR	Augmented Reality
ASIIN	Accreditation Agency Specialized in Accrediting Degree programs in Engineering Informatics, the Natural Sciences and Mathematics
E-Book	Electronic-Book
EQ	Emotional Quotient
EU	European Union
GMIT	Global Management of Innovation and Technology
IBM	International Business Machines
ICT	Information and Communications Technologies
IDI	Industry Digitalization Index
IEM	Industrial Engineering and Management
IMD	International Institution for Management Development
Industry 4.0	Fourth Industrial Revolution
IQ	Intelligence Quotient
IT	Information Technology

LFS	Labour Force Survey
MGI	McKinsey Global Institute
MOOC	Massive open Online Course
RFID	Radio Frequency Identification
SMEs	Small and Medium Enterprises
VR	Virtual Reality
WEF	World Economic Forum
WSN	Wireless Sensor Network

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1 Introduction

Digitalization is a phenomenon that has stimulated both academics and practitioners. It has been aiding in development towards creating the digital economy. It has been one of the key ingredients to leverage the modern society into fast growing technology driven society. The ever-growing digital technologies have reshaped the society to be adoptive to these technologies and services. It is vital for businesses and education system to adopt these changes and embrace digital transformation. EU has its own policy platform to capture benefits of digital transformations with its Europe initiative and Digital Single market strategy (Elliott and Ross, 2019). In context of Finland, the country has been very forward with integrating digital technologies and digitally transforming the businesses. A public research-funding agency Business Finland is providing various opportunities for new and established businesses. For example: they organize Digitalization programs such as Artificial Intelligence business, Mixed reality, 5th GEAR, New space economy and many more (Business Finland, 2018). Looking at these activities, it is definite that new skills and capabilities are needed to get accustomed to the changing business scenario. Digitalization is used in many context and areas and so one specific definition is not adequate. It can be used in various context in alignment with different frameworks of business, education and society.

1.1 Background

This thesis explores these needs and change of skills in the industries due to digitalization and ways to fill in those gaps of digital skills. The study is done in the context of Industrial Engineering and Management program (IEM) in LUT University. LUT University is a community that shares the passion of solving problems and has served as a forerunner in combining business and technology since its establishment (LUT University, 2018). IEM in LUT shares the same values and passion. Studies in IEM is a combination of economics, engineering and management to equip students with technology and management skills for organizational development and business process management. (LUT, 2012-2015). It is an integrative solution oriented program to add value to the activities in industries (LUT

University, 2019a). Although IEM consists of many disciplinarians in LUT, this research focuses on Innovation management, Operation management and Cost management areas of IEM studies.

Previously, studies has been done on the topic of Industrial and Engineering management, such as Industrial and Engineering Management graduate's professional profile by Lima et al., (2017) that discussed the demand of the companies regarding competences required for the Industrial and engineering management graduates. Similarly, defining engineering and management by Omurtag, (2009) discussed on the engineering management discipline. Additionally, impact of digitalisation on economy and labour market by Degryse, (2016) provides an overview of the impact that digitalisation has in the industries. This thesis however combining all these topics specifies the topic to the impact digitalization has on the IEM graduates.

The preliminary research of summer 2018 revealed the digital skills that are being provided in one of the master's program Global Management of Innovation and Technology (GMIT) of IEM degree program in LUT University. This preliminary research was done under Research team of Innovation Management in IEM department in LUT University. The result also showed the possibilities for the program's development in terms of digital skills. It led to thinking about the emerging digital technologies, trends and the digital skills that the graduates from IEM will need to tackle the challenges ahead in digitally advancing workplace. This thesis realises this gap to understand digitalization and the impact on digital skills for IEM graduates.

1.2 Objectives and Research questions

The main aim of this research is to clarify the need and demand of the of the digital skills company's business processes due to digitalization. The qualitative approach taken in the thesis gathers known knowledge and expertise from practitioners and academics. This assists the University to get a broader view on digitalization and its effects in business. Digitalization is a way for industries and economies to enhance their business. It offers various opportunities and resources to gain a competitive advantage over their competitors

and digital skills are the fuel for digitalization. The study especially focuses on the effects of digitalization and the direction of the company's demand on digital skills.

There are two main research questions as shown in Table 1 with their objectives. The first question helps to understand the status of the digitalization in the Finnish companies. There are two sub questions which helps to understand the concept of digitalization and digital skills in practice in Finnish companies. The second research question asks for the digital skills that the companies are demanding from the employees. The objective of the second question is to understand the types of digital skills that companies are demanding and what it implies on IEM program.

Table 1 Research questions and its objectives

RESEARCH QUESTION	OBJECTIVE
RQ1: What is the impact of digitalization in Finnish industry?	<ul style="list-style-type: none"> ➤ To understand the organizational change happening because of digitalization in companies residing in Finland. ➤ To identify digital skills that companies are searching for in their industries.
RQ1.1: What does Digitalization mean in Finnish industries? RQ1.2: What are the required Digital Skills?	<ul style="list-style-type: none"> ➤ To understand the status of digitalization in Finnish companies. ➤ To understand how digitalization have changed the need and demand of digital skills and understand the meaning of digital skills in the industries.
RQ2: What are Digital skills in demand for IEM graduates?	<ul style="list-style-type: none"> ➤ To identify the digital skills that companies are searching for in their industries from IEM graduates. ➤ To suggest approaches to include the digital skills in the IEM program and other educational activities.

1.3 Scope and limitation

The digital economy is growing very fast and there are different trends of digitalization accelerating it such as IoT and Big Data. Digital economy is accelerating in different areas

such as production, sales, operations, business processes and after sales processes. This is where industrial engineers come in play. Industrial engineers are working in all these sectors with positions such as project managers, consultants, country managers, operations managers etc. The demand and nature of required skills have changed over time with the development in technologies in these positions. This study explores these changes in skills and intends to provide a perspective on the digitalization process in organizations residing in Finland.

In addition, the preliminary research on the digital skills in IEM-GMIT revealed that there is a need to upgrade their strategy regarding digital skills. The basic theme of this thesis is to find and clarify the situation in companies and the University regarding digital skills. The question that arose from the preliminary study, “are the skills provided in IEM enough?” will be explored further in this thesis. The need for digital skills has arose from digitalization. Understanding digitalization and its elements is discussed in the Literature review which leads to the digital skills. The limitation however in the study is the focus on Industrial Engineering and Management (IEM) program and the number of companies taken for interviewing. The results and analysis focus on the IEM program in LUT. The digital skills provided as a result in the thesis are general and can be used as reference to further study and explore the details of the skills. The companies chosen are all residing in Finland. The sample taken is limited in size due to the time frame of the study.

1.4 Execution of the thesis

Figure 1 outlines the execution process of the research. The major research was done between September 2018 and April 2019 whereas the preliminary study was done between May 2018 and August 2018. The preliminary study was done under the research team in innovation management in IEM department. The aim of the study was to assess the digital skills in the Global Management of Innovation and Technology (GMIT) program in IEM department. The study’s finding provided the basis for the thesis to explore the emerging digital skills in the companies. The second phase of the study was Theory part. The theory consists of literature review aimed to collect and summarize theoretical knowledge on digitalization and its effects on digital skills. In addition, the knowledge about Industrial

Engineering and Management was also explored in the literature review to provide focus to the thesis.

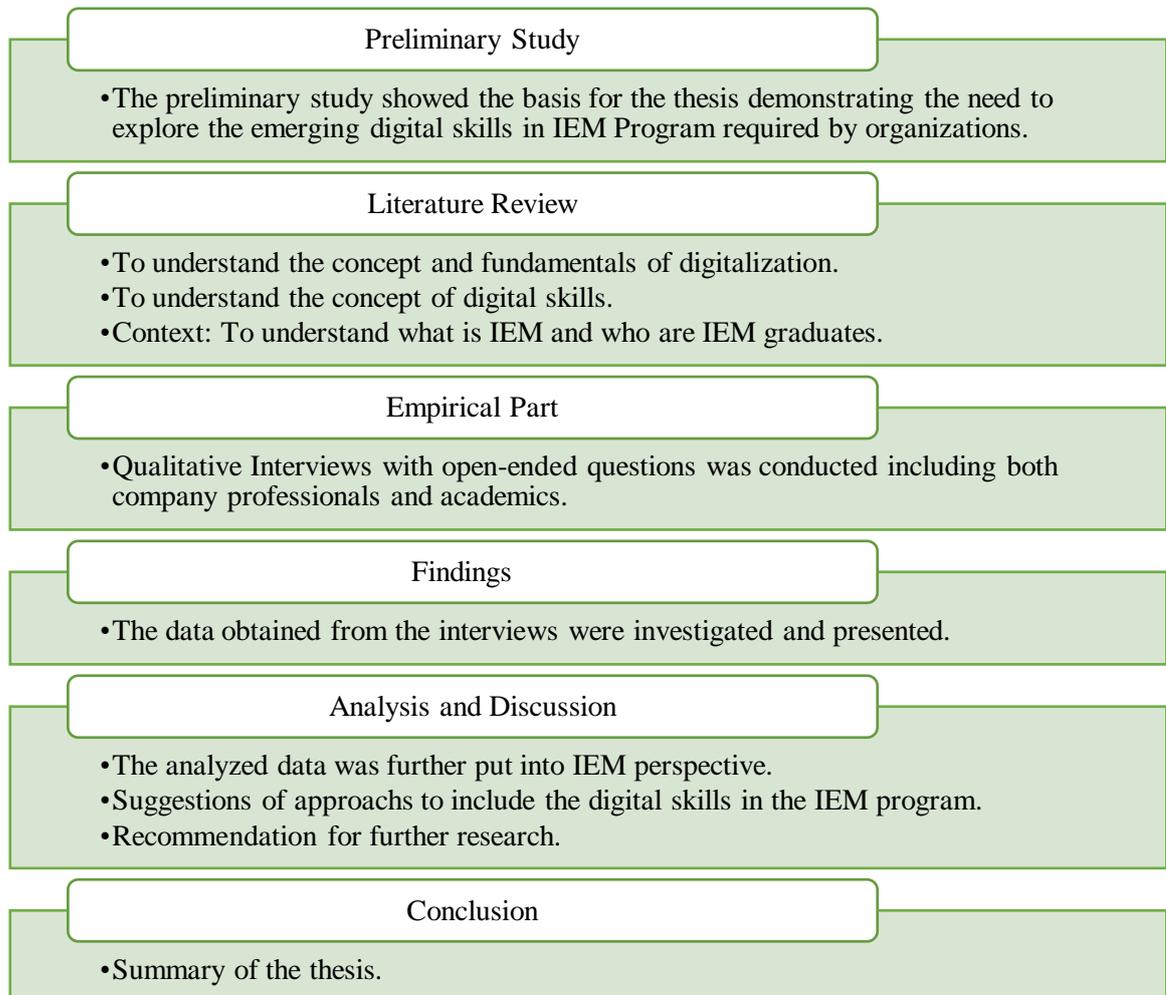


Figure 1 Execution of the thesis

For the empirical part of the thesis, qualitative interviews with open-ended questions were conducted including both company professionals and experts in the field. The companies were chosen from the alumni survey results that LUT University does annually. The data was collected from these interviews and analysed in NVivo. The interviews were open-ended with three general themes: first theme: IEM and LUT, second theme: Digitalization and third theme: Digital skills. It is a cross-sectional study, investigating a phenomenon and has a strict time-constraint. The findings from preliminary study was also considered in the study as a secondary data in the discussion phase of the study. The analysis of the interviews was

done qualitatively based on the theories and empirical part resulting in the suggestions on approaches to include the digital skills in the IEM Program. The details of the methodology are described in the chapter 4.

1.5 Structure of the thesis

The study is designed to be an exploratory research. It started as a preliminary research which lead to the question “Are the provided digital skills in IEM enough for digitally transforming industries?” To answer this question, this thesis explores the phenomenon of digitalization, the trends that are driving it relevant to IEM and its effect on digital skills. The Table 2 summarizes the flow of the thesis. The theories related to the topic of interest, methods for data collection, findings and recommendations are presented.

The study begins with an introductory chapter presenting the background of the thesis. This chapter provides information on the rationale of the thesis, objectives, scope, and relation of the thesis to previous studies and the structure of the thesis. The literature review in chapter 2 provides a thorough description of digitalization and digital skills. There are two main topics in the chapter. The first topic provides a holistic view of digitalization as a process of change in companies. It aims to explain the concept of digitalization and its fundamentals. Second topic defines the concepts of digital skills. In addition, chapter 3 provides an overview of IEM as a scientific discipline. It also presents the need of digital skills for IEM and describes the IEM in LUT University. Combining the literature from two topics in chapter 2, the study intends to provide an understanding of how digitalization affects the digital skills and what are those digital skills keeping in consideration IEM program.

Chapter 4 provides an overall view of the research context and methodological choices in the empirical part. Chapter 5 shows the breakdown on the results obtained from the empirical part. It intends to clarify the state of digitalization in the organizations and further changes in terms of workforce. In subchapter 5.4, the digital skills in demand from the organizations are listed and described. Chapter 6 analyses, discusses the results obtained in chapter 5, and provides implication on the IEM program and the graduates. The sub chapter 6.3 provides the possible approaches to include the digital skills in IEM program’ curriculum and

activities and concludes with recommendations for further research in the sub chapter 6.4. To conclude the thesis, the final assessment of the result is provided in chapter 7.

Table 2 Input-Chapter-Output

<i>Input</i>	<i>Chapter</i>	<i>Output</i>
Overview and Introduction to the thesis topic	Introduction	Objectives and concept of the thesis Structure Scope and Limitations
Literature Review on the Concept of Digitalization and its fundamentals. Literature Review on Digital Skills.	Digitalization and digital skills	Thorough description of the process of digitalization in an organization, its components and opportunities. Different concepts of the digital skills
Overview of the Industrial Engineering and Management studies, graduates.	Context: Industrial Engineering and Management	What is IEM program? Who are IEM graduates?
Define research context, methodological choices, data collection and analysis methods	Methodology	Clarification of the methods used, samples and context.
Collection of data from the open interviews taken from companies and experts.	Results	Organizational changes, trends and digital skills along with Future Changes and Challenges in context of digitalization
Digitalization status in Finnish companies. What are the digital skills according to the interviews?	Discussion	Implication on IEM program. Approaches to include digital skills in IEM program and activities. Recommendations for further research
Assessment of the results	Conclusion	Summary of the thesis

2 Digitalization and digital skills

Digitalization is the ability to change the existing products and services into digital variants and other aspects of human society using digital technologies (Parviainen et al., 2017). The use of digital technologies is increasing and so is the need of digital skills. For an increasing number of citizens, digital skills are at the centre to interact, work and learn in today's society (Brolpito, 2018). The fluidity on digitalization of labour markets demands flexible and responsive education for workers to acquire the right skills needed (Ceemet, 2018). This adoption of digitalization and the need for digital skills in industries is explored in the following literature review.

2.1 Digitalization in Digital Economy

Digitalization of products, services and processes has given birth to digital economy. If compared 2008 and 2018 top largest companies ranked according to the market value, most of the companies in 2018 are technology companies such as Apple, Amazon etc., whereas in 2008, most of them were oil companies (Johnston, 2018). This economic shift from physical to digital has changed the business ideology. Today, every industry uses technology to enhance their product, services and processes. Whether in farming or in high-tech industry, technology prevails to show its advancement and need in all the industries, in digital economy. Digital economy shows clear and distinct characteristics to differentiate itself from the industrial economy (Zhao et al., 2015). Those twelve characteristics are knowledge, digitization, virtualization, molecularization, integration/internetworking, disintermediation, convergence, innovation, presumption, immediacy, globalization and discordance (Don, 1996).

Digital economy is growing 7 times as fast as rest of the economy in Europe boosting economic growth and transforming industrial sector (EU, 2018). With all these changes towards digital society, it is not far-fetched to say that the world will be functioning very differently from how it is today (Espinel, 2016). Technologies such as block chain, 5G, 4D printing and virtual reality have huge impact on the societal and industrial level. In addition to the advancement in technology, creative problem-solving processes are also introduced

in digital economy creating blissful and satisfied customer experience. One of the best examples for this is sharing economy. Airbnb and Uber are the most recognised companies who are applying the sharing economy concept in their business strategy (Espinel, 2016). Similarly, Malaysia has become the first country to establish a Digital Free Trade Zone to promote e-commerce by providing state of the art technologies to SMEs (WorldBank, 2018). This is an impressive example of creating new opportunities in a digital platform to boost the country's economy.

