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THE EFFECT OF INDUSTRY 4.0 AND COVID-19 ON THE RESHORING OF PRODUCTION ACTIVITIES

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Abstract

This Thesis explores the relationship between Industry 4.0 and Covid-19 with the process of production activities reshoring. These two phenomena will be taken into consideration as one of the reasons for reshoring and their effect on the companies' decisions to reshore will be analyzed. The analysis is based on the European Reshoring Monitor database, which was updated so that it can incorporate data for a more recent period. The research questions being studied are the tendencies of companies to implement Industry 4.0 technologies while reshoring, the likelihood of the implementation of Industry 4.0 in parallel with reshoring, and the Covid-19 pandemic effects on the location strategies of companies that already started or finished their production activities reshoring. The first research question is examined through a comparison of the reshoring cases which include the implementation of Industry 4.0 technologies with the overall number of reshoring cases in the Sample. Further insight into the geographic location of the implementation and the size of the companies that implemented these technologies is provided. The consideration of the implementation timeframe was the basis for the second research question, examining the number of reshoring cases that include the implementation in parallel with reshoring and the number of cases that include the implementation in the period after reshoring. As for the previous research question, insight into the geographic location of the implementation is provided. The third research question, regarding the Covid-19 pandemic effect, compares the number of reshoring cases affected by Covid-19 with the number of cases affected by a similar event, observed in the European Reshoring Monitor database, that has, to some extent, affected the location strategies of some companies. Finally, the concluding remarks provide an overall explanation regarding the effects of Industry 4.0 and the Covid-19 pandemic on the reshoring of production activities.

Abbreviations

EU	European Union
GVC	Global Value Chain
MNE	Multinational enterprise
NACE	is the acronym (from the French 'Nomenclature statistique des Activites economiques dans la Communaute Europeenne' - Statistical classification of economic activities in the European Community
SME	Small and medium-sized enterprise
US	The United States

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Introduction

Taking a closer look at today's economic activities around the world, especially in the case of manufacturing companies, many interesting things and facts may be noticed. Not that long ago manufacturing companies started relocating their production activities from home countries to offshore locations because of various reasons. While exploiting the benefits of offshored production became sort of a trend, manufacturing companies also came across different problems and disadvantages of offshored production. Disadvantages, many of these companies faced, made them consider relocating production activities back to the home country or closer to the home country. The process of relocating activities back to the home country, in this Thesis, will be referred to as **reshoring** and this is the core of this Thesis. While reshoring, as a process of activities relocation, tends to solve different problems coming from offshoring, many authors have been arguing whether this process is accelerated by the technological progress and emergence of new technologies and local, regional, or global events. New technologies emerging, in this Thesis, aim at the rapid development and implementation of various Industry 4.0 technologies and these technologies are considered since they characterize a new, fourth, Industrial Revolution. The effect of some special regional or global events on the reshoring is analyzed through the Covid-19 pandemic. This Thesis aims to analyze the effects of new technologies and the Covid-19 pandemic on the process of reshoring. Analysis of the effects will result in answers to three research questions. Two research questions focus on the relationship between new technologies that fall under the Fourth Industrial Revolution and reshoring, while the third one questions the effect of a global pandemic on the process of reshoring. Chapter 1 of this Thesis explains Global Value Chains in detail and explains the emergence of offshoring. The same Chapter also highlights the disadvantages of offshoring and how it inspired regionalization and general relocation of activities. Chapter 2 focuses on the literature review of reshoring and what exactly is reshoring. The disadvantages of offshoring, presented in Chapter 1, are in Chapter 2 presented as reasons for reshoring. Chapter 3 concentrates on Industry 4.0 as an Industrial Revolution and its connection to the process of reshoring. Chapter 3 provides different theories, from different authors regarding the connection between these new technologies and reshoring. Chapter 4 is entirely dedicated to the Covid-19 pandemic and its effects on international trade and internationalized industries. Chapter 4 also shows a theoretical connection between the pandemic and offshoring/reshoring. Chapter 5 is the core of the Thesis since it contains the empirical analysis. The analysis was conducted on the updated European Reshoring Monitor database. The database was originally

made by Eurofound and it contains 250 European reshoring cases, all of them containing information regarding the location of reshoring, previous offshoring, reasons for reshoring, which business activity was reshored, case narrative, etc. The case narrative section was vital for the updating of the database since the update of the database was made by the creation of the additional case narrative that will cover a period from 2019 to 2023. Following the update of the database, a creation of the Sample was conducted and the final Sample that was used for the analysis within Chapter 5 has 197 reshoring cases. Analysis in Chapter 5, performed on the created Sample, focuses on three research questions, from which two research questions have the implementation of Industry 4.0 technologies in the process of reshoring, timeframes of the implementation, and geographical location of the implementation of these technologies, while third research question focuses on the Covid-19 pandemic effects on the location strategies of companies that already started/finished their process of production activities reshoring. The final chapter, Chapter 6, of this Thesis summarizes all of the findings and conclusions for each research question from Chapter 5.

1 Chapter 1 - Global Value Chains

For a long time, global value chains have been the most important way in which companies and workers from developing countries integrate into the global economy (Gereffi & Fernandez-Stark, 2016). The global value chain specifies different activities that are required to be performed, in this case in different locations around the world, for producing a final product (Gereffi & Fernandez-Stark, 2016). According to Gereffi and Lee (2014), the Global Value Chain framework was created to better understand how value is created, captured, sustained, and leveraged in all industries. Activities that are included in the value chain are (Gereffi & Fernandez-Stark, 2016):

- Research & development (R&D)
- Production
- Design
- Marketing
- Distribution
- Services

All the stated activities are adding different economic value to the final product. From above stated activities production and distribution are the activities that have the lowest added value to the final product. On the other hand, R&D and different after-sale Services are the activities that have the highest value. This distinction is best represented through the so-called Smile Curve of High-Value Activities in Global Value Chains.

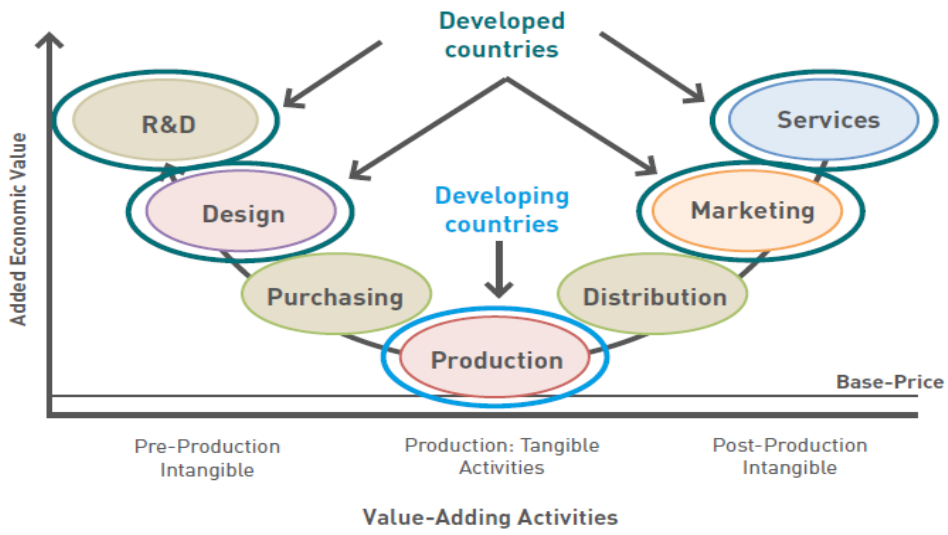

Figure 1: Smile Curve of Value-Adding Activities in Global Value Chains (Gereffi & Fernandez-Stark, 2016, p.14)

