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NORDIC COUNTRIES DIGITAL INTENSITY AND
DIGITAL MATURITY

— *The Impact of COVID-19 in the ICT Sectors*

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ABSTRACT

The high growth in digitalization makes the Nordic countries digital leaders. This research focuses on a comparative analysis of the Nordic countries (*i.e.*, Finland, Denmark, Norway, Sweden) and assesses the current economy and digitalization development, the Nordic digital intensity, the Nordic digital maturity, and the performances of the ICT sectors of the Nordic countries with an emphasis on the impact of COVID-19. The analysis based on the digital transformation, IT infrastructure, and ICT industry growth shows which country is performing better in handling the pandemic. The graphical visualizations and multiple linear regression models have been used for the analysis. This research determines that the Nordic countries have very good levels of digital transformation, digital innovation, and the financial capability of ICT industries to handle the detrimental impact of COVID-19 despite a negative economy that occurred in the Nordic countries during this crisis. Moreover, the results also show that the degree of digital integration among people, process, and technology is the highest in Denmark among the Nordic countries. The level of digital maturity is higher in Sweden, followed by Denmark, on the network readiness before and after COVID-19 started. Finland has the highest level of digital maturity and Sweden has the second-highest level of digital maturity based on the digital performance progress. The capacity of digital innovation is also higher in Sweden compared to the other Nordic countries. According to thesis result, the levels of ICT infrastructure and innovation in the ICT sector are healthier in Sweden and Finland as both have stable ICT industries to achieve more digital progress in the future. The theoretical contributions and practical implications are discussed.

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1 INTRODUCTION

The digital transformation of a country can be realized by the extents of digital intensity and digital maturity (OECD¹, 2019b). Digital intensity refers to the combination of digital technology into products, services, and processes to achieve an extra capacity and endure the competitive advantage from existing resources to increase the growth of industrial and economical performances (Koch & Windsperger, 2017). Digital maturity relates to information and communication technology (ICT) maturity that includes infrastructural, applications, and ICT policy (Azman et al., 2014). Experts have also found that there is a relationship between digital maturity and financial performance (Westerman et al., 2012). According to the report of the OECD (2018), the world is becoming digital in terms of economies, governments, and societies where nearly half of the global population is attached to the internet. A survey result for the understanding of the e-commerce market in Europe in 2020 by PostNord (2020) has revealed that 96% of the total population (15-79 years) is shopping online in Sweden, followed by Finland 95%, Norway 94%, and Denmark 88%. Based on the European and the global viewpoints, the Nordic countries are known as digital leaders (Randall et al., 2018). According to Belényesi (2015), the digital progress, the inauguration of new products and technology, and the modernized whole industries nourish the productivity of a modern economy. Another research has supported this issue where the authors also stated that the economic development of a country widely depends on the fast development of the ICT considering big data, metadata, digitalization, and progress of artificial intelligence (Fifeková et al., 2019). Some of the leading ICT economic experts have also suggested that the economy of a country can be influenced by the digital infrastructure to facilitate the flow of goods, foreign trade, and public services toward the population (Raul Katz, 2020). According to research, Sweden ranked first based on network readiness score, and Norway, Denmark, and Finland ranked fourth, sixth, and seventh respectively based on the same score (Dutta & Lanvin, 2019). Being in the top ten countries according to The Network Readiness Index 2019 (NRI) scores published by the Portulans Institute and the World Economic Forum, the Nordic member countries have presented their good preparation in technology platforms and high levels of digital maturity in this digital evolutionary era (Dutta & Lanvin, 2019). The study result is also supported by the statistical analysis of the

¹ Organization for Economic Co-operation and Development

European Commission (EU) grounded on five categories i.e., internet connection, internet use, online transaction, e-commerce, and e-Governance of each country (European Commission, 2020). Based on this report, among 28 countries of the EU (before Brexit), the Nordic countries hold the top four positions based on those five categories. Finland, Sweden, Norway, and Denmark are ranked first, second, third, and fourth, respectively (European Commission, 2020a). The information technology market of the Nordic region has revealed changes in the technology practice, work processes, IT products and services obtaining, and consumption. The experts think that these changes have been occurred in the Nordic IT market because of the digital transformation of businesses (Sørensen et al., 2019). To achieve these digital transformations, the Nordic companies are trying to handle the digital solutions and business models to establish digital innovation. The analysts have supported that the Nordic organizations have adopted developing technologies to ensure cost-effectiveness and relevance to customers in past years (Sørensen et al., 2019), assuming that such types of digital transformation are the demands of a global economy that is digitally transformed (Sørensen et al., 2019). According to Szabolcs (2017), connectivity is important for economic growth because the digital age has transformed the actual lives into a computer-generated world. The author argued that internet use makes a significant impact on financial progress and trade openness (Nagy, 2017). In another study, it is suggested that digital skills are important for the preparedness of a nation to participate in the evolving digital economy (Mutula & Brakel, 2007).

During the COVID-19 pandemic, an efficient and well-prepared digital society is important. As a result, the Nordic governments have decided to develop digitalization strategies, agendas, and plans for a better digital future. In Europe, the Nordic countries have achieved the most progressive digital economies (Leinonen, 2020). As the Nordic countries are treated as digital leaders, all countries have implemented processes of the national strategies regarding digitalization. The digital competencies of these countries vary based on their policies (Randall et al., 2018).

It has been argued that the Nordic countries should highly focus on thinking about execution rather than thinking on planning and these countries need to take steps for bold and big investments in digitalization and execute those plans as fast as possible (Kirvelä et al., 2017). Another research has studied the threat of the COVID-19 pandemic and its impacts on the socio-economic system of a country and the advantage of digitalization to

mitigate that threat (Raúl Katz et al., 2020). The experts believed that the COVID-19 pandemic impacts on the economy might be mitigated by advanced technology platforms. As such, a reasonable investment in the ICT sectors is highly demanded because a financially strong ICT platform can launch different development programs to efficiently use the countries' manpower and assets through teleworking (Raúl Katz et al., 2020). Moreover, according to a report by the OECD, the slowdown situation can introduce some myths about the new economy. The economic benefits of the ICT sector have not vanished due to the slowdown and collapse in the ICT-producing sector. The ICT sector helps a country's economy to improve its labour and capital market (OECD, 2003).

The interest to study this topic is driven by the achievement of leading positions of the Nordic countries in digitalization, the advanced technology platforms, and the level of digital maturity. Moreover, some researchers have found that the Nordic countries digital preparedness are falling than previous years records and other researchers have shown that good technology platforms of 26 countries have helped to handle the pandemic situation during the SARS-CoV breakout in 2003 (Raúl Katz et al., 2020; Wilder-Smith et al., 2020). And this COVID-19 pandemic might mitigate the damaging situation through the well-prepared digital technology platform and developed ICT sectors (Raúl Katz et al., 2020; Wilder-Smith et al., 2020). After analysing the literature and the scientific contributions on these concepts, the interests of the author of this thesis have been accelerated and motivated to assess how the Nordic economies, the digital intensity, and maturity levels are affected during the COVID-19 pandemic, how much the ICT sectors of the Nordic countries are ready to handle this situation, and which country situation is better than others in the Nordic region. After the COVID-19 outbreak, limited numbers of literature have covered the topic related to the Nordic country digitalization level and the comparative positions of the ICT sectors. The result of this thesis will show how digital transformation is influenced by the COVID-19 pandemic situation, how well the Nordic countries are dealing with the pandemic situation with their strong technology system, and how much the ICT sectors are ready to cope up with such crisis. The thesis will also try to show how a digitalized country (e.g., Finland) is impacted by any pandemic crisis with its current digital capacity and industry.

1.1 Key Concepts

Some key concepts like digital transformation, digital intensity, digital maturity, ICT infrastructure of this thesis are defined below

Digital Transformation:

Digital transformation refers to the application and utilization of modern technologies in the business processes to achieve organizational goals efficiently. Digital maturity is getting more popularity because of digital transformation (Aslanova & Kulichkina, 2020).

Digital Intensity:

Digital intensity refers to the combination of digital technology into products, services, and processes to achieve an extra capacity and endure the competitive advantage from existing resources to increase the growth of industrial and economical performances (Koch & Windsperger, 2017).

Digital Maturity:

Digital maturity refers to the organizational systematic preparation to adapt enduring digital change (Aslanova & Kulichkina, 2020). Digital maturity relates to information and communication technology (ICT) maturity that includes infrastructural, applications, and ICT policy (Azman et al., 2014).

ICT Infrastructure:

ICT infrastructure refers to the information technology (IT) infrastructure. IT infrastructure consists of physical and virtual means and resources and it helps in data flow, data storage, data processing, and data analysis (Longbottom & Bigelow, 2021). A financially strong ICT platform can launch different development programs to efficiently use the countries' manpower and assets through teleworking (Raúl Katz et al., 2020).

1.2 Objective of the Thesis

The objective of this thesis is to perform a comparative analysis of major Nordic countries i.e., Sweden, Denmark, Finland, and Norway in relation to digital intensity and digital maturity. Based on the discussion provided earlier, the following four research questions guide this thesis.

R1: What is the current situation of the Nordic countries based on economy and digitalization?

R2: What are the digital intensity levels of the Nordic countries and how the levels vary from one country to another?

R3: What are the digital maturity levels of the Nordic countries and how the levels vary from one country to another?

R4: How the COVID-19 pandemic situation impacts the digitalization and the ICT sectors of the Nordic countries and based on the assessments' results which country is stronger than others in terms of financial impacts on the ICT sector?

In trying to answer the research questions, the analysis will be divided into four main parts given below –

1. Current Situation Analysis of Nordic Countries based on Economy and Digitalization
2. Digital Intensity Analysis of Nordic Countries,
3. Digital Maturity Analysis of Nordic countries, and
4. The COVID-19 impact in ICT Industry.

The following sections are organized as follows; Chapter 2 provides the previous literature and Chapter 3 discusses the data collection and methodology. Chapter 4 reveals the data-based analysis, and the results will be discussed in Chapter 5. Finally, Chapter 6 will discuss the overall conclusion of the report.

2 LITERATURE REVIEW

This chapter will review the existing literature about the Nordic countries' digital intensity and digital maturity. Previous research regarding important economic factors, the insight into ICT sectors' performance, and the COVID-19 impacts will also be reviewed in this chapter.

Digitalization of the Nordic Countries

According to the researchers, the Nordic countries are highly digitalized in the whole world (Johnsen et al., 2018). To achieve the digital transformation, the Nordic companies are trying to handle the digital solutions and business models to establish digital innovation or innovating their current business models. Analysts argue that Nordic organizations have adopted developing technologies to ensure cost-effectiveness and relevance to customers in past years (Sørensen et al., 2019). According to a survey report by Microsoft, the largest companies of the Nordic countries give the highest priority to digitalization. Microsoft has strengthened this issue by a survey result of 90 largest companies which shows that almost 90% of the companies put the focus on the digitalization priority. The report also shows another survey result of MIT on 400 companies which suggested that the strong digital intensity of companies generates more revenue, more profit, and higher market value (Microsoft & Quartz, 2020). The Nordic organizations have realized that the competitiveness and survival of the business are highly dependent on a successful digitalization trajectory (Dutta & Lanvin, 2019). Sweden ranks first based on network readiness score, whereas Norway, Denmark, and Finland rank fourth, sixth, and seventh, respectively (Dutta & Lanvin, 2019). Thus, choosing the Nordic countries is highly supported by the demands of the digital revolutionary era and the thesis has efficiently chosen the Nordic regions as an area of interest.

Digital Economy Indicators

Figure 1 shows the estimation of the digital economy among different regions. For this type of assessment, researchers follow two ways i.e., the level of internet penetration and the level of digital economy development (Chirkunova et al., 2019). In Figure 1, researchers have assessed digital economy development based on the internet penetration

in daily life and businesses. Mostly, ICT development rather than ICT cost and employment influences the data on internet use. A high number of economic activities can be accessible because of the development of digital technologies (Chirkunova et al., 2019). Some other experts argued that the Nordic countries’ performances in digitalization are different because these countries are now failing to continue their prosperity in digitalization due to a high ambition, the laser-sharp focus, and the execution ability (Kirvelä et al., 2017).

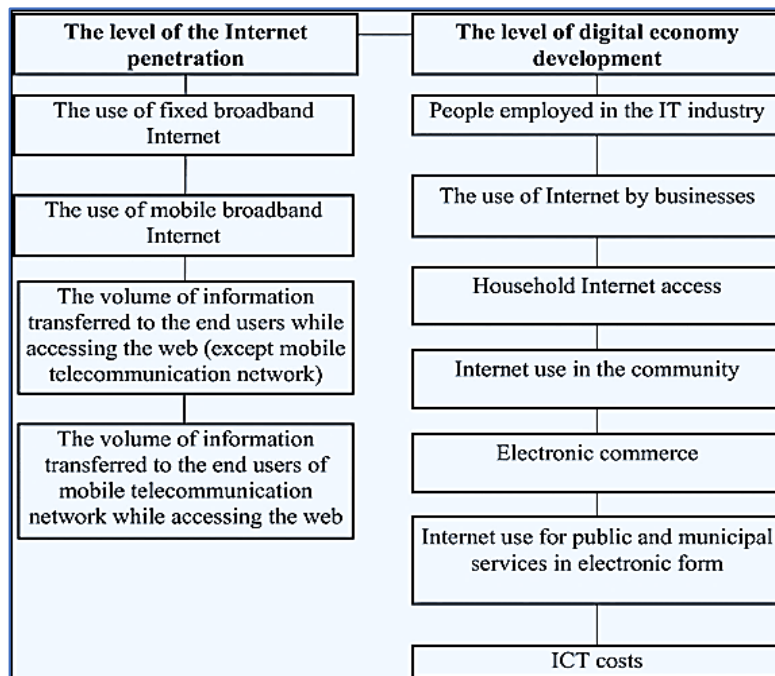


Figure 1: The Structure of Digital Economy Indicators.

Source: (Chirkunova et al., 2019)

Digital Transformation and the Pandemic Challenge

Elbak (2020), asserted that the organizations of the Nordic countries are obviously developing through the digital transformation ride. Another study result has found that developing countries are less prepared with digital technology to handle pandemic challenge whereas developed countries are significantly frontrunners with digital preparedness (Raúl Katz et al., 2020). As already indicated that the overall aim of this thesis is to assess and examine the relationship among digital intensity, digital maturity, and ICT industry performance of the Nordic countries, the previous studies have supported this research endeavor and its aims. The researchers have also suggested that another outbreak from China called SARS-CoV brought out over 26 countries in 2003 and the negative impacts on their economies due to pandemic outbreak have been

minimized by an advanced internet infrastructure ((Raúl Katz et al., 2020; Wilder-Smith et al., 2020). The experts believe COVID-19 pandemic impacts on the economy might be mitigated by the advanced technology platforms (Raúl Katz et al., 2020). This pandemic has changed the growth of e-commerce significantly in 2020 especially in the established markets that have the capacity to foster their e-commerce in aggregation with amplified demand during the COVID-19 (PostNord, 2020). Based on the research reviews, this thesis reveals the impact of the COVID-19 pandemic on the ICT sectors and the digital transformation of the Nordic countries.

Relevant Actors

This thesis will reflect on different relevant actors to analyze the digital maturity and intensity of the Nordic countries and the impacts on their ICT sectors. This consideration for different actors has been supported by a previous study of the Nordregio Report 2019. According to this study, various types of actors like public sectors, different companies, civil society, and other actor groups play a vital role in the digital transformation of the Nordic countries (Randall & Berlina, 2019). To analyze the digital intensity level, this report has focused on the participation of individuals with public authorities of the Nordic countries, individual's internet use and internet access, individual's basic overall digital skills, and the level of e-commerce, customer relationship management (CRM), and enterprises' secure transactions. According to the Nordregio Report 2019, all the Nordic countries have almost similar goals for digitalization though they are following different national digital strategies. The Nordic countries digitalization's goal focuses on the digital public services, supportive growth, business innovation, and digital security (Randall & Berlina, 2019). Based on the digitalization, the focused areas are digitalizing government services, developing digital infrastructure, improving e-health services, making smart cities, encouraging the public for digital participation, rising local business and startup culture (Randall & Berlina, 2019).

NRI, DESI, and GDP

Every year, the World Economic Forum (WEF) reveals the Networked Readiness Index (NRI) to indicate the ICT status of different countries (Pratipatti & Gomaa, 2019). Researchers have used the Network Readiness Model to examine the network readiness score and rank the countries based on their digital readiness, usage, and impacts. The four

pillars of the reformed NRI are Technology, People, Governance, and Impact (Dutta & Lanvin, 2019). The purpose of the NRI model is to show that digital technology will try to have a positive influence on the economy and quality of life to achieve Sustainable Development Goals (SDG) (Dutta & Lanvin, 2019). Therefore, using the NRI scores to measure digital maturity will be an effective approach to assess the digital competitiveness of the Nordic regions.

The Digital Economy and Society Index (DESI) is also printed on the European Commission report annually. It represents the overall digital performance of Europe and the progress of the European countries in terms of digital competitiveness (European Commission, 2019). According to Laitso et al. (2020), the DESI index based on its five dimensions are useful to understand the current digital economy performance and to predict future performance. The DESI index has been used to analyze and compare the digital economy performance of Greece with the other EU-28 member countries (Laitso et al., 2020). This research will practice both indexes' data for analyzing the digital maturity.

In another research, it has been revealed that there is a link between a dependent variable GDP (per capita) and other variables relating to digitalization to evaluate the digital performance of an economy (Stremousova & Buchinskaia, 2019). The same research has also suggested that GDP (per capita) is used internationally as a vital macroeconomic clue. But for digital adoption and development issues, there are no internationally recognized measures to understand its economic effect. This gap has created because of different starting points on the digital transformation of recent nations, industries, and enterprises (Stremousova & Buchinskaia, 2019).

The Impact of COVID-19 and the ICT Industry

To analyze the impact of the COVID-19 on ICT sectors, this thesis uses the relationship between Nordic countries based on the annual GDP rate and additional factors such as size of the ICT sectors, profits from e-commerce, business enterprises expenditure on research and development (BERD) in the ICT sectors, and the international trade of ICT services. Thus, the selection of a real GDP growth rate to evaluate the digitalization sector's performance is supported by previous research. It has been argued that ICT has a very strong relationship with the economic growth of a country (Colecchia & Schreyer,

2002; Saidi et al., 2015). Moreover, it has been suggested that ICT plays two important roles in the economy. Firstly, it deepens the capital investments and secondly, it increases the contribution in all productive factors (Colecchia & Schreyer, 2002; Saidi et al., 2015). The ICT sector is the most powerful reason to see the change in advanced society (Koski et al., 2002). Casal et al. (2005) has also mentioned that the ICT sector is powerful not only to form an industrial sector but also to spread other sectors of a country through digital technology. ICT sector influences the progress of the economy, society, and environment of a country but there is still a debate regarding the extent of this progress (Casal et al., 2005). Globalization and progress in the ICT sector have created pressure on the economy of the Nordic countries and it causes a boost of the ICT sectors to ensure the competitive advantage of the Nordic countries (Ahlqvist et al., 2007). Though the Nordic countries are different mildly in terms of industrial strategies, they all have almost similar visions for the ICT strategies (Ahlqvist et al., 2007). Danish ICT strengths rely on the areas of software, sensor, and wireless technologies while possible areas of ICT strength in Finland focus on mobile and wireless infrastructure and setting up production units (Ahlqvist et al., 2007). The Swedish ICT strength will emphasize the area of the combined production system while Norway has the possible areas of ICT strength in reducing the challenges in SMEs (Ahlqvist et al., 2007). Moreover, the ICT sector also helps a country's economy to improve its labor and capital market (OECD, 2003). The researcher believes that the COVID-19 has impacted the ICT sector with a considerable loss in the first quarter of 2020 but the ICT industry is determined to create a real comeback in this situation (Bombe, 2020). Digital performance influences the stock market performance of a country positively and it shows the higher the digital maturity is, the better the digital performance is (Eremina et al., 2019). This thesis will analyze the ICT stock market performances to realize the IT infrastructure and the capability of the Nordic countries' digital economies to handle the pandemic situation.

3 METHODOLOGY

This chapter will show how the data are collected, prepared for analysis, and discuss the methodology followed to evaluate and assess the data. This research will be conducted based on purely quantitative data collected from different secondary sources.

3.1 Data Analysis Analytical Tool

The analytical tool “R” will be used to prepare and analyze the numerical data collected from different secondary sources. This analytical tool has been used in many high-quality time-series researches and researchers have suggested that “R” has many established and built-in packages like *ggplot2* to analyze time-series data clearly (McLeod et al., 2012). Though “Mathematica” is also a useful software system with different helpful capabilities, most of the researchers prefer to work with time series data using “R” because of its exceptional broad platform (McLeod et al., 2012). All numerical data will be prepared for comparative analysis among the Nordic countries. To prepare data for analysis, missing values have been adjusted with estimated values. According to a researcher, time-series missing values can be adjusted by the last observation carried forward (LOCF) method, mean computation, median computation, and mood computation methods (Kang, 2013). In this thesis, missing values are handled by using both the *LOCF* method and the *mean computation* method. If the last year’s data is available for any variables, the missing value is filled by the last year’s data. When the last year’s data is not available i.e., the beginning of the time series data, the missing values will be fixed by the mean value of available data. To visualize the trend of different variables for the Nordic countries ‘*ggplot2*’ visualization method of an analytical tool “R” will be used to illustrate the figures in relation to pre and during COVID-19 situation. To solve the first research question, individual country-level data will be shown based on their economy and digitalization transformation performance. The second question regarding the digital intensity level analysis will be revealed by a comparative analysis of different Nordic countries based on eight factors (mentioned in part one of data collection). These eight factors will be examined and visualized separately. The third research question i.e., digital maturity level analysis will also follow the “*ggplot2*” visualization method using “R” based on different national scores and values (mentioned in part two of data collection). Regarding the final research question, the impact of

COVID-19 on the performance of the ICT sector will be examined using data visualization, coefficient of correlation, and multiple linear regression model. The visualization method will show how the GDP growth of a country is influenced by the other six factors related to the ICT sector and digitalization. The *ggplot2 package visualization method* will show the relationship between GDP growth rate and six other variables i) NRI, ii) Size of the ICT sector based on value-added to GDP, iii) Profit from e-commerce sales, iv) BERD in the ICT sector, v) International trade in ICT services, and vi) Company investment in emerging technology). Regression method is widely practiced method for time-series data analysis and forecasting because of its simple implementation and this method is useful to draw the relationship between the forecasted value and the factors affecting the forecasted value (Athiyarath et al., 2020). Then, a *multiple linear regression* will be measured on the ICT stock market for the overall Nordic market and other four countries' ICT stock markets. The regression will help to show the impact of ICT industry performances of the selected Nordic regions on overall Nordic ICT industry performance. Here, overall Nordic index performance will be dependent variable and independent variables are ICT indexes for Finland, Denmark, Norway, and Sweden. The multiple linear regression model will be represented by the given formula. Formula source: (Tranmer et al., 2020).