2.1.1 Concept of Digitalization

Digitalization is established as one of the major trends changing both business and society in the near future (Parviainen et al., 2017). It is one of the main element in the 4th industrial revolution (Degryse, 2016). Digitalization occurs at different levels of the society and interact with each other to move towards the digital world. Finnish Innovation Fund SITRA defines digitalization with four different characteristics: Big data, IoT, platform economy and cloud services, and expanding use of robotics, Artificial Intelligence and automation replacing human labour (Hautamäki et al., 2017).

Digitalization is known to possess the ability to transform the existing products or services to digital variants offering advantages over the existing tangible products (Greeven et al., 2017). According to Greeven et al., (2017), the impact of digitalization can be identified in three different viewpoint, internal efficiency; improved way of working through digital means, external opportunities; new opportunities in existing business and disruptive change; change in business roles. Although digitalization is a well-known phenomenon and experts have been aggressively using it, the definition of digitalization is complex. It does not only describe a process but is a larger space where disruptions and transformations happen. Hence, to understand digitalization, concept of digital disruption and transformation is also studied further.

Digital disruption is a transformation because of the use of digital technologies that impact on the value of existing products and services in the industry (Oxford, 2018). It has the capability to reshape the markets and overturn incumbents faster than the history has ever

seen (Bradley et al., 2015). According to the survey by Bradley et al., (2015) Technology products and services has the most potential for digital disruption while pharmaceuticals having the least. Out of all the respondents in the survey, 75 percent included companies from all over the world; strongly agree that digital disruption is a form of progress. It is caused by new and innovative digital technologies and impacts on existing products and services offered (Oxford, 2018).

One of the major market changes by digital disruption is the music industry. It has changed rapidly and has a new business model to sell its products and streaming services (Ilmarinen and Koskela, 2015). Furthermore, e-books have disrupted the traditional book industry along with threats to the booksellers but changing the business to platform market (Gilbert, 2015). Similarly, another example of digital disruption that has changed the way of working in companies is digital twin. It is the exact replica of the products, assets services or processes in a living model. It allows the testing, monitoring and analysing of the IoT present in the twin (Kennedy, 2018). Simulating real transactions in the digital twin helps to reduce risk factors and directly impacts on data-driven decision-making process. It is still a challenge for companies to understand how and where the digital twins can be used to create value in the company.

Digital disruption leads an organization to transform the system digitally, either in small scale or in a larger scale depending on the severity of the disruption. Digital transformation is a process to accept and embrace the digital technologies and business models to elevate their performance level (Bradley et al., 2015). It is an important piece of a puzzle in today's economy. It drives business change and innovation (Fauscette, 2018). This change and innovation create new opportunities and gives a competitive advantage to the company. The change and modernization in the businesses has produced trends such as IoT, digital platforms, AI etc. that heavily influence the economy. To lead as a digitally transformative company, reshaping customer values and transforming their operations using digital technologies for customer interaction and collaboration is necessary (Berman, 2012).

Digital transformation is not just about technology but the strategy driving the business (Kane et al., 2015). One of the very recent strategic use of technology is the use of wearable

technology which improves the work environment safety features (Khakurel et al., 2018). It is new concept but shows that a new technology disrupts the traditional way of working transforming the system of safety at work place. This feature has the potential to engage the employees through user engagement features and content (Asimakopoulos et al., 2017). In turn, it allows the workers to monitor their stress levels and health pattern creating a systematic way of monitoring worker's health (Milosevic et al., 2012). Similarly, Blockchain can be used in various aspects of business. The insurance industry can have a huge benefit from the use of this technology to verify assets and track-prevent fraud (Hill et al., 2017). Hill et al., (2017) further stated, "*Artificial Intelligence continues to drive change in how business and governments interact with customers and constituents.*" This way, digitalization be a cycle of change that occurs in an organization. Digitalization is a journey to reinvent an organization creating value and new revenue streams. To summarize the digitalization process, it can be described as a continuous cycle that leverages the business processes, creating value and opportunities for an organization as shown in Figure 2.

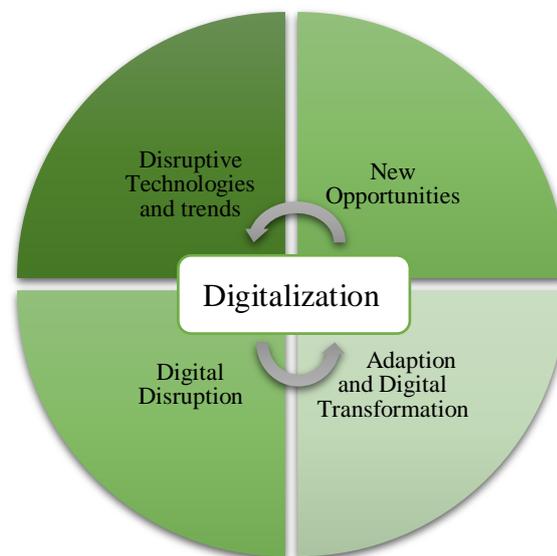


Figure 2 Digitalization in perspective

2.1.2 Opportunities with Digital Innovation

Digitalization has provided opportunity to foster innovation in the digital world. It created a necessary condition for digital innovation among various firms example: E-book which created capabilities for digital publishing, previously a non-digital product (Yoo et al., 2010). Digital innovation disrupts and transforms industries from strategy, operations, technology to culture (Gallina, 2018). Digital Innovation has shifted the nature of innovation process and outcomes yielding traits for pervasive digital innovation such as digital technology platforms, emergence of distributed innovations and the prevalence of combinatorial innovation (Yoo et al., 2012).

Digital innovation brings opportunities to organizations that helps to expand and enhance their products and services (Nylén and Holmström, 2015). For example, organizations hold Hackathons to nurture digital innovation in different fields depending on their interest such as technology centric, socially oriented and even internal company oriented (Briscoe, 2014). Another example comes from Facebook, they created the like button in the platform through hackathon (Briscoe, 2014). Yoo et al., (2010) has put forward three characteristics of digital innovation. They are reprogrammability, homogenization and self-referential nature. Reprogrammability allows a device to function in variety of functions separating the semiotic functional logic to the physical device; Homogenization refers to the accessibility of a data in all digital devices and thirdly self-reference refers the use of digital technology to reflect on the technology and innovate further (Yoo et al., 2010).

The college students of today represents the first generations who grew up with the technology and have lived their life surrounded by digital tools and toys (Prensky, 2001). Digital natives (born after 1980) are not just experiencing personal relations such as friendship in a different way but also relate to information differently, more in a malleable way (Palfrey and Gasser, 2010 pp. ix). Hence, the students have changed and they no longer can relate to the educational system that was designed to teach (Prensky, 2001). Digital natives are creators and innovate with a different approach and using different tools (Palfrey and Gasser, 2010). Students today are seen as digital natives and organizations expect them

to provide a different perspective on opportunities helping them develop digital products, services and business models (Legner et al., 2017).

Opportunities such as collaboration with different firms and organizations, better IT support, low cost of digital infrastructures, digital footprint of all the processes comes along with the integration of digital technologies into digitally transforming a company or an organization. For example, Customer and partner engagement being one of the main source of digitalization push, they should be highly involved with the change creating a major source of value for the organization (Legner et al., 2017). Organizations must be vigilant in what type of innovation will create more value and opportunity without being confined by the norms.

Another very popular example is the digital camera prototype that was rejected by Kodak because it did not represent the relevant opportunities according to the frames described (Nylén, 2015). The universities and educational system has embraced the digital capabilities and established open access information with possibility to communicate across cultures through internet breaking the barrier and exploring new ideas (Palfrey and Gasser, 2008). This is an example that shows there are various opportunities with digitally transforming economy. Digital innovation in the company helps fostering opportunities such as business model transformation, products and services, new revenue streams, creating digital capabilities, core element refining etc. (Berman, 2012).

2.1.3 Basic elements of digitalization

Technologies are undoubtedly changing the way business processes are performed and therefore, for a company's success, it is vital to expand the employee's digital skills according to the digital trends (Ismail, 2017). These trends or elements of digitalization allows keeping track of the ongoing technologies and being at competitive advantage over competitors. According to a the research by Kane et al., (2015), maturing digital organizations are intolerant on the digital skills gap and constantly looking to close it which leads them to use digital trends to build up necessary skills to capitalize on the trends. Vermesan and Friess, (2014) have put forward the elements of digitalization as IoT, Big

Data, Advanced Analytics and Applications. Additionally, Legner et al., (2017) has also stated that digitalization is enabled by converging IT megatrends such as social, mobile, big data, cloud, smart etc. Evaluating the rationale of SITRA, Legner et al., (2017) and Vermesan and Friess, (2014), there are four elements that are put forward in this thesis considering the relevancy to IEM program as shown in Figure 3. These are some of the basics in digitalization process. The relevancy of these elements for this thesis is further clarified in the Table 3.

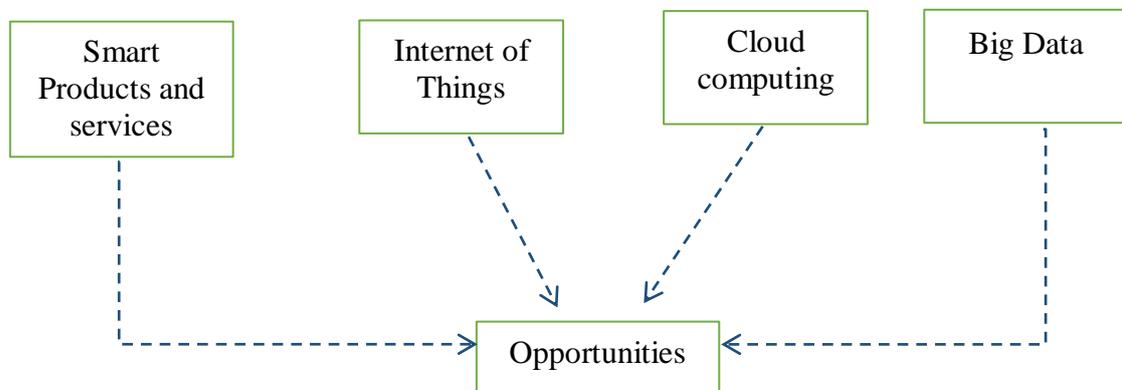


Figure 3 Elements of digitalization adapted from Vermesan and Friess, (2014)

Table 3 Rationale behind choosing the elements

<i>Basic elements</i>	<i>Rationale behind choosing these elements for the thesis</i>
<i>Smart Products and services</i>	Digitalization offers expansion of the offers the organizations currently have in their profile (products and services). This allows them to capitalise new possibilities. Integration of IT and technology possibly improves the quality and value the products and services. This is essential looking from the managerial perspective in different sectors.
<i>Internet of Things</i>	IoT is connecting different physical devices over a network and is predicted to connect billions of devices increasing the amount of information obtained and shared. Its opportunities extend from household devices to industrial applications. Hence, it could be valuable to consider IoT as an area of interest in IEM considering the potential IoT brings to the organization.
<i>Big Data</i>	With the increment in smart products, services and networked setting, the data also increases in similar manner. This abundance of data demands for proper analysis and reasoning of the data. This brings opportunities in different sectors and demands for skills corresponding to it.
<i>Cloud Computing</i>	Platform economy is a demanding agenda and one of the sought knowledges in the organizations. The appeal of Cloud services and cloud platforms are increasing because of their cost effective and efficient behaviour for the organizations. Many technologies work through cloud computing and is an essential part of the offerings in transformation to digital economy.

Smart Products and services

Smart technologies have high technology integration along with the awareness of their surroundings and possess the ability to react to it (Worden et al., 2003). The concept of smart technologies can be applied in various area of business, society and organization. The products and services labelled as smart are enabled by smart technologies. Smart phones, smart home technologies, smart watch, smart clothing etc. are some of the examples of smart technologies.

Smart connected products offer new functionality and capabilities with expanding opportunities that overcomes the traditional product borders (Porter and Heppelmann, 2014). Porter and Heppelmann (2014) has grouped the capabilities of the product in four stages:

Monitoring, Control, Optimization and Autonomy. Monitoring is the ability of the product to sense the product's condition, environment and operation, which in turn can alert the changes to the mainframe. Control is the stage in which a software is embedded in the product controlling the functions and personalization according to the user. Optimization is the third stage, which goes beyond control, and can enhance the performance along with predictive, diagnostic and service and repair functions. The last phase is Autonomy, which combines all the preceding stages and performs function autonomously by self-coordinating with other products and systems, self-diagnosing and servicing.

Smart products and services can be applied in vast areas of business. One of the examples of smart products is the autonomous system and the use of AI in autonomous space exploration by NASA (Hedberg, 1997). Similarly, smart city applications are also gaining popularity with the increase in connectivity. (Tekes, 2018), has put forward smart city solutions that includes, smart transport mobility, smart energy, smart building and planning, and examples of smart cities in Finland. The report focuses on the autonomous and electric vehicles, renewable energy systems with smart grids and other smart solutions for the efficient and smart buildings (Tekes, 2018).

Internet of Things (IoT)

Internet of Things is a scenario where sensors, actuators and other smart technologies are connected; everything has a unique identifier communicating over the internet. This allows person to object and object-to-object communications (Liu, 2018). IoT allows an autonomous exchange of information between the devices around us that uses technologies such as Radio Frequency Identification (RFID) and Wireless Sensor Network (WSNs) to further process the available information for decision-making based on performed automated action (U.Farooq et al., 2015).

With the increase in smart solutions for homes, schools, industries and individual lives, IoT is expanding to all the products. It is believed that IoT will change the way of business, perceived values of products and services will change with the evolvement in IoT (Sinha and Park, 2017). Business processes need different IoT mechanisms according to their

current and future need or demand. IoT driven business ecosystem creates a value distribution dynamics and provides value protection mechanism for all the parties involved in the value distribution (Sinha and Park, 2017). Some of the business application areas using IoT are listed below (Romeo, 2019).

- Connected Industry
- Smart City
- Smart energy
- Connected car
- Smart agriculture
- Connected building
- Connected health
- Smart retail
- Smart supply chain

In addition to IoT gaining popularity, Hyperconnected networks are also emerging high in the corporate list. Hyperconnected world is a world where everything that needs to communicate will communicate over a network. It can be person-to-person, person-to-machine and machine-to-machine(Ranadive, 2013). Hyperconnectivity is high on the corporate agenda and viewed positively by the organizations (Economist, 2015). The majority of the firms believe that the failure to adapt Hyperconnectivity in the organization will create a high risk (Economist, 2015).

Big Data

Data management and analytics is strongly linked with digitalization, where digitalization acts both as enabler and a control mechanism (Kotarba, 2017). Big Data is a High-Volume, high velocity assets demanding cost-effective and innovative forms of processing information that enables the insight, decision and process automation (Gartner, 2019). Big data is gathered from sensors, GPS Signals from cell phones, social networks and many more(McAfee and Brynjolfsson, 2012). The value of IoT comes from use of Big data to solve specific problems and create new services (Guillemin et al., 2014). This real or non-

real time-based amount of information that is gathered through smart devices and technologies allows overcoming managerial challenges. The technological advances have opened opportunities to collect and process data by using devices such as sensors. They collect passively a large amount of data. This leads to a collection of database in huge quantities (Japkowicz and Stefanowski, 2016). Millions of data can be collected from any object that has a digital pathway to connect to a device. Connected devices allows the industries to access and analyse the data to their advantage.

In 2012, the volume of data in the internet per second outnumbered the data crossed in whole 1990 (McAfee and Brynjolfsson, 2012). It is estimated to have 50 billion devices networked in 2020 (Stergiou et al., 2018). Holger Hürtgen and Niko Mohr has recently put forward a statement that *“Data has become the new corporate asset class-and the best way for companies to generate and access it is to digitize everything they do. Digitizing customer interactions provides wealth of information for marketing, sales, and product development, while digitizing internal processes generates data that can be used to optimize operations and improve productivity”* (Forbes, 2018). Global Pulse is an initiative by United Nations; It wants to leverage the Big Data for Global development for example: to prevent a region from slipping back to poverty (Lohar, 2012).