From the graphical representation of activities from which the value chain is composed, it is also noticeable that activities are divided between those performed in developed countries and those performed in developing countries. The reason for that is and has most of the time been, **lower costs in developing countries.** This particular fact magnifies the reason for many European and US companies offshoring their production in the previous few decades. Bettiol et al. (2022) state that following a smile curve of value creation in GVC, the organization within the value chain implies highly skilled and more complex production activities are located in developed countries, while labor-intensive and low-skilled activities are located in emerging countries. According to Bettio et al. (2022), two reasons for locating low-skilled labor-intensive activities in emerging economies are - economies of scale and low labor costs. On the other hand, the idea of a Global Value Chain enabled many low- and middle-income countries to increase their participation in global trade (Brenton et al., 2022). Despite the general increase in participation of developing countries, small and medium enterprises in these developing countries have many difficulties becoming a part of the value chain, which prevents them from using global trade advantages (Gereffi & Fernandez-Stark, 2016).

The value chain describes all the activities that firms and their workers perform to bring a product for an idea to end use and beyond (Gereffi & Fernandez-Stark, 2016). Gereffi and Fernandez-Stark say that the activities that comprise the value chain can be contained within a single firm or divided among different firms. Global value chain analysis, used and mentioned by Gereffi and Fernandez-Stark (2016), provides a holistic view of global industries both from top-down and bottom-up. The top-down analysis focuses on how leading firms govern their global-scale affiliate and supplier networks. On the other hand, the bottom-up analysis focuses on how business decisions affect the trajectory of economic and social upgrading or downgrading in specific countries and regions (Gereffi & Fernandez-Stark, 2016).

The top-down analysis includes three dimensions and those are (Gereffi & Fernandez-Stark, 2016):

- Input-output structure of a Global Value Chain
- Geographic scope
- Governance structure: Lead firms & Industry organization

On the other hand, the bottom-up also includes three dimensions of the analysis, that represent local dimensions and those are (Gereffi & Fernandez-Stark, 2016):

- Upgrading
- Local Institutional context

- Industry Stakeholders

Despite upgrading and local institutional context having a great impact on the location strategy of manufacturing firms and their decisions on where to locate specific activities, In this Thesis, I will mostly concentrate on the top-down analysis which includes three previously mentioned dimensions. For better understanding, all three dimensions will be briefly explained.

1.1 Top-down dimensions of the analysis

1.1.1 Input-output structure of a Global Value Chain

A chain represents the entire input-output process that brings a product or service from the initial idea to consumers (Gereffi & Fernandez-Stark, 2016). The input-output structure is typically represented as a set of value chain boxes connected in a way to show a flow of tangible and intangible goods and services (Gereffi & Fernandez-Stark, 2016). This helps us to identify and differentiate segments of the value chain by the value they are adding to the product or service (Gereffi & Fernandez-Stark, 2016). Gereffi & Fernandez-Stark (2016) stated that identifying different segments of the value chain helps us to specify their characteristic and dynamics. This dimension can be used in this paper as well since the paper is mostly concentrated on manufacturing activities that are, not so rarely, performed by foreign suppliers. The reasons for reshoring, which are part of the further disadvantages of offshoring text, may come from the input-output structure of the value chain and these will be identified later.

1.1.2 Geographic Scope

This dimension of the top-down analysis had a great impact on the improvements in transportation and telecommunications infrastructure. This led to supply chains being highly globally dispersed and different activities being performed in different locations (Gereffi & Fernandez-Stark, 2016). These improvements made it possible for each country worldwide to leverage its competitive advantage (Gereffi & Fernandez-Stark, 2016). For some countries, these advantages are specific know-how and higher capital, while others' competitive advantages are lower labor costs and cheaper raw materials (Gereffi & Fernandez-Stark, 2016). These different specific advantages made it possible for companies from every country to become part of a global value chain. In 2016, despite the previous trend of globalization and some favorable circumstances for companies to take advantage of lower costs and cheaper raw materials, Gereffi & Fernandez-Stark (2016) stated that evidence suggests that there may be a trend toward regionalization.

1.1.3 Governance

This third dimension of top-down value chain analysis concentrates mostly on how the chain is controlled and coordinated by the lead companies (Gereffi & Fernandez-Stark, 2016). The governance analysis requires the identification of the lead firm in the sector, its location, and its power over suppliers (Gereffi & Fernandez-Stark, 2016). Gereffi and Fernandez-Stark (2016) mention five different governance structures that are determined by three variables: **complexity of information shared between participants, codification of the information for production, and level of supplier competence.**

The five different governance structures are (Gereffi & Fernandez-Stark, 2016):

1. **Market** - simple transactions including easily transmitted product specifications and central governance mechanism is price rather than lead firm
2. **Modular** - suppliers make products according to specifications and take full responsibility for the production. Switching costs are low, while buyer-supplier interactions can be complex
3. **Relational** - buyers and sellers rely on complex information that is not easily transmitted or learned. This governance mode creates great mutual reliance, but lead firms still specify what is needed and are able to exercise some control over the supplier
4. **Captive** - smaller suppliers are dependent on one or a few buyers. Lead firms have a great degree of control. This structure also implies high switching costs for both parties
5. **Hierarchy** - Hierarchical governance describes chains characterized by vertical integration and managerial control within lead firms that develop and manufacture products in-house. This governance structure is characterized by complex products.

1.2 Offshoring

Since many European and US companies realized that the production and distribution costs are lower in developing countries, those companies decided to take advantage of low costs for, mostly labor-intensive value-adding activities, like production. There were and still are two ways for this: **outsourcing** and **offshoring** (Martinez-Mora & Merino, 2014). Many companies outsourced activities that were formerly internalized in order to gain competitiveness through reduced costs or increased flexibility or efficiency (Martinez-Mora & Merino, 2014). This trend of outsourcing and offshoring made production not concentrated in one geographical location, but split into phases located where the advantages to be gained were greatest (Martinez-Mora & Merino, 2014).

Offshoring means the relocation of all or part of the activities from developed to developing countries (Martinez-Mora & Merino, 2014). Terms offshoring and outsourcing can sometimes be confusing and Eriksson et al. (2021) in their chapter called "Critical Manufacturing Prerequisites for Successful Reshoring" which is a part of Operations and Supply Chain Management, stated that there is a need for clearer explanation and distinction between these terms.