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \dots + \beta_n X_n + \varepsilon$$

Here,

Y = Dependent Variable

β_0 = Intercept

β_i = Coefficient (slope for x_i); where, $i = 1, 2, \dots, n$

X_i = Independent Variables; where, $i = 1, 2, \dots, n$

ε = Error

This multiple linear regression model is widely used in different time series data analyses for trend prediction. Before analyzing the regression model, the correlation will be analyzed to check the strength of the relationship between dependent and independent variables. To check the fitness of this multiple linear regression model, the report will examine Standard Error. The formula used for this measure is given below. Formula source: (Smith, 2012).

$$SEE = \sqrt{\frac{\sum(Y - \hat{Y})^2}{n - (k + 1)}}$$

This statistical analysis will show how the trend is affected by the COVID-19 pandemic, which country has handled this pandemic impact effectively and how a digitally strong country performs in this pandemic situation. The financial market data will be compared through the time series line chart made by the ggplot2 package of R.

3.2 Data Collection

This thesis utilizes the secondary sources of data. As such, data published in open sources like the Nordic statistics, country profiles, journal articles, the European Commission and the Nasdaq Nordic are mainly used to evaluate the Nordic countries digital intensity, digital maturity, and the impact of COVID-19 on the ICT sector performances. The data collection for various indicators of this thesis is followed by four parts. Here, the data collection based on the different analysis is given below.

3.2.1 Current Situation Analysis of Nordic Countries based on Economy and Digitalization

Each Nordic country will be reviewed based on its economical and digitalization stage. This analysis will help to realize the current situation of the Nordic countries. Five factors will be examined in this report and these factors are explained below.

- i. Real GDP Growth Rate:

According to the European Commission (2020d), the growth rate for Gross Domestic Product (GDP) of a country shows the economic movement of that country. It helps to compare the dynamic economic development of a country over time and with economies of various sizes.

- ii. Size of the ICT sector (ICT value added to GDP):

The total value added of the ICT sector estimation is based on summing the data of ICT manufacturing and ICT services and it is examined by the relative percentage of GDP to

show how much value has been added to GDP from the ICT sector of a country (European Commission, 2020i).

iii. Profit from E-commerce Sales:

According to the European Commission (2020d), enterprises are progressively relying on e-commerce sales or online sales to maximize their business profits and COVID-19 has largely influenced e-commerce sales to grow in the future.

iv. Business enterprise Expenditure on Research and Development in the ICT sector:

The European Commission (2020c) has mentioned that BERD in the ICT sector shows how much R&D expenditure has been made for the ICT innovation in a country to realize the attractiveness and importance of the ICT sector.

v. International Trade in ICT Services:

According to the report published by OECD (2009), ICT services and goods are the most powerful factors of international trade over the years. Another report published by United Nations Conference on Trade And Development (UNCTAD: 2015), reveals the links between economies and the international value chain by enhancing the competitiveness of the ICT industry. Table 1 shows the data collection sources of variables.

Table 1: Indicators and Data Collection Sources

Indicators (%)	Source of Data
Real GDP growth rate	(International Monetary Fund (IMF), 2020)
Size of the ICT sector (ICT value added to GDP)	(CEIC, 2020; OECD, 2020b)
Profit from e-commerce sales	(European Commission, 2020j)
BERD ² in the ICT sector	(OECD, 2020a)
International trade in ICT services	(UNCTADSTAT, 2020)

Moreover, the individual ICT stock market will be reviewed to assess the financial performance of ICT stock market of each Nordic country, and the individual ICT stock market performance data will be compared with the overall Nordic ICT performance.

² Business Enterprise Expenditure on Research and Development

3.2.2 Digital Intensity Analysis of Nordic Countries

To realize the level of digital intensity, *eight factors* will be analyzed in this thesis. These eight factors are related to digital transformation tendency in the Nordic countries:

i. Internet Use and Activities-Online Course:

The data is published in Eurostat by the European Commission (EC) and it shows the level of internet used particularly in online activities based on doing an online course by individuals who are 16 to 29 years old. This data will help to understand the level of digital involvement of the young generation in their online activities (education system) in the Nordic countries. The researcher believes digital technology creates a digital society that influences the activities of education, service, entertainment, and social interaction (Ribble & Bailey, 2007).

ii. E-commerce, Customer Relation Management (CRM), and Secure Transactions of Enterprises:

The data is published in Eurostat by EC based on the enterprise data where at least 10 people are employed. This percentage of data will show the level of information and communication technology used in enterprises' business activities, CRM, and digital transactions in the Nordic countries to realize the level of digital intensity. It will help to understand how widely digital technologies are used by customers and enterprises in the Nordic countries. According to the report of EC, the digital platform is very important to make a significant business performance in a digital era where small and medium enterprises are trying to maintain a single digital market (European Commission, 2015).

iii. Individual's Internet Use:

This data is collected from the Nordic statistics published by the Nordic Co-operation. Data is composed of the level of internet use of individuals aged between 15 to 74. According to OECD (2017), digital technologies can raise social connections where people use more internet to get information regarding health care, skill's development, and financial activities (OECD, 2017). Thus, the level of individual internet use will show how digital transformation is proceeding in the Nordic countries.

iv. Individual's Level of Digital Skills:

The data is published in Eurostat by the EC based on the basic overall digital skills of the Nordic countries. The level of basic overall digital skills will help to realize the digital intensity of the Nordic countries considering the integration of the digital technology, process, and people. According to EC (2020), digital transformation in the European industry has influenced the level of digital skills of individuals and employment conditions at their work.

v. Individual's Internet Purchase Level:

The data is published in Eurostat by EC based on the level of internet purchase of individuals aged between 15 to 74 in the Nordic countries. This data will show how which Nordic countries people are highly involved in the online purchase by making a digital order for the product. A large number of people who are digital-savvy like to review the product by checking valuable information related to the product sitting at home before making any decision (Sunitha & Gnanadhas, 2014). Thus, the level of internet purchase of individuals will indicate the level of digital intensity of that Nordic countries.

vi. Individual's Internet and Broadband Access Level:

Data has been collected for both internet and broadband accesses separately from Eurostat published by EC. This data will help to show the strength of the digital transformation of Nordic countries based on the level of internet and broadband access. Digital transformation highly depends on the high-quality entrance to communication systems and services at reasonable prices (OECD, 2019a). Thus, if the Nordic countries have a good level of individual's internet and broadband access, it means they have a good intensity to digital transformation.

vii. Level of Digital Interaction:

Data related to the level of digital interaction between individual and public authorities through digital technologies is collected from Eurostat published by EC. The data show which country is advanced in obtaining digital information, downloading digital forms, and submitting it digitally. This level will help to give an idea of the digital transformation tendency of the Nordic countries.

viii. The Digital Adoption Rate:

Data for the level of the digital adoption rate of Nordic countries have been derived from the report entitled “Digital 2020: Global Digital Overview” by the Datareportal. Three different variables related to the growth rates of mobile connection, internet user, and social media users will be shown to realize the digital adoption rate of the Nordic countries. These three different data relate to the growths of mobile connection, internet user, and social media user. If the adoption rate is high, it means the digital transformation tendency will be high. The higher the level of techno savviness in the country, the higher the number of individuals utilizing the internet and mobile applications to gather information (Samson et al., 2014). The percentage data will be collected for 10 years (2010-2019) and a comparative analysis will be made based on this data for the Nordic countries. But the European Commission has published 5 years of data for individual’s level of digital skills (basic overall digital skills) i.e., 2015-2019.

3.2.3 Digital Maturity Analysis of Nordic Countries

In this thesis, *three measures* will be utilized to analyze the digital maturity level of the Nordic countries. These measures are explained below.

3.2.3.1 The Network Readiness Index (NRI) 2020:

The Network Readiness Index 2020 score represents the leading global indicators regarding the use and impact of information and communication technology (ICT) in an economy. According to the latest report in 2020, the top performer in the 2020 index is Sweden. The NRI report of 2020 plots the network-based readiness scenery based on 4 pillars (technology, people, governance, and impact) of 134 economies including 60 variables (Portulans Institute, 2020). Figure 2 shows the NRI model to estimate the score.

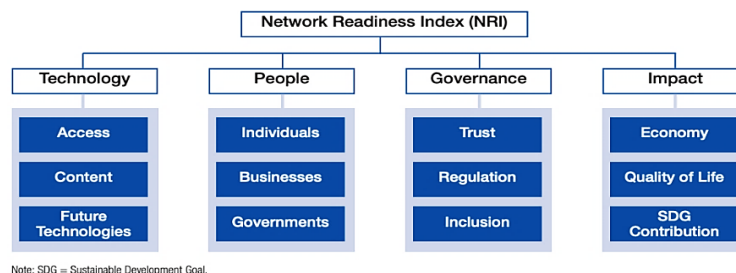


Figure 2: The Network Readiness Index Model

Source: (Portulans Institute, 2020)

The NRI scores are mentioned in this report based on the data published by Portulans Institute & World Economic Forum. This data will be used to analyze the digital network preparedness of the Nordic countries based on 4 pillars of the network readiness measurement depicted in Figure 2. Here, the first pillar shows the access and content of technology and the second pillar is related to the use and investment in ICT by people. The other two pillars represent the rules and regulations issued and handled by the government on network economy and the impact of network economy on economy, society, and human. This report will focus on the overall NRI score. It will help to realize the digital maturity of the Nordic countries. The overall NRI score will be shown in 0-100 scale points and for 10 years (2009-2020). But the data for 2017 and 2018 was not published in any source. Thus, according to the researcher’s suggestion, the missing values are adjusted with last year’s data (Kang, 2013).

3.2.3.2 The Digital Economy and Society Index (DESI: 2020)

Following “The Digital Economy and Society Index” (DESI: 2020) published by the European Commission, this report will examine the digital competitiveness of the Nordic countries based on five pillars illustrated in Figure 3. The higher the score, the better the digital performance. Thus, good digital performance will indicate the position of digital maturity of Nordic countries. Figure 3 shows the five dimensions of DESI data followed in this thesis.



Figure 3: Five Dimensions of DESI

Source: (Prezi, 2021) based on European Commission data.

i. Connectivity:

According to the report of the European Commission (2020a), the connectivity of DESI shows the developments of the broadband market in the European Union. It considers the supply and demand of fixed and mobile broadband. Connectivity assesses the speed of fixed broadband, the availability of the next generation access in fixed broadband with at least 30 Mbps, the availability of high-capacity networks, and the charge of retail offers under the fixed broadband connectivity. Mobile broadband connectivity assesses the coverage of 4G and 3G, and the sign of 5G readiness. The European Commission considers digital connectivity as a social right in the European Union.

ii. Human Capital/Digital skills:

In the report of the European Commission (2020b), the human capital/digital skills assesses the basic internet user skills and the advanced skills and development of human capital. This report has also suggested that having an internet connection will be fruitful if sufficient digital skills are paired with it to achieve advantages in the digital society and economic growth.

iii. Use of Internet Services:

According to the European Commission (2018), a citizen having an internet connection and digital skills should be practiced in online activities such as online purchase and communication. The level of use of internet services influences the demand and supply of broadband networks. The report has also mentioned that this dimension of DESI assesses the extents of online content, online communication, and online transactions of a country.

iv. Integration of Digital Technology:

The report of the European Commission (2018) presents this dimension to assess the level of digital adoption of country businesses and the e-commerce of online sales channels of a country. This dimension is important to increase the economic growth of a country by ensuring efficient use of technology, saving time and money. It also helps to realize the digital infrastructure based on connectivity and human skills.

v. Digital Public Services:

According to the same report, European Commission (2018), digital public services is a dimension of DESI to assess the level of interaction of business and citizens with the public authority like eGovernment services or eHealth services.

The report has used this index because the DESI score summarizes some relevant variables related to the digital performance in Europe and paths the development of the European Union Member States in the digital effectiveness and competitiveness. Based on this score data, this report will make a comparative analysis for the Nordic countries' digital competitiveness. Data are represented in a 0-100 scale. The European Commission has started monitoring the digital progress of different economies and publishing report and statistical data in the name of the Digital Economy and society index since 2014. Thus, this report will review 5 years of data for DESI index analysis to understand the digital maturity of the Nordic countries.

3.2.3.3 Company Investment in Emerging Technology by Nordic Countries

The score for company investment in emerging technology or future technology is published by the network readiness index in its first pillar i.e., technology. The data has been published in World Economic Forum 2016 database and the NRI 2020 analysis report by Portulans Institute. For the purpose of the current research, data has been collected for 9 years (2012-2020) as these yearly data are available through open access. The purpose of using this data is to realize the level of company investment to promote digital transformation. This score will also represent the capacity of a country's businesses for digital innovation. This data will help the analysis to show which country is more matured in terms of their future technology's innovation. According to the researcher's suggestion, the missing values are adjusted with last year's data based on the last observation carried forward (LOCF) for time series data (Kang, 2013).

3.2.4 The Impact of COVID-19 in ICT industry

To show the COVID-19 impacts, multiple indicators will be use and analyzed. Some of data collected in the previous two parts will also be used based on its importance and relevance. This report will also show the relationship between a dependent variable (real GDP growth rate) and other elements (independent variables) relating to digitalization in the ICT sectors of the Nordic countries. The yearly percentage data will be collected for

real GDP growth rate, size of the ICT sector based on ICT value added to GDP, profit from e-commerce sales, business enterprise expenditure on research and development (BERD) in the ICT sector, and international trade in ICT services. The data for each Nordic country will be analyzed to have a comparative analysis among their economical situations for the last 11 years (2009-2019). The data will be arranged based on pre and during Covid-19. The impact of COVID-19 in ICT industry analysis will be made based on the ICT stock market index for each Nordic country and the overall Nordic ICT stock market index. The stock market price will be collected on daily basis for the last 8 years (2012-2019). The closing price will be considered for this report analysis. These historical ICT market prices for each Nordic country will be collected and organized from the sources given below.

Table 2: Stock Index Data Collection

Indexes	Country	Sources of Index Data
N Telecommunications EUR PI	Nordic-all	(Nasdaq Stock Market-Nordic, 2020)
OMX Copenhagen Telecommunications PI	Denmark	(Nasdaq Stock Market-Denmark, 2020)
OMX Helsinki Telecommunications PI	Finland	(Nasdaq Stock Market-Finland, 2020)
OSE 45 Information Technology (OSE45GI)	Norway	(Investing.com-Financial market, 2020)
OMX Stockholm Telecommunications PI	Sweden	(Nasdaq Stock Market-Sweden, 2020)

This stock market index data is chosen based on a relationship with the ICT sector as there is no specific ICT sector index data for these Nordic countries. To review the ICT sector performance, this report has chosen telecommunication sector indexes to collect data for overall Nordic, Finland, Denmark, and Sweden from Nasdaq Stock Market. On the other hand, the Norwegian sector-wise stock market index is unpublished in the Nasdaq Stock Market. Thus, another largest financial market data provider Investing.com is chosen. It has provided information and technology sector index data for Norway.

4 ANALYSIS

The analysis section has been followed by four research questions that are the objectives of the thesis. Firstly, the current situation based on digitalization and economic growth of Nordic countries will be analyzed individually. Secondly, the level of digital intensity of Nordic countries will be viewed and compared to each other. Thirdly, the level of digital maturity will be evaluated and compared among the Nordic countries and finally, the ICT sectors' financial performances of Nordic countries will be assessed and compared. The impacts of COVID-19 will also be shown in these analyses.

4.1 Current Situation of Nordic Countries Based on Economy and Digitalization

To analyze the current situation of Nordic countries, some economic and digitalization related indicators like Gross Domestic Product (GDP), the Network Readiness Index (NRI) score, size of the ICT sectors based on value-added by the ICT sector in GDP, profits from e-commerce, Business enterprise Expenditure in R&D (BERD) in the ICT sector, and international trade of ICT services will be considered. The ICT stock market for each Nordic country will also be shown to assess the current situation of Nordic countries. Each Nordic country will be evaluated separately in this part.

4.1.1 Finland:

4.1.1.1 *GDP, NRI, Size of the ICT sector:*

Figure 4 represents the yearly growth of Gross Domestic Product (GDP), the Network Readiness Index (NRI), and the size of the ICT sectors based on value-added to GDP of Finland for the last 12 years (2009-2020). Figure 4 shows the digital transformation scenario of Finland considering its economy and COVID-19 impacts. The dashed red line specifies the area starts for the impact of COVID-19 on the curve of GDP, NRI, and size of the ICT sector in Finland.

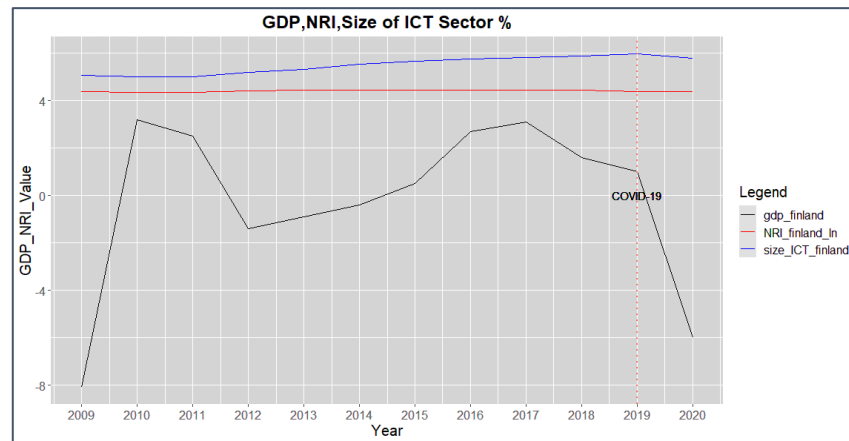


Figure 4: GDP, The Network Readiness Index, Size of the ICT sector-Finland

Source:(CEIC, 2020; (IMF), 2020; OECD, 2020b; Portulans Institute, 2020; World Economic Forum, 2016)

According to Figure 4, in 2009, the growth of GDP is negative i.e., -8% and within 1 year, Finland's GDP rises positively as it is seen that the black line has a sharp upward trend line up to 2010. In the mid-2011 to the mid-2014, Finland's GDP growth falls less than 0% though after 2012 the curve for GDP starts going upward. Despite the GDP has a downward growth from 2017, it falls sharply after COVID-19 emerged at the end of 2019. The size of the ICT sector represented by the blue line has a steady growth i. e. close to 5% with the growing GDP up to 2012 and after 2012, the growth rate of the size of the ICT sector in Finland increases and reaches close to 6% in 2020 with a slight negative change from 2019. The NRI score also has a growth of more than 4% with any change in GDP of Finland for the last 12 years and COVID-19 does not impact the network preparedness of Finland though it has a sharp negative GDP in 2020. Thus, Finnish GDP growth is negative after 2019 and remains -6% in 2020 while the growths of the NRI score and the size of the ICT sector are positive i.e., more than 4% despite the damaging impact of COVID-19. It shows Finland has a good network preparedness with a developed size of the ICT sector that added values to GDP. It proves that the digital transformation of Finland is in a very good position and its negative economy does not hamper or hinder the network preparedness and the size of the ICT sector severely.

4.1.1.2 GDP, Profit from E-commerce Sales, BERD in ICT, ICT International Trade

Figure 5 indicates the growth of real GDP, profits from e-commerce sales, business enterprise expenditure for research and development (BERD) in the ICT sector, and the international trade of ICT services of Finland for the year 2009 to 2020. Figure 5 helps to

understand the digital innovation opportunity of Finland considering the economy and COVID-19 effect. The dashed red line shows the starting of COVID-19.

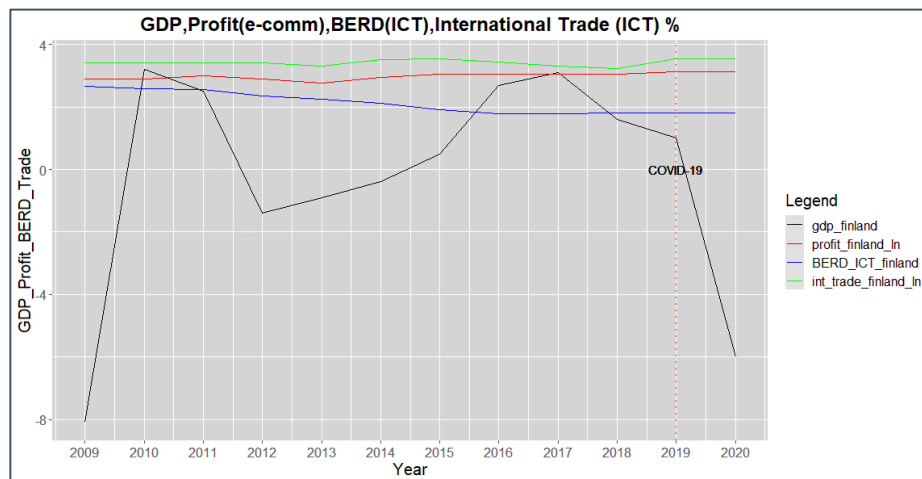


Figure 5: GDP, Profit (e-com), BERD(ICT), Int'l Trade-Finland

Source: (European Commission, 2020; IMF, 2020; OECD, 2020a; UNCTADSTAT, 2020) *Note: Year 2020 data is estimated except GDP.