Cloud Computing

Cloud Computing refers to those infrastructures that are outside the device and all the data storage and computing happens in it (Stergiou et al., 2018). The cloud-based sharing platforms such as Microsoft cloud services and Google cloud services are very common in the industries. It is not a peculiar practice to see organizations using cloud-platforms, but there is more than that. Cloud computing is a larger space where sharing platform is a part of it. The increase in devices contributes to large amount of data. With this amount of data that is being produced, cloud is the best technology until now to store and analyse the data effectively (U.Farooq et al., 2015).

The scope of cloud-based system (platforms, data storage or analysis), is very high. Cloud computing can include software, data management, storage and computing using various

physical or virtual services. These are standardized and configurable online computer services (OECD, 2014). It is often an inexpensive way for consumers and businesses instead of buying large expensive physical infrastructure. There are four very common service models for cloud computing: Infrastructure as a Service (IaaS), Platform as a Service (PaaS), Software as a Service (SaaS) and Anything as a Service (XaaS) (OECD, 2014). These services can be deployed into organizations in different ways such as private, public, hybrid and many more. According to Ferkoun (2014) Cloud computing increases competitiveness for optimal resource utilization and offers most common uses of cloud computing such as private and hybrid cloud, testing and deployment, big data analytics, storage, disaster recovery, backup, and infrastructure and platform services.

Additionally, there can be security concerns in cloud-based systems. IBM released a research data to address the fact about security breach in cloud-based systems. In its Eleventh Annual cost of a data breach study, conducted by Ponemon Institute, it was found that the total cost of a data breach is 4 million dollars (Mozumder et al., 2017). There has been many researches and developments in this area of concern. Some of the common threats on misusing and data breaches are Misuse of Cloud Computational Resources and Data Breaches including malicious or criminal attack, systems malfunction and Human error (Mozumder et al., 2017). There are existing very effective cyber security but there is always a chance of leakage. The cyber security area is building up very fast and will have great impact in future.

2.2 Digital skills in perspective

A skill as defined by Belin and Pri, (2014), is a learned ability to perform any task without the need of much effort. The digital nature of occupations requires the skills and knowledge people need to perform in their jobs also to be digital (Knickrehm, 2015). Digital skills comprises of range of skills from basic digital literacy skills to general workforce and also the specific digital skills for ICT professionals (Motyl et al., 2017). These changes in digital skills are brought by the advancement in technology and its adoption in different sectors. *“If you want to be relevant in working life, it’s probably smart to focus on developing your skills in areas where machines still struggle,”* says Katri Saarikivi, a member of the steering group of Aalto’s EE Digital Business network (Hammarsten, 2017).

The demand of the digital skills comprises of broad range of the abilities and competences. Berger and Frey, (2016) classifies the digital skills into three types based on the European e-skills Forum's 2004 Synthesis Report as practitioner skills, user skills and e-leadership skills. According to van Laar et al., (2017) Digital competence is a key concept in discussion about what kind of skills people must have. Digital competence is a set of skills, knowledge and attitude that requires using ICT and digital media to share, solve problem, communicate and collaborate (Ferrari, 2012).

According to the WEF, there is a considerable amount of disproportion of skills between the graduates and the employers need in most economies. The changes in the demand of future skills from 2018 to 2022 is shown in the Future of jobs report by (World Economic Forum, 2018), which is also shown in the Table 4. As seen in the Table 4, the declining skills are those, which are repetitive jobs such as maintenance, memory, quality control etc. Whereas, skills that need independent thinking and emotional intelligence, problem solving etc. are increasing in trend. To address these shifts in the need for skills, companies either retrain their existing employees, hire someone new or hire a freelancer with those skills. Matti Pohjola, Aalto University's Professor in Economics states "*For larger companies, creating an explorative culture can be challenging and hence many companies have solved this dilemma by setting up co-creation efforts with start-ups.*" (Sinclair, 2017).

Table 4 Comparing skills demand, 2018 vs. 2022 (World Economic Forum, 2018).

2018	Trending 2022	Declining 2022
Analytical thinking and innovation	Analytical thinking and innovation	Manual dexterity, endurance and precision
Complex problem-solving	Active learning and learning strategies	Memory, verbal, auditory and spatial abilities
Critical thinking and analysis	Creativity, originality and initiative	Management of financial, material resources
Active learning and learning strategies	Technology design and programming	Technology installation and maintenance
Creativity, originality and initiative	Critical thinking and analysis	Reading, writing, math and active listening
Attention to detail, trustworthiness	Complex problem-solving	Management of personnel
Emotional intelligence	Leadership and social influence	Quality control and safety awareness
Reasoning, problem-solving and ideation	Emotional intelligence and ideation	Coordination and time management
Leadership and social influence	Systems analysis and evaluation	Visual, auditory and speech abilities
Coordination and time management		Technology use, monitoring and control

A brief and specific definition of digital skills is not enough since it goes far beyond technology (Skillsoft and Training zone, 2017). The most trending digital skills in demand are focused on proficiency in new technologies. However the human skills are the most which are growing in value (World Economic Forum, 2018). Human skills such as creativity, critical thinking, having an emotional and subjective outlook in addition to the objective perspective on things. The founder of Alibaba Jack Ma, (2018) stated that “*To gain success a person will need high Emotional quotient (EQ); if you don’t want to lose quickly you will need high IQ, and if you want to be respected you need high Love Quotient (LQ)- the IQ of love.*”

Digitalization and diffusion of digital technologies while in one hand displace workers but in other hand, creates entirely new jobs because of digital transformation (Berger and Frey,

2016). Degryse (2016) have put forward the jobs in Digital Economy, where he illustrates the possibilities of new jobs and the existing jobs at risk as summarized in Table 5. It shows that the clerical jobs, construction jobs etc. that needs less cognitive thinking, are at very high risk.

Table 5 Jobs in digital economy (Degryse, 2016)

Jobs at greatest risk	Jobs at least risk	New jobs
Office work and clerical tasks Sales and commerce Transport, logistics Manufacturing industry Construction Some aspects of financial services Some types of services (translation, tax, consultancy, etc.)	Education, arts and media Legal services Management, human resources management Business Some aspects of financial services Health service providers Computer workers, engineers and scientists Some types of services (social work, hairdressing, beauty care, etc.)	<p>Top of the scale:</p> <p>Data analysts, data miners, data architects</p> <p>Software and application developers</p> <p>Specialists in networking, artificial intelligence, etc.</p> <p>Designers and producers of new intelligent machines, robots and 3D Printers</p> <p>Digital marketing and e-commerce specialists</p> <p>Bottom of the scale:</p> <p>Digital “galley slaves” and other “mechanical Turks” working on digital platforms Uber drivers, casual odd jobbing in collaborative economy.</p>

Both reports from World Economic Forum, (2018) and Degryse, (2016) suggests that the repetitive jobs in areas such as construction, logistics and regulated services are at high risks. Whereas, the jobs that needs critical thinking and integration of human element in the tasks such as developing architecture, designing, human resources etc. is least at risk.

2.2.1 21st Century Digital skills

21st century skills are conceptualized in a framework of three types of skills: learning skills, literacy skills and life skills according to the Partnership for 21st century P21 (2008) (van Laar et al., 2017). Another expert group categorises the skills into ways of thinking, ways of working, tools for working and living in the world (Binkley et al., 2011). Both frameworks support creativity and originality in working life. 21st century skills are influenced by the digital technologies allowing transformation of skills towards digital environment. The Table 6 and Table 7 provides a framework that combines 21st century skills and digital skills. van Laar et al. (2017) has conceptualized the digital skills and 21st century skills and formulated a framework for 21st century digital skills (core 21st century digital skills and conceptual 21st century digital skills).

The framework is developed from articles in various fields. The core skills are the basic skills needed to perform in various occupations. The conceptual skills are the skills that complements the core skills. As seen in the tables above, ICT plays a central role in the 21st century digital skills. Digital skills differ from ICT skills so that it comprises of the ability to discuss ICT technologies according to the situation solving a problem with creativity and critical thinking as demonstrated in van Laar et al. (2017) article The relation between 21st century skills and digital skills. The term ICT is general meaning to defines the devices, applications, network components and systems that allows to communicate and network in any digital environment (Rouse, 2017). ICT includes everything from smartphones to robots. Rouse, (2017) has listed the components of ICT, which are Internet Access, Cloud Computing, Software, Hardware, Transactions, Communications Technology and data. In response to the demands of the global environment, higher education has adopted ICT to enable students get the required knowledge and skills (Altbach and Rumbley, 2009; Tadesse et al., 2018).

Table 6 21st century core digital skills (van Laar et al., 2017)

<i>Core 21st century digital skills</i>	<i>Concept</i>
<i>Technical</i>	Skills to accomplish practical tasks by recognizing online environments for navigation and maintain the orientation using devices.
<i>Information management</i>	Skills to make informed decision using ICT to search select and manage information efficiently.
<i>Communication</i>	Skills to communicate ideas, share information to one or multiple people or market using variety of media platforms.
<i>Collaboration</i>	Skills to work in a team to exchange information negotiate and decision making with mutual a common agenda keeping mutual respect of all the participants.
<i>Creativity</i>	The skills to generate new ideas or formulate new concepts from existing ones and convert these ideas into products and services, which is considered as novel in the field.
<i>Critical Thinking</i>	The skill to reflect on the provided information and make informed judgement and choices with enough evidence supporting the claims.
<i>Problem Solving</i>	The skill to cognitively understand and process the situation actively using the knowledge to solve a problem.

Table 7 Conceptual Digital skills (van Laar et al., 2017)

<i>Conceptual 21st century digital skills</i>	<i>Concept</i>
<i>Ethical Awareness</i>	The skill to be aware of the social responsibility, knowledge of legal and ethical aspects when using ICT.
<i>Cultural Awareness</i>	The skill to show the understanding of different cultures and ability to respect them.
<i>Flexibility</i>	The skill to acknowledge and adapt one's behaviour, attitude and thinking to a changing situation of ICT environment.
<i>Self-direction</i>	The skill to set, manage and access own goals when using ICT
<i>Lifelong learning</i>	The skills to explore opportunities in ICT to improve capability.

The 2012 report from OECD put forward a proposal that puts ICT as a multidimensional assembly having three components: technical use of software and hardware, interact in cognitive process and the degree of literacy tasks such as reading and writing digital materials (Asiyai, 2014; Tadesse et al., 2018). Furthermore, the components of ICT and the skills required is defined in Information and Communication Technology (ICT) literacy by Irvin, (2007) which is shown in the Table 8.

Table 8 ICT literacy components (Irvin, 2007)

<i>Proficiency</i>	<i>Definition</i>
<i>Define</i>	Using digital tools to identify and represent an information need
<i>Access</i>	Collecting and/or retrieving information in digital environments
<i>Manage</i>	Using digital tools to apply an existing organizational or classification scheme for information
<i>Integrate</i>	Interpreting and representing information, such as by using digital tools to synthesize, summarize, compare, and contrast information from multiple sources
<i>Evaluate</i>	Judging the degree to which digital information satisfies the needs of an information problem, including determining authority, bias, and timelines of materials
<i>Create</i>	Adapting, applying, designing, or constructing information in digital environments
<i>Communicate</i>	Disseminating information relevant to an audience in an effective digital format

The expected growth on ICT employment until 2020 is measured to be increased above 40 percent in management, business architecture and analysis based on Eurostat LFS data (Berger and Frey, 2016). The trend of rising importance of ICT maybe because of the abstract tasks that are increasing in modern labour markets (Falck et al., 2016). Industrial integration of ICT creates opportunities and has been evolving to create competitiveness in the different sectors. One of the examples is a research done in cooperation under IMS scheme by Abramovici and Filos, (2011) for integration of ICT in manufacturing. It shows

that the ICT is a major driver of innovation in manufacturing sector and has high potential to improve products, processes and services (Abramovici and Filos, 2011).

Additionally, there are numerous studies done to highlight the importance of ICT and the measurement and effect of ICT integration in students (e.g. Asiyai, 2014). The study of the Asiyai, (2014) on the integration of teaching and learning in higher education concluded that, ICT integration in education could help flourish the efficiency in instructional delivery increasing student's interest in learning, enhances collaborative networking and encourages teaching towards student centric approach.

The growing digital culture in organizations are driving the need of digital skills. Microsoft, (2019) has stated that 90 percent of the jobs in next two decades will need some digital skills while also showing that there is increasing gap of cloud skills. Embracing digital skills contributes to increase business productivity, develops competitive edge, increases revenue and allows business to build relationships (Barker, 2018). Most of the Businesses whether incumbents or the start-ups have realised the importance of digital channels and media. Similarly, Universities have also recognised the importance of providing digital skills to the students. Finnish universities have recognised this fact and have taken various initiations to tackle the challenge. For example: in LUT University, DIGI-USER- Smart Services for Digitalisation is a LUT Research platform provides a user-centric approach to systematic issues at different levels to co-create digital services in a multi-disciplinary environment (LUT University, 2019b).

2.2.2 Skills for Industry 4.0

According to Stăncioiu, (2017) Industry 4.0, *“It is a significant transformation of the entire industrial production by merging digital and internet technologies to conventional industry.”*. As defined by Matzler et al., (2017) and Kagermann et al., (2013) Industry 4.0 is *“a networking of autonomous, self-controlling, self-configuring, knowledge-based, sensor assisted and spatially distributed production resources (production machines, robots, conveying and storage systems, operating equipment) including their planning and control systems”*. Some fundamental concept of Industry 4.0 can be categorized by Smart Factory,

Cyber-physical Systems, Self-organization, New Systems in development of products and services, Adaptation to human needs and Corporate Social Responsibility (Lasi and Kemper, 2016).

Industry 4.0 intends to create a system which can make own decisions to monitor and maintain the physical systems. This is an era of fourth industrial Revolution, characterized by a system of intelligent network systems and processes (Bloem et al., 2014). It is currently happening and is driven by technological transformation forces (Hermias, 2017). Industry 4.0 is changing the companies' way of doing business. The changes that occur in different sectors because of Industry 4.0 varies. An example of changes occurring in the manufacturing industry due to the rise of Industry 4.0 is shown in the article by Aulbur et al., (2016). Table 9 shows an overall representation of changes happening in various parts of the manufacturing industry.

Table 9 Industry 4.0: What is changing in companies(Aulbur et al., 2016)

	<i>Traditional Manufacturing</i>	<i>Industry 4.0 Manufacturing</i>
<i>Process</i>	Rigid and manual	Agile and automated
<i>Product</i>	Standardized	Personalized and customized
<i>Scale of factories</i>	Large factories at centralized locations	Small factories at decentralized locations
<i>Supply chain</i>	Stock based planning	Dynamic and predictive
<i>Success metric</i>	Low cost, high efficiency	High return on capital employed (RCOE)
<i>Client relationship</i>	Low and indirect	High and direct

Robots will do many of the work activities such as production, assembly, quality inspection etc., (Stăncioiu, 2017). AI enabled cyberphysical systems such as Industry 4.0 will radically boost the digital transformation in labour and employment (Elliott and Ross, 2019). According to Acemoglu and Autor, (2011), computerization has been widely considered to

be constrained to repetitive tasks although recently, automation has widened to non-routine tasks (Berger and Frey, 2016). World Economic Forum has listed the top 10 skills to thrive in Industry 4.0, which are listed below (World Economic Forum, 2018). The skills mentioned by the WEF are complex and not technical but revolving around technology. This suggests that the skills required or in demand are multidisciplinary and dynamic skills.

- Analytical thinking and innovation
- Active learning and learning strategies
- Creativity, originality and initiative
- Technology design and programming
- Critical thinking and analysis
- Complex problem solving
- Leadership and social influence
- Emotional intelligence
- Reasoning, problem-solving and ideation
- Systems analysis and evaluation

One of the examples that addresses the change in labour market to find a solution for manufacturing sector is an EU based project FACTS4WORKERS under the 2020 Research and Innovation programme. It served as a front model for advanced technical solution in manufacturing sector in Europe (Facts4Workers, 2016). This consortium of variety of countries and industries helped taking initiation towards smart factory solutions for manufacturing industry in a worker-centric workplace (Facts4Workers, 2016).

The changes that occur in organizations due to inclusion of digital technologies have been increasing. To address this shift, WEF has projected the impact of Industry 4.0 on the workforce by industry and proportions of the companies which is shown in the following Table 10 (World Economic Forum, 2018). According to WEF, the value change could change by 59 % and workforce reduction can be 50 %. This type of change needs new workforce who excels on things that automation cannot affect.