Offshoring is a term used to refer to the performance of tasks in a country different from where the firm's headquarters are located (Eriksson et al., 2021).
On the other hand, **outsourcing refers to the performance of tasks under some contractual arrangement by an unrelated party** (Eriksson et al., 2021).

Martinez-Mora and Merino (2014) highlight the relocation to developing countries in their explanation of offshoring, while Eriksson et al. (2021) only suggest that the location is not the home country of a company. Either way, the idea is clear, and making assumptions about where the activities are relocated is irrelevant.

Eriksson et al. (2021) presented a visual representation that combines two choices available for companies regarding supply markets and two choices regarding supply channels.

Figure 2: Four possible Supply Management Decisions (Eriksson et al., 2021, pp.250)

This representation provides us with four possibilities that derive from the **different combinations of supply channels and supply markets** that a company may use. These four combinations are called Supply Management Decisions. Changes between these four Supply Management Decisions can be offshoring, outsourcing, simultaneous offshoring and insourcing, and simultaneous offshoring and outsourcing. This is also represented in the same manner, and different movement from one Decision to another is categorized as explained.

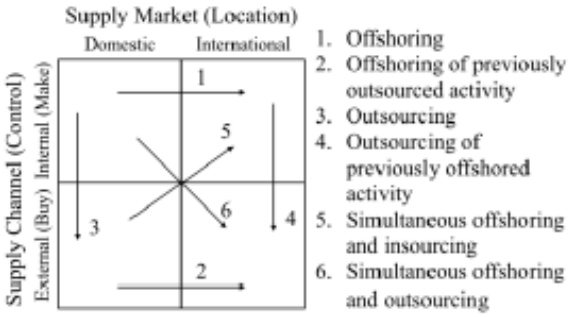

Figure 3: Six possible results of combining Supply Channels and Supply Markets explaining outsourcing and offshoring terminology (Eriksson et al., 2021, p.250)

Despite the possibility that the offshoring could include relocation from one developed country to another, that wasn't the case so often. This relocation of all or part of the activities from developed to developing countries became so "popular" that some value-adding activities almost disappeared from developed countries. The case of China, which in the past few decades became the synonym for the production of clothes, footwear, or toys shows the best how popular offshoring was (Martinez-Mora & Merino, 2014). Offshoring, for years, has been attractive for production activities including routine tasks. Because of this, locations (countries and regions) that offered low labor costs and economies of scale advantages were chosen for the location of production sites for many big multinational corporations (Ancarani et al., 2019).

Some of the biggest brands of clothes, sportswear, home appliances, cosmetics, and so on, have been using an offshoring strategy for the good old reason - lower costs. Adidas for example offshored in 1995 and located their production in China. Another big sportswear brand, Nike, has its production located in Vietnam. Another example of a worldwide known company can be taken. Apple has most of its products produced in China as well. It is possible also to look at one of the biggest and most successful tool and equipment manufacturers in the world, Hilti, a Liechtenstein-based company, that has production plants all over the world (Germany, Austria, Hungary, Mexico, India, China). These few examples show us perfectly that whatever industry we pick, the biggest producers probably offshored their production.

1.3 Recent trend shift

This described model of the global value chain has been a subject of change in the last period, both because of the **shift in global demand** (Gereffi & Fernandez-Stark, 2016) and **Covid-19**. The change regarding the Covid 19 will be discussed and explained later. The shift in global demand and rapid development of some countries, like China, India, Brazil, and Mexico, have led to a change in the global value chain structure (Gereffi & Fernandez-Stark, 2016). These

mentioned countries became, at least partially, those that now benefit from the global value chain in the sense that companies from those countries are taking advantage of lower production costs somewhere else. Companies from these countries, that once have been in charge of, for example, production for some companies based in Europe or the United States, have now moved to higher value-adding activities in the global chain. This practice is called **economic upgrading** (Gereffi & Fernandez-Stark, 2016).

Besides the shift in global demand and economic upgrading of some participants of value chains, there are various reasons why companies have considered abandoning offshoring. Reasons for abandoning offshoring are predominantly tied to various problems and hidden costs of offshoring that companies realize only after the activities have been already offshored. Since there are various problems and hidden costs, companies started thinking of a solution for those problems, one of the obvious solutions is the relocation of activities somewhere else. The focus here will be the relocation of activities back home, for which terms **backshoring** and **reshoring** have been used, or close to home country, for which terms **nearshoring** and **friendshoring** have been used. To speak about and analyze reshoring/backshoring and nearshoring, it is required to first highlight and discuss different problems that occurred during the offshoring of different activities for companies from different industries. The disadvantages of offshoring will, at the same time, be reasons for reshoring/backshoring and nearshoring.

1.4 Disadvantages of offshoring and the rise of the regionalization question

At the beginning of this "trend" of offshoring, in both developed and developing countries, companies had some benefits. Companies from developing countries benefited from inclusion into the Global Value Chains, while low labor cost advantage has been the aim of many companies from developed countries, especially in Europe and Northern America. Companies from developed countries managed to lower their production costs, but that led to a decrease in domestic production in the US and Europe (Steffen Kinkel, 2020).

Maybe the biggest problem with offshoring is that the vast majority of companies have been looking only at the lower cost benefits and haven't realized other potential problems, or have been ignoring them during offshoring decision-making. Some of the disadvantages are cost-related, but other disadvantages are more related to the quality of the products manufactured abroad, transportation and supply issues that have been present or occurred during Covid-19,

legislative changes, and other disadvantages that are unique to some countries or regions to which the production activities have been offshored to.

Moradlou and Backhouse (2016) in their article stated that different types of costs are associated with manufacturing location decisions. Costs are divided into **Expected costs**, **Unexpected costs**, and those that can be **categorized as both**. In Expected costs, Moradlou and Backhouse put: transportation, increase in fuel price, expensive labor, higher inventory, extra management, and travel costs. On the other hand, Unexpected costs are Intellectual property, quality problems, communication problems, productivity differences, intercultural differences, and language barriers. Costs categorized as both unexpected and expected are exchange rate risk, environmental legislation, fluctuation in fuel price, and coordination costs. These costs, or their increase at the locations where the production has been offshored to, together with other non-cost disadvantages raised the question of relocation of previously offshored activities. This relocation question mostly concentrated on the relocation of the activities back or closer to the home country of the company.

Eriksson et al. (2021) simply stated that in many cases, moving to low-cost regions had negative impacts due to unanticipated business results, which can serve as proof that global sourcing decisions are highly complex. Despite the lack of a more straightforward explanation, these authors included factors other than costs. In addition, Ancarani et al. (2019) grouped several operational and strategic challenges in offshoring. These challenges include shrinking labor cost advantages in some countries, rising freight costs, unsatisfactory product quality, growing demand for production flexibility, and customer responsiveness. Ancarani et al. (2019) made these challenges the root of reshoring.