As shown in Figure 5, in 2010, when GDP indicated by the black line reaches its first peak i.e., close to 3%, the growth for international trade of ICT services (i.e., more than 3%) represented by the green line is higher than the growth of profit generated by e-commerce sales (i.e., close to 3%) and BERD in the ICT sector (i.e., less than 3%). In Figure 5, the red line indicates the growth of profit from e-commerce sales and blue line represents the growth of BERD in the ICT sector of Finland. Up to 2013, Finland maintains its growth in profits from e-commerce sales, BERD in the ICT sector, and the international trade of ICT services even though the growth of GDP is negative from 2012. While Finland enjoys its second peak of GDP growth in 2017, the growth of profit from e-commerce sales is more than 3% and the growth of international trade of ICT services is 3%. It shows the progress of GDP helps the growth of profit from e-commerce sales to rise in Finland. In 2017, the gap between international trade of ICT services (green line) and profit from e-commerce sales (red line) reduces because of the slight upward trend of profit from e-commerce sales while the GDP growth is close to 3%. But the growth of BERD in the ICT sector decreases in Finland from 2014 to 2020 and now it is below 2%. After the COVID-19 starting at the end of 2019, the growth of profit from e-commerce sales and BERD of the ICT sector remain stable from last year despite a negative growth of GDP. Thus, the digital innovation opportunity of Finland is also in a good position

though there is a negative growth of its economy during the pandemic situation like COVID-19.

4.1.1.3 ICT Share Price Impact on Overall Nordic ICT Share Price

Figure 6 shows a comparison between the Finnish ICT stock market’s daily share prices (closing) and the ICT stock market’s daily share prices of the overall Nordic for the last 9 years (2012-2020) including the impact due to COVID-19. The dark red line indicates the financial performance of the ICT sector of Finland and the black line represents the same for the overall Nordic region.

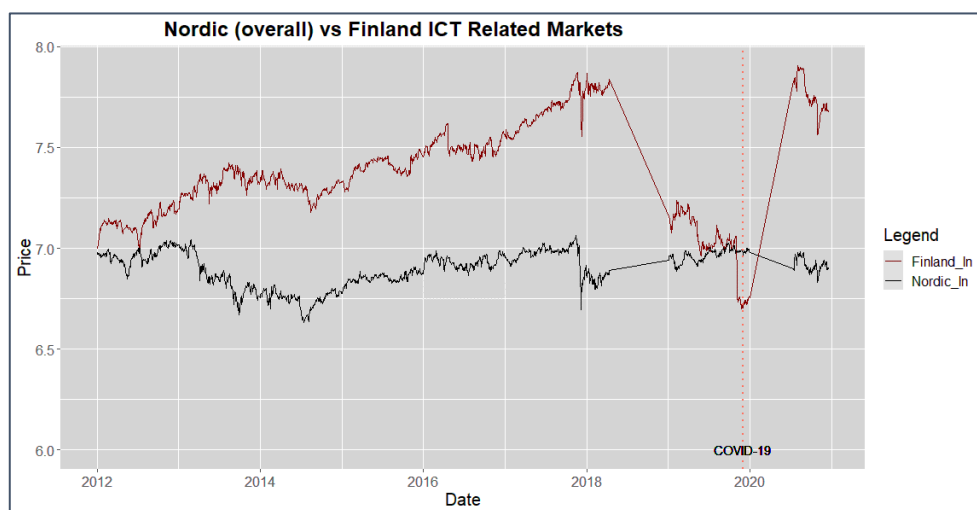


Figure 6: ICT Stock price- Nordic vs Finland

Source:(Nasdaq Stock Market, 2020)

Figure 6 shows how the Finnish ICT stock market influences the performance of the overall Nordic ICT stock market to realize the financial strength of the ICT industry and the information and technology infrastructural platform in Finland. Finland has a good performance in its ICT stock market, and it is higher than the level of the overall Nordic ICT stock market performance. Though the gap between Finland and the overall Nordic financial performances of the ICT sector is short up to 2013, the gap has started to increase after the mid-2013 and it is the highest in 2018. At the beginning of 2018, the Finnish ICT stock market performance has grown more than 7.75% (maximum) and for overall Nordic the number is less than 7%. After few months of 2018, the Finnish ICT stock price falls sharply as the dark red line falls hard up to 2019 in Figure 6. COVID-19 has been emerged in December of 2019 according to the red dashed line in Figure 6. A slightly before the COVID-19, the Finnish ICT share market has started shrinking and reached very close to the overall Nordic ICT share market. COVID-19 has badly impacted

the Finnish ICT industry’s performance immediately as the dark red line has crossed the black line negatively. But within the mid-2020, the Finnish ICT industry has been able to make a stepper upward curve for its ICT share prices and it becomes more than 7.75% again like the maximum level in 2018. After the mid-2020, the performance of the Finnish ICT share market decreases a little. Thus, Finland has a very good financial strength in its ICT industry and the capacity to handle the pandemic effect on financial performance of the ICT industry. It has more than 5% better performance than the overall Nordic ICT stock performance. It also proves that Finland has a strong information and technology infrastructural platform to continue its digital innovation in the future despite the damaging effect of COVID-19.

4.1.2 Denmark

4.1.2.1 GDP, NRI, Size of the ICT sector

Figure 7 represents the yearly growth of Gross Domestic Product (GDP), the Network Readiness Index (NRI) and the size of the ICT sectors based on value-added to GDP of Denmark for the last 12 years (2009-2020). Figure 7 will show the digital transformation scenario of Denmark considering its economy and COVID-19 impacts. The dashed red line specifies the area starts for the impact of COVID-19 on the curve of GDP, NRI, and size of the ICT sector in Denmark.

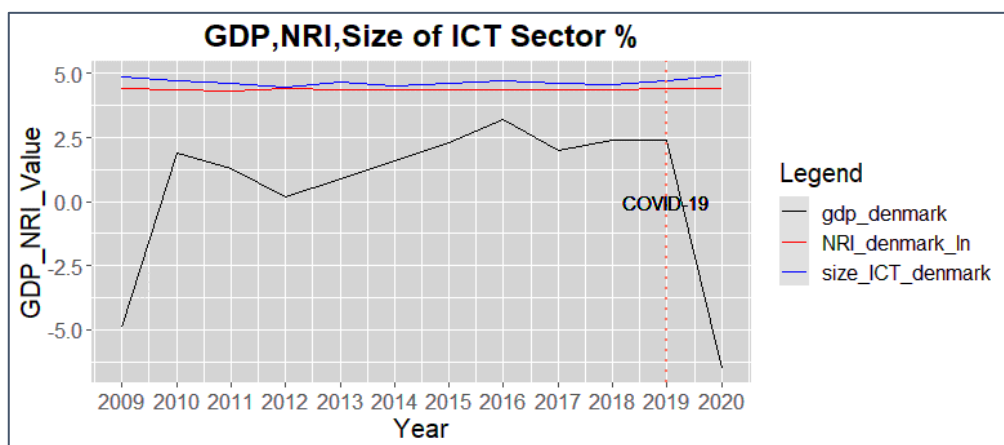


Figure 7:GDP, The Network Readiness Index, Size of the ICT sector- Denmark

Source:(CEIC, 2020; IMF, 2020; OECD, 2020b; Portulans Institute, 2020; World Economic Forum, 2016)

As shown in Figure 7, the GDP growth indicated by the black line starts with a negative rate i.e., -5% in 2009 and less than 1 year the growth becomes more than 1% in 2010 and this is the first peak of GDP growth in the last 12 years. When the GDP growth rate

reaches its first peak in 2010, the size of the ICT sector (blue line) of Denmark is close to 5%, and the NRI growth (red line) more than 4%. The growth of GDP falls in 2012 i.e., close to 0% while the gap between the growths of size of the ICT sector and NRI is minimum. In 2016, Denmark enjoys the highest peak of GDP growth in 12 years i.e., more than 2.5% while the size of the ICT sector in Denmark slightly improves and the NRI growth remains stable like previous years. Denmark’s GDP has a downward curve from 2016 to 2017 and starts going upward from 2017 to 2018 while the growth is stable up to 2019. Though the NRI score growth is stable up to 2020, the size of the ICT sector in Denmark continues improving in a little manner up to 2020 despite the COVID-19’s negative impact on GDP in 2020. It shows Denmark has a very good network preparedness with a settled size of the ICT sector that added values to GDP. It supports that the digital transformation of Denmark is good and its negative economy has less impact on the network preparedness and size of the ICT sector in Denmark.

4.1.2.2 GDP, Profit from E-commerce Sales, BERD in ICT, ICT International Trade

Figure 8 indicates the growth of real GDP, profits from e-commerce sales, business enterprise expenditure for research and development (BERD) in the ICT sector, and the international trade of ICT services of Denmark for the year 2009 to 2020. Figure 8 will help to understand the digital innovation opportunity of Denmark considering the economy and COVID-19 effect.

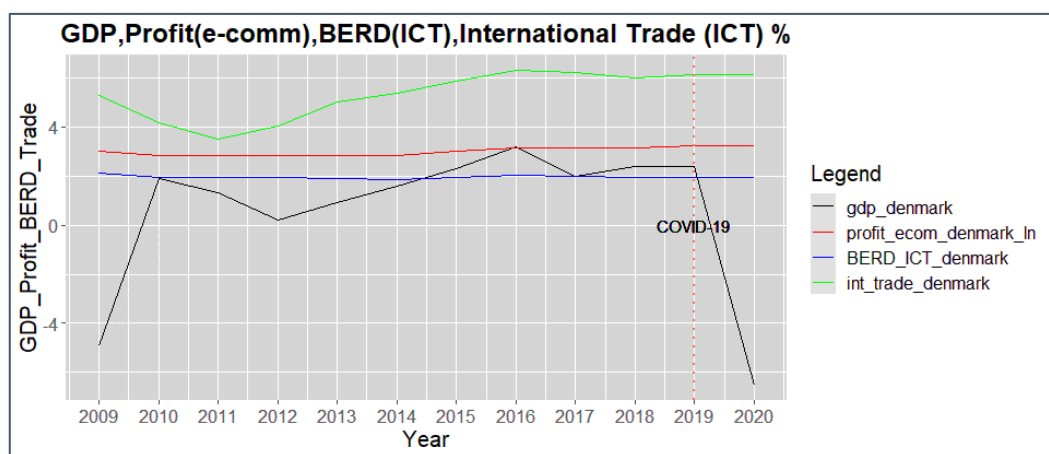


Figure 8:GDP, Profit (e-com), BERD(ICT), Int'l Trade-Denmark

Source: (European Commission, 2020; IMF, 2020; OECD, 2020a; UNCTADSTAT, 2020) *Note: Year 2020 data is estimated except GDP.

In Figure 8, the green line represented the growth of international trade of ICT services that is slightly down from 2009 to 2011 but it remains more than 3%. After 2011, international trade of ICT services has started making an upward curve and continues up to 2016 holding a growth rate of more than 6% while the growth of GDP (black line) reaches the highest peak in the last 12 years i.e., 3%. The growth for profits from e-commerce sales represented by the red line is stable and better than the other stable growth rate of BERD in the ICT sector represented by the blue line in 12 years. The growth rates for profits from e-commerce sales and BERD in the ICT sector are close to 3% and 2% respectively while the growth of GDP has decreased sharply after the emergence of COVID-19 in 2019 and reaches more than -6%. There is no downward effect on profits from e-commerce sales, BERD in the ICT sector, and the international trade of ICT services for the negative growth in GDP of Denmark in 2020 because of the damaging impact of COVID-19. Thus, the digital innovation opportunity of Denmark is also good though there is negative progress in its economy during the pandemic situation like COVID-19.

4.1.2.3 ICT Share Price Impact on Overall Nordic ICT Share Price

Figure 9 shows a comparison between the Danish ICT stock market’s daily share prices (closing) and the ICT stock market’s daily share prices of the overall Nordic for the last 9 years (2012-2020) including the impact due to COVID-19. The red line indicates the financial performance of the ICT sector of Denmark and the black line represents the same for the overall Nordic region.

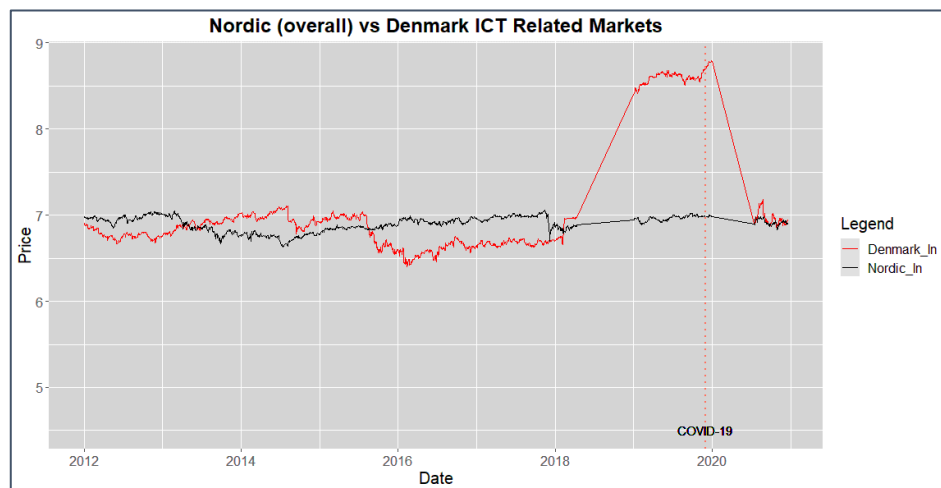


Figure 9: ICT Stock price- Nordic vs Denmark

Source: (Nasdaq Stock Market, 2020)

Figure 9 shows how the Danish ICT stock market influences the performance of the overall Nordic ICT stock market to realize the financial strength of ICT industry and the information and technology infrastructural platform in Denmark. Denmark has a below performance in the ICT stock market, and it is lower than the level of the overall Nordic ICT stock market performance in two different time periods such as 2012 to mid-2013, and mid-2015 to 2018 based on Figure 9. After mid-2013 and before mid-2015, the financial performance for the Danish ICT industry shows a better performance than the overall Nordic ICT stock performance, and the Danish ICT share price maintains a growth close to 7%. After 2018, Denmark has shown high financial performance of its ICT stock market and it creates a huge gap between the overall Nordic ICT stock market performance (i.e., close to 7%) and the Danish ICT stock market performance (i.e., more than 8.75%). COVID-19 has drastically impacted the financial performance of the Danish ICT industry as the red line in Figure 9 falls sharply from the end of 2019 to the mid-2020. Though the financial performance of the Danish ICT sector has struggled to hold its progress in 2020, the previous performance can suggest that Denmark is able to grow again in 2021. Thus, Denmark has a very strong financial strength in its ICT industry and the capacity to handle the impact of COVID-19 on the financial performance of the ICT industry. It also proves that Denmark has a strong information and technology infrastructural platform to continue its digital innovation in the future despite the damaging effect of the pandemic in 2020.

4.1.3 Norway

4.1.3.1 GDP, NRI, Size of the ICT sector

Figure 10 represents the yearly growth of Gross Domestic Product (GDP), the Network Readiness Index (NRI), and the size of the ICT sectors based on value-added to GDP of Norway for the last 12 years (2009-2020). Figure 10 will show the digital transformation scenario of Norway considering its economy and COVID-19 impacts. The dashed red line specifies the area starts for the impact of COVID-19 on the curve of GDP, NRI, and size of the ICT sector in Norway.

As shown in Figure 10, Norway has enjoyed stable growth from 2012 to 2019 in the growth of NRI score which is more than 3.75% and after COVID-19, the growth stays almost stable in Norway. The growth for the size of the ICT sector in Norway is lower than the growth of network readiness from 2009 to 2018 and it becomes equal in 2019

before the pandemic has started. After COVID-19, the growth rate of GDP for Norway sharply falls, and the size of the ICT sector reduces slightly in 2020 while the NRI score remains its regular growth. It shows Norway has a good network preparedness and the size of the ICT sector (i.e., less than 3.75%) that added values to GDP still needs to be progressed to upsurge its digitalization in the future. It supports that the digital transformation of Norway is good and its negative economy has less impact on the network preparedness but a small impact on the size of the ICT sector.

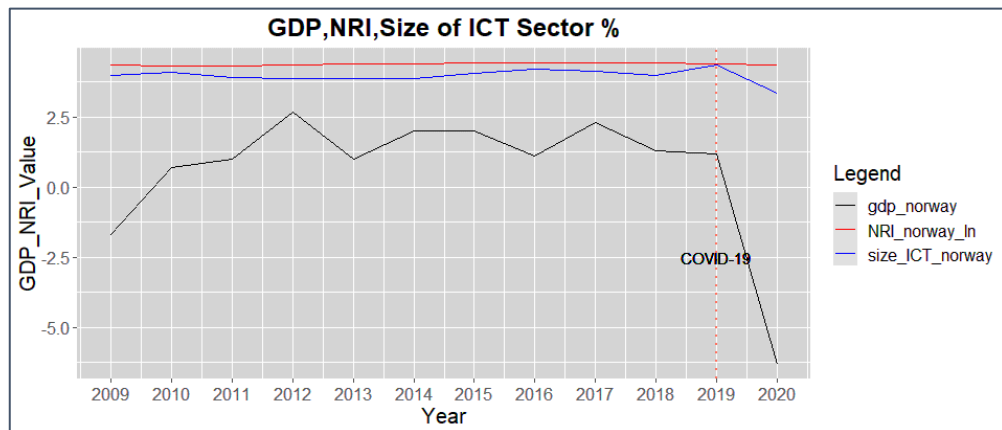


Figure 10:GDP, The Network Readiness Index, Size of the ICT sector- Norway

Source:(CEIC, 2020; IMF, 2020; OECD, 2020b; Portulans Institute, 2020; World Economic Forum, 2016)

4.1.3.2 GDP, Profit from E-commerce Sales, BERD in ICT, ICT International Trade

Figure 11 indicates the growth of real GDP, profits from e-commerce sales, business enterprise expenditure for research and development (BERD) in the ICT sector, and the international trade of ICT services of Norway for the year 2009 to 2020. Figure 11 will help to understand the digital innovation opportunity of Norway considering the economy and COVID-19 effect. The red and blue flatter curves indicate the growths of profits from e-commerce sales and BERD in the ICT sector respectively in Norway for the last 12 years.

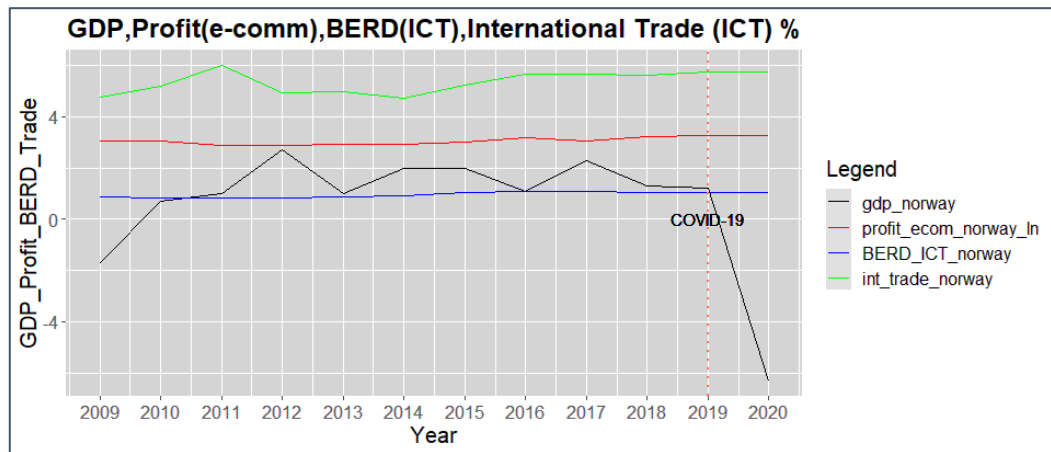


Figure 11:GDP, Profit (e-com), BERD(ICT), Int'l Trade-Norway

Source: (European Commission, 2020; IMF, 2020; OECD, 2020a; UNCTADSTAT, 2020) *Note: Year 2020 data is estimated except GDP.

In Figure 11, the growth of the enterprises’ expenditure on research and development in the ICT sector is very low i.e., close to 1% and it is below the growth of GDP in Norway from 2011 to 2019. The growth rate of the international trade of ICT services of Norway represented by the green line in Figure 11 is higher and has been maintaining a consistent growth rate that is close to 5% in the last 12 years despite the negative growth in GDP in 2020 due to COVID-19. Despite the negative GDP growth rate because of the impact of COVID-19 from 2019 to 2020, the stable growth rates of profits from e-commerce sales, BERD in the ICT sector, and the international trade of ICT services of Norway for the last 12 years indicate that the digital innovation opportunity of Norway is good.

4.1.3.3 ICT Share Price Impact on Overall Nordic ICT Share Price

Figure 12 shows a comparison between the Norwegian ICT stock market’s daily share prices (closing) and the ICT stock market’s daily share prices of the overall Nordic for the last 9 years (2012-2020) including the impact due to COVID-19. The blue line indicates the financial performance of the ICT sector of Norway and the black line represents the same for the overall Nordic region.