Table 10 Projected 2022 effects on workforce by industry and proportion of the companies by %
(World Economic Forum, 2018)

	<i>Overall</i>	<i>Automotive, Aerospace, Supply Chain & Transport</i>	<i>Aviation, Travel & Tourism</i>	<i>Chemistry, Advanced Materials & Biotechnology</i>	<i>Consumer</i>	<i>Energy Utilities & Technologies</i>	<i>Financial services & investors</i>	<i>Global health & healthcare</i>	<i>Information & communication Technologies</i>	<i>Infrastructure</i>	<i>Mining & Metals</i>	<i>Oil & Gas</i>	<i>Professional Services</i>
<i>Modify value chain</i>	59	82	44	71	83	78	56	67	55	78	44	87	60
<i>Reduce workforce due to automation</i>	50	48	50	38	57	56	56	47	55	33	72	52	37
<i>Expand task specialized characters</i>	48	52	50	42	51	52	44	33	57	56	56	52	51
<i>Modify locations of cooperation</i>	48	42	50	58	54	52	67	73	55	28	44	57	54
<i>Expand the workforce</i>	38	50	39	38	34	19	31	27	41	28	22	35	71
<i>Bring financing on board for transition</i>	36	38	33	29	40	37	31	20	34	56	22	30	37
<i>Expand workforce due to automation</i>	28	20	50	29	23	19	25	20	52	22	33	26	57

With the evolvement of Industry 4.0, recent research Baygin et al., (2016) shows that there is a shortage of qualified personnel trained in this area. There are different approaches taken by the educational institutes to be prepared for the Industry 4.0. For example, corresponding to the Industry 4.0, the education 4.0 is also an emerging topic. Education 4.0 focuses on the needs of Industry 4.0 where human and technologies are aligned creating a multidisciplinary platform to create new possibilities (Aziz Hussin, 2018). This means that instructors, teachers and professors are also in need of change and improve their digital skills to keep up with the demand of the industry. The fundamental digital skills for instructors are recording

and editing videos, creating interactive and visually contents, using social networking websites, social bookmarking, digital portfolios and non-traditional quizzes (Aziz Hussin, 2018).

2.2.3 Integration of digital skills

Digitalization has not only transformed the skills in demand but also the way skills are obtained. The digital revolution transforms the requirement for the expertise and transforms the way the skills are acquired, shared and deepened (Belin and Pri, 2014). It is a challenge for University Instructors to provide the environment to develop skills that the employers seek (Adams, 2014). To address this challenge and tackle the lack of digital skills in labour market, Martin and Grudziecki (2006) has suggested three stage approach to develop digital literacy. This approach includes Digital Competence (skills, concepts, approaches, etc.), Digital Usage (Professional discipline application), and Digital transformation (innovation and creativity) where, Digital literacy refers to the ability to use Information and Communications Technology supporting innovation to use it in appropriate way (Martin and Grudziecki, 2006). First stage being the very basic digital competence level, second level is the digital competence within specific professional domain and third step is innovation and creativity with the ability to change the professional domain (Ferrari, 2012). This framework can be used in an organization to understand the level of digital skills in employees and enhance it accordingly.

A proper integration is defined by how the technology has been used and why rather than the amount of technology being used (Earle, 2002; Sadik, 2008). A meaningful technology integration and learning can be achieved when the a curricula utilizes the authentic tasks that allows the learners to actively build their own thinking and meaning about experiences allowing more interdisciplinary project-based instruction (Jonassen et al., 1999; Sadik, 2008). (Coccoli et al., 2014) has proposed a concept of smarter universities consisting of educational aspects such as communication, social interaction, knowledge sharing, governance, wellness etc. The model is represented by shared vision among all the stakeholders in the university derived from a tertiary point such as industries, type of school

etc. and lead to apply the strengths of the university in the territory in terms of social, economic areas both virtually and physically (Coccoli et al., 2014).

One of the examples of successful digital integration is in design and crafting skills. Traditionally hand crafted designs of guitar models are crafted through digital design software and printed three dimensionally in 3D Printers (Zoran, 2015 pp. 386). Similarly, a digital motion analyser and an accelerator can be used to train the physical skills by using signal processors (G.G. Liversidge J.F. Bishop, D.A. Czekai, 1980). Another emerging example is digital storytelling. According to the digital storytelling Association, it is the modern expression of the traditional storytelling art (Menezes, 2012). The exercises and activities in digital storytelling fosters creativity and has concrete and practical outcome allowing students to be creators and have ownership (Menezes, 2012).

In educational system, integrating digital systems can be in many form and variety of places. Frerich et al., (2014) provided four main units of focus for engineering education corresponding to the industry 4.0 i.e., virtual learning environment, mobility and internationalization, student lifecycle and professional competency. These units focus on the industry 4.0 era and leads to creative, interdisciplinary opportunity in the education system (Frerich et al., 2014). Another example is MOOC, which is a web-based course having the characteristic to scale itself with regard to the number of participants and open (Kjeldstad et al., 2014). It has strengthened the open courseware policy and created new opportunities and challenges for the developers and education (Kjeldstad et al., 2014).

2.3 Summary of the chapter

The uprising of digitalization in the fourth industrial revolution has given a boost to the digital economy and is flaming the need for digital skills. Digital skills are needed in most areas of the business since the processes, products, services, communication and information sharing etc. are becoming more and more digital. Most of the literatures studied for this thesis indicated that there is an increasing gap of digital skills between the industries and the workforce. The studies also suggested that digitalization is one of the factors contributing to this gap. Since, this study intends to find the digital skills in demand by the industries for IEM graduates; the literature review included the concept of digitalization and digital skills providing the platform to start the empirical part.

Digitalization is a process of change that has occurred due to various factors changing the concept of work in the industries. This change has given rise to demand in skills that are digitally influenced which traditional workforce cannot fulfil. Those skills may range from hard digital skills to cognitive skills in digital environment. To fulfil this gap, educational system needs to produce graduates' who are competent to take on those tasks. This is the base for the empirical part of this study. Figure 4 shows the purpose, process and summary of the literature review of this thesis.

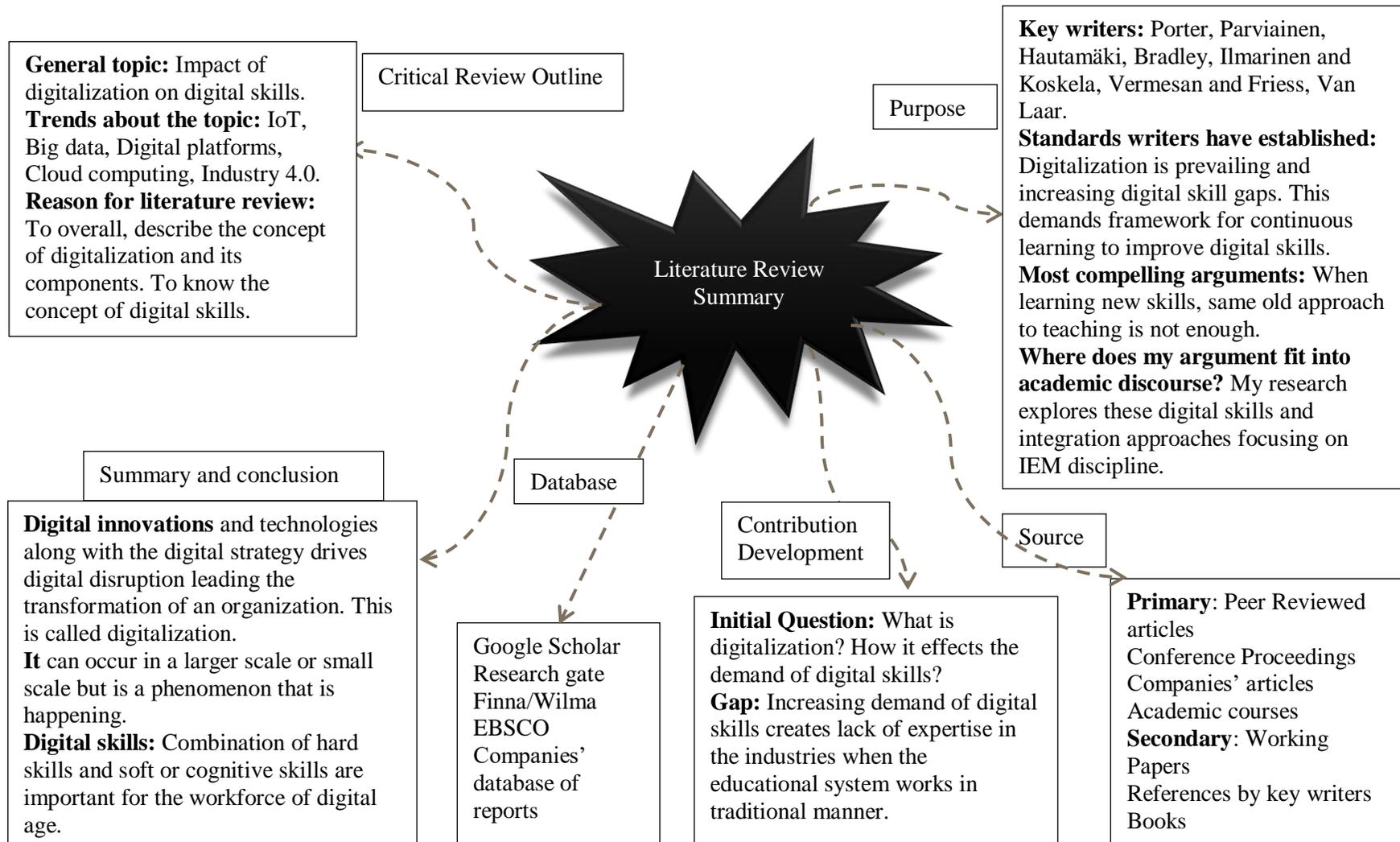


Figure 4 Summary of Chapter 2 and 3

3 Context: Industrial Engineering and Management as a scientific and practical discipline

Industrial Engineering and Management discipline consists of different aspect of industry according to the university and the country where university resides. In general, it is a multidisciplinary subject allowing graduates to work in various field. Industrial Engineering's basic concept is to teach the students how to make production efficient, maintain quality and decrease cost in industrial organizations (Hermias, 2017). Its aim is to understand various aspects of the organization such as economic, operational, technical, processes, etc., to improve competitiveness (LUT University, 2019c).

“Industrial Engineering is the engineering discipline that deals with the plan, design, development, knowledge, improvement, implementation, installation and evolution of the performance of complex processes or integrated systems of people, technology, and information.” (Marin-Garcia and Lloret, 2011).

For an industrial engineering and management graduate, it is important to know and understand the holistic concept of technologies and algorithms to improve and innovate the processes. According Marin-Garcia and Lloret, (2011) students in industrial engineering field should have an extensive knowledge of mathematical and methodological proficiency and is aware how to optimize the various processes using different methods. IEM covers a wide range of subject and so the graduates are expected to have creative approach to problem solving. IEM graduates theoretically, can understand this three-level concept and analyse the organization's levels as well as find innovative ways to improve the quality of the process within. They have knowledge of many specific areas in various industries such as performing division tasks, splitting into simple types of work, deciding on how to use the limited resources within the constraints given etc. (Marin-Garcia and Lloret, 2011). A seven year data analysis of the profession and competences of IEM graduates carried out by Lima et al., (2017), has provided the top growing professional practice areas of IEM graduates and is listed below.

- Quality
- Project Management
- Production Management
- Product Design
- Marketing
- Maintenance
- Industrial Optimization
- Ergonomics and Human factors
- Economics Engineering
- Automation
- Supply chain management

3.1 Digital Skills and IEM program

Higher education has been facing challenges to keep up with the rapidly evolving digital environment. The main concerns are the balance between theoretical and applied knowledge, and including soft skills and business management skills into technical degrees (Atasoy, 2012). This description is closely related to what IEM stands for i.e. theories, application, soft skills and business management skills. Yorke, (2004) has described employability as a set of achievements in skills, understandings and personal attributes that makes graduates more attractive to the employers (Lima et al., 2017). Omurtag, (2009) suggests that in IEM context, students should be able to competent to mobilize themselves in various professions in large functions, which can be related to production and service systems. Those various areas may include different functions and variety of tasks. Hence, knowledge of various technologies related to the area of own interest and personal development plan is necessary. This allows the students to be familiar with the state-of-the-art technologies and be aware of the trends surrounding it.

In addition to the technical knowledge, non-technical knowledge should also be considered in the IEM curricula. Non-technical skills such as creativity and analytical research skills, dealing with stress have gained popularity than before (Lima et al., 2017 pp.10). The study

concluded that the transversal skills that have gained popularity in the seven years period of the study are as follows.

- Foreign languages
- ICT
- Teamwork
- Planning/Organization
- Leadership
- Communication
- Initiative
- Autonomy/Liability
- Interpersonal relationship
- Dynamism
- Goal orientation
- Negotiation etc.

Social skills is one of the most needed skills in 2020's from students perspective (Ahonen and Kinnunen, 2015). This however maybe difficult to achieve in a traditional instructor-centred University Classroom (Fisher and Newton, 2014). IEM program is concerned to develop in a way that it includes transversal competences in the curriculum planning, where transversal skills refer to the competences that are beyond technical subjects and related to professional practice (Lima et al., 2017 pp.4). Although some consider soft skills or non-technical skills as intangible, these skills are very quickly becoming requirements that carries the tangibles and increases productivity allowing sustainable competitive advantage in global market place (Bancino and Zevalkink, 2007).

3.2 IEM in LUT University

Industrial Engineering and Management Department is a branch of engineering science that combines technology, business and leadership studies to tackle complex challenging problems (LUT University, 2019d). In LUT University, the IEM program has six programs i.e. Operations Management, Global Management of Innovation and Technology,

Entrepreneurship, Industrial Engineering and Management in Lahti Unit, Data Analytic in Decision Making, and Digital Service Engineering(LUT University, 2019c).

LUT IEM has appointed as an exceptional status three times as “A centre of Excellence in University Education” by Finnish Higher Education Evaluation Council in the years 2001-2003, 2004-2006 and 2010-2012 (LUT University, 2015). Additionally, Global Management of Innovation and Technology (GMIT) is one of the ASIIN accredited program in IEM in LUT University since 2017 (LUT University, 2019e) which focuses on Innovation and technology management. Along with this LUT provides their students digital library platform, which enables students to research on the topic of interest online. LUT also provides cloud platform for students and instructors to communicate and collaborate online. LUT has been committed to finding innovative approach to solve problems for products and services in all the degree programs. Hence, various projects contributing to the innovation and digitalization has been conducted. Some of the projects from IEM department that deals with digitalization and digital technologies are listed in the Table 11.

Table 11 Examples of digitalization projects in LUT in IEM program (LUT University, 2019c)

<i>Projects on digitalization</i>	<i>Description</i>
<i>CEPHEI</i>	The ERASMUS+ project tackles digitalization and communication challenges in Universities launching a consortium platform for open education in Industrial Innovation connecting teachers, students and Universities.
<i>Digital Accounting 2025</i>	The project is responsible for the challenges of competence brought by digital digestion, focusing on Digital Business and Service Process and Analytics.
<i>FACTS4WORKERS</i>	The EU funded project (2014-2018) focused on increasing problem solving and innovation skills for workers in manufacturing sector in Europe.

Apart from the various projects, LUT has been leaning towards digital services for the students and staff members. For example, The LUT Bot is a personal study advisor for the programmes in LUT, which allows interactive platform to find the right degree programme. LUT also announced the LUT digital strategy of education 2020. Under this strategy, LUT has centrally chosen the digital learning and teaching technologies and platforms supporting digital environment (LUT University, 2019f). Additionally, LUT has provided several information systems that which support the study related activities for students and staff.

4 Methodology

This chapter aims to provide a thorough description of the methodologies used in the study of the thesis. The subchapters following illustrates the context and methodological choices along with the explanation of those choices. The next stage provides information on how the data for the thesis was collected and analysed.

4.1 Research Context

The major emphasis in exploratory research is on discovering ideas and insights on the topic of interest and so the design must be flexible enough to provide opportunity for different aspect (Kothari, 2004). This research aims to explore the types of digital skills that are needed in digitally evolving organizations keeping the context in and around Industrial engineering and management studies. The in-depth interviews with the experts from both academics and companies aided to achieve the aim of the thesis. The objective of the thesis was to explore the digital skills that are and will be important for IEM graduates. In addition, approaches to include these digital skills in the IEM curriculum and activities was also proposed. The study shows the need of the digital skills in academics as well as in companies, which allows an open discussion about the rapidly changing job market for the graduates.