All of the precise disadvantages and problems of offshoring will be visible in the reasons for reshoring since those are the drivers of change of the manufacturing activities location.

2 Chapter 2 - Reshoring and reasons for reshoring

Regarding all the previous problems with offshoring, which have been categorized in the previous chapter as disadvantages of offshoring, there has been greater interest lately for relocation of the production back home. There are many examples from various industries where both MNEs and SMEs faced some of the previously stated disadvantages and are seeking a solution for previously stated disadvantages and problems. Since most of the disadvantages can be directly connected to the geographical distance of different activities composing the value chain, SMEs and MNEs started reconsidering their production location strategies.

When everybody just thinks about these problems and possible solutions, everyone immediately can say “Bring production back home” or even “Bring the production closer, not to the other part of the world” and that is the whole point. To further discuss bringing production activities back home (reshoring) some theoretical views and definitions will be presented. Afterwards, the disadvantages of offshoring will be presented as reasons for reshoring, since reshoring is perceived as the solution.

2.1 What is reshoring?

Since definitions and explanations of offshoring have been presented previously, ***reshoring can be defined as a reversal of previously offshored business activities*** (Eriksson et al., 2021). In this definition, it is required to strongly highlight the “previously offshored” part, which indicates that there is no reshoring without previous offshoring. Ancarani et al. (2019) give an almost identical definition of reshoring, stating that ***reshoring is a reversal of offshoring initiative, irrespective of who is performing the manufacturing activities in question.*** The main difference is that Ancarani et al. (2019) take into consideration the question of who is performing the manufacturing activities and in this way, mentioning it in the definition highlights the potential confusion between reshoring and insourcing. Eriksson et al. (2021) explained the difference between reshoring and insourcing in the same manner in which the difference between offshoring and outsourcing was made.

As for the offshoring and outsourcing differences, Eriksson et al. (2021) used Supply Management Decisions visual representation and decisions regarding the Supply Market and Supply Channel to explain, in a more conventional supply terminology, the difference between reshoring and insourcing. Below is the overview of Reshoring and Insourcing Terminology (Eriksson et al., 2021)

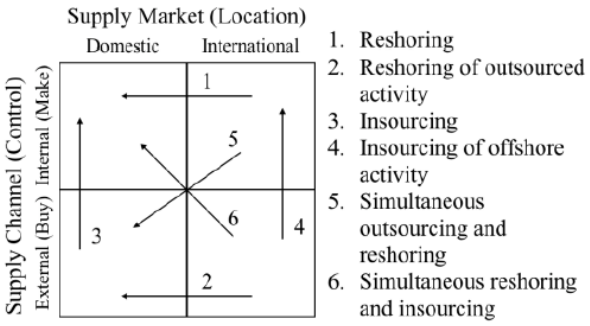

Figure 4: Six possible results of combining Supply Channels and Supply Markets explaining reshoring and insourcing terminology (Eriksson et al., 2021, p.251)

This kind of representation of Supply Management Decision clearly indicates that reshoring is a matter of change in the Supply Market (Location) which can, but doesn't have to include changes in the Supply Channel and vice versa.

Another distinction that needs to be made is between terms of reshoring and backshoring. Steffen Kinkel (2020) stated that both terms are used for exactly the same thing - **relocation of the production activities back to the home country of the parent company**. Both terms can be used without any confusion and differences between them, it is just a matter of choice. In further text term **reshoring** will be used for the relocation of production activities back to the home country of the parent company. However, some sources that will be used further in the text may use the term backshoring and in some cases, this term may appear.

Besides relocation back to the home country of the parent company, a company can, as part of their production location strategy, decide to relocate a production somewhere close to the home country of the parent company. Relocating producing activities somewhere close to the home country of the parent company may still help companies mitigate or even eliminate any problems that occur with offshoring. This relocation close to the home country of the company is called **nearshoring** (Ancarani et al., 2019). The term nearshoring and this sort of definition provided by Ancarani et al. (2019) implies the relocation of production activities to a geographic location closer to the home country than the previous location of offshored production activities.

Another definition of reshoring provided by Boffelli et al. (2021) states that ***reshoring is a voluntary corporate strategy regarding the home-country partial or total relocation of production to serve local, regional, or global demands***. This definition, as the definition of Ancarani et al. (2019) highlighted the question of *who is performing manufacturing*, highlights another important thing - **full or partial relocation**. Boffelli et al. (2021) in their definition implied that it is not required to relocate all the activities previously offshored back home, but that reshoring of at least some parts of offshore activities is still considered and defined as reshoring. Even though this may seem logical without explanation, it is important to clearly include partial reshoring as well, since there are many reshoring cases including only partial reshoring.

As said before, reshoring represents a possibility for companies to ***"reverse"*** the offshoring process and annulate some, most, or all of the possible disadvantages that have become obvious in the offshoring process. Many authors distinguish four different types of reshoring because there are different possibilities for how reshoring can be performed. Moradlou and Backhouse (2016) have listed four reshoring scenarios which are:

- **In-house reshoring** is where companies supply their domestic market by relocating entire or part of their wholly owned manufacturing facilities from a foreign country to their home country.
- **Reshoring for outsourcing** where companies supply their domestic market by shifting manufacturing activities from wholly owned manufacturing facilities from the offshored location to home-based supplier
- **Reshoring for insourcing** where companies supply their domestic market by changing the companies' sourcing strategy from offshored suppliers to wholly owned manufacturing facilities in the home country.
- **Outsourced reshoring** is where companies supply their domestic market by converting their supply mode from offshored suppliers to home-based suppliers

2.2 Reasons for reshoring

After explaining reshoring and providing insights and definitions on it from different authors and researchers, it needs to be analyzed why some companies decided to reshore their production activities that were previously offshored and which problems, that offshoring brought, are or will be fixed with reshoring. As mentioned and, to some extent, explained in the first chapter, there are some challenges, or better to call them disadvantages of offshoring. Many companies faced different problems after offshoring their manufacturing activities and reshoring was offered as a solution.

It was mentioned earlier that some authors focused on cost-related challenges of offshoring and derived reasons for reshoring from those, while other authors tend to create a list of disadvantages/challenges that include lower quality of products, increased need for production flexibility, and others. It was stated previously that Ancarani et al. (2019) described those disadvantages as operational and strategic challenges in offshoring, while Moradlou & Backhouse (2016) used three categories of costs, whose increase can represent a disadvantage of offshoring. Now it is time to try to properly categorize these disadvantages/challenges of offshoring that are drivers and reasons for reshoring. Eriksson et al. (2021) have specified five specific groups of reasons for reshoring. These five groups are:

- **Global competitive dynamics**
- **Host country**
- **Home country**
- **Supply chain**
- **Firms specific**

Global competitive dynamics group of factors includes factors like political risk, changes in the global economy, eroding comparative advantages, instability of exchange rates, and increased competition on resource assets.

Host country factors include diminishing growth opportunities, inadequate quality, theft of intellectual property and weak patent enforcement, high employee turnover, lack of trust and commitment among staff or suppliers, and risk of public relations disaster due to supplier malfeasance.