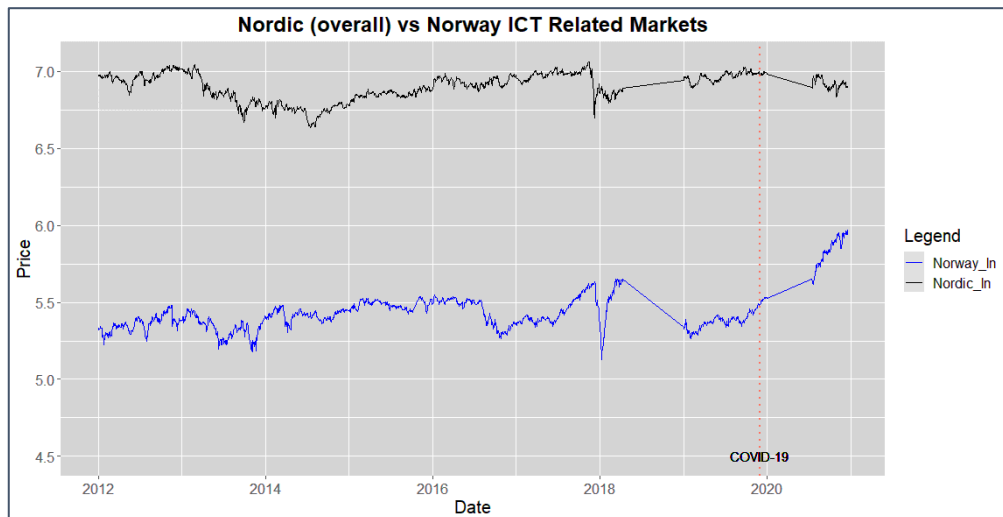


Figure 12: ICT Stock price- Nordic vs Norway

Source:(Investing.com-Financial market, 2020)

Figure 12 shows how the Norwegian ICT stock market influences the performance of the overall Nordic ICT stock market to realize the financial strength of ICT industry and the information and technology infrastructural platform in Norway. The ICT stock market performance of Norway has a low influence on the overall ICT performance in the Nordic region. The gap between two lines indicates the financial performance of the ICT stock market in Norway is not very good for the last 12 years but despite COVID-19 effects, the Norwegian ICT stock market performance continues improving from 2019 to 2020. It reaches close to 6% while the overall Nordic ICT stock performance growth is more than 6.5%. Thus, Norway does not have a good financial strength in its ICT industry, but it is increasing its capacity to handle the pandemic effect on the financial performance of the ICT industry. It also proves that Norway has a less strong information and technology infrastructural platform to continue its digital innovation in the future to mitigate the damaging effect of COVID-19.

4.1.4 Sweden

4.1.4.1 GDP, NRI, Size of the ICT sector

Figure 13 represents the yearly growth of Gross Domestic Product (GDP), the Network Readiness Index (NRI), and the size of the ICT sector based on value-added to GDP of Sweden for the last 12 years (2009-2020). Figure 13 will show the digital transformation scenario of Sweden considering its economy and COVID-19 impacts. The dashed red line specifies the area starts for the impact of COVID-19 on the curve of GDP, NRI, and size of the ICT sector in Sweden.

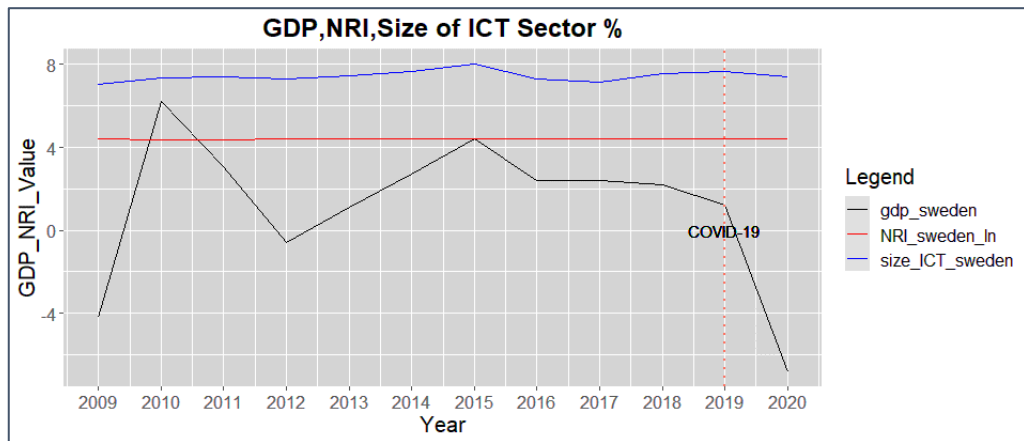


Figure 13: GDP, The Network Readiness Index, Size of the ICT sector- Sweden

Source:(CEIC, 2020; IMF, 2020; OECD, 2020b; Portulans Institute, 2020; World Economic Forum, 2016)

In Figure 13, Sweden has very good and stable growth in the size of its ICT sector from 2009 to 2014 represented by the stable blue line in Figure 13 i.e., less than 8% while the GDP growth rate has both upward and downward curves shown by the black line in Figure 13. In 2009, Sweden’s GDP growth rate starts from -4% and within 1 year, it changes positively and reaches more than 6%. The rate of GDP growth comes down gradually after 2010 and in 2012 it becomes negative for the second time in the last 12 years. In 2015, Sweden’s GDP growth has touched its second peak i.e., more than 4% while the growth of the size of the ICT sector has also increased and achieved 8% growth. After 2015, the growth of GDP in Sweden again starts falling but not negatively up to 2019 and the growth rate of the ICT sector’s size reduces slightly up to 2018. The growth rate for NRI score in Sweden presented by the red line in Figure 13 is also stable and the rate remains more than 4% from 2009 to 2020 though the GDP growth rate has fallen sharply and the growth rate of the size of the ICT sector has reduced slightly after 2019. It shows Sweden has a good and stable network preparedness with an advanced size of the ICT sector that added values to its GDP. It means the digital transformation of Sweden is good and its negative economy has less impact on the network preparedness and size of the ICT sector.

4.1.4.2 GDP, Profit from E-commerce Sales, BERD in ICT, ICT International Trade

Figure 14 indicates the growth of real GDP, profits from e-commerce sales, business enterprise expenditure for research and development (BERD) in the ICT sector, and the international trade of ICT services of Sweden for the year 2009 to 2020. This graph will

help to understand the digital innovation opportunity of Sweden considering the economy and COVID-19 effect.

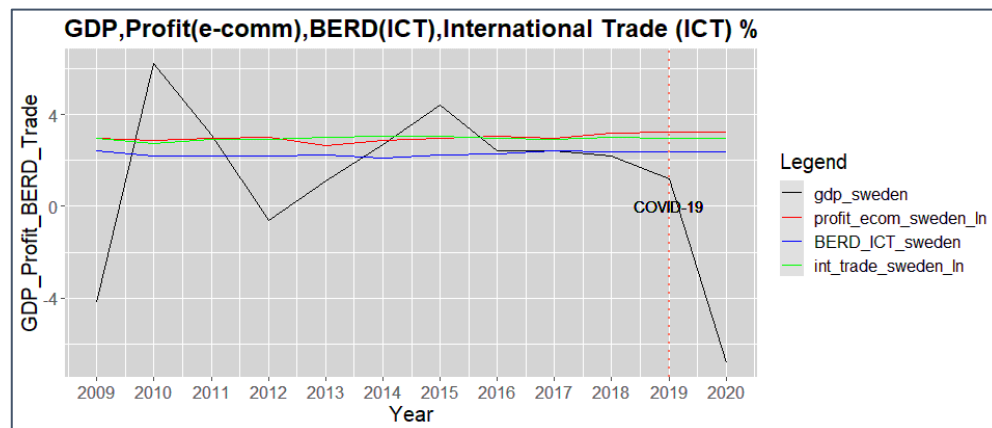


Figure 14: GDP, Profit (e-com), BERD(ICT), Int'l Trade-Sweden

Source: (European Commission, 2020; IMF, 2020; OECD, 2020a; UNCTADSTAT, 2020) *Note: Year 2020 data is estimated except GDP.

According to Figure 14, the growth rate for BERD in the ICT sector in Sweden presented by the blue line is more than 2% for the last 12 years while the growth rates for both international trades in ICT services shown by the green line and profits from e-commerce sales shown by the red line are close to 3% for the last 12 years in Sweden. Despite the negative growth in GDP in 2019 to 2020 due to COVID-19, the growth rates for profits from e-commerce sales, BERD in the ICT sector, and the international trade of ICT services of Sweden remain in a neutral position relating to the previous years. The growth rate of profits from e-commerce sales in Sweden slightly increases in 2019 too though the COVID-19 has started its damaging impacts at the end of 2019. Moreover, the digital innovation opportunity of Sweden is less good because Sweden’s enterprises have not increased their research and development expenditures in the ICT sector significantly for the last 12 years to boost the future digital innovation opportunity. Negative progress in its economy due to COVID-19 can impact this BERD in the ICT sector in the future too.

4.1.4.3 ICT Share Price Impact on Overall Nordic ICT Share Price

Figure 15 shows a comparison between the Swedish ICT stock market’s daily share prices (closing) and the ICT stock market’s daily share prices of the overall Nordic for the last 9 years (2012-2020) including the impact due to COVID-19. The blue line indicates the financial performance of the ICT sector of Sweden and the black line represents the same for the overall Nordic region.

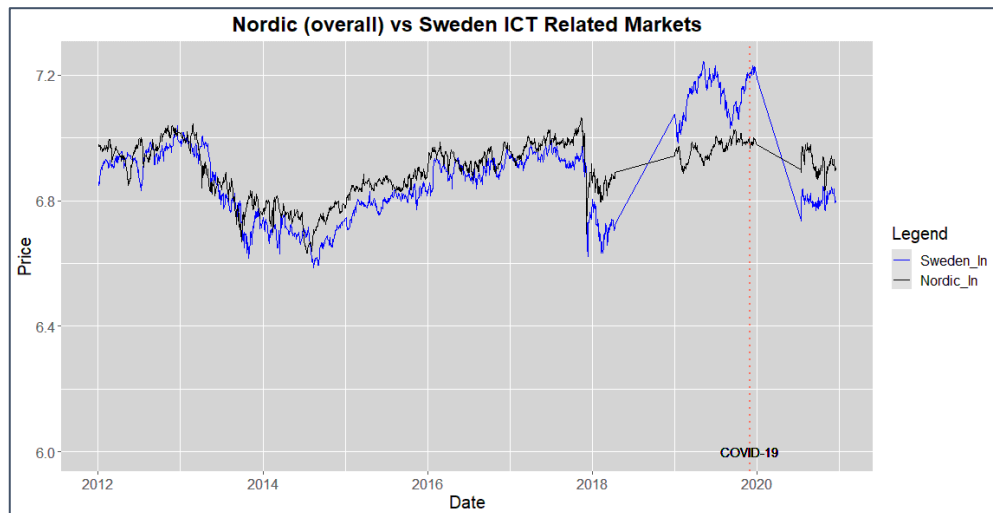


Figure 15: ICT Stock price- Nordic vs Sweden

Source: (Nasdaq Stock Market, 2020)

Figure 15 shows how the Swedish ICT stock market influences the performance of the overall Nordic ICT stock market to realize the financial strength of the ICT industry and the information and technology infrastructural platform in Sweden. From 2012 to early 2018, the growth rate for the Swedish ICT stock market and the overall Nordic ICT stock market were very close to each other and moves in the same manner where the growth rate ranges from 6.2% to more than 7%. From 2013 to mid-2018, the Swedish ICT share price performs a little bit less than the overall Nordic ICT share price. the Swedish ICT share index performs better after mid-2018 and gets a sharp growth up to 2019. Just before COVID-19 started at the end of 2019, the Swedish share price in the ICT stock market falls but does not cross the overall Nordic ICT stock share price. Though the share price for the ICT sector in Sweden remains better up to the beginning of 2020, it starts decreasing after few days in 2020. Thus, Sweden has good financial strength in its ICT industry and the capacity to handle the impact of COVID-19 on the financial performance of the ICT industry. It also proves that Sweden has a standard information and technology infrastructural platform to continue its digital innovation in the future despite the damaging effect of the pandemic in 2020.

4.1.5 The Network Readiness Index Ranking

Table 3 shows the yearly ranks of the Network Readiness Index for Finland, Denmark, Norway, and Sweden for the last 12 years. Every year this data is published to show the position of these Nordic countries in terms of their network preparedness and the low

rank is treated better. These rankings show how matured the countries were in the field of digitalization.

Table 3: NRI Ranking-2020

Year	Finland	Denmark	Norway	Sweden
2009	6	1	8	2
2010	6	3	10	1
2011	3	7	9	1
2012	3	4	7	1
2013	1	8	5	3
2014	1	13	5	3
2015	2	15	5	3
2016	2	11	4	3
2017	2	11	4	3
2018	2	11	4	3
2019	7	6	4	1
2020	6	2	7	1

Source: (Portulans Institute, 2020; World Economic Forum, 2016)

According to Table 3, Finland ranked the second four times in the NRI index from 2015 to 2018, but after the damaging impact of COVID-19 Finland's NRI ranking has dropped to seventh in 2019 and sixth in 2020. The scenario for Finland in NRI ranking in 2020 is like the NRI ranking of 2009 and 2010. Thus, after 2018, Finland is facing a bigger position in NRI ranking compared to previous years, but Finland's NRI ranking is in the top 10 for the last 12 years. It shows good strength in the field of network preparedness and a good digital maturity for Finland. Denmark ranks badly compared to other Nordic countries in its NRI from 2014 to 2018, it regains its earlier strong position in 2019 that is sixth and becomes second in 2020. In the last 12 years, Denmark has not been in the top 10 for 5 years but recently in the top 2. Norway ranks for NRI improves from 2013 (fifth) to 2019 (fourth), but COVID-19 has damaged its position and throws Norway's NRI rank in seventh position in 2020. Norway also ranks in the top 10 in terms of its network preparedness strength for the last 12 years that shows a good maturity of Norway in digitalization. Finally, Sweden has a very much strong network preparedness as the rank remains in the top 3 for the last 12 years where it becomes first in 2020. It shows the ICT is widely used and has a good impact on digital maturity largely in Sweden and Denmark respectively in 2020. Finland and Norway have reduced their strengths for ICT application in 2020 though Finland has started overcoming the position slightly from 2019.

4.1.6 The Digital Economy and Society Index Ranking

In Table 4, the rankings based on the digital economy and society index (DESI) for Finland, Denmark, Norway, and Sweden have been given.

Table 4: DESI Ranking-2020

Year	Finland	Denmark	Norway*	Sweden
2015**	3	2	4	1
2016	4	1	-	3
2017	2	4	-	4
2018	2	3	-	1
2019	1	3	-	2

Source: (European Commission , 2020) * European Commission Report does not include the overall ranking for Norway from 2016-2020. ** European Commission starts reporting about digital progress by DESI report from 2014.

According to Table 4, the DESI ranking shows all the Nordic countries of the thesis have ranked in the top 4 though the European Commission has not published the ranking data for Norway after 2015. The digital progress is determined by the DESI rankings where Finland does the best by being first in 2019. Sweden has lost its first position in 2019, while Finland grabs it in 2019 and continues this first position in 2020 too. Moreover, the digital progress of the four Nordic countries is significantly good where Finland is the best.

4.2 Digital Intensity Level Analysis of Nordic Countries

As mentioned, the thesis will analyze the level of digital intensity or the degree of digital integration among people, processes, and technology. The analysis shows the Nordic countries' digital intensity level and make a comparison to realize the position of the Nordic countries i.e., Finland, Denmark, Norway, and Sweden for the last 10 years. To understand the digital intensity level, this analysis will consider the Nordic countries level of internet use and activities based on the online course, enterprises' e-commerce, CRM and secure transactions, individual's internet use, individual's basic overall digital skills, individual's internet purchase, individual's internet and broadband access, digital interaction between individual and public authority, and the rate of digital adoption.

4.2.1 Internet Use and Activity Level-Online Course

In Figure 16, the percentage data for the use of the internet and online course-based activities has been given for the last 10 years (2010-2019). The dashed red line shows the

starting of COVID-19. Four colors i.e., black, red, blue, and green represent the trends for Finland, Denmark, Norway, and Sweden respectively in Figure 16. Such information help to realize the digital intensity level of the Nordic countries based on internet use and online course activity.

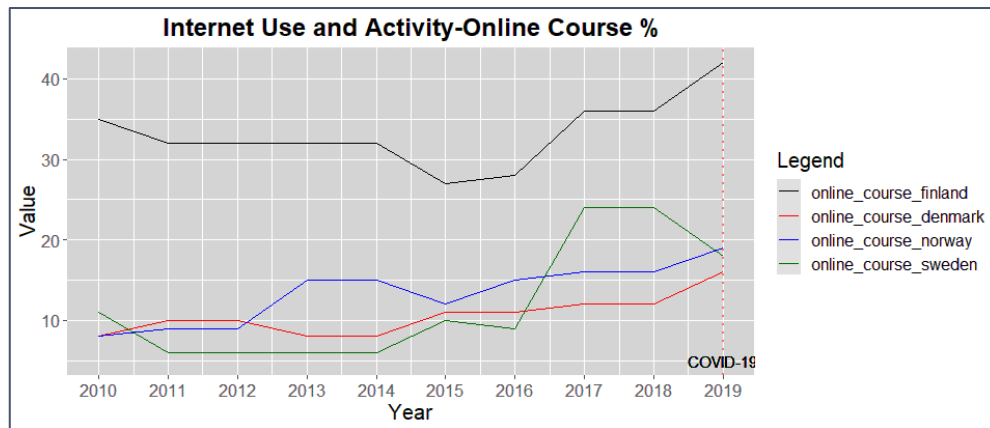


Figure 16: Level of Internet Use and Online Course Activity-Nordic

Source: (European Commission, 2020a [isoc_bde15cua]), * EC does not publish data for 2020.

Finland has a higher level of internet use and online activity related to online courses for the last 10 years i.e., more than 25% while the growth of this trend is slightly steeper from 2016 and before 2019, the level is more than 40%. In 2010, Sweden starts its level from more than 10% while the growth rates for Denmark and Norway are less than 10%. Within one year, Sweden’s curve falls and remains close to 5% up to 2014 while Denmark and Norway are doing better than Sweden. Norway performs slightly less than Denmark in internet use and online activities up to 2012. After 2012, Norway makes an upward growth and maintains it between 15% to 20% while the growth rate for Denmark is between 5% to less than 20%. After 2016, Sweden has improved its level of internet use and online activities largely and it achieves close to 25% growth from 2017 to 2018 whereas Norway achieves more than 15% and Denmark achieves more than 10%. Moreover, before the year of COVID-19, more than 40% growth has been seen in Finland for internet use and online activities whereas the other Nordic countries show growth rates between 15% to 20%. Though the European Commission has not published data for 2020 at the end of this year, it can be predicted that the growth rate of internet use and online course activity will not be hampered badly in Finland compared to the other Nordic countries. Thus, Finland has much higher digital intensity and Denmark has the least among the Nordic countries whereas Sweden and Norway have an almost similar levels of digital intensity.

4.2.2 E-commerce, Customer Relation Management (CRM) and Secure Transactions of Enterprises

In Figure 17, the combined percentage data for enterprises' e-commerce, customer relationship management (CRM) and secure transactions has been given for the last 10 years (2010-2019). The dashed red line shows the starting of COVID-19. Four colors i.e., black, red, blue, and green represent the trends for Finland, Denmark, Norway, and Sweden respectively in Figure 17. Figure 17 will support to realize the digital intensity level of the Nordic countries based on e-commerce, CRM, and secure transactions level of enterprises.

From 2010 to 2012, Norway shows a high level i.e., more than 35% in the growth of e-commerce, CRM, and secure transaction of enterprises and after 2012, it experiences a sharp fall which carries a growth level of less than 30%. From 2010 to 2013, Finland has the least level of growth in e-commerce, CRM, and secure transaction of enterprises i.e., less than 22.5% while Denmark and Sweden have growth rates of more than 27.5% and 25% respectively.

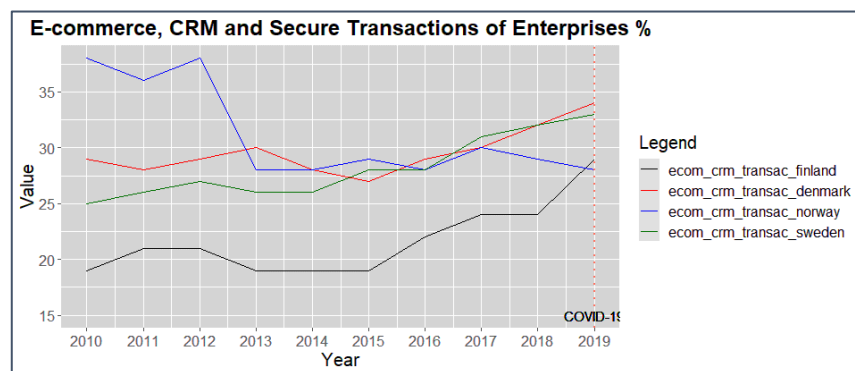


Figure 17:Level of E-commerce, CRM, Secure Transaction of Enterprises-Nordic

Source:(European Commission, 2020a [isoc_bde15dec]), * EC does not publish data for 2020.

Though Finland performs less than other countries in the last 9 years (2010-2018), it has crossed the level of Norway (i.e., close to 27.5%) in 2019 and reach a growth rate close to 30%. After 2013 to before 2017, Denmark, Norway, and Sweden have made a growth rate between 25% to 30%. After 2017, Sweden slightly decreases the percentage growth of e-commerce, CRM, and secure transactions of enterprises whereas Norway reduces it largely. Denmark does the best and continues rising in 2019 while Finland has also raised its growth and crossed the growth of Norway but Sweden. Before COVID-19, Denmark had the best level of digital intensity in the Nordic countries and Sweden comes the next.

Finland has done better than Norway. COVID-19 will not badly hamper the growth of Denmark and Sweden as they have a high level of digital intensity based on their high level of e-commerce, CRM, and secure transactions of enterprises.

4.2.3 Individual Internet Use

In Figure 18, the percentage data for the use of internet by individual has been given for the last 10 years (2010-2019). The dashed red line shows the starting of COVID-19. Four colors i.e., black, red, blue, and green represent the trends for Finland, Denmark, Norway, and Sweden respectively in Figure 18. Figure 18 will help to show the digital intensity level of the Nordic countries based on the level of individual’s internet use.