4.2 Methodological choices

The study follows qualitative research approach to explore the impact of digitalization on digital skills using abductive approach. Qualitative research studies the meaning and relationships between the participants in the study and abductive approach generalizes the interactions between the specific and general topics to explore a phenomenon (Saunders et al., 2015 pp.148). Qualitative approach to research concerns the subjective assessment of the attitudes, opinion and behaviour and generally the techniques used are focus group interviews, projective techniques and depth interviews (Kothari, 2004).

The primary data is gathered from interviews and secondary data was gathered from the preliminary research. In total, ten company experts from eight different companies and two

academic experts were interviewed. While choosing the companies and interviewees, three things were considered i.e. knowledge in digitalization and HR process in their company, familiarity with IEM program and LUT graduates' interest in the company. Most of the companies chosen were the ones where IEM graduates are either working or started to work after graduating from LUT University. In addition, most of the interviewees chosen were IEM graduates or affiliated with the IEM program. All the companies interviewed were digitally advancing and interested in developing digital products and services in their sector in Finland.

The research is a cross-sectional study involving phenomena i.e. digitalization and in a certain time frame. Cross-sectional studies are carried out at a certain point of time or over a short period and are expected to estimate the prevalence of the outcome of interest for a given population (Levin, 2006). The purpose of the research discovers answers and explorative research is done to gain familiarity with a phenomenon and insights on the topic (Kothari, 2004 pp.2). To understand the in-depth context of digital skills according to the companies and experts, semi-structured interview was chosen as a research strategy. Semi-structured interviews are the qualitative research interviews which has a list of themes and some key questions which may vary from interview to interview in given organizational context (Saunders et al., 2015 pp. 391). The interviews consisted of three themes with open-ended questions in each theme. Some interviews were done face-to-face whereas some are done through skype. More on data collection is explained in the chapter 4.3.

The Figure 5 shows the research methodology for this study. The research reflects on the 5 W's and 1 H i.e. What is digitalization and digital skills? Where is digitalization happening? Why digital skills are important. Who are the industrial engineering and management graduates? When is digital skills needed? How can these digital skills be implemented in the IEM program?

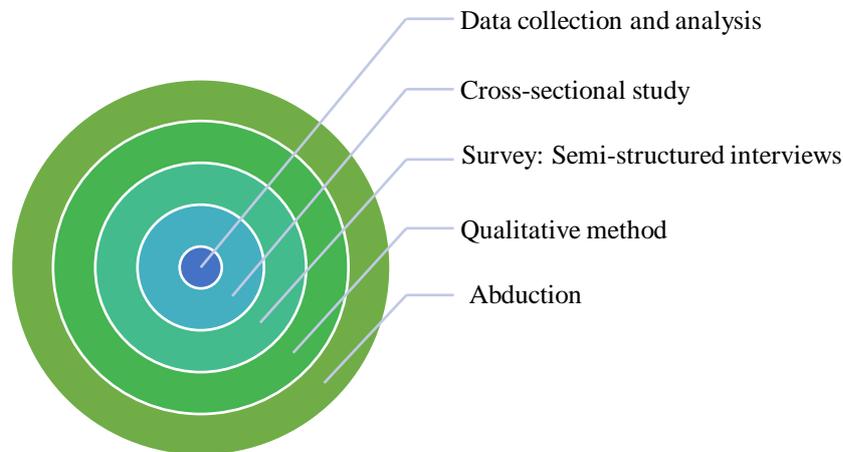


Figure 5 Research onion for the study adapted from Saunders et al., (2015 pp. 124)

4.3 Data collection

Each year since 2011, LUT University carries out a survey with alumni of IEM department. According to these yearly alumni survey by LUT University, IEM graduates can hold many different occupations and in different industries. The survey from 2011 to 2017 was compiled in the early stages of this research. The survey helped to list the top 15 companies and top 15 job positions. This list formed a base for the study to begin with. According to the criterion defined in chapter 4.2, the companies were chosen for interviews to collect the data.

There are two types of data in this study; one is primary data that includes the data from semi-structured interviews and another is secondary data from the preliminary study interviews of students from the Global Management of Innovation and Technology program (GMIT). Semi-structured interviews involves questioning process guided by themes in a systematic manner to probe elaborate responses (Qu and Dumay, 2011 pp.246). The primary data are those which are collected for the first time and thus are original while secondary data are those which are collected and passed through statistical process already (Kothari, 2004 pp.95). The preliminary research as secondary data provided insights on the skills that are provided in the University in GMIT.

The companies and academic experts were contacted via direct email and from the online contact form from the company's websites. Most of the companies were responsive and interested in the topic. According to the criterion explained in the chapter 4.2, the companies were chosen and the date for the interviews were fixed. A pre-research on the interviewees in social media platform and email conversations gave the idea about the interviewee's interests and career path. Table 12 provides the details on the interviews taken. A to H represents the company experts and 1 and 2 represents the academic experts from IEM.

Table 12 Interviewees

<i>Organizations</i>	<i>Interview type</i>	<i>Position of the interviewees</i>	<i>Firm type</i>	<i>Time</i>	<i>Date</i>
<i>A</i>	Group (a1 and b1)	Design Manager and Proposal Engineer	Incumbent	1:12:48	15.11.2018
<i>A</i>	Individual	Director of Research (Involved in academic projects with LUT)	Incumbent	48:24	02.11.2018
<i>B</i>	Individual	High technology and ICT business expert and consultant	Start-ups	55:41	15.11.2018
<i>C</i>	Individual	Sales	Start-ups	43:46	26.11.2018
<i>D</i>	Individual	Director, Digital Stakeholder Relations	Incumbent	38:19	05.12.2018
<i>E</i>	Individual	Production manager	Incumbent	29:27	18.12.2018
<i>F</i>	Individual	Head of Digital Intelligence & Advisory, Digitalization & New Services	Incumbent	40:52	13.12.2018
<i>G</i>	Individual	Director, Head of Management & Collaboration Solutions	Incumbent	40:51	19.12.2018
<i>H</i>	Individual	Vice President IT	Incumbent	56:33	16.01.2019
<i>1</i>	Individual	Professor of Practice	Academic	33:27	01.11.2018
<i>2</i>	Individual	Professor	Academic	38:47	05.11.2018

The questionnaire was semi-structured with three themes, i.e., IEM and LUT, Digitalization and Digital Skills. The semi-structured interviews gave a format to the interview with the liberty to provide general experiences and views on the topic in the interviewee's point of view. The interviewees were from different organizations ranging from traditional manufacturing to high-tech. The interviews were held in person or via skype in convenience with both the participants of the interviews. The interview questions are available in the Appendix 2. The interviews taken were recorded via Skype or recorder and were transcribed manually.

Additionally, secondary data was obtained from the preliminary data. The data was gathered from the interviews with the students from the Global Management of Innovation and Technology (GMIT) in IEM program between May-July 2018. The students were chosen according to their work status i.e. if they are working in a company or an organization. The interviews taken were open-ended and explored the need of digitalization in the program. It demonstrated that the students are willing to be more active in learning digital skills. The interviews yield that the provided tools and skills from the program is satisfactory. It shows that there is a room for improvement in the program. Hence, this thesis addresses this emphasis on the need of digital skills exploring what is needed in the companies.

4.4 Data Analysis

The purpose of data analysis is to summarize and find relations between the raw data to present structured information. The analysis of the data intend to compute the measures and searching patterns of relationship in the existing data group (Kothari, 2004 pp.122). Qualitative analysis of data refers to the process of resolving data into its components revealing its characteristics including its elements and structure (Dey, 2003 pp.31). The transcribed interview data were analysed using NVivo 12. NVivo is a software that provides a set of tools that assists in analysis of qualitative data allowing the user to manage data and ideas, query, visualize and report the data (Bazeley and Jackson, 2013 pp.2-3).

Using NVivo, the transcribed data were divided into two parts, one is present situation and another being future. The first part deals with the present and possible future scenario of the

organizations in context of digitalization and digital skills, whereas second part contributes to the suggestions, what can be done and how to tackle these changes of the digitalization and digital skills in the organization. These two parts were then coded into different themes. Coding refers to assigning symbols or numbers to align them in a category or class (Kothari, 2004 pp.123). These coded themes were then divided into four groups as mentioned in the chapter 6.2. The coded data allowed the raw data to be structured and easy to look for themes. Once the themes were identified, the information was analysed and presented in various forms such as word clouds, content analysis, query analysis, word frequency, diagrams etc. The Figure 6 shows the overall structure of the process of data analysis.

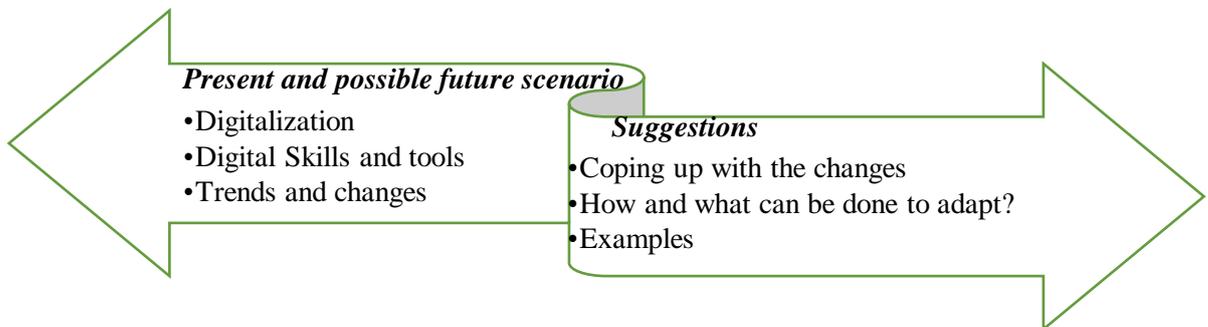


Figure 6 Data analysis process and themes

4.5 Data quality of the research

The data from semi-structured interviews can have various data quality issues. Some of the issues according to Saunders et al., (2015 pp. 396), the semi-structured interviews can have issues such as reliability/dependability, forms of bias, cultural differences, generalisability/transferability and validity/credibility. The most common criticisms on qualitative method of research are the research is an assembly of personal impressions, strongly subjected to bias from participants, lacks reproducibility and generalisability (Mays and Pope, 1995 pp.109).

Reliability/dependability is a concern in the semi-structured interview since it lacks standardization and prone to interviewee or response bias (Saunders et al., 2015 pp. 397). The interview questions were made in context of the IEM program. There was fixed themes

and the interviewees were experts in their field with knowledge of IEM. The interviews were semi-standardized. However, the research is exploratory and is intended to discover digital skills from their point of view hence; the research is more flexible in questions. Reliability and validity according to Smith, (2003 pp. 604), are conceptualized as trustworthiness, rigor and quality in qualitative paradigm. Concerns on cultural differences should also be considered in the qualitative data research process since it represents certain societies and culture and not applicable to others (Gobo, 2011; Saunders et al., 2015 pp. 398). The interviews taken were between cross-national respondent and researcher. Hence, a cultural reflection was necessary prior and in the interviews. To avoid the cultural difference, the approach to interview was informal at the beginning to create a relaxed environment for both the participants.

Generalisability/transferability is very often raised in qualitative research interviews because the research is based on small sample and the extent to which it can be generalised is limited (Saunders et al., 2015 pp. 398). The main question to ask about generalisability during the research is if the sampling strategy theoretically comprehensive to ensure generalisability (Mays and Pope, 1995 pp.112). The topic of this study is vast and general but the context to which the result is oriented is specific to IEM program. Validity/credibility is referred to the researcher's ability to gain access to the interviewee's knowledge and experience (Saunders et al., 2015 pp. 398). To keep the credibility of the research, the respondents were given the context of IEM, Digitalization and Digital skills in this research, which allowed them to express their opinion on the topic clearly. The respondents were open to give viewpoints on the topics from different angles. Additionally, the interviewees were the contacts who were known either to researcher or close to researcher's colleagues, which build trust between the participants.

5 Findings

This chapter presents the results from the semi-structured interviews. There are two sub topics in this chapter. The first topic shows the standard of digitalization in the Finnish companies. It provides practicality of the organizational change due to digitalization. The understanding of digitalization, its drivers and effects on organizations are also made clear. The description and information provided in the sub topics shows the flow of digitally evolving work place. These change demands digital skills, which is the second topic chapter 5.2. It provides information on the emerging digital skills according to the interviewees. The digital skills are listed and described according to the results obtained.

5.1 Digitalization in the companies

Digitalization as per the interviewees hold slightly different meaning in each organization. All the interviewees described shortly about the digitalization process in their organization. All the informants elaborated the meaning of digitalization, their drivers and effects in general for their organization. The meaning of digitalization overall expanded from very technology oriented to business oriented. The common link in the definitions was cheap digital information that can be stored, analysed and used to enable more revenue streams. Table 13 shows the common themes used to describe digitalization according to the experts from different organizations. Head of digital intelligence from Company F summarized digitalization in following way.

“Digitalization is not the end goal. There is a business purpose behind it to improve internal efficiency and transform part of business or to start a new business, which then supports the overall business strategy for sustainable profitable growth.”

Table 13 What is Digitalization?

<i>Digitalization themes</i>	<i>Explanation</i>
<i>ICT</i>	<ul style="list-style-type: none"> • ICT enabled change is called digitalization. • Digitalization is a platform to leverage ICT and find solutions.
<i>Business</i>	<ul style="list-style-type: none"> • To improve internal efficiency and transform part of business or to start a new business is digitalization. • Digitalization is not tech oriented but business oriented. It should enable more revenue, decrease cost, improve productivity, processes and supports overall business strategy which is sustainable profitable growth,
<i>Technology</i>	<ul style="list-style-type: none"> • Using digital technologies to increase the production and selling of new digitalized product. For example, using Virtual Reality (VR) or Augmented Reality (AR) technologies integrated with the products. • Predictive maintenance, product watching the environment itself and productizing process is digitalization.
<i>Information</i>	<ul style="list-style-type: none"> • Information system transparency in various areas of business. • Data integration and sharing information with stakeholders. • Replacing human-to-human or concrete transactions with the help of technology in the processes.

According to the interviews taken, there are certain factors that are driving digitalization in the organizations. They are customer expectation, technology and innovation, and knowledge and growth. These factors fuel digitalization in the organization and demand for change. This demand drives digitalization and delivers change in the organization. Company D elaborates the push for digitalization providing the trends that company is following.

“From marketing perspective, Company D is behind the trends of customer experience, platforms and customer navigation analyzation.”

This forms a process of drivers and effects, which requires dynamic skills from the people involved. The Figure 7 shows an overall process of reason behind digitalization and its effects in an organization. It shows the how the drivers or push factors pressure the organizations to change digitally and the types of changes that occur in the organizations.

This process of change influences the digital skills and causes change in dynamics of the digital skills required by the organizations from the employees.

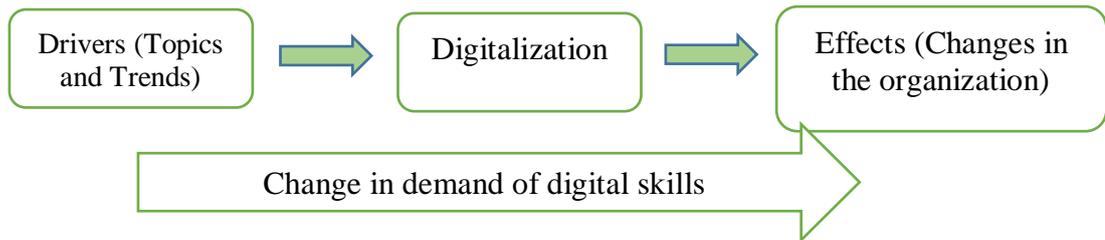


Figure 7 Digitalization in organization: drivers and effects

5.1.1 Drivers

Digitalization is driven by various factors in each organization. Academic expert 1 expressed his view on digital technology trends in following way.

“Most important technology in digital transformation has not changed in the last decade. Connectivity: first via fixed internet and then then via mobility are the fundamental changes that are taking place.”