Home country group of factors include Political incentives, domestic goodwill, access to qualified personnel, the increased degree of automation, higher productivity and work morale among staff, increased awareness of the environmental impact, increased focus on sustainability, and strengthening the brand through the "made-in" effect.

Supply chain group of factors include Innovation, research, development suffering due to the distance to manufacturing, high coordination costs, risk of disruption, the importance of and issues with delivery performance, difficulties to match production and consumption volumes, growing demand for and shortage of accessible transportation, inability to provide services related to the product, increased demand on customization, and difficulties due to physical and mental distance.

The last group of factors are **Firm-specific factors**: wrong estimation of benefits and risks in the offshoring decision, lack of knowledge about the host country, overhasty offshoring decisions, and over-estimation of cost saving during the offshoring decision.

A very important part of this thesis and one of the crucial resources for the analysis is the European Reshoring Monitor, a project done by the European Foundation for the Improvement of Living and Working Conditions (Eurofound), which includes over 250 reshoring cases in the EU area in the period from 2014 to 2018. Reshoring cases presented in the European Reshoring Monitor include different reshoring reasons stated by each company individually. Below all of the reasons that were stated in the database are presented in a table. It can be seen that there are 29 different reasons for reshoring and it can be stated that all of the reasons come from some difficulty or a challenge that occurred at the offshore location.

These real cases reshoring reasons are:

Reasons for reshoring from Eurofound cases				
Automation of the production process	Brexit	Change in taxation	Change in total cost of sourcing	Competitive pressure
Customer demands	Customer vicinity	Delivery time	Duties	Economic crisis
Exchange rate risk	Firm's global reorganization	Improvement in efficiency	Intellectual property protection	Know-how in the country
Labor costs' gap reduction	Logistics costs	Loyalty to the home country	Made-in effect	Poor quality of offshored production
Production flexibility	Proximity to customers	Proximity to suppliers	Quality control	R&D vicinity
Rationalization of costs	Size of the lots	Supply chain reorganization	Untapped production capacity	

Table 1: An adjusted table containing reasons for reshoring from Eurofound reshoring cases

All the companies whose reshoring cases have been presented in the European Reshoring Monitor were able to choose one or more reasons and the database now contains companies with just one reason and those with many. The reasons presented differ from each other and some are based on costs, while others are based on quality, efficiency, some host country risks, etc. It is possible to compare and match reasons for reshoring from the European Reshoring Monitor (table above) with five groups of reasons for reshoring from Eriksson et al. (2021) and it is obvious that all five groups of reasons are represented. Brexit, Economic Crisis, and Exchange rate risk, for example, will fall under the Global competitive dynamics group. Quality control and Intellectual Property protection, on the other hand, will fall under the Host Country group of reasons, while the Made-in effect, know-how in the country, Loyalty to the home Country, and Automation of the production process fall under the Home Country group of reasons. Reasons from the European Reshoring Monitor that match with the Supply Chain

group of factors stated by Eriksson et al. (2021) are Delivery time, Proximity to customers, and Logistics cost. Lastly, Supply Chain reorganization and Firm's global reorganization can be classified as Firm specific group of reasons.

Because this database includes reshoring cases and reasons up to 2018, some global, regional, and country-level events may also affect the location of production activities decisions for these and other companies, but those events happened after 2018. These changes and updates of these reshoring cases, which will include these later events, will be presented in the analysis since the main focus of the analysis will be the updated European Rehoring Monitor. Updated, in this case, means that all the relevant activities regarding activities location decisions from 2018 to 2023 have been added in addition to previous information.

3 Chapter 3 - Industry 4.0 and its Connection to Reshoring

Since the 1990s when offshoring became a "preferable" production location strategy until now many things changed. The world economy suffered from two big crises and we were all witnesses of rapid technological advancement. In years when multinational corporations started offshoring and outsourcing their production abroad to developing countries, most of the digital tools and communication possibilities weren't even imaginable. Through the years technology advanced rapidly and that affected both our private lives and businesses, their business processes and production activities. Technology improved a lot and opened new possibilities that started affecting industries.

De Propris and Bailey (2020) state that innovation matters and that a process of creating new knowledge can be translated into innovation. Innovation drives the competitiveness of firms, industries, and places. De Propris and Bailey (2020) also state that a new wave of technological innovation has started to fundamentally alter how things are made and it signals the start of an era of huge change.

3.1 Previous technological revolutions and their impact

The first technological revolution, which is labeled as the **First Industrial Revolution**, started with innovations related to steam power, cotton, steel, railways, and mechanization (De Propris and Bailey, 2020). This also led to a surge in the factory system. The biggest change that the First Industrial Revolution brought is the industrialization of rural areas and the emergence of industrial cities (De Propris and Bailey, 2020). Unrecognizable change in society was brought by people moving from farms to factories and this shift was massive (Blinder A., 2006). Blinder (2006) uses the fact that in 1810 84% of the workforce in the US was engaged in agriculture and 3% in manufacturing, while in 1960 the percent of the workforce working in manufacturing rose to 25%. The effects of these changes, which happened in the late 18th and beginning of the 19th century, are visible even today.

The second big change, called the **Second Industrial Revolution**, happened soon after the first one, in the second half of the 19th century. The Second Industrial Revolution is characterized by the introduction of electricity, heavy and mechanical engineering, and synthetic chemistry. We witnessed the period of mass production and the emergence of complex business forms, like multinational corporations (De Propris and Bailey, 2020). Blinder (2006) stated that the

Second Industrial Revolution shifted jobs once again, now from manufacturing to services. Blinder (2006) also states that by 2004 one-sixth of the nonagricultural jobs were in manufacturing, while five-sixth produced services. Results of this Industrial Revolution are, as is the case with changes resulting from the First Industrial Revolution, visible today.

After the second revolution, the world didn't wait for a long time for the next one, the **Third Industrial Revolution** which brought innovations in electronics, computers, petrochemicals, and aerospace. These innovations encouraged the emergence of more flexible organizations, such as firm clusters and industrial districts (De Propris and Bailey, 2020). Mentioned new technologies enable faster communication and transport that pushed and accelerated the process of globalization in production and commerce (De Propris and Bailey, 2020). As mentioned by De Propris and Bailey (2020) ***the process of globalization was accelerated by the Third Industrial Revolution and globalization is best represented by the emergence of the Global Value Chains***. This phenomenon characterizes the way in which business has been conducted in the last few decades and even now.

However, new technologies and innovations emerge, and conducting business in today's world highly depends on those technologies and innovations. Is the World going to be more globalized than ever or companies are going to turn global/regional, it can only be observed.