According to Figure 18, in 2019, both Norway and Sweden have 98% individuals using the internet whereas Denmark has close to 97% and Finland has more than 95%. Thus, Norway and Sweden have more digital intensity levels compared to Denmark and Finland while Denmark performs better than Finland in 2019. Sweden has a very downward curve from 2013 to 2015 while the other three Nordic countries enjoy a slight growth. Denmark and Norway have maintained a growth between 93% to 98% from 2013 to 2019. Finland has a continuous upward curve that shows the continuous growth of internet use by individuals in Finland from 2010 to 2019. In 2010, Norway had less than 94% individuals using the internet and it has increased by more than 4% in 2019. Sweden started its growth rate for individual internet use by 91% in 2010 and in 2019 it has increased by 7% whereas Finland increases by 9% and Denmark improves by less than 9%. Moreover, before COVID-19, Norway and Sweden had a better digital intensity level based on the use of the internet by individuals. Denmark had more individuals using the internet than Finland.

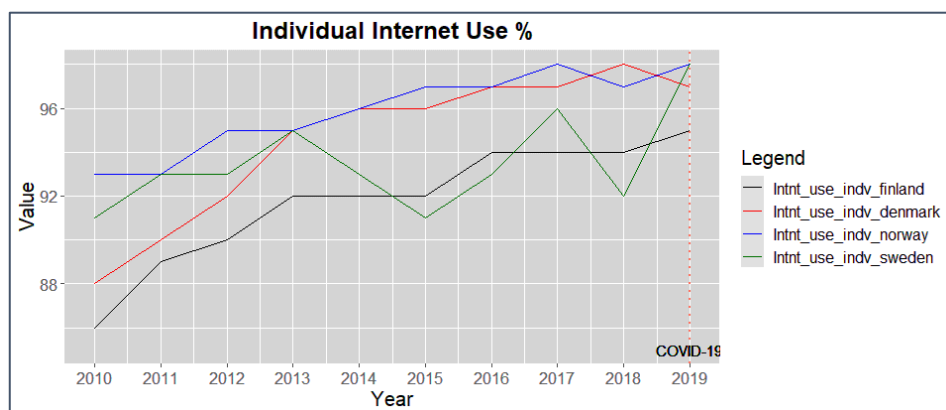


Figure 18:Level of Individual Internet Use-Nordic

Source:(European Commission & Nordic Co-operation, 2020; [isoc_ci_ifp_fu, isoc_ci_ifp_iu]), * EC does not publish data for 2020.

4.2.4 Individual Basic Overall Digital Skills

In Figure 19, the percentage data for the basic overall digital skills by individual has been given for the last 5 years (2015-2019). The dashed red line shows the starting of COVID-19. Four colors i.e., black, red, blue, and green represent the trends for Finland, Denmark, Norway, and Sweden respectively in Figure 19. Figure 19 will represent the digital intensity level of the Nordic countries based on the level of an individual's basic overall digital skills.

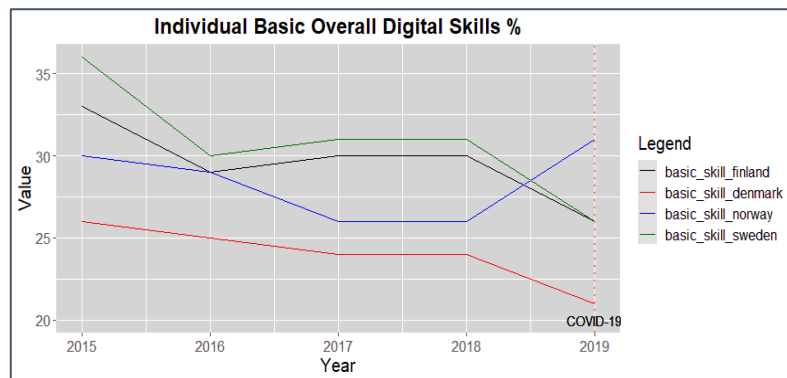


Figure 19: Level of Basic Overall Digital Skill of Individual-Nordic

Source: (European Commission, 2020a [isoc_sk_dskl_i]),* EC does not publish data for 2020.

In Figure 19, the growth for the individuals' basic overall digital skills in Sweden is more than 35% in 2015 and in 2016 it has decreased by more than 5%. Individual's basic overall digital skill increases slightly from 2016 to 2018 and after 2018, it drops sharply by more than 4%. In 2015, Finland has more than 32% of individuals having basic overall digital skills but it reduces by more than 2.5% in 2016. From 2016 to 2018, Finland's growth rate for its individual's basic overall digital skills increases a little and remains close to 30% while it decreases largely in 2019 and matches with the growth rate of Sweden i.e., more than 25%. Though the growth for the level of individual's basic overall digital skills in Norway is lower than Finland and Sweden from 2015 to 2018, Norway has developed its individual's basic overall digital skills from 2018 and achieved the highest growth rate i.e., more than 30% in 2019 among the other Nordic countries. Denmark had the least progress in terms of individual's basic digital skills in the Nordic countries for the last 5 years and in 2019 it is below 22%. Thus, before COVID-19, Norway had the highest digital intensity level based on the level of individuals' basic overall digital skills in the Nordic countries while Finland and Sweden come the next having the same level.

4.2.5 Individual Internet Purchase

In Figure 20, the percentage data for the level of internet purchase by individual has been given for the last 10 years (2010-2019). The dashed red line shows the starting of COVID-19. The trends for Finland, Denmark, Norway, and Sweden are represented by the four colors i.e., black, red, blue, and green respectively in Figure 20. Figure 20 will represent the digital intensity level of the Nordic countries based on the level of individual’s internet purchase.

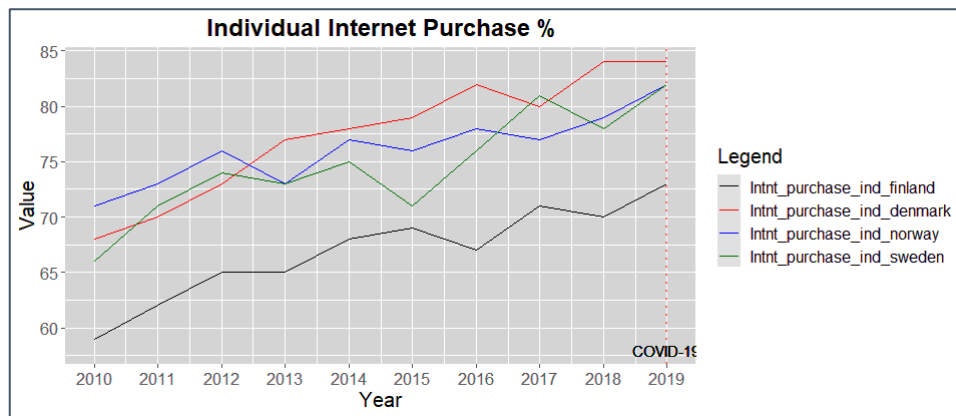


Figure 20: Level of Internet Purchase of Individual-Nordic

Source: (European Commission & Nordic Co-operation, 2020; [isoc_ec_ibuy]),* EC does not publish data for 2020.

According to Figure 20, from 2010 to 2019, all Nordic countries have enjoyed the rising percentage of individual internet purchase, but Denmark has performed much better after 2012. The growth of internet purchases by individuals in Finland is the least compared to other Nordic countries for the last 10 years. In Finland, the growth rate has increased by less than 10% from 2010 to 2015 but increased by less than 5% from 2015 to 2019. Before COVID-19, more than 72% of total individuals in Finland have purchased the internet. In Denmark, more than 10% growth in internet purchase by individuals has been made from 2010 to 2015 where the growth rate is less than 9% from 2015 to 2019. Before COVID-19, less than 85% of total individuals in Denmark have purchased the internet. In Norway, the growth rate increased by more than 5% from 2010 to 2015 but Norway’s internet purchase level is higher in 2010 i.e., more than 70% up to 2012. the blue curve shows Norway has reduced individuals’ internet purchase growth than the growth rate of Denmark from 2013 to mid-2016. As Sweden has developed its level of individuals’ internet purchase largely after 2015, Norway has experienced a decreased level of internet purchase growth from Sweden from mid-2016 to mid-2017. Sweden enjoys the highest

growth rate for individuals' internet purchase in 2017 i.e., more than 80% among the Nordic countries. Before COVID-19, Norway and Sweden have more than 82% of total individuals who purchase the internet. Moreover, digital intensity level in terms of internet purchase of individuals in the Nordic countries, Denmark has a better position and Finland has the least position compared to other Nordic Countries before COVID-19 in 2019.

4.2.6 Individual Internet and Broadband Access

In Figure 21, the percentage data for the levels of internet access and broadband access by individuals has been given for the last 10 years (2010-2019). The dashed red line shows the starting of COVID-19. The trends for Finland, Denmark, Norway, and Sweden are represented by the four colors i.e., black, red, blue, and green respectively in Figure 21. Figure 21 will represent the digital intensity level of the Nordic countries based on the level of individuals' internet and broadband access.

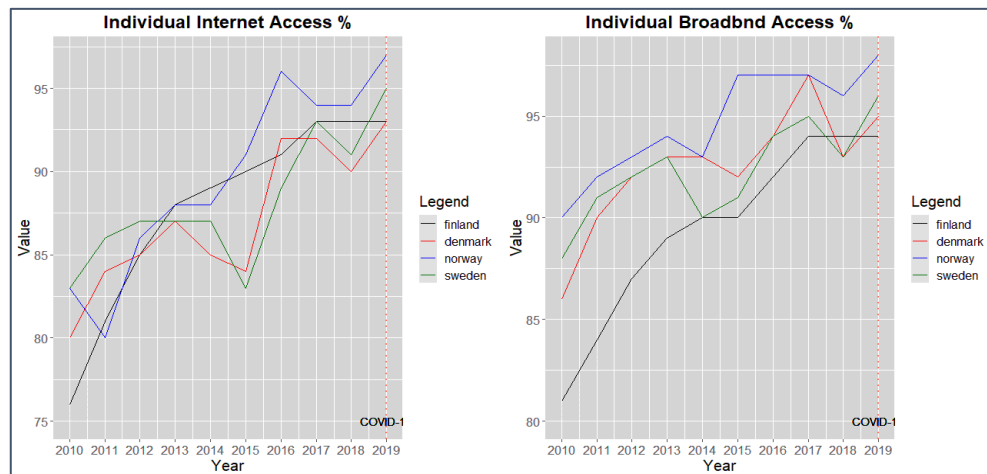


Figure 21:Level of Internet & Broadband Access of Individual-Nordic

Source:(European Commission & Nordic Co-operation, 2020; [isoc_ci_in_h, isoc_ci_it_h]), * EC does not publish data for 2020.

According to the left graph of Figure 21, in 2010, Norway and Sweden have the same position for the level of *individual internet access* i.e., more than 82% whereas Denmark (80%) has a better position than Finland (more than 75%). Among other Nordic countries, Finland and Norway have developed their internet access growths more sharply and achieved growths less than 12% and 8% respectively in mid-2012. Finland and Norway have crossed the growth levels of individuals' internet access in Denmark and Sweden in 2013 while Norway has crossed all other Nordic countries after 2014 up to 2019. More than 96% of individuals in Norway have internet access while Sweden has 95% of

individuals and the other two Nordic countries have more than 92% of individuals for internet access before COVID-19. In terms of *individual broadband access* (right graph in Figure 21), Norway has held a better position in the last 10 years in Nordic regions compared to Denmark, Sweden, and Finland though Denmark performs like Norway i.e., less than 97% in 2017. From 2010 to 2017, Finland has the least growth of individual broadband access and the growth rate ranges from more than 80% to less than 95%. From 2013 to 2016, Sweden has seen a fall in the growth of broadband access by individuals and Sweden’s performance is like Finland i.e., 90% in 2014. Before COVID-19, the percentages of broadband access are more than 97% of individuals in Norway, more than 95% of individuals in Sweden, and less than 95% of individuals in Denmark and Finland. Moreover, the digital intensity in terms of individuals’ internet and broadband access Norway is the best and Sweden is better than the other two Nordic countries.

4.2.7 Digital Interaction (Individual and Public Authorities)

In Figure 22, the percentage data for digital interaction between individual and public authority has been given for the last 10 years (2010-2019). The dashed red line shows the starting of COVID-19. The trends for Finland, Denmark, Norway, and Sweden are represented by the four colors i.e., black, red, blue, and green respectively in Figure 22. Figure 22 will represent the digital intensity level of the Nordic countries based on the growths of obtaining digital information, downloading official digital forms, and submitting official digital forms.

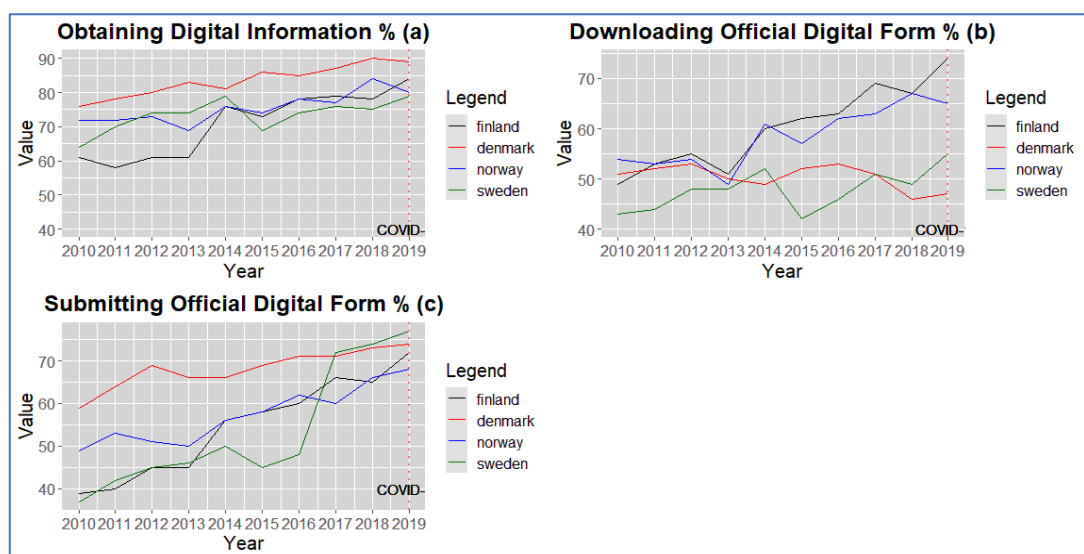


Figure 22: Level of Digital Interaction-Nordic

Source: (European Commission & Nordic Co-operation, 2020; [isoc_ciegi_ac]),
 * No available data for 2020.

According to Figure 22 (a), in the last 10 years, Denmark has achieved a good position in terms of *obtaining digital information*. In 2019, more than 85% of total individuals get digital information from the public authority of Denmark while the percentage of total individuals obtaining digital information from the public authority in Sweden, Finland, and Norway are less than 80%, less than 85%, and more than 80% respectively. The differences between the growth rates of obtaining digital information in 2019 from 2010 are less than 25% in Finland, less than 15% in Denmark, less than 10%, and 15% in Sweden. Though Denmark has a good level of digital intensity among other Nordic countries in terms of obtaining digital information, Finland has achieved remarkable growth in the last 10 years, providing support for the progress of digital intensity in Finland. After 2014, Sweden has decreased its growth in digital interaction in terms of obtaining digital information from public authority as the green line shows below 70% growth in 2015 while Finland and Norway maintain growths of close to 75% and Denmark holds more than 80% growth. Moreover, before COVID-19, Denmark has the highest digital intensity in terms of digital interaction by obtaining digital information from public authority and Finland is in the second position.

According to Figure 22 (b), the growth rate for digital interaction by *downloading official digital forms* from the public authority is the highest in Finland from 2014 to 2019 among four Nordic countries. Norway has a growth rate for digital interaction by downloading official digital forms close to Finland from 2014 to 2019. Before COVID-19, more than 75% of total individuals in Finland make digital interactions with public authority by downloading official digital forms while Norway has 65% of total individuals for downloading official digital forms. After 10 years in 2019, Denmark has reduced its growth in digital interactions by downloading official digital forms from public authority by less than 5% and more than 45% of total individuals in Denmark maintain digital interactions with public authority by downloading official digital forms. Sweden has less than 55% of total individuals who are downloading official digital forms to make digital interactions with public authority in 2019 and the growth rate for such digital interaction increases after 2015 i.e., less than 45%. Recently, Sweden is in a better position than Denmark for maintaining digital interaction with public authority in terms of downloading official digital forms. Moreover, before COVID-19, Finland has the highest digital intensity as the digital interaction by downloading official digital forms and Norway comes in the next position.

According to Figure 22 (c), the red line shows an upward trend for Denmark for the last 10 years, and up to 2017, it has the top position for maintaining digital interaction with public authority by *submitting official digital forms*. After 2017, the growth rate for digital interaction by submitting official digital forms in Denmark becomes slightly lower than the growth rate for digital interaction in Sweden. Before COVID-19, more than 75% of total individuals make digital interactions in Sweden by submitting official digital forms while Denmark has less than 70% of total individuals for the same digital interactions with public authority. In 2010, the digital interaction level for Finland is less than 40% and after 5 years, it increases by more than 15% in 2014. After 2014 the level of digital interaction also increases by more than 15% till 2019 and it achieves more than 70% of total individuals in Finland who interact with public authority by submitting official digital forms. Norway (i.e., more than 55%) has performed better than Sweden and Finland up to 2014 and this level has been increased by less than 15% in 2019. Before COVID-19, less than 70% of total individuals in Norway create digital interactions in terms of submitting official digital forms. The digital intensity level is the highest in Sweden in 2019 and Denmark has the second-highest level of digital intensity in terms of digital interaction between public authority and individuals by submitting official digital forms.

Moreover, Finland has a slightly better position than Norway before COVID-19. The overall situation for digital interaction shows Denmark has a good position for maintaining digital interaction with public authority in terms of both obtaining digital information and submitting official digital forms for the last 10 years though recently, Sweden is better for maintaining digital interaction by submitting official digital forms than Denmark. Finland has a good digital interaction with public authority in terms of downloading official digital forms and Norway has a close position to Finland based on the level of downloading official digital forms. Moreover, Denmark has a stronger level of digital intensity in terms of digital interaction between individual and public authority.

4.2.8 The Digital Adoption Rate

In Figure 23, the percentage data for digital adoption rate based on the growth rates of mobile connection, internet user, and social media users has been given for the last 4 years (2017-2020). The dashed red line shows the starting year of COVID-19. The trends for Finland, Denmark, Norway, and Sweden are represented by the four colors i.e., black, red, blue, and green respectively in Figure 23.

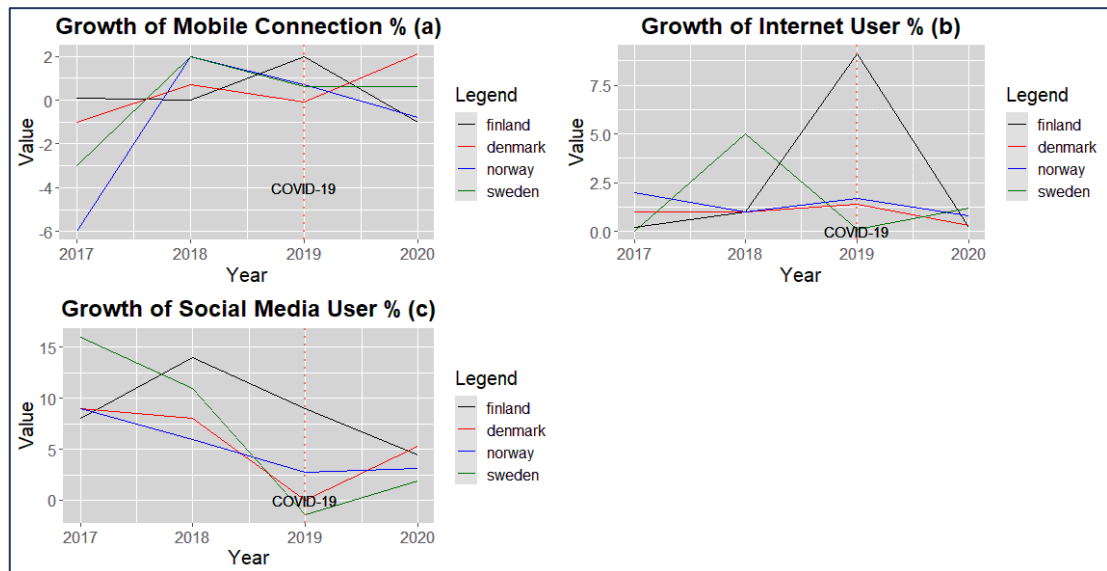


Figure 23:Level of Digital Adoption-Nordic

Source:(Datareportal, 2020)

Figure 23 will represent the digital intensity level of the Nordic countries based on the level of digital adoption. According to Figure 23 (a), the *growth of mobile connection* for Denmark, Sweden, and Norway are negative from 2017 to mid-2017 where the growth rate for Norway is the worst. Finland has enjoyed zero to more than zero percent growth in mobile connection from 2017 to mid-2019 while in 2019 the growth is the highest among the Nordic countries. Though Finland was the best in mobile connection growth (close to 2%) in 2019 among other Nordic countries, in 2018, both Sweden and Norway performed the best (close to 2%) in the same growth rates. In the beginning of 2019, Denmark had 0% growth in the mobile connection trend whereas both Norway and Sweden had less than 1% growth in the same trend. The reds dashed line areas show, after 2019, the mobile connection-level has been increased in Denmark as the red curve in Figure 23 (a) is upward up to 2020 and the growth rate has increased by more than 2%. After 2019, though Sweden has enjoyed constant growth in mobile connection up to 2020, Finland and Norway have faced a reduction by less than -1%. Thus, the digital adoption level in terms of mobile connection is the highest in Denmark among other Nordic countries while Sweden is better than Finland and Norway based on the same level. According to Figure 23 (b), the *growth of internet users* is higher in Norway i.e., less than 2.5% in 2017 while Finland and Sweden have 0% growth in internet user level. After one year, Sweden’s position for internet users has increased by 5% whereas other Nordic countries have a growth of less than 1.25% in internet users’ level. After 2019, the level of internet user is decreased sharply in Sweden as the green line is downward in Figure

23 (b) up to 2019 though it increases after 2019 up to 2020 by 1.25%. At the beginning of 2019, Finland's internet users' level has increased by more than 8.25% but after 2019, the growth rate for internet users in Finland falls by more than 8% in 2020. The growth rate for internet users also falls slightly in Norway and Denmark in 2020 (i.e., close to 0%) while this rate slightly increases in Sweden and reaches close to 1.25% in 2020. Thus, before COVID-19, the digital adoption rate based on internet user growth rate is largely higher in Finland but after COVID-19 has started, the digital adoption level is slightly better in Sweden among other Nordic countries. In Figure 23 (c), *the growth of social media users* helps to realize the level of digital adoption level in Nordic countries. The growth rate for social media users decreases in Sweden from 2017 (i.e., more than 15%) to 2019 (i.e., less than 0%) but after 2019 and despite COVID-19, the social media users increase by less than 2.5% up to 2020 in Sweden. In 2018, Finland's social media usage rate is the highest i.e., more than 12.5% while Sweden has more than 10% growth in social media users. In 2018, Norway has less than 2% growth compared to the growth rate of social media users in Denmark i.e., more than 7%. After mid-2018, all Nordic countries' social media users have reduced but Denmark and Sweden have seen sharp reductions by more than 7% and more than 10% respectively. After COVID-19 has started, Finland has decreased its social media users and reached a growth rate of less than 5% in 2020 while the social media usage rate is slightly better in Denmark i.e., more than 5% in 2020. In 2020, social media users increase in Sweden and Norway but the rates are less than 2.5% in Sweden and more than 2.5% in Norway. Thus, before COVID-19, Finland has the highest position in the digital adoption rate based on social media users but after COVID-19 has started, Denmark has a better position at the same level. Moreover, the overall digital adoption level is better in Denmark as Denmark has a better position in mobile connection's level and social media users' levels compared to other Nordic countries in 2020. Before 2020 Finland has a better position in the digital adoption level based on the levels of mobile connection, internet users, and social media users. Thus, the digital intensity level is higher in Denmark and Finland as their digital adoption rates are better.