Interviews taken yield three different types of topics as driving force for digitalization, which is shown in the Figure 8. The interviewed organizations and experts pointed out various trends that they follow in terms of digitalization. The trends according to the interviews follow three basic themes suggesting the driving force for digitalization. The push can come from the customer’s side, technology and innovation, and knowledge and growth. The industries follow these technological trends to make their company efficient, reducing risks and gaining advantage to their competitors.

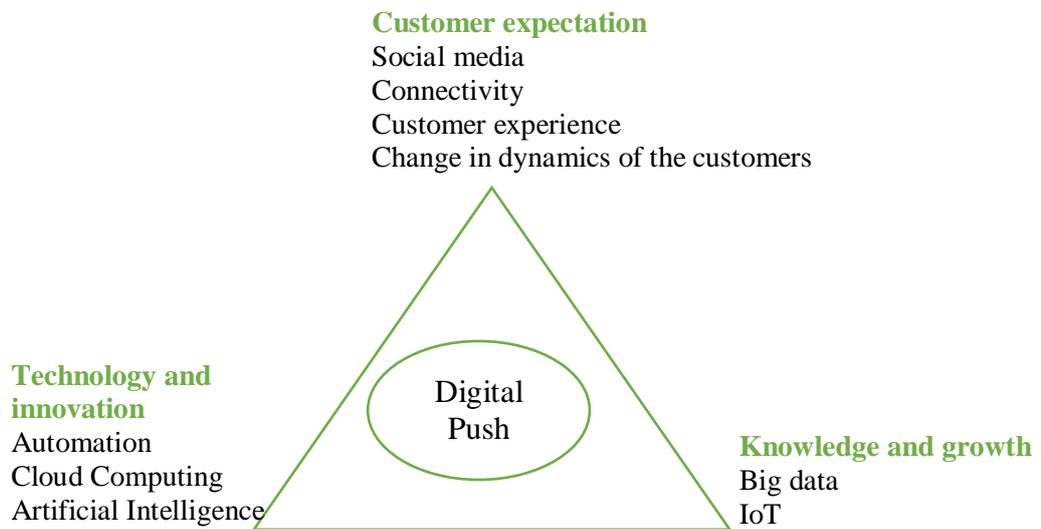


Figure 8 Trends according to the companies for digital push

All the interviewees suggested that customer expectation is one of the key factors that push the organization towards digitalization. The interviews implied that the end consumer's expectations change very rapidly whether following new technology trend or influence from an influencer in social media. Company H describes the effect of customer expectation in the organizational change in following way.

“I would say our technologies have served us well in the past, but as the customer expectations change as their need from technology are evolving, our systems today I would say don't fit the purpose anymore. So, we need to review that. And that's one of the very big transformation we're doing with my team.”

Whereas the demand of corporate customers does not change rapidly but has high impact on the organization because it is driven by technology and profitability. The technology varies within different area of work in the organization. In some cases, external threats can also be a push to innovate within the company. For example, company D expressed its view on the push for digitalization as follows.

“Ecommerce, back then Finnish business were chasing the international businesses. Now also same challenges, retail business: afraid of amazon coming to Finland. Platforms have developed, lot of artificial intelligence, social media is connected, and advertising, targeting data goes in between.”

5.1.2 Effects

The push from digitalization generates a wave of change in an organization. All the interviewees were positive about digitalization in their companies and the changes that comes with it. It is perceived as an opportunity to grow and develop from the organizational point of view. Both incumbents and start-ups companies were positive about the changes and the academic experts were positively embracing digitalization as an opportunity.

Business as usual

Currently, digitalization effects in most of the areas in the organization according to the interviewees and will influence many different levels internally and externally. All the informants agreed that the digital tools that they use in the company are useful for example skype. However, when the changes happen, people are less reluctant to change the already established tools. Self-learning and self- reflection came out as one of the most important part of change in an organization that employees need to prepare. The digital tools that organizations are currently using are shown in the following Table 14.

Table 14 Tools used by the companies

<i>Communication/Sharing</i>	<i>Data Presentation</i>	<i>Data storage and analysis</i>
<ul style="list-style-type: none"> • Skype • SharePoint • Email • Slack • social media (Internal Facebook, Yammer) • Intranet 	<ul style="list-style-type: none"> • Targeted newsletters • Microsoft Office (Word, Pdf, PowerPoint) • Print materials 	<ul style="list-style-type: none"> • ERP • Database (automatic or manual) • Mobile apps for specific purposes. • DMS systems • Customer database • Web analytics • Cloud database • Macros

According to the interviews, digitalization effects differently in various departments in the organization. Six of the interviewed organizations (A, D, E, F, G and H) were incumbents in their field. Companies A, D and E are producing physical products. They indicated that digitalization is seen positively in the company but the transition to digital products and processes is seen far away. Although, the integration of digital products and outsourcing of digital elements for the companies is progressing. All these incumbents have a digitalization department but is not generating revenue and are there in immature state. Company D expressed its perspective on the topic in following way.

“Need for digital change is not in our DNA. We produce physical product, so we do not have digital revenue models now. Core business won’t be digital for a long time, but we need to keep eyes open and innovative about things to get value from data to serve customers in a better way.”

Among F, G and H companies, G and H are digitalizing their processes and business and were returning investments. Whereas company F approached digitalization as an overall umbrella working as a different department overlooking the processes and providing

research and suggestions on the process they handle. The head of digital intelligence in company F defines the purpose of their department in the following way.

“We Approach from a problem, challenge and opportunity point of view, not from a technology point of view. If there is an area where we can improve, we can enable more revenue, decrease cost or improve productivity; we look from that point of view.”

Companies B and C representing high-technology based companies expressed their view in a different fashion. B was very open to change and quick to adapt to new technologies and trends which the customer companies look for. The customer’s demand drives the approach to digitalize the business. While company C identifies the problems and develops the technology products to expand the usage of the product in different areas. Company C describes their process of digital integration in following way.

“When new technology is introduced, it is tested out and presented to other organization, how it can be applied to other organization. Testing guys are tech savvy, but their work and conversation aren’t based on results, how much tech they can introduced to business processes. We are in this space and similar model is applied to different technologies. We are in early phase of adoption. It is how we can make work more efficient using digital technologies, in VR AR it could be design to transition from building physical prototype to virtual one.”

Changes and Challenges

According to the organizations interviewed, the estimation to future is a challenge. The change is fast and unpredictable. The products and services that were popular ten years ago is not relevant today and the products and services that are in trend right now did not exist then and irrelevant after ten years. Organization G summarized the future estimation in following words.

“I am unable to answer what happens in 10 years, future estimation work; whatever we can imagine is too modest in 10 years’ time. We will start to digitalize people.”

The future of workforce according to the company and academic experts show that it demands dynamic capabilities. Multidisciplinary and fluidity at work will be needed. The gap between the technical experts and business experts will narrow down. Company G gives an example of narrowing gap between two departments in following manner.

“When digitalizing human resource operations, we changed operation mode for global harmonized, centralized, globalized system. The change implemented was lot around self-service. Manager is going to faceless system; he understands HR jargon and take part of HR professionals, making it cleaner.”

Similarly, company H shared their views in the following way,

“In future, we won’t know which one the IT colleague is, and which one is business colleague because they work very closely.”

The companies are always looking for new opportunities to capitalise their products and services and optimise their internal and external processes. Company C intends to do the same and reduce the process time from design process.

“Digital design can cut down the cost in design process. Other possibilities are trainings, heavy machineries, real equipment are used for work, and in VR we can train the workers.”

Most of the interviewees agreed that processes will be automated and one of the interviewees indicated that most of the production line would be fully automated. This automation of products and processes will generate huge amount of data. The challenge is to produce focused data that is useful to improve the system or create a new system. Along with big data, the automated system allows easy adjustment to the system and with needed quality

changes. This will reduce human error and the assembly cell will be visible vividly. One of the interviewees suggested that the customer's database system that is available now would be fluid. These changes will demand for workforce that understands different disciplines and the need for new skills will emerge.

The digitalization according to the interviewees are not only confined to systems and process. The next step will be digitalizing humans. One of the interviewees hinted that the humans will be soon digitized, and the plantation of chips would be the start. Physical products will be reduced and will change to digital products (e.g. cash, keys). One of the interviewees pointed out that the digital platforms that are available now is working in the systems, but the ownership of the platforms are not defined, and it can be a challenge to address this in near future.

5.2 Digital skills

All the interviewees agreed that there is a need for change in the skills of the workforce and the so in the education system. The digital skills that has been defined today is most likely to change in few years. Multidisciplinary and multi-dynamic workforce was very popular answer among the interviewees when asked about the type of demand of employees. When asked about the lack of skills in IEM graduates, academic expert 1 responded in following way.

“The challenge here is that once you enter an IEM jobs, you are supposed to be the creator. You are supposed to create systems rather than content in the system that others have created. This is the key skill set lacking in many people.”

Here, to analyse the implications and point out the digital skills for IEM program, the types of jobs the IEM graduates hold is also taken into consideration. To know the types of jobs IEM graduates are holding after graduating from LUT, the annual survey from LUT was analysed from year 2011 to 2018. It yielded that the IEM students hold jobs in managerial

position mostly, then in engineering positions, specialists, researchers, designers, controllers, sales, controllers and analysts respectively.

Combining the need and lack of digital skills in companies and keeping in mind the types of positions IEM graduates hold, the interviews yield on the five main themes of the digital skills that the interviewed organizations want and will look for in future. These skills are listed below.

- Interpersonal skills in digital age
- Understanding business and digital business
- ICT Skills
- Digital creativity
- Digital social intelligence

Most of the interviewees shared their experience and leaned on hiring person with better cognitive skills than hard skills for IEM graduates and the kind of positions they hold. The head of digitalization in company F shared that most of the work requires done as a head of digitalization is using soft skills such as collaborating with different departments, presentation and communication. Company H shared similar thoughts on the value of soft skills following way.

“We're a smart-stupid, we make patterns but if we do not use it 10 times, we break it. That is how our brains work. So being aware of this is a key skill. We need to learn this as future students and universities that hard skills can be acquired always. You can learn anything. I'm sure of it.”

According to the interviewees, the skills such as learning software and using new technology can be learned easily but what is challenging to learn is cognitive skills such as awareness, agility, handling conflicts, etc. and now both in a physical and digital environment.

5.2.1 Interpersonal skills in digital age

As per the interviewees and the results, interpersonal skills such as communication and negotiation skills are at priority. Eight out of the eleven interviewees pointed out that communication is one of the key skills in digital skills. The approach to communication, ability to learn and use various tools etc. is seen as an advantage for the job applicants. Technologies are not created or innovated in the established companies, which are not based on technology itself. Technologies are outsourced and the employees these companies need are the ones who can communicate well with both the experts and amateurs. Company H describes this situation in following way.

“I would need people who are able to communicate very well and explain complex ideas in simple way or able to buy or manage or administer technical systems together with suppliers and vendors. It is so important because also 90% of technology today's purchased; it's not developed in companies anymore.”

In addition to this, entrepreneurial attitude is considered as a competitive edge for the applicants according to the interviewees. The curiosity and eagerness to try new technologies and being brave to lead in a digital platform is crucial for organizations. Company A (a1) referred to entrepreneurial skills to be important in the strategic business management.

“In strategy we are tied to do conventionally, it's evolving but more space for your own thoughts is needed.”

Furthermore, according to the respondents, soft skills plays an important role in the hiring process. The skills such as ability to explain complex matters, persuasion, influencing etc. are kept in regards in the companies. Company G shared their views on the soft skills in following way.

“I do recruit people, education does not matter a lot, it is more about soft skills and how they are displayed in the discussion. The ability to explain, summarize, digest the information of any problem or challenge is important.”

Summarizing all the viewpoints of the interviewees, there are basic five skills listed in the Figure 9.

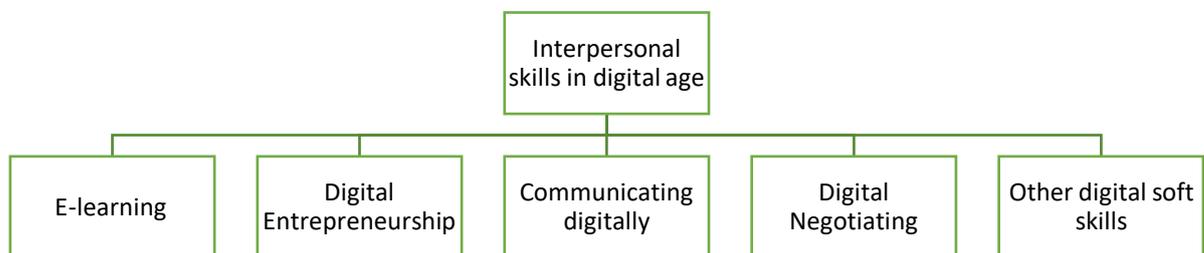


Figure 9 Interpersonal skills in digital age

5.2.2 Understanding business and digital business

All the interviewees agreed that business understanding is one of the important skills for IEM graduates' whether it is organizing of a team or self-organization, finding new opportunities in the work place. Six out of eleven interviews strongly pinpointed the importance of business understanding for new graduates. According to the interviews, the understanding of the business process, opportunities and models are essential. To know the practical ways of company processes provides advantage over other applicants in the hiring process. Company H shared an example of understanding opportunities in business as such.

“If you look at how people make roads and then if you go in outside in the snow you will see that you have the path and then you have where people are walking and it's different sometimes. Why? Because people's behaviour is justified by very sometimes rational or irrational patterns. Observing those is part of the skills of tomorrow being able to realize, hey,

something is not as intended or there is an opportunity here. That's how you make business.”

This example shows how opportunities in business can be discovered with observation and critical thinking. This same example can be taken and put into digitally advanced work. People leave digital traces in the internet, which can be observed and analyzed to create new business opportunities. Company G shared their view on skills about business understanding and selling in similar way.

“Regardless of roles, we sell ideas, persuade people, handle conflicts and come to consensus.....Academics are very good at getting technical skills, but self-awareness and basic interpersonal skills are lacking.”

According to the interviews, the management style or knowledge is not same as it used to be before. There have been ongoing changes due to various factors in organizations and need variations in business. Therefore, innovativeness and multidisciplinary understanding is considered highly advantageous for managers in today’s changing environment. Connecting dots and able to maximise the output with less resources strategically and tactfully is one of the key skills required by the organizations from the managers. Globalization and technology advancement have broadened the area where managers were limited before. Hence, with these changes, managers can expand the field and develop accordingly.

Business as usual is advancing with social media, internet and new technologies. This leads to the expansion of business in new areas, which needs new skills such as being innovativeness in the existing processes and products. Figure 10 shows the importance of the innovativeness, E-organization and business understanding for the IEM employees in managerial tasks.

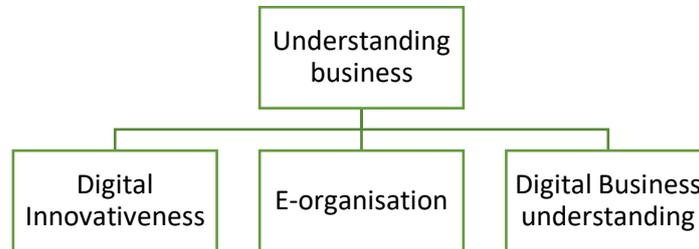


Figure 10 Digital business skills

5.2.3 ICT Skills

ICT Skills as theories suggest in 21st Century Digital skills 2.2.1, consists of various fields related to technology. According to the interviews taken, the ICT skills varied in three different areas that are important for IEM. Table 15 shows the ICT skills that the organizations find important while hiring IEM graduates in their companies. The interviews yield that data and algorithms, e-organization, communication and technology are the fields that IEM should focus on when building ICT skills.

Table 15 ICT capabilities for IEM

Areas	Meaning
Data and algorithms	Obtain and analyse data, interpret the data and find its purpose, create algorithms, check the quality of algorithms and its relation to the processes
E-organization	Digital emotional wisdom, organizing team and ability to use different tools (excel based, cloud based etc.)
Digital Communication	Verbal, non-verbal and listening skills in digital platforms, preparing and sharing structured information, making and editing informative videos.
Technology	Ability to tinker and leverage technology, understand state of the art technology.

Digitally advancing companies demand for multi-dynamic workers. The work description for the same position has significant difference if compared five years ago and today. Managers now must know different fields and jargon of different positions including HR, IT etc. This allows the understanding and smoother collaboration in teams. Therefore, the understanding of ICT skills with business understanding and organizational skills is important for organizations while hiring new graduates.