3.2 Fourth Industrial Revolution (Industry 4.0)

According to many authors, for some time we have been witnessing a new industrial revolution in manufacturing. This is based on the implementation of a variety of digital production technologies, new materials, and IT-enables processes (Kinkel, 2020). To be more precise, new technologies that are characteristic of Fourth Industrial Revolution are (De Propris and Bailey, 2020):

- biotech
- nanotech
- neuro-technologies
- 16 information and communication technologies
- mobile tech
- 3D
- artificial intelligence
- robotics
- censoring

- space technologies
- drones

Industry 4.0 is a German term that describes the group of production technologies where components and machines communicate and coordinate their operation in factories and value chains (Kinkel, 2020). Terms that are also used for the implementation of mentioned new technologies in the production activities are "Smart manufacturing" and "Manufacturing 4.0" (De Propris and Bailey, 2020). For the sake of avoiding any misunderstandings and clarity, only the term "Industry 4.0" will be used further in the text.

Dilyard et al. (2021) mention the exponential rate of technological change that includes blockchain, artificial intelligence, cloud-based systems, the Internet of Things, big data analytics, machine learning, and 3D printing. All of these newly developed technologies fall under the term Industry 4.0 (Dilyard et al., 2021). According to Dilyard et al. (2021), all these technologies impact the way in which GVCs operate and innovate, and it helps GVCs to become more flexible and lower operational risks. As one out of five driving forces for GVC transformation Zhan (2020) stated new industrial revolution implies the application of new technologies. Zhan (2020) also states that new technologies applied in the production activities of global MNEs will have a great impact on the configuration of GVC and that each technology will affect the "smile curve" of a specific GVC in a different manner.

To be more specific about how the Industry 4.0 technologies may or will change production activities around the world and within GVCs, De Propris and Bailey (2020) stated **four main changes**:

- **Greater implementation of digital technologies** in the production process and between producers and customers. Enhancement of both productivity and flexibility of production that will lead to "mass customized" products. Between firms, digital technology will enable the integration and orchestration of distant machines along the value chain. There is rising concern that robotization and digitalization will alter the balance between capital and labor inputs, with inevitable consequences for jobs, wealth distribution, and societal equity.

- Creation of new pathways for value creation. Here there is a particular highlight on **"Servitization"**. Customers are buying services along with products. Services enable the enjoyment of the product's intrinsic functions.

- Some new technologies lend themselves to efficiently scaling down productions, **opening up new opportunities for small producers with personalized, customized, and innovative products**. Customers co-innovate and co-produce with the manufacturer

- Almost all technologies can be deployed to **enhance the environmental sustainability of production processes and consumption**

Kinkel (2020) states that it is expected that ***Industry 4.0 will allow highly flexible and highly efficient production***, which will make it possible for manufacturers to produce individualized products under the economic conditions of a mass producer.

The expected impact of Industry 4.0 technologies on processes inside factories and production itself was enormous. It was argued that the Internet of Things, AI, robotics, and other related technologies will increase efficiency, productivity, responsiveness, and flexibility (De Propris and Bailey, 2020).

Efficiency is expected to increase through cost-efficiency, energy-efficiency, and labor-efficiency (De Propris and Bailey, 2020). Cost efficiency and energy efficiency have always been some kind of objective and it can be said that companies intended to become more efficient, in terms of costs and energy used, for a long time. However, labor efficiency is a kind of gray area and this may be one of the crucial concerns about the implementation of Industry 4.0 technologies. Industry 4.0 is expected to impact productivity and **higher productivity** is expected to come from automation that will directly affect lead time, it will make processes more flexible, and better quality control. Another benefit is **greater responsiveness**, which can be achieved by quicker collection and processing of data from the production process and along the supply chain (De Propris and Bailey, 2020). The data collected provides a sort of feedback that could be used to enhance processes and responses (De Propris and Bailey). De Propris and Bailey (2020) stated **flexibility** as another advantage of the implementation of Industry 4.0 technologies and this flexibility refers to "mass customization". This is a case in which companies are able to produce in smaller batches.

De Propris and Bailey (2020) took the example of Bosch that briefly explained the advantages of new (Industry 4.0) technologies. It is stated that ***technology is able to connect factories at different locations across the value chain and make those factories able to produce customized products, with flexible processes and higher capital-intensive production*** that will lower inventory or rejects to zero.

All these benefits of Industry 4.0 technologies stand and there is no doubt that companies nowadays are able to take advantage of this, more or less, innovative and recent technology in the manufacturing processes, but in other activities as well. Higher productivity, efficiency, greater responsiveness, and flexibility are some of the objectives of practically any manufacturing company on the planet.

3.3 Connection between Reshoring and Industry 4.0

All the technologies that were mentioned earlier, that are under the Industry 4.0 technologies, are undoubtedly going to help manufacturing companies achieve their most important objectives and increase individual competitiveness. However, taking into consideration location strategy decisions like offshoring, and most recent one reshoring, the role of Industry 4.0 needs to be discussed. Firstly, looking at one of the benefits of implementation of Industry 4.0 technologies, productivity and flexibility that are coming from digitalization and especially robotization, an argument can be made that this decreases the demand for labor. If we go back to one of the main reasons why companies offshore, it can be seen that it is low labor costs. Robotization may directly affect the demand for low-cost labor and companies might, after losing one of the biggest benefits of offshoring, decide to relocate, more precisely reshore, their manufacturing activities and take advantage of being closer to the markets and customers. This potential reshoring after robotization and implementation of additional Industry 4.0 technologies, may enable companies to solve other problems that arise from offshoring, like transportation, communication, and quality control.

However, there is another perspective to the potential effect of Industry 4.0 technologies on Global Value Chains and the manufacturing location strategy for a company. De Propris and Bailey (2020) mentioned Industry 4.0 technologies connecting factories at different locations. De Propris and Bailey (2020) highlight that digitalization might integrate and orchestrate distant machines. This way of implementation of Industry 4.0 technologies might, to some extent, slow down and even stop the reshoring trend and help companies solve some of the issues of offshoring and continue to take advantage of the opportunities offered abroad.

Ancarani et al.(2019) state that Industry 4.0 technologies are expected to lead to an increase in operational efficiency and productivity by enabling customization of manufactured products, and making the production chain more automatic and flexible. Ancarani et al. (2019) also mention that it can only be speculated in which way Industry 4.0 technologies are going to affect Global Value Chains and manufacturing location decisions. Either these technologies

will support an international network of operations or re-concentrate manufacturing in advanced economies. Regarding this, scholars in supply chain management have **suggested a correlation between Industry 4.0 and manufacturing location decisions**. Scholars suggest that firms that are reshoring their manufacturing activities are expected to adopt new technologies when the technology intensity and complexity of the supply chain are high and when there is a high risk of losing control over offshore manufacturing and issues with intellectual property (Ancarani et al., 2019). This was only a suggestion by scholars it was still left for discussion whether these assumptions are correct. Further, some findings and methodology of analysis of Ancarani et al. (2019) will be used to present the connection between Industry 4.0 and reshoring. First of all, it is required to make a connection between manufacturing location decisions and the technological choices of a company. Ancarani et al. (2019) used previously established literature knowledge that the ***technological decisions of a firm, including the firm's decision in which technology and how advanced technology to invest in, have its antecedents in the firm's competitive priorities***. The competitive priorities of a firm are:

- Cost
- Quality
- Flexibility
- Delivery

At the same time, these competitive priorities of a firm have been key antecedents of location decisions and initiatives for both offshoring and reshoring.