4.3 Digital Maturity Level Analysis of Nordic Countries

Regarding the research question three, digital maturity level analysis will examine the network preparedness of Nordic countries by the Network Readiness Index (NRI) score, the digital performance growth by the Digital Economy and Society Index (DESI) score, and the capacity of digital innovation by the investment level of businesses on emerging technology.

4.3.1 The Network Readiness Index (NRI)

The Network Readiness Index will show which Nordic country has well-prepared network to make competitive advantage in the use and impact of information and communication technology (ICT) in an economy.

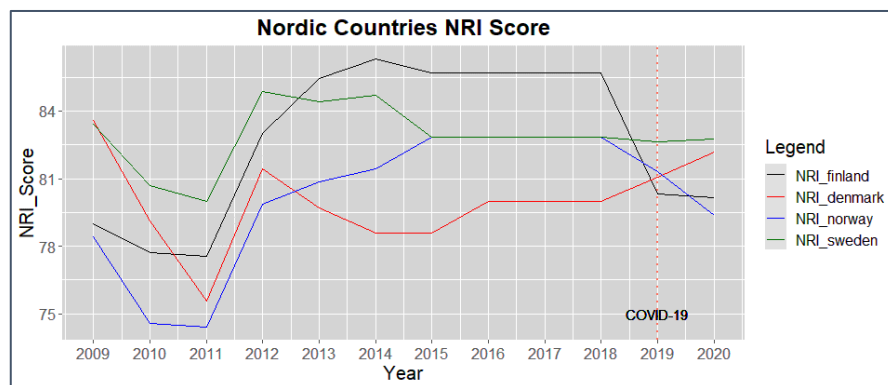


Figure 24: NRI Score (Nordics)

Source:(Portulans Institute, 2020; World Economic Forum, 2016)

In Figure 24, the score of the Nordic countries for the last 12 years is given and shown by black, red, blue, and green lines that represent Finland, Denmark, Norway, and Sweden respectively in Figure 24. The red dashed line shows the starting year of COVID-19. In 2009, Sweden and Denmark perform better than Finland and Norway but after two years in 2011, Sweden and Finland perform much better than Denmark and Norway. The score rises for all Nordic countries from 2011 to the end of mid-2012 where Finland does the best in network preparedness. Before 2013 to before 2019, Finland’s network preparedness is the best among other Nordic countries though it decreases after 2018. Before COVID-19, Finland does a very bad performance in NRI score compared to other Nordic countries but in 2020, the NRI score has seen slightly better than the NRI score in

Norway. Sweden and Norway have almost the same network preparation from 2015 to 2018 but after 2018, Norway's network readiness starts decreasing. The network readiness is the worst in Denmark from 2013 to 2018 as the red curve is below other curves in Figure 24. Sweden maintains the same level of network preparation (more than 82.5%) from previous years up to 2020. In 2020, Denmark (less than 82.5%) has achieved the level of network readiness close to Sweden while Sweden is the best among other Nordic countries. Thus, according to the NRI score result, before COVID-19 and after the COVID-19 started the network preparedness is better in Sweden in Nordic countries.

4.3.2 Digital Economy and Society Index (DESI)

The Digital Economy and Society Index (DESI) will show the digital performances of the Nordic countries based on five dimensions i.e., connectivity, human capital, use of internet, integration of digital technology, and digital public services. The higher the digital performance is, the higher the digital maturity is in the Nordic countries.

4.3.2.1 DESI Score of Nordic Countries

Table 5 shows the DESI score of Finland, Denmark, Norway, and Sweden for the last 6 years and Figure 25 will show the trends of their scores to realize the growth of digital performances in the Nordic countries.

Table 5: DESI Score (2015-2020)-Nordic

	2015	2016	2017	2018	2019	2020
Finland	66	67	67.2	62.8	68.1	72.3
Denmark	68	68	63.2	62.5	66	69.1
Norway	63	65	61.8	61.9	64.2	69.5
Sweden	68	67	63.2	64	67.5	69.7

Source: (European Commission, 2020)

According to Table 5, Finland had the best and Denmark had the least digital performances among these four Nordic countries though Sweden, Norway, and Denmark have very little difference in digital progress in 2020. The digital performance score for Finland is higher than other Nordic countries by less than 3% whereas the gaps among other Nordic countries' digital performance levels are less than 1% in 2020. Finland has also achieved the highest score in 2019 and 2017 but the gap with Sweden's DESI score is very low in 2019. In 2018, Sweden has performed the best in digital progress and followed by Finland. The DESI score measures very good digital performance for Denmark from 2015 to 2016 and after 2016, Denmark has lost its remarkable performance

among these four Nordic countries. In 2015, Sweden and Denmark both maintain the same level of digital progress what is better than Finland and mostly Norway. After one year, Denmark, Finland, and Norway drive their scores upward to show growth in digital performances, but Sweden does not. Norway does not show the best digital performance among these Nordic countries in the last 6 years where Finland, Denmark, and Sweden have shown it twice in the last six years. Figure 25 given below shows the growth of the DESI score of the Nordic countries for the last 6 years (2015-2020). The scores of the Nordic countries are shown by black, red, blue, and green lines that represent Finland, Denmark, Norway, and Sweden respectively in Figure 25 where the red dashed line shows the starting year of COVID-19. Figure 25 will visualize the position of the Nordic countries based on their digital performance measured by DESI score and help to realize the impact of COVID-19 in their digital performances.

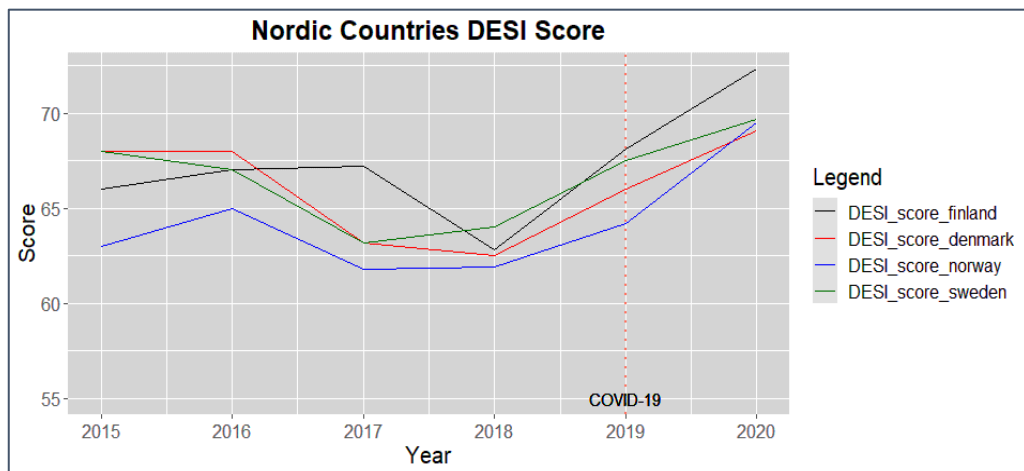


Figure 25: DESI Score (Nordics)

Source: (European Commission, 2020)

According to Figure 25, before COVID-19 has started, Finland has the highest progress in digital performance while Sweden has slightly less progress in digital performance. The level of digital progress is higher in Denmark after Finland and Sweden. Norway is trying to increase its digital growth but till 2019, it does not achieve a better position than the other three Nordic countries. After the COVID-19 started at the end of 2019, despite the pandemic, all Nordic countries have maintained continuous growth in digital performances. Finland does the best and followed by Sweden in 2020. Norway has achieved a better position than Denmark in terms of digital progress in 2020. All in all, Finland has a higher level of digital maturity based on the DESI score and Sweden comes in next.

4.3.2.2 Five Dimensions of DESI Score

Figure 26 shows the individual score for each of the Nordic countries in different dimensions of the Digital Economy and Society Index in the last 6 years (2015-2020). The scores of the Nordic countries are shown by black, red, blue, and green lines that represent Finland, Denmark, Norway, and Sweden respectively in Figure 26. The red dashed line shows the starting year of COVID-19.

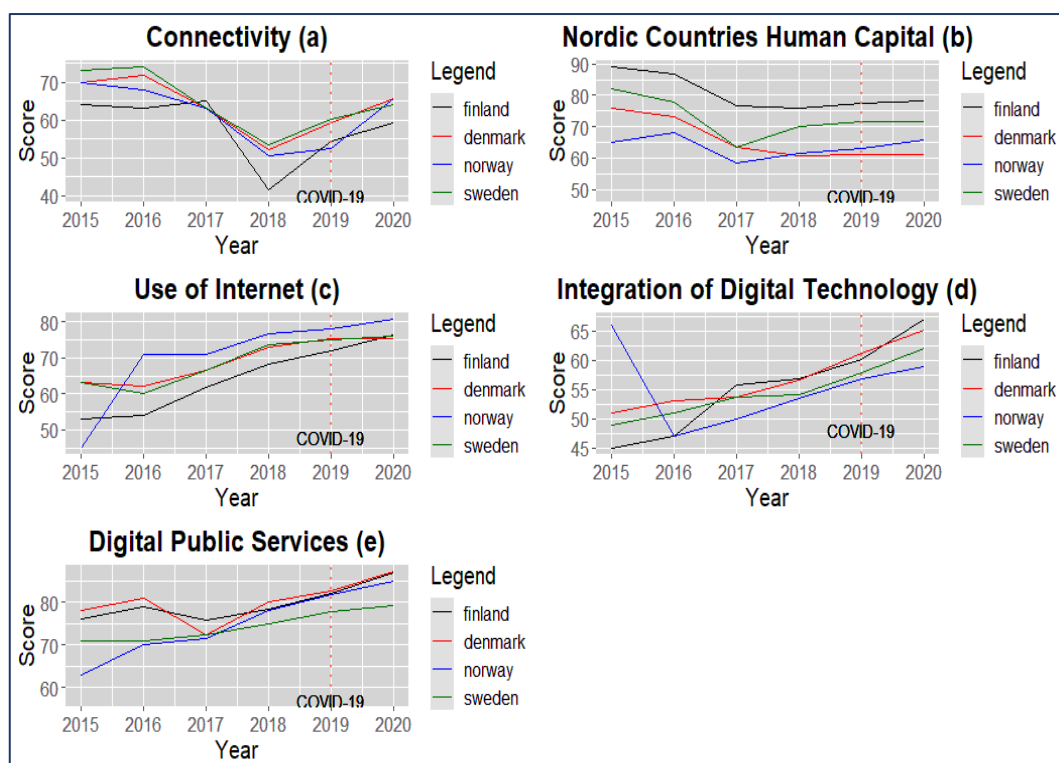


Figure 26: Scores for Five Dimensions of DESI

Source: (European Commission, 2020)

Connectivity is the first dimension of the Digital Economy and Society Index and it measures the level of development in the fixed and mobile broadband market. In Figure 26 (a), before the COVID-19 started, Sweden has the most developed broadband market followed by Denmark. Finland's broadband market development rises sharply from 2018 and crosses the level of Norway's broadband market before 2019. After the COVID-19 started, the development levels in the broadband market for Denmark and Norway performed better than Sweden while Finland has made the least development in the broadband market in 2020. *Human Capital* is the second dimension of the Digital Economy and Society Index and Figure 26 (b) will show the level of the basic internet user skills, advanced skills, and development of human capital. Before 2019, Finland has the highest score based on the level of human digital skills which is less than 5% higher

than the score of Sweden. Though Denmark has more human capital with digital skills than Norway's before 2018, the level of human capital with basic and advanced digital skills increases in Norway than Denmark's from 2018. After the start of COVID-19 in 2019, the level of human capital's digital skills of Sweden and Denmark remain mostly unchanged from previous years to 2020. Human capital's digital skills levels slightly increase in Finland and Norway despite the impact of COVID-19 at the end of 2019 to 2020. Moreover, Finland has the best position among the four Nordic countries and Finland is followed by Sweden in terms of the digitally skilled human capital in 2020 where Norway is better than Denmark based on the same term. The *Use of Internet* is the third dimension of the Digital Economy and Society Index and shown in Figure 26 (c). It assesses the extents of online content, online communication, and online transactions of the Nordic countries to realize their online involvement. The level of online activities is the highest in Norway after mid-2015 to 2020 (more than 80%) though the impact of COVID-19 has reduced the gap of the levels of online activities with the other three Nordic countries i.e., Finland, Sweden, and Denmark in 2019. At the beginning of 2019, people's involvement with online activities in Norway is higher than in Denmark and Sweden by more than 2% but it is higher than Finland by more than 5%. After the beginning of COVID-19 at the end of 2019, Norway continues to grow its level of online content, online communication, and online transactions which is higher than Finland and Sweden by less than 5% while more than 5% gap is noticed in Figure 26 (c) for Denmark in 2020. Despite the COVID-19, Finland has performed very well to increase its level of online content, online communication, and online transactions than Sweden and Denmark in 2020 i.e., more than 75%. The fourth dimension of the Digital Economy and Society Index shown in Figure 26 (d) is the *Integration of Digital Technology*. This dimension assesses the level of digital adoption of a country's businesses and the level of e-commerce of online sales channels of a country. According to Figure 26 (d), digital technology integration in Norway is more than 65% what is the largest percentage in the Nordic countries in 2015. Within one year, Norway's integration of digital technology level becomes the lowest percentage i.e., less than 47% in 2016 which is like the percentage in Finland though Finland has improved its level from 2015 by more than 2%. The integration of digital technology seems better in Denmark than other three Nordic countries after mid-2015 to mid-2016. After 2018, all Nordic countries have increased the level of digital adoption and e-commerce of their businesses and online sales channels, but Denmark and Finland have performed better than Sweden and Norway before and

after the pandemic (COVID-19). In 2020, Finland made the highest (close to 70%) development in the integration of digital technology while Denmark has made slightly more than 65% development though the performance in Denmark shows 2% better than Finland at the beginning of 2019 in Figure 26 (d). Before 2019, Sweden has made less than 2% higher integration in digital technology than Norway's and this gap increases after mid-2019. In 2020, Norway integrated digital technology by close to 5% fewer than Sweden's. Thus, Finland has the highest level of integration of digital technology and Denmark is next among the four Nordic countries. *Digital Public Services*, the final dimension of the Digital Economy and Society Index shown in Figure 26 (e). The purpose of this dimension is to assess the level of interaction of business and citizens with the public authority i.e., eGovernment services or eHealth services. According to Figure 26 (e), the level of interaction between business/citizens with public authority is the highest in Denmark and the least in Norway from 2015 up to mid-2016 while Finland performs much better than Sweden from 2015 to 2016. In 2017, Denmark has fallen sharply from its previous performance and made a level of less than 75% interaction in business/citizens with public authority like Sweden has made in 2017. Though Finland has made the highest interaction with public authority and individuals in 2017, Denmark has taken its best position again in 2018 to 2020. Before COVID-19, Denmark performs much better (i.e., 80%) among other three Nordic countries while Norway and Finland perform almost in the same levels of interactions (i.e., less than 80%), but Sweden does much less (i.e., 75%) than others. In 2020, Finland performs close to Denmark and both have less than 87% development in the level of interaction between public authority and individuals while the development rate is close to 85% in Norway and less than 80% in Sweden. However, Denmark and Finland have made the higher interactions of business and citizens with the public authority like eGovernment services or eHealth services while Sweden has performed the least among the four Nordic countries. Moreover, based on the five dimensions of the Digital Economy and Society Index shown in Figure 26, Finland has the best digital performance in 2020 in the Nordic region. Thus, according to the five dimensions of the DESI score, Finland has the highest digital maturity in 2020 and then Denmark has the better potentiality compared to Sweden and Norway.

4.3.3 Company Investment on Emerging Technology (Capacity for Digital Innovation)

Figure 27 shows the growth rate of investment by enterprises in each Nordic country on emerging technologies in the last 9 years (2012-2020). The scores of Nordic countries are shown by black, red, blue, and green lines that represent Finland, Denmark, Norway, and Sweden respectively in Figure 27. The red dashed line shows the starting year of COVID-19. This data visualizes the capacity of Nordic countries' enterprises capacity for digital innovation.

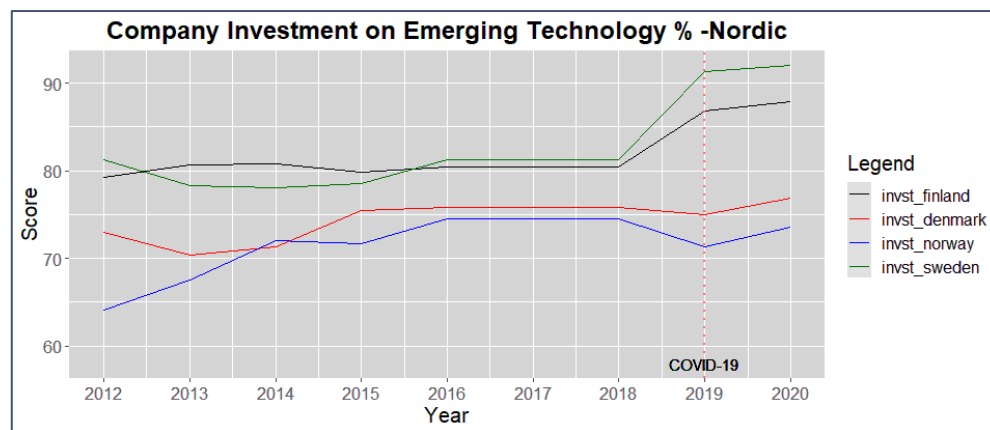


Figure 27: Companies Investment on Emerging Technology (Nordic)

Source: (European Commission, 2020)

According to Figure 27, Sweden and Finland have a larger capacity for digital innovation than the digital innovation capacity of Denmark and Norway for the last 9 years. After 2018, Sweden has increased its capacity sharply by more than 10% while Finland has increased it by more than 5%. Norway's digital innovation capacity has been reduced after 2018 by less than 5% while Denmark remains stable after 2018 holding a better position than Norway. Before and after COVID-19 started, Sweden businesses have invested the highest amount in emerging technology though the progress of investment becomes slightly flattered during the pandemic running in 2020. And Finland's businesses investment in digital innovation is also better than the level of Denmark and Norway despite the COVID-19 has impacted Finland's capacity for digital innovation. Moreover, Sweden has the highest digital maturity in terms of capacity for digital innovation and Finland is in the next position.

4.4 The Impact of COVID-19 in the ICT sector of Nordic Countries

As per research question four, this thesis examines the impact of COVID-19 in the ICT sectors of the Nordic countries by the comparative trend analyses for real GDP growth rates, size of the ICT sectors, business enterprise expenditures on research and development in the ICT sector, international trades in ICT services, and the financial performances of ICT industries for the last 12 years (2009-2020). These analyses show how COVID-19 has impacted the Nordic countries' ICT sector performances. It will also show how strong the Nordic countries are to handle the pandemic with their strong ICT industries and good IT infrastructural platforms and how they are different to each other in terms of the ICT sectors.

4.4.1 A Comparative Analysis of Nordic Countries based on COVID-19 Impact in the ICT sector

4.4.1.1 Real GDP Growth Rate- Nordic Countries

Figure 28 has shown the percentage growth of real GDP of the Nordic countries for the last 12 years starting from 2009 to 2020. In 2019, the impact of COVID-19 starts and the red dashed vertical line in Figure 28 indicates the start of this pandemic. The color for GDP growth rate indication of Finland, Denmark, Norway, and Sweden are black, red, blue, and green, respectively. Figure 28 will help to show the economic performances of the Nordic Countries for the last 12 years.