Most of the interviewees agreed on the trend that Big data and IoT is increasing and with that the amount of data and algorithms used will also increase. Hence, the data integration is very important for business to expand and create new opportunities. Company D expresses their view on the impact of data and IoT on jobs in following way.

“Manual work is being done now but will be automated. So, somebody is needed to watch those algorithms, following the quality and check correct the data. Whenever error or problems occur, we need to communicate with experts and customers.”

The role of IEM graduates in this would be obtaining interpreting and finding the purpose for this data. In addition, with the increase in automation products and processes will be automated; with this, the need for monitoring this automated process and quality checking the algorithms will be needed.

Furthermore, interviewees were consistent on the need of organizing and communicating capabilities of the graduates. Moreover, the ability to tinker with the technology and understand different technologies came out as an important skill for organizations in hiring IEM graduates.

5.2.4 Digital Creativity

“We Approach from a problem, challenge and opportunity point of view, not from a technology point of view. If there is an area where we can improve, we can enable more revenue, decrease cost or improve productivity; we look from that point of view.”

To integrate technology with business as usual, Company F provided the above approach to solve problem and tackle new challenges. Business starts with solving a problem and with more problems comes more business. All the interviewees expressed that they need problem solvers. With the increase in digital technology, creativity and problem-solving has taken a turn to digital age. The skills are the same but the medium and platform has changed. To solve a problem, which has occurred in digital environment it is important to know basic understanding of different field inside it. This leads to the understanding that the knowledge of basic coding, security and networking, data integration and analytics, search engines and platforms is critical.

Creativity in digital age means to understand the environment, being comfortable in digital world and discover new ideas as the world grows. This comfortability and understanding of different disciplines in digital environment are very important to remain creative in the digital age. Most of the interviewees expressed the importance of the digital creativeness. To be digitally creative understanding of various fields, critical and analytical thinking is crucial. According to the interviews, the ability to be flexible and losing the rigid way of thinking is one of the important aspects of creativity and is appreciated in most of the companies. Company G shares the value of the creativity and modern ideas is following way.

“We need the fresh thinking, latest tech, trends, getting interesting new ideas from fresh graduate is something very crucial to keep fresh.”

5.2.5 Digital social intelligence

Social Intelligence in virtual world allows advancement in market segmentation, risk assessment and decision-making process. The ability to connect with people digitally while working in a globalized environment is an important aspect for the organizations, which are advancing digitally. The value addition from the employees who are digitally social is getting more and more recognized by the companies. With the increase in amount of data

available, it is important to know the value that can be created from it. Company H supports this idea and shared their view in following way.

“Understanding that you can have hyper specialized people, hybrid generalist, being able to understand they come from different countries, gender sexual preferences, age, ability and use it as a strength.”

Employees having digital social intelligence help companies realise the opportunities that are not visible to amateur users. The Figure 11 represents the socio-digital skills that the interviewees were most interested to see in their future employees. Collaborating with global colleagues and stakeholders is an important part of jobs that IEM graduates hold. Regardless of the jobs one is holding the core of any business is to sell ideas which demands for social skills. From digitally advancing businesses point of view the ability to sell ideas online and handling conflicts and coming to a decision is essential.

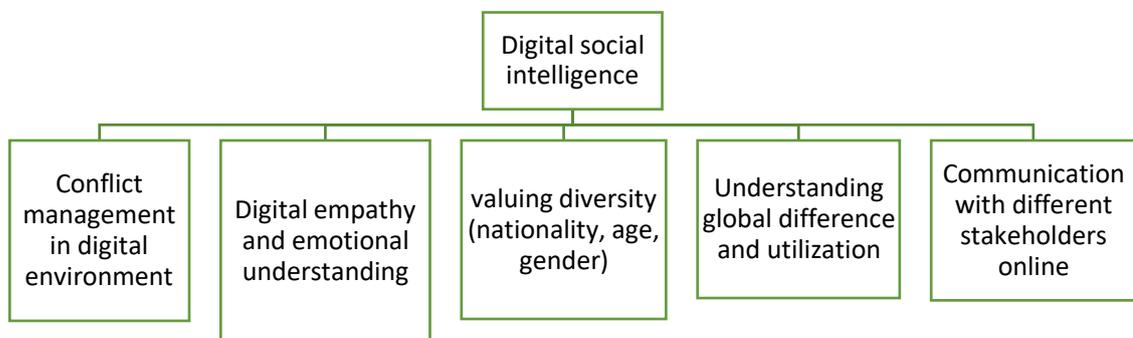


Figure 11 Digital social intelligence

6 Analysis and Discussion

This chapter analyses the results obtained from the semi-structured interviews and puts it into context by formulating the result's implications on IEM in the sub chapter 6.1. It reflects on the digital skills and suggests what areas IEM program should focus on to achieve the demand of the industry. After defining these areas, sub chapter 6.2 provides suggestions on approaches to implement the identified digital skills from in the IEM program. Then sub chapter 7.3 presents the impact on the IEM graduates after implementation of the approaches and lastly, sub chapter 6.4 provides recommendations for further research. The overview of this chapter is shown in Figure 12

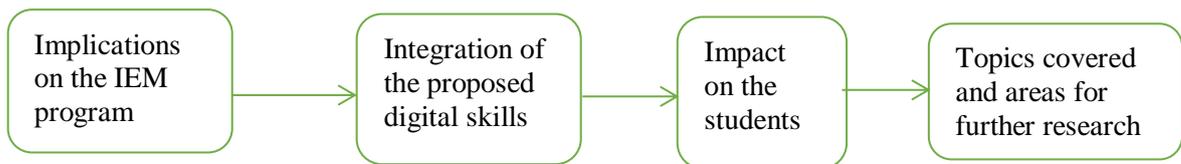


Figure 12 Overview of analysis

6.1 Implications on the IEM

Industrial Engineering and Management curriculum is moulded to create creators of the system. The discipline yields disruptors than followers of the established systems. Therefore, it is vital for the program to maintain the level of education to the current established and futuristic scenarios. According to the results, industries are moving towards digitalizing their products, services and processes either fully or partially. Furthermore, digitalization of human workforce was also mentioned in some of the interviews. This availability and acceptability of digital changes in industries displays that the future is uncertain and further possibility of radical change is possible. For IEM Masters' program, this kind of change can have larger effect on the curriculum and activities. As per the study's result, it suggests the focus of IEM regarding their digital strategy should be on four agendas. Those four agendas are shown in Table 16

Table 16 Implication of the thesis for Industrial Engineering and Management program

Focus of the content in the program	Reason to focus
Promote digital management	<p>To foster creativity allowing to modify and change the systems.</p> <p>To promote open-minded attitude and approach solving problems in an innovative way.</p>
Encourage the digital innovative culture	<p>To develop ability to cherish the change, accept and adapt to uncertainty and leading in such circumstances.</p>
Environment to know and experience the advances in technologies	<p>To identify the available and possible future technologies.</p> <p>To explore the use of the technologies for a profitable business.</p> <p>To develop ICT skills</p>
Stimulating discussions to critically analyse about digital topics and trends	<p>To explore the latest trends.</p> <p>To be able to analyse those trends in various scenarios.</p> <p>To understand the possible benefits and drawbacks of those trends for a business</p>

To address globalization, technological shift and other emerging global issues, innovative attitude in business is critical. Innovativeness circles around being creative, modifying or changing the process and products, and an open-minded culture. A skill that is seen vital for many organizations in present scenario and is considered as one of the important aspects of IEM in many institutes. When a University provides the environment to encourage digital Innovation, it helps in elevating skills such as communication and entrepreneurship. For example, if a project is provided to a group of students, the students should be able to choose and manage their platform and present the results. In the present scenario, only the written

form of presentation and evaluation is irrelevant. The evaluation of the work should be not done only by the instructor but also by the team members with different criterion. Building an innovative culture in digital platform means to provide students opportunity to choose from variety of options, decide to choose, and finish the task according to their choices. This kind of activity boosts critical thinking, proactive attitude and responsibility towards the work.

Another main agenda that the results suggested is digital management. The fast-growing economy demands people with skills to manage the changing environment and lead the people along the way. The results show that the managers and CIO's are not aware what next change could be, but they are prepared for it. Corresponding to this, IEM curriculum could also shed light on the uncertainty of the industries. Uncertainty management provides the curriculum with an advantage to be prepared for the future changes. It allows the curriculum to be open towards change that provides the students with the ability to negotiate trade and deal with different situations. In addition, it also trains the students to be agile to changing business environment and be a leader in such circumstances.

Next two parts of the IEM program are technology and trends. Technology, latest and futuristic both are essential part of the curriculum in IEM. The results suggest that the technology itself is not very important for IEM graduates but the use of technology in different departments is important. According to the results, industry demands for multidisciplinary candidates. They seek candidates who can communicate with people from different background and expertise. This suggests that the students if exposed to other disciplines in the University are familiar with collaborating and communicating with various fields, they are better suited candidates for the companies. If this kind of culture is provided to the students in the University in IEM, it allows the program to be dynamic and multidisciplinary.

The results suggest that one of the important criteria for selection of new candidates is curiosity to learn. Building curiosity about topics is not an easy task for the University to obtain but it is possible for the academic program to provide a stage for students to ask and answer questions regarding technologies of their interest such as:

- How the technology can be used in different areas?
- Who will benefit from using the technology and where shall it be placed?
- Why the technology is important for the business?
- What kind and When the technology can be profitable to the business?

Therefore, IEM program if be able to provide a platform where students can explore these questions and provide solutions for problems would enhance the value of the program and the graduates. To answer these questions, it is needed that the program includes current and evolving technologies in the curriculum or other activities. Trends that tells what the proceedings of the technology and business in the world are currently. IEM program is an innovative fast growing and changing field, which shows the necessity for the program to be updated with the emerging trends and technologies. Many different trends that have emerged that are beneficial for a business. It is crucial for IEM program to be able to support the students to discover latest trends, a platform to analyse the trends to know the possible benefits and drawbacks for any business. The trends can be technological, marketing, social or industrial trends depending on the interest of an individual.

6.2 Suggestions: Integration of digital skills

The implications on IEM program from the obtained results suggest that IEM program should focus on four main things to achieve the desired skillset demanded by the companies. In addition to the implications, the types of job positions IEM graduates are holding is considered while suggesting approaches to include digital skills in IEM program is.

A mind mapping tool was used to obtain the approaches that is suggested in the thesis, which helps in inclusion of the digital skills discovered through the interviews. The mind map can be found in the Appendices. It starts with the IEM oval in the middle. It represents the whole IEM program. Then next layer is of the implications that were introduced in the chapter 6.2. These implications are made according to the results of the thesis and directly corresponds to the digital skills discovered in the analysis of the interviews. These implications show or pave a path for IEM program to produce the kind of digitally advanced University graduates' companies are looking. These four areas then start a layer of approach that is relevant to

achieve the implied analysis. This layer proposes suggestions on how the implications can be achieved. Furthermore, this layer pans out to another layer deducting the approaches to the ground level. These ground level topics are further deducted clarifying the approaches. To simplify the mind map, the four implicated themes are shown in Figure 13, Figure 14, Figure 15 and Figure 16 separately and divided into sub-themes.

The first theme is divided into four sub-themes that supports promotion of the digital management. For example, use of online management systems such as Slack build curiosity among students and allows them to communicate in a faceless system. Digital prototyping of the tasks and results helps students and instructors to have a proper vision of ideas and suggestions. Similarly, having a platform online or a forum where the topics of the courses can be discussed and analysed helps in building critical analytical thinking of the students. Another priority of the Universities should be to teach how to e-learn. E learning is very common method to learn new skills in today's world. Although, many people struggle to learn online since they are habituated to have traditional learning environment.

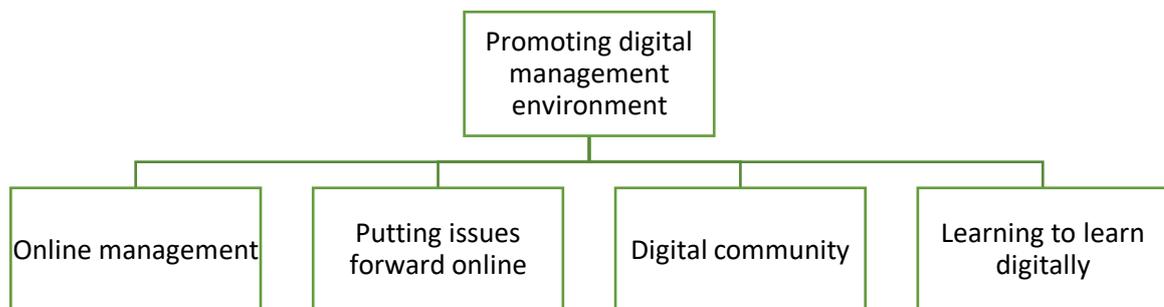


Figure 13 Integrating digital management

Second theme includes three main sub-themes. To build an innovative culture in the university topics such as self-reflection and design thinking are crucial. Having an online portfolio of students and instructors and being able to reflect on the goals and achievements of the students on their skills helps in building curiosity and provides a boost to reach personal goals on the digital skills. Similarly, digital storytelling can be embedded in the

courses which requires students to know the business cases and experiences. This is a very good tool to reach to students since it gives a personal touch. Game exercises and digital design thinking approach to problem solving processes would be a good option since the innovativeness of any products and services needs fresh new ideas. This also increases data literacy among students and they are more familiar with using and analysing data in different perspectives.

Additionally, interactive digital learning such as blended learning and MOOC courses can be helpful to enhance digital learning. Allowing instructors or professors to be as facilitators or coaches rather than as a medium for information providers could help foster creativity in the students. This is because, the students independently perform their projects or tasks and teachers can provide suggestions and constructive feedback regularly through a digital medium. Another option is having blog and Vlogs of the program or University that is used specifically for digitalization topics helps to show that the program is interested in digitalization and is open to it. The ideas and interests of the professors and the researchers when shared in a platform shows the shared vision of the program and University on digitalization through those blogs and Vlogs.

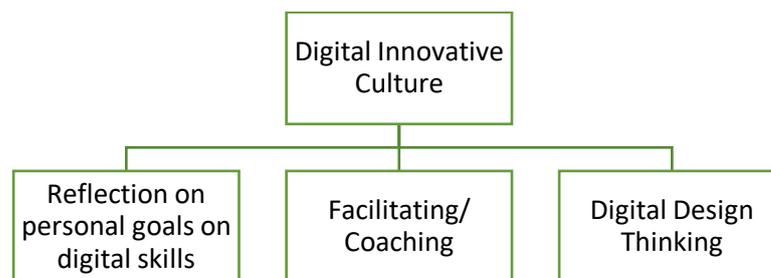


Figure 14 Integration of digital innovative culture

Third theme includes three main subthemes, which allows students, professors, and researchers to probe discussions about digital topics and trends in the world. If there is a new technology digital trend in hype, then discussing or at least sharing the topics online will create awareness among students allowing them to think and talk about it. The instructor plays an important role in probing discussions. If an instructor, researcher or a professor is talking about a trend then it becomes a topic of interest for the students and they start to talk

or discuss about the topic. This can be done in social media groups, blog, and internal platforms or in classes. In courses, if cases related to digital transformation in companies is provided to students and allow them to read, analyse, suggest and discuss on the topic, this will create an environment of collaboration and allows them to understand and critically analyse the topics in technology and business perspectives. Another topic to consider probing discussions is digital creativity. The ability to imagine and conceptualise the digital trends and topics or future possibilities through use of audio, video and different digital tools enhances digital creativity in students. This can be embedded in the courses via different models.