So, there is a connection between Industry 4.0 technologies, which are clearly part of the technological decision of a firm, and manufacturing location decision since they are both connected to or better to say, coming from, competitive priorities of a firm.

During the development of a model of the analysis, Ancarani et al. (2019) claim that different competitive priorities may require different technological choices once a firm relocates its production back to its home country. This means that **the adoption of Industry 4.0 technologies during reshoring will depend on whether firms compete over cost, quality, delivery, or flexibility** (Ancarani et al., 2019). Reshoring, when a firm is competing based on costs, is usually driven by the reduction of offshore cost advantages and firms cannot deal with those reductions of advantages, such as higher costs of labor, higher costs of logistics, and other related costs (Ancarani et al., 2019). In this scenario, companies need to maintain their

economies of scale and competitive pricing to stay competitive in the market and these companies may be forced to substitute labor for capital by introducing Industry 4.0 technologies in their production activities (Ancarani et al., 2019). After companies with cost priorities that have or had initiatives to reshore and the conclusion that those companies are required to implement Industry 4.0 technologies to stay competitive, let's look at the companies with quality as a competitive priority. Companies with quality as their competitive priority are more focused on brand image and product performance (Ancarani et al., 2019). Reshoring of manufacturing activities by quality-focused companies is often connected to the "made in" effect that arises from producing in developed (home) countries and this increases brand recognition (Ancarani et al., 2019). There are some industries for which the quality of the products and the brand image are very important and may create premium prices, such as apparel, food processing, leather, etc (Ancarani et al., 2019). There is a great practical example for this presented by Martinez-Mora and Merino (2014) which is based on the example of the companies from Spanish footwear sector, mostly concentrated in Alicante, that decided to fully or partially reshore production activities, previously offshored, because of controlling the whole production and being able to maintain a high level of quality. Martinez-Mora and Merino (2014) limited these findings to the companies that manufacture high and mid-high ranges and that offshored just part of the production, not all production activities, while the experience for companies manufacturing lower ranges and offshoring entire production has been a bit different. Highly specialized human capital and price premiums that are associated with the "made in" effect are likely to weaken the incentive of the company to invest in advanced technologies (Ancarani et al., 2019). So, the conclusion that can be made from this Ancarani et al. (2019) statement is that some industries are more focused on specialized human capital and companies that are part of those industries are more focused on brand image and the creation of customer's perception that products coming from certain countries have higher quality. On the other hand, automation of the production process, for example, may lead to greater quality of the product by means of high maintenance and better quality control (Ancarani et al., 2019). How companies with quality competitive priority decide on the level of technological development in the process of reshoring, has two opposite arguments and different opinions are available on this topic. In the case of flexibility being a competitive priority, companies seek product variety and a greater level of customization, while maintaining cost-effectiveness (Ancarani et al., 2019). Differentiation and customization of each product requires companies to produce smaller batches of each product and this may increase transport costs when production of smaller batches is offshored (Ancarani et al., 2019). As mentioned by Ancarani et al. (2019) there are ambiguous findings regarding the relation between flexibility and process

innovation that rely on automation. The a positive association between flexibility production and Industry 4.0 technologies because robots and machine-to-machine communication will lead to flexibility by making autonomous decisions (Ancarani et al., 2019). The ambiguity of findings about this relation arises from the opinion that customers will pay a premium price for customized products only if that product provides higher performance quality, which can be achieved through highly skilled employees and not automation (Ancarani et al., 2019). This opinion about the negative relation between flexibility production and Industry 4.0 technologies uses the quality of the product and premium price as proof, despite this priority being presented on its own. Because of this, simply looking at flexibility without any further connections and factors, it can be said that Industry 4.0 technologies should enable companies to achieve greater production flexibility. And lastly, in case of delivery being the competitive priority of companies, especially in case of reshoring, there is a weakened incentive for companies to invest in advanced technologies. This decreased incentive to invest comes from the fact that reshoring on its own solves delivery problems and locates companies closer to their customers and there is no need and incentive to invest in further technologies that may enable delivery reliability and delivery speed (Ancarani et al., 2019).

Ancarani et al. (2019) created a hypothesis ***"The adoption of Industry 4.0 technologies following backshoring will significantly vary across firms with different competitive priorities."*** and this was one out of three hypotheses that were part of the analysis. **The data used and analyzed by Ancarani et al. (2019) proved this hypothesis** and it can be said that different competitive priorities will affect the adoption of Industry 4.0 technologies after reshoring.

The same topic, the connection between reshoring and Industry 4.0 technologies is analyzed by Fratocchi and Di Stefano (2020). Fratocchi and Di Stefano (2020) used both findings from external literature and empirical findings in their analysis. The literature review includes 115 articles that were selected based on several criteria and it includes the article that was used above.

Findings of the external literature (115 sampled journal articles) clearly showed that the relationship between reshoring and Industry 4.0 technologies has been specifically addressed by only 4 out of 115 journal articles (Fratocchi and Di Stefano, 2020), including the article presented earlier. The analysis of the literature didn't provide homogenous results and showed that a single Industry 4.0 technology may have an effect on manufacturing relocation decisions, but their impact is highly dependent on the strategic aims pursued by the company (Fratocchi and Di Stefano, 2020). This statement that the impact of Industry 4.0 technologies depends on

strategic aims is the same as the statement of Ancarani et al. (2019) that different competitive priorities will have different effects on the adoption of Industry 4.0 technology.

In the empirical analysis conducted by Fratocchi and Di Stefano (2020), the results showed that **12.7% of reshoring (backshoring) decisions were motivated by the adoption of automation and/or other innovative product/process technologies (excluding 3D printing/additive manufacturing)**. In addition, reshoring motivations that were most often cited jointly with production automation are 'cost and difficulties in controlling host country activities' and 'made in effect', with 21.4% and 15.6% respectively. Assumption of Ancarani et al. (2019) that companies with quality priority, to which "made in" effect belongs to, have weak incentive to invest in advanced technologies because of price premium and high-skill labor may be incorrect, since "made in" effect is second most jointly cited motivation with production innovation. **A connection between cost and difficulties in controlling production automation clearly proves that companies with costs as competitive priorities are most likely to invest in advanced technologies**.