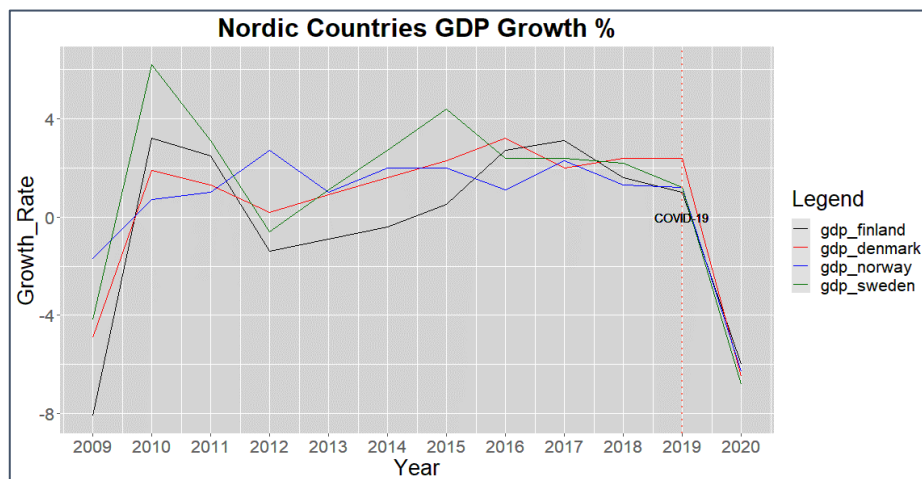


Figure 28: GDP Growth Comparison

Source:(International Monetary Fund (IMF), 2020)

According to Figure 28, all Nordic countries of this thesis have experienced negative growth in 2009 and they have started having more than zero percent growth rate in their GDP in 2010. In 2012, the growth rates of GDP in Finland, Sweden, and Denmark fell again. Norway had a growth rate of more than 2% while Denmark had close to zero growth. Finland and Sweden have faced negative growths in GDP in 2012. Finland had the lowest growth rate in GDP compared to other Nordic countries from 2012 to 2015 and the rate changes negatively until 2014. Sweden has a very good growth rate in GDP than others GDP growth rates from 2013 to 2015. Sweden enjoyed more than 4% of GDP growth in 2015 whereas Denmark and Norway have growth rates close to 2%. The growth rate of Norway's GDP starts falling in the middle of 2014. After 2015, Finland and Denmark start having upward GDP curves while Sweden and Norway have downward GDP curves up to 2016. After 2016 to 2018, each country is very close to each other in terms of their GDP growth rate i.e., close to 2%. In 2019, the COVID-19 starts and the impact on GDP growth rates of the Nordic countries are downward. Only Denmark holds its growth rate of more than 2% and others make it close to 1% until the beginning of 2019. At end of 2019, COVID-19 spreads, and the damaging impact on GDP growth of the Nordic countries rises. Though all Nordic countries' GDP growth rates fall negatively, Denmark's GDP falls lately compared to other countries' GDP. Thus, all Nordic countries make very similar economic performances in the last few years, but Denmark has a good position among the studied Nordic countries despite the COVID-19.

4.4.1.2 Size of the ICT Sector Based on Value added to GDP- Nordic Countries

Figure 29 shows the percentage change of value-added to GDP by Nordic countries for 12 years starting from 2009 to 2020. This value-added to GDP indicates the size of the ICT sectors of the Nordic countries. The colors for growth rate indication of Finland, Denmark, Norway, and Sweden are black, red, blue, and green, respectively. The dashed red line shows the year of COVID-19 starting. In Figure 29, Sweden is undoubtedly better than other Nordic countries and it has added more than 7% of value to GDP by its ICT sector for the last 12 years.

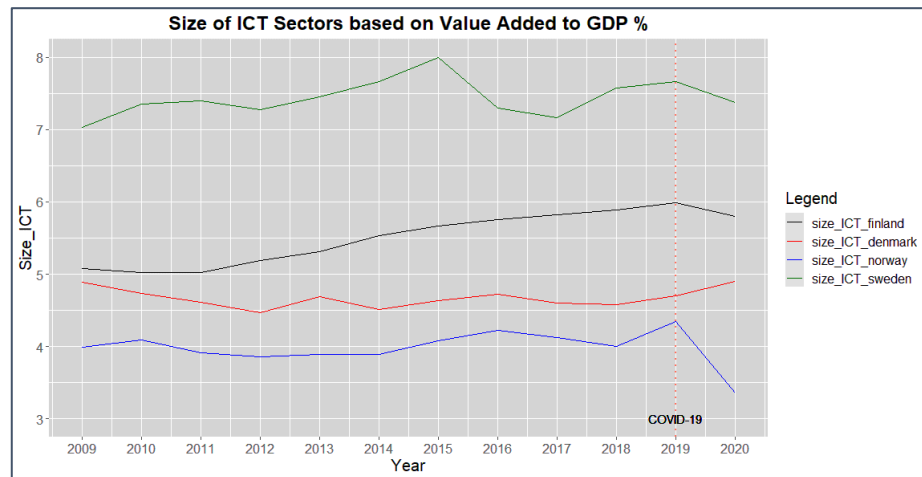


Figure 29: Comparison of Size of the ICT Sectors

Source:(CEIC, 2020; OECD, 2020b)

In 2015, the value-added rate of the Swedish ICT sector in GDP is the highest (8%). During COVID-19, after the red dashed line in Figure 29, Sweden has a slight downward curve, and it expresses the size of the ICT sector in Sweden reduces. Finland has an upward curve for the size of the ICT sectors from 2011 to the beginning of 2019 and it has a larger ICT sector compared to the size of the ICT sectors in Denmark and Norway. COVID-19 has decreased the rate of value-added by the ICT sector in Finland to its GDP and it indicates the size of the ICT sector in Finland reduces after 2019 to 2020. The size of the ICT sector in Denmark is better than the ICT sector size in Norway for the last 12 years. After COVID-19, the size of the ICT sector for Sweden, Finland, and Norway decreases while Denmark enjoys an increase in its size of the ICT sector despite the impact of a pandemic. Moreover, from the very beginning, Sweden has the largest ICT sector in the Nordic countries though the COVID-19 has reduced its size in 2020. Finland has the second large ICT sector and experienced a reduction in the size of the ICT sector after COVID-19. Only Denmark continues rising its size of the ICT sectors in 2020. Moreover, in 2020, Sweden has added less than 7.5% value to GDP by its ICT sector while Finland adds less than 6%, Denmark adds less than 5% and Norway adds less than 3%. Sweden is in the highest position in terms of the size of the ICT Sectors and followed by Finland for the last 12 years.

4.4.1.3 Business Enterprise Expenditure on R&D in the ICT sector- Nordic Countries

Figure 30 has shown the percentage change of business enterprise expenditure on research and development (BERD) in the ICT sectors of the Nordic countries for 12 years

starting from 2009 to 2020. Figure 30 will show the attractiveness of the ICT sectors in the Nordic countries by evaluating their BERD in the ICT sectors. The colors for growth rate indication of Finland, Denmark, Norway, and Sweden are black, red, blue, and green, respectively. The dashed red line shows the year of COVID-19 starting.

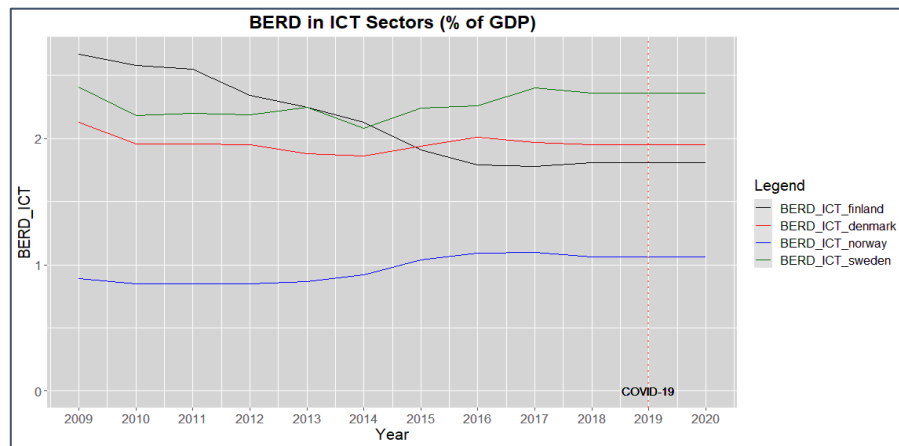


Figure 30: Comparison of BERD in the ICT sectors

Source: (OECD, 2020a); *Note: Year 2020 data is estimated.

The green line in Figure 30 shows that the business enterprises in Sweden have spent the highest on research and development in the ICT sector from 2014 to 2020 compared to other Nordic countries' BERD in the ICT sectors. From 2009 to 2013, Finland has spent the highest on research and development in the ICT sector. In 2013 and 2014, the BERD in the ICT sector of Finland performs almost like Sweden i.e., more than 2% as Finland's BERD curve starts falling continuously from 2011 to 2016. From 2010 to 2014, Denmark's BERD in the ICT sectors is less than 2% while Norway's BERD in the ICT sectors is less than 1%. After 2015 the BERD in the ICT sector of Sweden, Denmark, and Norway rises but it reduces only in Finland. Finland loses its remarkable position after 2014 by Sweden (close to 2%) and by Denmark (less than 2%) in 2015. Norway has a low trend for BERD in the ICT sectors compared to other Nordic countries from 2014 to 2020 though Norway has increased its BERD in the ICT sectors after 2014 by spending more than 1% on research and development in the ICT sector. During COVID-19, the scenario for the changes in BERD in the ICT sector is stable for all Nordic countries but Sweden has the highest BERD in the ICT sector i.e., close to 2.5%. The gap between Finland and Denmark reduces as the COVID-19 arrived though Denmark (close to 2%) spends more than Finland (i.e., less than 2%) for the last 6 years (2015-2020). In 2020, Denmark's position for BERD in ICT comes after Sweden and then Finland and Norway come. Moreover, despite COVID-19, the BERD in the ICT sector for the Nordic countries

are mostly unchangeable than the previous years. Thus, before and after COVID-19 starting, Sweden’s BERD in the ICT sectors is followed by Denmark. It represents that the attractiveness of the ICT sector in Sweden is the highest among the other Nordic countries despite the damaging impact of COVID-19. Finland has better importance in its ICT sector than Norway’s.

4.4.1.4 International Trade in ICT Services

Figure 31 shows the percentage changes of international trade in ICT services of Nordic countries for the last 12 years (2009-2020). The colors for growth rate indication of Finland, Denmark, Norway, and Sweden are black, red, blue, and green, respectively. The dashed red line shows the year of COVID-19 starting. Figure 31 will help to realize the links between economies and the international value chain of the Nordic countries by enhancing the competitiveness of their ICT industries.

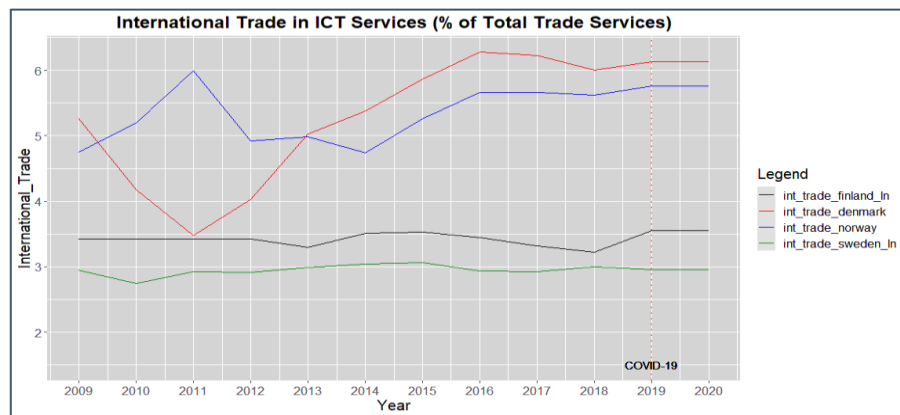


Figure 31: Comparison of Int'l Trade of ICT Services

Source: (UNCTADSTAT, 2020) *Note: Year 2020 data is estimated.

According to Figure 31, the competitiveness of the ICT industry in Norway to make a better link between Norway economy and international value chain is the highest from mid-2009 to mid-2012 i.e., more than 5%. Denmark (more than 5%) performs better at the beginning of 2009 but this position declines sharply up to 2011. In 2013, Denmark makes its development again in international trade of ICT services (more than 5%) and crosses the previous highest performer Norway (less than 5%). Denmark’s growth (ranges from more than 5% to more than 6%) for international trade in ICT services remains the best among other Nordic countries while Norway takes the second position for international trade of ICT services growth (ranges from less than 5% to less than 6%) for the last 8 years (2013-2020). The growth in international trade in ICT services is better

in Finland i.e., close to 3.5% while Sweden’s international trade in ICT services development is close to 3% for the last 12 years (2009-2020). After 2018, Finland enjoys an increase in international trade in ICT services and it crosses 3.5% in 2019 while Sweden has not seen any changes in its growth. Moreover, in terms of international trade in ICT services, Denmark (more than 6%) is performing very well in Nordic countries despite the pandemic effect of COVID-19. Norway (less than 6%) is performing close to Denmark. Sweden has done the least in international trade in ICT services. Moreover, Denmark has the highest level of the link between its economies and international value chain by enhancing the competitiveness of its ICT industries and followed by Norway.

4.4.2 A Comparative Analysis of COVID-19 Impact on Financial Performance of Nordic ICT Sectors

4.4.2.1 Overall Nordic ICT Share Price and Individual Country’s ICT Share Price during COVID-19

Figure 32 given below will show the individual Nordic countries’ ICT stock market performance to realize the potential digital improvement and possibilities. The ICT industry performances for each Nordic country are shown for 9 years 2012-2020. The colors for stock market performance indication of Finland, Denmark, Norway, Sweden, and Nordic are dark red, red, blue, green, and black, respectively. The dashed red line shows the year of COVID-19 starting. Figure 32 will also help to understand the strength of ICT infrastructures of the Nordic countries.

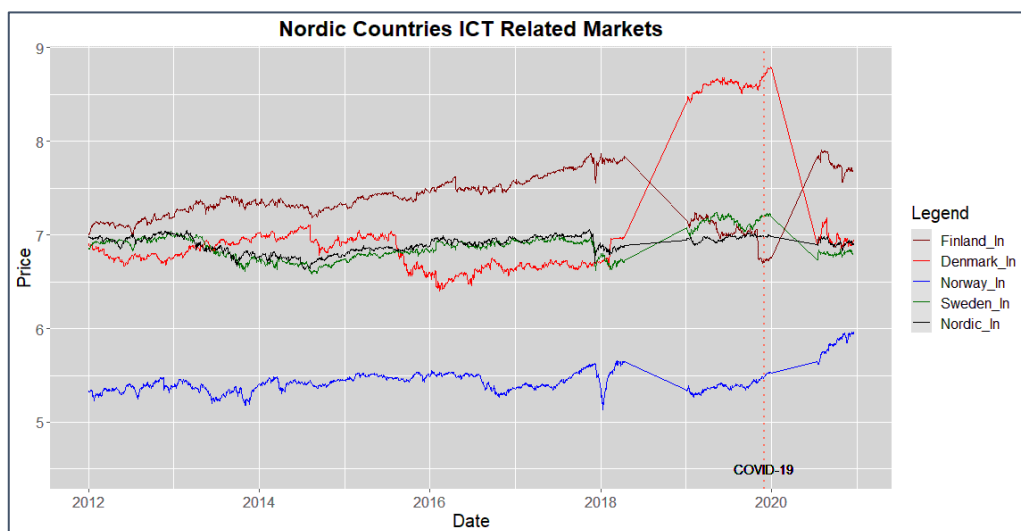


Figure 32: Comparison of ICT-related Stock Markets

Source:(Investing.com-Financial market, 2020; Nasdaq Stock Market, 2020)

Figure 32 shows the trend of ICT stock market share prices (closing price) of four Nordic countries and overall Nordic ICT stock market share price. Among the Nordic countries, Norway's ICT-related share price market performance is very low among other Nordic countries for the last 9 years (2012-2020). The ICT stock market performance of Norway decreases in 2019 due to COVID-19 impacts but it starts enjoying its higher growth slightly before 2020. It shows the strength of the ICT industry and the digital innovation possibility in Norway are weak and less attractive to investors for its future ICT infrastructural development. The ICT stock market performance in Finland shows the best position in the Nordic region for the last 7 years (2012-2018). Finland's ICT share market starts declining after 2018 and it drops by more than 1% in 2019. COVID-19 has drastically hampered the Finnish ICT stock market performance of its last 8 years (2012-2019). This scenario does not last long, and the ICT market performance of Finland starts increasing again just before 2020 despite the impact of COVID-19 and crosses all other Nordic countries' ICT stock market performances after 2020. It shows the strength of the ICT industry and the digital innovation possibility in Finland are very good and highly attractive to investors for its future ICT infrastructural development. The ICT stock market performances for Denmark show a downward growth from 2012 to mid-2013 and from late-2015 to 2018. Before-2014 to before-2016, the ICT market performance in Denmark is better than the ICT market performances of overall Nordic and Sweden but Finland. Though Covid-19 crisis, the ICT share market of Denmark shows the highest growth among all other ICT share market performances in the Nordic region from 2018 to early 2020. Its performances start decreasing sharply in 2020 and Denmark follows Finland. Thus, investors can still be attracted to this ICT industry to invest as Denmark has a healthy history of its stock performances and a strong ICT industry including good digital innovation possibility.

Finally, the ICT stock market performance in Sweden is very consistent in growth and strong to hold the performance even if in any pandemic situation like COVID-19. In 2019, Sweden tries to maintain its consistent growth but in 2020 it experiences a slight decline. Sweden is the most attractive platform to invest in the ICT sector compared to other ICT share markets in the Nordic region as the performance fluctuation is very low in Sweden for the last 9 years (2012-2020). From 2012 to 2018, Finland has a strong ICT stock market than Sweden and Denmark. After 2018 Denmark's ICT stock market performs the best compared to the ICT stock market performance of Sweden and Finland. After COVID-19 starting, Denmark still has the highest performance in its ICT stock market

performance and followed by Sweden and then Finland but after 2020, Finland is followed by Denmark and then Sweden. Moreover, Finland has the best ICT sector performance and good digital innovation possibilities rather than Denmark at the end of 2020 though Denmark has a good base for healthy ICT market growth from the middle of 2018 to beginning of 2020. Sweden is very consistent in its ICT market growth while Norway has less ICT sector performance and digital innovation possibilities compared to others in the last 9 years.

4.4.2.2 Impacts on Financial Performance in ICT Industry of Nordic Countries during COVID-19

In this section, an individual country's ICT stock market will be evaluated based on the overall Nordic ICT stock market. Multiple linear regression will be computed to show the level of influences made by different ICT stock markets' performances on the overall Nordic ICT stock market performance. Thus, the regression equation will provide a forecast that how the Nordic overall ICT share price is impacted by the ICT share prices of Finland, Denmark, Norway, and Sweden during the COVID-19. This representation will also represent the country of the Nordic region that has a strong ICT industry with good financial performance to establish a healthy ICT infrastructure. Before showing the regression analysis, the report will analyze the relationship among all the ICT stock indexes. Table 6 shows the correlation among the ICT stock markets. Figure 33 will show the graphical presentation of the correlation among the ICT stock markets.

Table 6: Correlation among ICT Stock Markets

	Nordic_In	Finland_In	Denmark_In	Norway_In	Sweden_In
Nordic_In	1.0000	-0.0321	0.1605	0.0498	0.7701
Finland_In	-0.0321	1.0000	-0.5874	0.4929	-0.4231
Denmark_In	0.1605	-0.5874	1.0000	-0.1221	0.6071
Norway_In	0.0498	0.4929	-0.1221	1.0000	-0.1744
Sweden_In	0.7701	-0.4231	0.6071	-0.1744	1.0000

According to Table 6, in the last 9 years index data including 2020, the stock market index related to the ICT sectors in Denmark, Norway, and Sweden have made positive correlations with the overall Nordic stock market index in the ICT-related sectors. But Finland has a negative correlation with the overall Nordic stock market index in the ICT-related sector. The Finnish ICT index negatively correlates with the overall Nordic ICT index by -3.21% and the correlation graph, Figure 33 also shows a negative visual mark (almost vanish circle) with the overall Nordic ICT stock market. Swedish ICT index does

it by 77.01% according to Table 6. According to Figure 33, Sweden makes a big circle mark with the overall Nordic ICT market. Denmark has associated with the overall Nordic ICT index by 16.05% and in Figure 33 the correlation graph also shows Denmark has a good connection with Sweden in terms of ICT stock market performance. There is a little positive relationship by the Norwegian ICT index on the overall Nordic ICT index i.e., 4.98% according to Table 6 but Figure 33 does not show any remarkable circle mark for such little positive correlation.

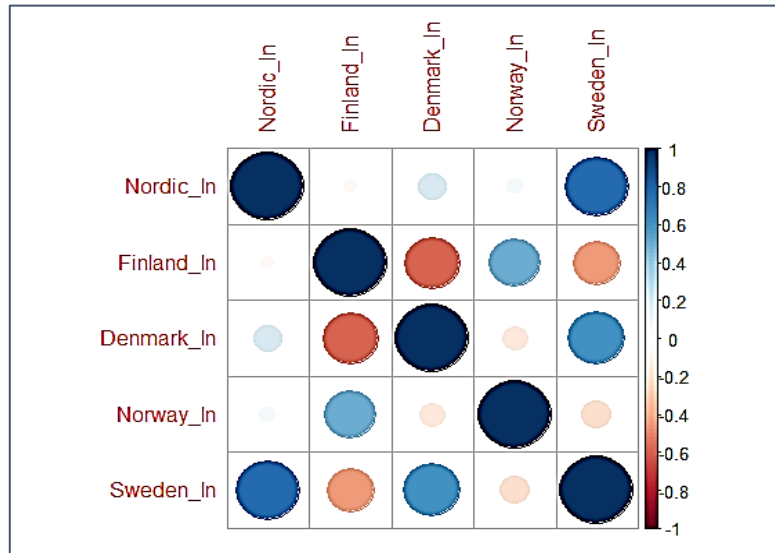


Figure 33: Correlation

Though the pandemic attack of COVID-19, the relationship of the ICT-related stock market of Sweden is remarkable compared to the other Nordic countries and it is highly correlated with the overall Nordic ICT stock market performance. Thus, the correlation result shows that the ICT infrastructure and innovation in the ICT sector are healthier in Sweden that highly influences the overall Nordic ICT industry performance. Among Denmark, Norway, and Finland, only Denmark shows a little positive relationship with the overall Nordic ICT market performance. The Finnish ICT market has a moderate negative-connection with the Danish ICT market and a weak negative-connection with the Swedish ICT market though the Finnish ICT market is positively connected with the Norwegian ICT market to a moderate extent. The Swedish ICT market has more than moderate positive-connection with the Danish ICT market and a below moderate negative-connection with the Finnish ICT market. The Norwegian ICT market has a weak negative connection with the ICT market of Sweden and Denmark. Here the regression model will help to realize the extent of different ICT markets’ response to the overall Nordic ICT market Performance. The regression equation results are shown in Table 7.