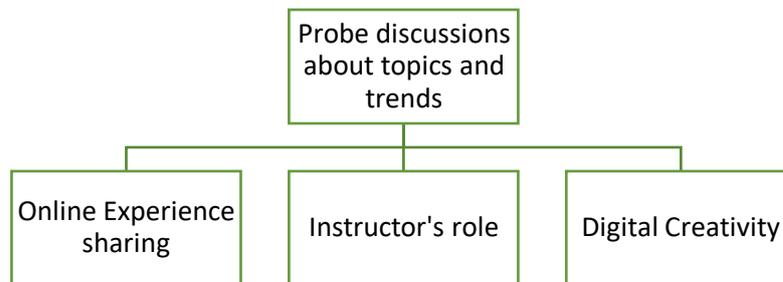


Figure 15 How to probe discussions about topics and trends

The last theme is about having opportunities to know and experience the technologies. It includes three sub-themes. Collaboration with the local SME's is very important if the program wants to be more active in digitalization phenomenon. Working with the companies is always exciting and fruitful for both students and vice versa. For IEM, options such as collaborative project-based learning which allows exploiting or exploring digital technologies, experience sharing lectures about digital transformation in the industries via online or videos or physically and technology and space sharing with companies are beneficial in the long run. In addition to this, availability of the needed digital tools in one platform creates an environment for students to try different digital tools and get familiar with the technologies available in digital world. The digital tools maybe animation tools, digital prototyping tools, Digi labs, and mathematical tools. Although, to have the highest impact of the tools available, the use of these tools in the courses and lectures, encouraging students to use these tools for the presentations, projects etc. is important.



Figure 16 Creating environment to provide opportunities to know and experience the technologies

6.3 Impact on the students

Addressing the increment of use of technology in organizations, technology has become fundamental part of the organization and they demand graduates who are competent to adopt to this environment. After the results are analysed, implications on IEM is shown and the approaches to integrate the digital skills in the program is presented, this chapter presents the impact on the IEM graduates with the implementation of the approaches suggested.

Basic skills such as communication, sharing information, analytical thinking, understanding the business opportunities etc., are still an important factor but with technologies embedded in the problem and solution. Therefore, the understanding of the technology and its use, understanding of the digital environment and the approach to solving problems in it was very popular viewpoint with the interviewees. This suggests that the basic skills are still the same but the climate where the skills are being used have changed, the tools have changed, and approach has changed. The Figure 17 shows the possible scenario of an IEM graduate that will be probed by the implementation of the digital skills suggested in the chapter 6.2. Interpersonal, creativity and problem-solving skills all together with the goal of bringing logic to the problem and situation, understanding and explaining the complex issues and entrepreneurial attitude fulfils the need for digital innovation.

Another important aspect that will possibly be improved in students is ICT skills. ICT has a generous amount of skills to explore and learn. For Industrial Engineering and Management graduates, ICT skills is an important part of the curriculum and their job. The

topics of ICT varies with the interest and goals of the University where the program is held. As from the analysis of the result and implication of the results in the IEM program, the graduates can develop their ICT skills to be proficient in four different areas as shown in the Table 15. As IEM graduates, it is valuable to understand the state-of-the-art technologies available. The awareness of the technology increases the expertise and the ability to tinker and leverage those technologies while solving the problems. The approaches provided in the chapter 6.2 allows the students to be aware of the technologies and experience them in a way that their employability status improves. The approach focuses on the communication and information systems in various ways and provides opportunity for both the students and instructors to be present and efficient in the learning process.

In addition to the ICT and being digitally innovative, with those approaches integrated, the students can know what kind of leaders they should be in digitally transforming businesses. Leadership for non-digital world has been on top of the skills required in leading jobs. Although, what does it mean in digital platforms? When talked about digital leadership and influencing in digital world, the meaning of leadership changes. The introduced approaches in the chapter 6.2, such as online management, learning and collaboration opportunities provides opportunity for the IEM program to create a platform for the students to be a leader. For example, collaborating with different companies provides students with experience and confidence to work in a professional environment. In addition, Project based learning and online management integration helps students to track and observe their growth, which increases self- awareness and promotes leadership.

The study indicated that the practical understanding in the IEM graduates needs to be improved. The knowledge of different theories related to business was enough for the organizations, but the practical understanding of the processes, opportunities and organization was missing from the graduates. This is tackled by the approaches suggested such as exploitative and explorative projects from companies, possible shadowing opportunities in companies and project-based learning approaches to studies. It is an important factor for the organization that the graduates understand the business processes and opportunities digitally and understands the practical approach to work.

IEM being a multidisciplinary program needs to have graduates who can work in dynamic environment. Thus, basic understanding of different field of studies and work such as IT, networks and security in digital surroundings is important to understand. The result from the interviews showed that the more people have general idea about various field, the better it is looked upon as interesting to the organizations. Hence, the approach such as collaborative projects with companies and other disciplines in the University is suggested in the chapter 6.2. Additionally, softer skills are added to the approaches. The understanding of different cultures and valuing the diversity in the team is highly appreciated quality by the companies and is lacking in the University studies. According to the empirical findings, digital emotional intelligence such as, how to keep everyone in the digital conference intact and engaged or how to communicate in a setting of different culture colleagues and being aware of oneself came forth as appealing to the organizations. Figure 17 provides the pictorial representation of the competences that the IEM graduates may gain if approaches provided are applied in the IEM curriculum and activities.

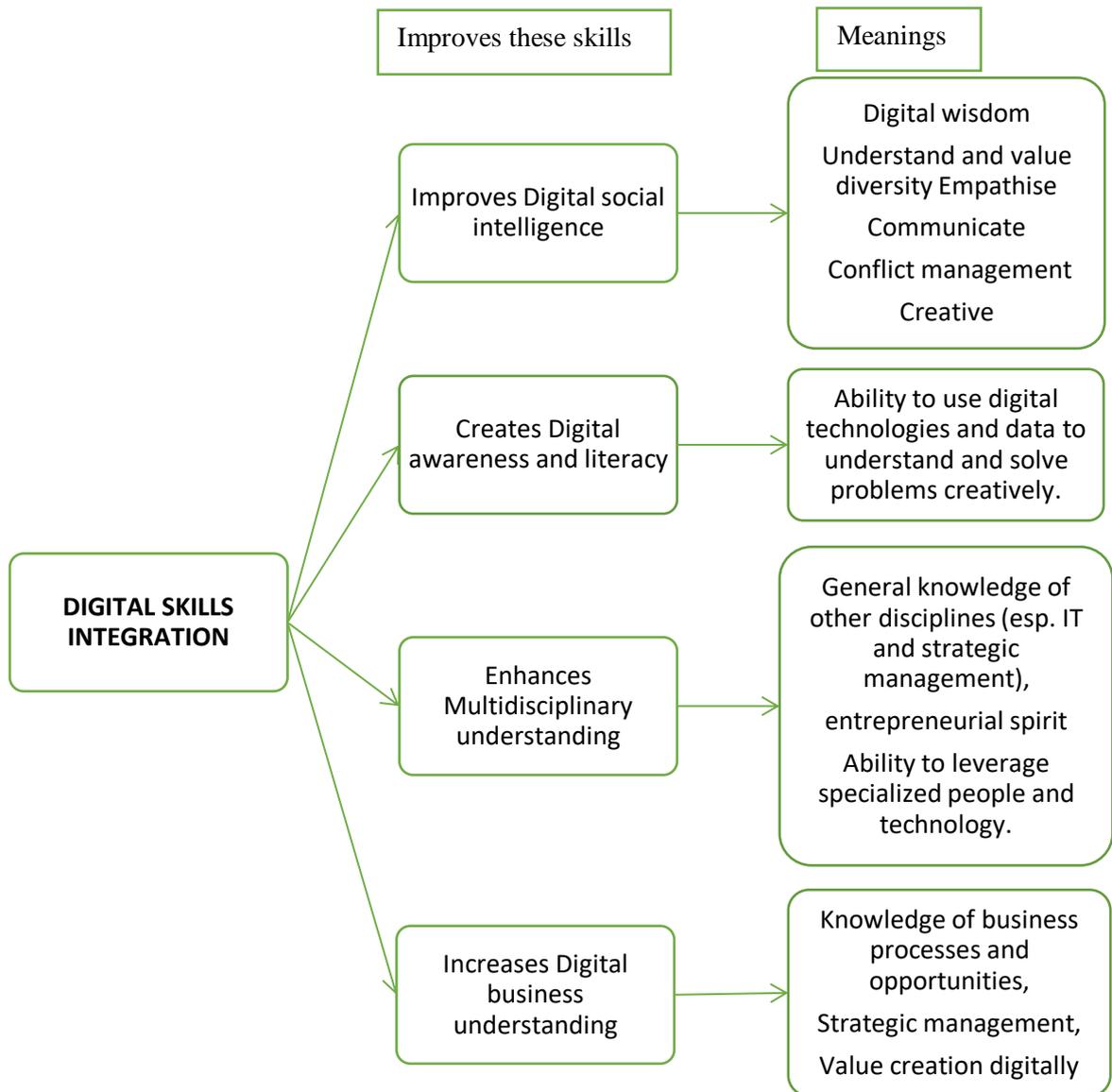


Figure 17 Leadership qualities for IEM graduates

6.4 Topics covered and areas for further development

This thesis explored the general digital skills that the master's degree program in IEM may need to integrate in the program as per the need and demand of the Finnish Industries. When the IEM study is focused on the innovative and digital management with the goal of producing digital leaders, the results obtained from the interviews can be generalised in such scenarios. Following Table 17 presents the concise answers to the research questions presented in the beginning of the study.

Table 17 Conclusion and answers to the research questions

Research questions.	Summary of the objectives achieved.
RQ1: What is the impact of digitalization in Finnish companies?	<ul style="list-style-type: none"> ➤ The organizational change is driven by factors such as Customer expectation, Knowledge and growth, and technology and innovation. ➤ The changes that occur due to digitalization: Use of more digital tools in the companies. The gap of the digital skills availability and demand increases. Therefore, the need for new digital skills increases.
RQ1.1: What does Digitalization mean in Finnish industries? RQ1.2: What are the required Digital Skills?	<ul style="list-style-type: none"> ➤ Digitalization holds various themes in different organizations. General themes being use of ICT, strategic business opportunity, more use of technology and information sharing. ➤ Digital skills share a pool of skills combining both hard and soft skills in digital environment for Finnish companies.
RQ2: What are Digital skills in demand for IEM graduates?	<ul style="list-style-type: none"> ➤ The main themes in digital skills are Interpersonal skills in digital age, understanding business and digital business, ICT Skills, Creativity and problem-solving skills in digital environment and digital social intelligence. ➤ The approaches comprise of various practical suggestions which includes putting effort from students, professors to other researchers and sharing digital tools, experiences with collaboration with the companies.

The IEM department has various fields and each degree program needs to offer these skills to the courses and work together with the instructors to implement them. Further research can be done to go into details of the specific degree program to figure out the goals of the program regarding digitalization. Then with a vision intact, the implementation of the digital skills and approaches will be concrete in each program. I would recommend the degree program directors to share their vision on providing digital skills for the students. Then each course professors, researchers to be present in the same vision and carrying out tasks to explore and enhance digital environment in the program together with the students.

7 Conclusions

The initial task set for this thesis was to find the general digital skills for master's degree program in IEM, which corresponds the digitalization status of the organizations residing in Finland. Digitalization is perceived as a constructive and progressive step towards the future in the Finnish organizations. Various factors such as customer expectations, technology and knowledge cause digitalization to foster in an industry. They drive digitalization in companies and allow them to digitally advance their products, processes and services.

With evolving digitalization, the demand of digital skills has also changed, and this thesis addresses this shift to provide a cross-sectional view on what digital skills do companies want in context of IEM graduates and the positions they hold in their companies. The results from the preliminary study presented the need for digital skills inclusion in the IEM program, which helped to establish the topic for this thesis. The literature review of the study provided the concept and basics elements of digitalization at the time of research. The theories and literatures identified the lack of digital skills in the workforce and established the growing gap between the availability and demand of the digital skills. In addition to this IEM context gave the thesis frame and limitation to narrow down the focus of the study.

The thesis yields five main themes of digital skills for IEM graduates. These themes will help to determine the potential future job skills for IEM graduates. The digital skills are focused on the creative and analytical potential in digital environment. These skills are further analysed and possible implications on IEM program is also presented in the thesis. To make the program digitally advanced, the results from the thesis implies to focus on digital innovative culture, digital management, getting experience and discussing the digital technologies and trends. These themes can be applied in the IEM program with the approaches explained in the suggestion section which in turn helps digitally progress both the program and the graduates. This helps further and develop the program digitally and the graduate's skills to be in a leadership position in digitally transforming industry.

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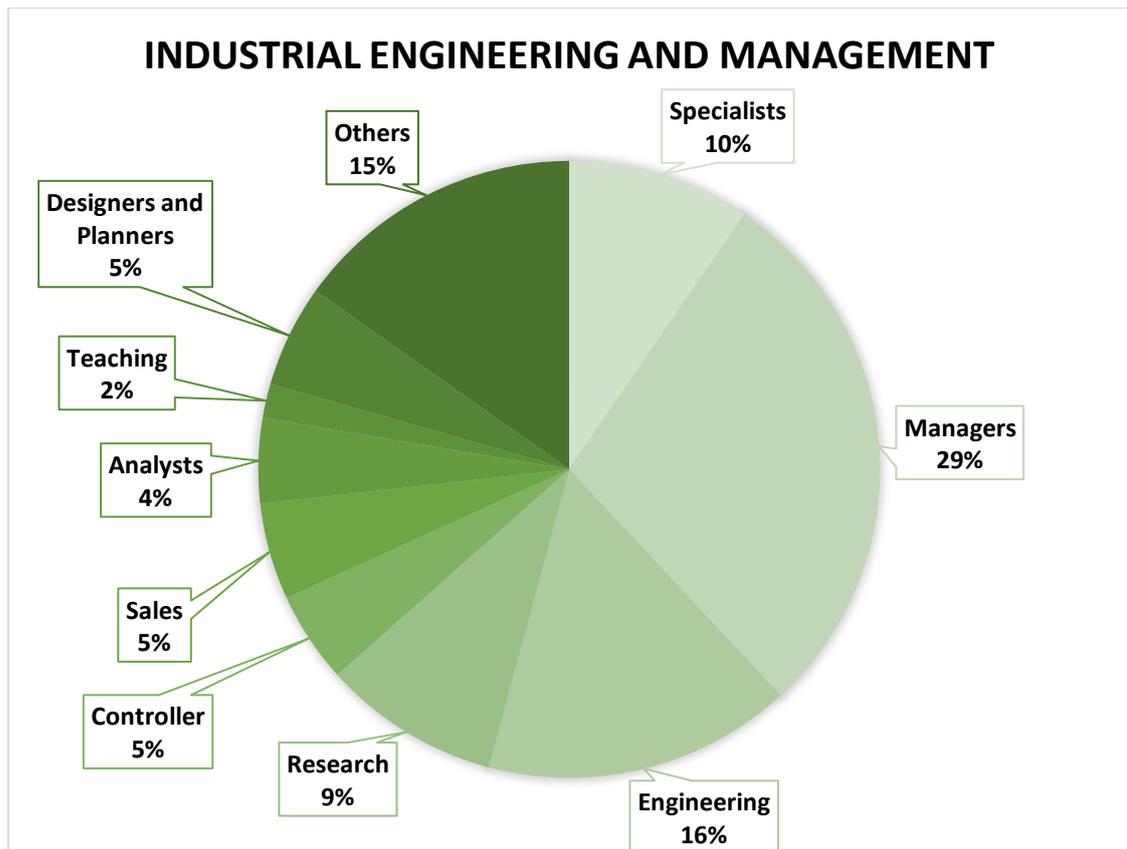
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9 Appendices

9.1 Appendix 1: Annual survey results from IEM department.



9.2 Appendix 2: Basic themes of the interview questionnaire

First phase: About LUT and IEM 15 MIN

1. Experience in work life (knowledge about LUT?).
2. How would u describe IEM studies and research in LUT when you compare it to the Company's research or project work that you do?

Second phase: About digitalization in business processes: 10 MIN

1. What is digitalization in your opinion?
2. What kinds of different digital trends that you follow? What are the prominent ones that you as an employee of COMPANY NAME are interested?
3. What is your experience in coping up with the changes in business transformation caused by digitalization in the processes?
Sub-question: How would you describe these changes will grow in future?
4. What kinds of tools do you use for digital analyzation?

Third Phase: About digital skills and capabilities 15 MIN

1. Future of the (product and services) company producing or providing?
2. What does it mean for next gen? How will it affect their job skills?
3. How do you cope up with the changes brought by digitalization and digital transformation?
4. What are your thoughts on the expectation and demand of the economy in terms of digital skills and capabilities? What about for IEM graduates?
5. Would you like to suggest something to the university IEM department in terms of adding value to the graduates they are producing and the employees that you are getting?

Anything else?

9.3 Appendix 3: Mind map of the digital skills integration in IEM program