Table 7: Regression Table & Model Fitness

	(Intercept)	Finland _ln	Denmark _ln	Norway_ ln	Sweden_ ln	Standard for model fitness
Estimate	1.842	0.044	-0.058	0.087	0.679	
Residual standard error	0.041					Closer to zero the better
Multiple R-squared	0.782					Higher the better (> 0.70)
Adjusted R-squared	0.781					Higher the better (> 0.70)
F-statistic	1726					Higher the better (number)
P value	< 2.2e-16					less than .05 is good

According to regression Table 7, the regression equation is made here:

$$Y = 1.84221967 + (0.04425377) \text{ Finland_ln} - (0.05840598) \text{ Denmark_ln} + (0.08692589) \text{ Norway_ln} + (0.67891159) \text{ Sweden_ln} + 0.04091$$

Here,

Dependent variable Y = Nordic _ln

Independent variables (Xi) = Finland _ln, Denmark _ln, Norway _ln, Sweden _ln

Intercept (a) = 1.84221967

Error (e) = 0.04091

This equation is a good multiple regression model for the ICT stock market analysis in the Nordic countries. This model has a good fit to show the relationship between the dependent and the independent variables. The model has fulfilled all the rules of thumbs of regression analysis to prove model fit like close to zero error (i.e., 0.041), more than 78% R², larger F statistics (i.e., 1726), and significance level close to zero (i0.001). This equation has also proved the relationship between different countries' ICT stock market performances and the overall Nordic ICT stock index. If the Finnish and the Norwegian ICT stock market performances increase by an additional unit, the overall Nordic ICT stock market increases by 4.43% and 8.69% respectively. For Sweden, any additional increase in ICT stock market performance, the overall Nordic ICT stock market also increases by 67.89%. The Swedish ICT stock performance has the highest impact on the overall Nordic ICT stock market performance though COVID-19 has hampered the performances of the ICT sectors in all the Nordic countries. If the Danish ICT stock market performance experiences an additional unit of change, the overall Nordic ICT stock market index needs to hold a negative change by 5.84% considering the COVID-

19 crisis. Thus, the regression analysis has proved that the COVID-19 pandemic cannot severely damage the ICT sectors' financial performances of the overall Nordic, Finland, Denmark, Norway, and Sweden. Finally, the Swedish ICT industry has a strong positive influence on the overall Nordic ICT performance in the last 9 years among the other Nordic countries. Norway has a slightly better position than Finland based on the positive influence made on the overall Nordic ICT performance for the last 9 years. The Danish ICT industry has made a slightly negative influence on the overall Nordic ICT performance for the last 9 years. The levels of ICT infrastructure and innovation in the ICT sector are healthier in Sweden.

5 DISCUSSION

This chapter discusses the results of the thesis based on the research objectives stated in the introduction section to examine the Nordic countries in terms of their current situation, digital intensity levels, digital maturity levels, and the impact of COVID-19 on the ICT industry.

Current situation analyses of the Nordic countries, which are the digital leaders, include the levels of digital transformation, digital innovation, and the financial capability of the ICT industry to handle the detrimental impact of COVID-19 despite a negative economy. According to (Johnsen et al., 2018), the Nordic countries are highly digitalized in the whole world. Leinonen (2020) suggests that in Europe, the Nordic countries have achieved the most progressive digital economies. It has been revealed that there is a link between a dependent variable GDP (per capita) and other variables relating to digitalization to evaluate the digital performance of an economy (Stremousova & Buchinskaia, 2019).

According to the findings of the thesis analysis, Finland has a very good level of digital transformation as it has a good network preparedness with a developed size of the ICT sector. The level of digital innovation opportunity is also high in Finland because of the standard expenditures of business enterprises on R&D in the ICT sectors. The results show that during the COVID-19 crisis, Finland based on its strong information and technology infrastructural platform is capable to foster digital innovation in the future and it has a very good financial strength in its ICT industry to improve its capacity for digital innovation. Therefore, it can be argued that Finland has the capability to handle a pandemic like COVID-19, though the GDP of Finland is negative during the pandemic. The results of the analyses show that Denmark has a very good network preparedness with a settled size of the ICT sector. It supports that the digital transformation of Denmark is good and its negative economy has less impact on the network preparedness and size of the ICT sector in Denmark. The digital innovation opportunity of Denmark is also good though there is negative progress in its economy during the pandemic situation like COVID-19. Denmark has a very strong financial strength in its ICT industry and a strong information and technology infrastructural platform to continue its digital innovation in the future despite the damaging effect of the pandemic in 2020. Though Norway has a

good network preparedness, the size of the ICT sector of Norway still needs to be progressed to upsurge its digitalization in the future. It shows that the digital transformation of Norway is good, but a negative GDP has created a small impact on the size of the ICT sector of Norway. The stable growth rates of profits from e-commerce sales, BERD in the ICT sector, and the international trade of ICT services of Norway for the last 12 years indicate that the digital innovation opportunity of Norway is good. Moreover, Norway does not have good financial strength in its ICT industry, but it is increasing its capacity to handle the pandemic effect on the financial performance of the ICT industry. Compared to the other Nordic countries, Norway has a weaker information and technology infrastructural platform to continue its digital innovation in the future to mitigate the damaging effect of COVID-19.

Moreover, the results show that Sweden has a good and stable network preparedness with an advanced size of the ICT sector that added values to its GDP. This means the digital transformation of Sweden is good and its negative economy has less impact on the network preparedness and size of the ICT sector. Moreover, the digital innovation opportunity of Sweden is stable because Sweden's enterprises have not increased their research and development expenditures in the ICT sector significantly for the last 12 years to boost the future digital innovation opportunity in Sweden. Thus, negative progress in its economy due to COVID-19 might impact the level of BERD in the ICT sector of Sweden in the short future too. Sweden has a good and stable financial strength in its ICT industry and the capacity to handle the impact of COVID-19 on the financial performance of the ICT industry. Sweden also has a standard information and technology infrastructural platform to continue its digital innovation in the future despite the damaging effect of the pandemic in 2020.

A comparative analysis on the level of digital intensity of the Nordic countries has evaluated the degrees of digital integration among people, process, and technology of the Nordic countries. The analysts argue the Nordic organizations have adopted developing technologies to ensure cost-effectiveness and relevance to customers in past years (Sørensen et al., 2019). According to (Chirkunova et al., 2019), a high number of economic activities can be accessible because of the development of digital technologies. The result of thesis analysis shows that before the year of COVID-19, the growth of internet use by online activities is higher by more than 20% in Finland compared to the other Nordic countries. Though the European Commission has not published data for

2020 at the end of this year, previous performance estimates that the growth rate of internet use and online course activity will not be hampered badly in Finland compared to other Nordic countries during COVID-19. Finland has a much higher level of digital intensity and Denmark has the least among the Nordic countries whereas Sweden and Norway have almost similar levels of digital intensity based on the level of internet use for online activities.

The highest level of e-commerce, CRM, and secure transactions of enterprises in Denmark shows the higher level of digital intensity in Denmark among the Nordic countries before COVID-19. Sweden has followed Denmark to show the second position in Digital intensity while Finland has done better than Norway. According to the results of the analysis, COVID-19 will not badly hamper the growth of e-commerce, CRM, and secure transactions of enterprises in Denmark and Sweden as these two countries have a high level of digital intensity. Previous research result shows that this pandemic has changed the growth of e-commerce significantly in 2020 especially in the established markets that have the capacity to foster their e-commerce in aggregation with amplified demand during the COVID-19 (PostNord, 2020).

Before COVID-19, the highest number of individuals using the internet has been seen in Norway and Sweden among the Nordic countries, whereas Denmark has more individuals using the internet than Finland. Norway has developed its individual's basic overall digital skills from 2018 and achieved the highest growth rate i.e., more than 30% in 2019 among the other Nordic countries. Denmark has the least progress in terms of individual's basic digital skills in the Nordic countries for the last 5 years (2015-2019). It should be mentioned that, before COVID-19, Norway had the highest digital intensity level based on the level of individual's basic overall digital skills in Nordic countries while Finland and Sweden both have almost the same level in 2019.

More than 82% of total individuals have purchased internet in Norway and Sweden before COVID-19 and it indicates their higher digital intensity levels based on the level of internet purchase compared to other Nordic countries whereas Finland has the least position. The levels of internet and broadband access of individuals in Norway are the best i.e., 96% and 97% before COVID-19 while 95% of individuals in Sweden have access through internet and broadband. Individuals having internet and broadband access in Finland and Denmark are less than 95% at the beginning of 2019. Moreover, Norway's

digital intensity is the highest based on the individuals' internet and broadband access and Sweden is better at levels compared to the other Nordic countries in 2019.

Digital interaction between individuals and public authority has been examined based on three benchmarks like obtaining digital information, downloading official digital forms, and submitting official digital forms. Before COVID-19, the overall situation for digital interaction shows Denmark has a good position for maintaining digital interaction with public authority in terms of both obtaining digital information and submitting official digital forms for the last 10 years (2010-2019) though Sweden is better for maintaining digital interaction by submitting official digital forms than Denmark in the last 3 years (2017-2019). Finland has a very good level of digital interaction with the public authority in terms of downloading official digital forms for the last 6 years (2014-2019) and Finland has a slightly better position than Norway before COVID-19 in terms of submitting official digital forms. Moreover, Denmark has a stronger level of digital intensity in terms of digital interaction between individual and public authority as Denmark is good in two of the three benchmarks related to digital interaction.

The last factor of measuring the digital intensity level of the Nordic countries was the digital adoption rate. Before COVID-19, Finland had the highest position in the digital adoption rate based on social media users but in 2020, Denmark had a better position than Finland. Moreover, the overall digital adoption level was better in Denmark as Denmark has maintained a better position in both mobile connection and social media user levels compared to other Nordic countries in 2020. Before 2020 Finland had the better position in digital adoption level based on the levels of mobile connection, internet user, and social media user. Therefore, the digital intensity level was higher in Denmark and Finland as their digital adoption rates are better though Denmark has a fewer growth in internet users in 2020.

In this thesis, data for seven factors out of eight studied factors of digital intensity like i) internet use and online course activities, ii) enterprises' e-commerce, customer relationship management (CRM) and secure transactions, iii) individual's internet use, iv) individual's basic overall digital skills, v) individual's internet purchase, vi) individual's internet, and broadband access, and vii) digital interactions between individual and public authority are unpublished by the European Commission at the end of 2020. Thus, the analysis result does not conclude any decision for the digital intensity

levels based on these seven factors of the Nordic countries after COVID-19 has been started in 2020. But the previous result can show that Denmark and Norway both have very good levels of digital intensity in most of the factors up to 2019.

A comparative analysis for digital maturity levels of the Nordic countries has examined the levels of network preparedness, digital performance, and capacity for digital innovation. In 2020, Denmark achieved the level of network preparedness close to Sweden while Sweden is the best among other Nordic countries. According to the NRI score result published by the World Economic Forum, before COVID-19 and after the COVID-19 started, the network preparedness is the highest in Sweden among the other Nordic countries and Denmark is in the second position. However, the level of digital maturity is higher in Sweden based on the network preparedness measured by the NRI score. After the start of COVID-19 at the end of 2019, despite the pandemic, all Nordic countries maintained continuous growth in digital performances according to the score published by the European Commission. Finland does the best followed by Sweden in 2020. Norway has achieved a better position than Denmark in terms of digital progress in 2020. According to Raúl Katz et al. (2020), developing countries are less prepared with digital technology to handle pandemic challenges whereas developed countries are significantly frontrunners with digital preparedness.

In 2020, Finland had the highest level of digital maturity based on the digital performance measured by the DESI score and Sweden had a better level of digital maturity compared to the other Nordic countries. The DESI score is made based on five dimensions like the level of progress in the broadband market, the level of the basic internet user skills and the advanced skills of human capital, the level of online content, online communication and online transaction, the level of e-commerce, and the level of interactions of business and citizens with the public authority like eGovernment services or eHealth services. Before COVID-19, Sweden had the most developed broadband market and then Denmark has. After the COVID-19, the development levels in the broadband market for Denmark and Norway performed better than Sweden in 2020. Finland had the best position among the four Nordic countries and followed by Sweden in terms of the digitally skilled human capital in 2020 while Norway is better than Denmark. Finland has maintained a leading position for its human capital's basic and advanced digital skills for the last 6 years (2015-2020), whereas Sweden permed better for the last 4 years (2014-2020) according to the DESI score of human capital. The level of online activities was the highest in Norway

after mid-2015 to 2020 (more than 80%) though the impact of COVID-19 has reduced the gap of the levels of online activities with the other three Nordic countries i.e., Finland, Sweden, and Denmark in 2019 according to the DESI score based on the use of the internet. The DESI score based on the integration of digital technology has shown that the level of digital technology integration was the highest in Finland in 2020 and followed by Denmark. Before COVID-19, Denmark has performed slightly better than Finland in the level of integration of digital technology. Denmark has performed much better (80%) among the other three Nordic countries in terms of the interaction between businesses, and individuals with public authority before COVID-19 and after COVID-19 started, Denmark and Finland have made the higher interactions of business and citizens with the public authority like eGovernment services or eHealth services while Sweden has performed the least among four Nordic countries. According to the five dimensions of the DESI score, Finland had the highest digital maturity in 2020 as Finland has achieved the highest score in the level of human capital, the level of the integration of digital technology, and the level of digital public services.

It has been argued that the Nordic countries should highly focus on thinking about execution rather than thinking on planning and these countries need to take steps for bold and big investments in digitalization and execute those plans as fast as possible (Kirvelä et al., 2017). Before and after COVID-19 started, Swedish businesses have invested the highest amount in emerging technology though the progress of investment becomes slightly flattered during the pandemic running in 2020. In addition, Finnish businesses' investment in digital innovation was also better than the level of Denmark and Norway despite the impact of the COVID-19 on the Finnish capacity for digital innovation. Moreover, Sweden had the highest digital maturity in terms of capacity for digital innovation and Finland was in the next position among the Nordic countries in 2020. The Nordic organizations have realized that the competitiveness and survival of the business are highly dependent on a successful digitalization trajectory (Dutta & Lanvin, 2019).

The analysis about the impact of COVID-19 on the ICT sectors of the Nordic countries has estimated the individual Nordic country's ICT stock market performance to realize the potential digital improvement and possibilities. It is discussed that the COVID-19 pandemic might mitigate the damaging situation through the well-prepared digital technology platform and developed ICT sectors (Raúl Katz et al., 2020; Wilder-Smith et al., 2020). The researcher believes that the COVID-19 has impacted the ICT sector with

a considerable loss in the first quarter of 2020 but the ICT industry is determined to create a real comeback in this situation (Bombe, 2020). The thesis analysis showed that before COVID-19, the Danish ICT stock market performance was the best in 2018-2019, this ICT market performance was below the levels of ICT market performances of Finland and Sweden. Danish ICT market performance dropped sharply after COVID-19 started at the end of 2019 and expanded through 2020. This high instability of the ICT market performance of Denmark has reduced its attractiveness though the Danish ICT stock market is performing slightly better than the Swedish ICT stock market performance in 2020. Norway had less ICT sector performance and digital innovation possibilities compared to others for the last 9 years (2012-2020). The ICT stock market performance in Finland shows the best position in the Nordic region for the last 7 years (2012-2018). Finnish ICT share market started declining after 2018 and it dropped by more than 1% in 2019. COVID-19 has drastically hampered the Finnish ICT stock market's previous performances of its last 8 years (2012-2019). This scenario does not last long, and the ICT market performance of Finland starts increasing again just before 2020 despite the impact of COVID-19 and crosses all other Nordic countries' ICT stock market performances after 2020. It shows the strength of the ICT industry and the digital innovation possibility in Finland is very good and highly attractive to investors for its future ICT infrastructural development. Sweden and Finland had better ICT sector performances and good digital innovation possibilities rather than Denmark at end of 2020. This is mainly because of the high stability of their ICT stock market performances despite the impact of the COVID-19 pandemic. Moreover, Denmark had a good base for healthy ICT market growth from the middle of 2018 to the beginning of 2020 and it shows the future growth of the Danish ICT stock market is likely to enhance the potentiality of digital improvement and possibilities.

The correlation results showed that the Swedish ICT market has a strong positive correlation (more than 77%) with the overall Nordic ICT industry performance. The regression equation has proved that any additional increase in the ICT stock market performance of Sweden increases the overall Nordic ICT stock market by 67.89%. If Finnish and Norwegian ICT stock markets' performances increase by an additional unit, the overall Nordic ICT stock market also increases by 4.43% and 8.69% respectively. If the Danish ICT stock market performance experiences an additional unit of change, the overall Nordic ICT stock market index needs to hold a negative change by 5.84%

considering the COVID-19 crisis. However, the regression analysis has demonstrated that the COVID-19 pandemic cannot severely damage the ICT sector's financial performance of the overall Nordic, Finland, Denmark, Norway, and Sweden.

Dutta & Lanvin (2019), think that the Nordic member countries have presented their good preparation in technology platforms in this digital evolutionary era. According to thesis result, all the Nordic countries' technology platforms are not performing the same. The Swedish ICT industry had a strong positive influence on the overall Nordic ICT performance in the last 9 years among the other Nordic countries. Norway had a slightly better position than Finland based on the positive influence made on the overall Nordic ICT performance for the last 9 years. The Danish ICT industry has made a slightly negative influence on the overall Nordic ICT performance for the last 9 years. Thus, the levels of ICT infrastructure and innovation in the ICT sector are healthier in Sweden.

6 CONCLUSION

This thesis has made a comparative analysis of the Nordic countries. It has analyzed the current economic and digitalization situations of the Nordic countries, their digital integrations, digital performances, and ICT industry performances. This combined analysis has made to realize how capable the Nordic countries are with their digitalization to handle the pandemic situation. COVID-19 has affected the digital performance of the Nordic countries. This thesis has also analyzed the effect of COVID-19 on the Nordic countries. The trend visualization method of this thesis helps to realize the previous history of the Nordic countries' digital intensity, digital maturity, and ICT industry performances.

The core objectives of the thesis were (i) to analyze the current situation of the Nordic countries based on their economy and digitalization, (ii) to assess the level of digital intensity, (iii) to examine the level of digital maturity, and (iv) to investigate the impact of COVID-19 on the ICT sector of the Nordic countries. Based on the results, it can be concluded that the Nordic countries (Finland, Denmark, Norway, and Sweden) are the digital leaders. Sweden has the best and the most stable level of network preparedness with an advanced size of the ICT sector compared to the other Nordic countries before and after the COVID-19 started. Denmark has also achieved a better network preparedness than Finland in the last two years (2019-2020), but the size of the ICT sector in Finland is much developed than the settled size of the ICT sector in Denmark in the last 12 years (2009-2020). Though Norway has a good level of network preparedness, the size of the ICT sector of Norway still needs to be progressed to upsurge its digitalization in the future among the Nordic countries. Before and after COVID-19, business enterprises in Sweden have spent the highest amount of money on research and development in the ICT sector, followed by Denmark, Finland, and Norway, respectively. Although Swedish business enterprises have the highest expenditure on R&D in the ICT sector, for the last 5 years (2015-2020), all the Nordic countries have enjoyed a very flat growth and remained in the same positions. Finland and Denmark, both have very good financial strength in their ICT industry and very strong information and technology infrastructural platforms. Sweden has a good and stable financial strength in its ICT industry and a standard information and technology infrastructural platform to increase its digital innovation in the future compared to Norway. The overall thesis result has

shown that digital intensity level is higher in Denmark and followed by Finland and Norway. The results show that the degrees of digital integration among people, process, and technology are the highest in Denmark among the Nordic countries. The level of digital maturity is higher in Sweden and Denmark is in the second position based on their network readiness before and after COVID-19 started. Finland has the highest level of digital maturity and Sweden has the second-highest level of digital maturity based on their digital performance progress before and after COVID-19 started. Norway has improved its digital performance slightly better than Denmark in 2020 though Denmark has higher digital maturity than Norway in 2019. Before and after the COVID-19 crisis, Sweden has the highest digital maturity in terms of capacity for digital innovation and Finland is in the next position among the Nordic countries based on the investment of companies in emerging technology. COVID-19 pandemic has not severely damaged the financial performances of the ICT sector of Finland, Denmark, Norway, and Sweden. The Swedish ICT industry has a strong positive influence on the overall Nordic ICT industry performance in the last 9 years while Norway has a slightly better position than Finland based on the same positive influences made. The Danish ICT industry has made a slightly negative influence on the overall Nordic ICT performance for the last 9 years. However, Denmark and Finland, both have very strong ICT industries for the last 2 years (2018-2020) whereas the Danish ICT stock market fluctuates its performance more than any other Nordic country. Thus, the levels of ICT infrastructure and innovation in the ICT sector are healthier in Sweden and Finland as both have stable ICT industries to achieve more digital progress in the future.

This thesis has some limitations in terms of country selection and data collection. For example, Iceland was not selected in this research due to the unavailability of data for Iceland. This thesis is completely based on numerical data of open sources or secondary sources and it has focused on collecting time series of data to show the real trend of different indicators of the Nordic countries and to make a comparative analysis along with COVID-19 impacts. This report has some data on missing values and handled those missing values based on scientific methods suggested by the researchers. One of the data handling methods is the LOCF method which is not an optimal approach because it may cause biases and invalid conclusions. Finally, the data for the latest year is unavailable in many cases. Thus, the result of this thesis may not show the exact picture, but it will provide an overview of the situation.

In the future, the latest data after COVID-19 will help to visualize the real picture of the Nordic countries, their digital intensity, and digital maturity extents. Future studies will also help to compare the before and after COVID-19 situation to understand the capability of the Nordic countries to handle the pandemic situation considering the ICT infrastructure.

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