4 Chapter 4- Covid 19 Impact on the GVC

4.1 How pandemic affected the international trade and internationalized industries

It was the end of 2019 when the first case of Covid-19 has been recorded. In the next several months the world changed in a way unimaginable until then, especially in the newer history. Everything stopped, the whole world was in a justified panic and each country tried to prevent the expansion of the pandemic within domestic borders. This affected every country worldwide economically and every country felt the consequences, without exception. As stated by Strange (2020) the last time the world witnessed a global pandemic was the H1N1 influenza pandemic in 1918. Governments of each country tried to minimize the effect of the pandemic by introducing different restrictions, mostly restricting movement to prevent the spread of the virus. It can be said that the effects of the pandemic have been multi-dimensional because it severely affected both public health and economic activities in each country (Strange, 2020). Lockdowns and other restrictions that were introduced to prevent the spread of the pandemic have negatively affected economic activities, while allowing people to work benefits the economy but may lead to a greater number of those infected (Strange, 2020). So, governments needed to consider both dimensions while making Covid-19 related decisions. Strange (2020) stated that the pandemic was contagious not just in the health sense but also in the economic sense because the global economy is interconnected through GVCs.

Stated multi-dimensional effect of the pandemic makes the economic situation different from other economic crises, for which potential remedies were easier to conceive and match with occurred problem (Strange, 2020). **The health dimension of this crisis made it hardly comparable to a classic economic crisis**. International trade and output in 2020 have reached their lowest level since World War II (OECD, 2022). This fact shows the scale and scope of the crisis that started because of the pandemic. Comparison with the global economic state in the period of World War II shows the extended effect of other dimensions on the economic state, like it was mentioned by Strange (2020).

Covid-19 also had an unprecedented effect on Global Value Chains and highlighted supply chain vulnerabilities. Lockdowns, which came out of the intent to prevent the spread of the pandemic, led to borders closing, disruption of production on a global level, transportation problems, and decreased demand (Brenton et al., 2022). The effect of Covid-19 is best grasped by the data about the decrease of exports in both services and goods. In 2020 the overall exports

of services decreased by 16.7%, which is double the decrease of exports of goods which decreased by 8.2% (OECD, 2022). This data shows perfectly the difference between the vulnerability of exports of services and goods. The vulnerability of service global trade and goods global trade has also been shown in the post-pandemic period when the recovery of global trade started and service exports are recovering slower than goods trade (OECD, 2022). In the same manner, Strange (2020) divided the effects of the pandemic on the supply side and demand side and provided explanations and examples of which industries and how those industries will be affected by the pandemic. Restricted movement of employees is the first example of the supply-side effects (Strange, 2020), since companies within many industries haven't been prepared for remote work or remote working isn't an option in that specific industry, and physical presence is a must. Strange (2020) stated back in 2020 that the retail, hospitality sector, and other service industries would be particularly hit and it can be confirmed by previously presented OECD findings which state that the export of services experienced double the decrease of export of goods (OECD, 2022). There is also an indirect effect on suppliers of intermediate goods and services, caused by cancelling orders and extension of payment periods (Starnge, 2020). Demand-side effects include changes in consumption and purchasing patterns (Strange, 2020). Strange (2020) predicted in 2020 that demand for many products will fall, even without supply restrictions. Strange (2020) stated that much of consumer spending is "social" because it involves close contact with other people. These products and services that are "social" like bars, restaurants, events, concerts, etc. were replaced by other products and services (Streaming services, delivery, e-commerce, etc.).

Who was most affected?

Brenton et al. (2022) stated that middle- and low-income countries were hit the hardest. This may have several good and logical explanations. Middle- and low-income countries are usually concentrated in the production of few products and companies from these countries are not deeply integrated into the GVCs. This is the source of the vulnerability of these countries and their companies (Brenton et al., 2022). During the pandemic, lockdowns and closed borders made big companies, that outsourced and offshored their production to developing countries, cancel their orders and stop production. Great examples of this are garment factories closed in Bangladesh and Vietnam (Brenton et al., 2022).

Getting closer to the end of the pandemic, or at least normalization of global trade, border opening, and lockdowns ceased, the GVCs started to get "back to normal". Demand and supply started to increase and tended to reach the previous level, or even higher. However, even the recovery from the pandemic and recession hasn't been even (Brentonet al., 2022). Countries

and companies from those countries that were highly integrated into the GVCs have recovered quickly and more successfully. The recovery of the trading partners also had a great impact on the recovery of the countries and companies (Brenton et al., 2022).

4.2 Has the pandemic highlighted some problems of offshoring even more?

Even though GVCs increase the vulnerability to foreign shocks and reduce the exposure to domestic shocks (Brenton et al., 2022), this paper needs to concentrate on the developed countries and big companies from these countries in the period before the pandemic that decided to outsource and especially offshore their production to developing countries, mostly because of the lower production costs. When the effect of the pandemic on international trade has been discussed, it was mentioned and it needs to be highlighted that demand from developed countries and canceled orders have disrupted supply and closing of production sites in developing countries. This affected both developing and developed countries, in a different way, and probably triggered the question about GVC structure and the probability of some kind of production relocation, reshoring, or nearshoring.

From the reasons for reshoring, or disadvantages of offshoring as it was classified, it is obvious that some disadvantages are tightly related to the distance of the production sites or partners to whom the production has been outsourced. In the Eurofound 250 reshoring cases, there are reshoring reasons such as:

- Delivery time,
- Proximity to suppliers,
- Proximity to customers
- Logistics costs
- Duties
- Change in total cost of sourcing

These disadvantages were mostly highlighted during the lockdowns and international trade reduction, caused by the Covid-19 pandemic. Most of these disadvantages, if not all of them, would be avoided by placing production sites close to the biggest markets and greater proximity to the customers and suppliers. The pandemic showed that a global crisis like this jeopardizes international trade and puts big multinational companies in problems because of the inability to import goods from other countries, especially when they are located in another part of the world. Strange (2020) stated several comments by leaders of some of the world's biggest economies

regarding domestic production and becoming less dependent on global value chains. Donald Trump, a president of the United States during the period of the pandemic, mentioned decoupling of US and Chinese economies and bringing manufacturing activities back to the United States, while Australian Prime Minister Scott Morrison mentioned nurturing local manufacture and ensuring that domestic manufacturing is less reliant on global value chains (Strange, 2020).

Other disadvantages of offshoring, which are also the main reasons for reshoring in Eurofound 250 reshoring cases are not so tightly connected to and highlighted by the Covid-19 pandemic.

Reasons for reshoring from Eurofound cases				
Disadvantages highlighted by the pandemic	**Disadvantages unaffected by the Covid-19 pandemic**			
Change in total cost of sourcing	Automation of the production process	Brexit	Change in taxation	Competitive pressure
Delivery time	Customer demands	Customer vicinity	Economic crisis	Exchange rate risk
Duties	Firm's global reorganization	Improvement in efficiency	Intellectual property protection	Know-how in the country
Logistics costs	Labor costs' gap reduction	Loyalty to the home country	Made-in effect	Poor quality of offshored production
Proximity to customers	Production flexibility	Quality control	R&D vicinity	Rationalization of costs
Proximity to suppliers	Size of the lots	Supply chain reorganization	Untapped production capacity	

Table 2: An adjusted table containing reasons for reshoring from Eurofound reshoring cases that are highlighted by Covid-19

This table best represents which disadvantages of offshoring have been directly highlighted by the pandemic. So in this table, out of 29 offshoring disadvantages, 6 of them are directly highlighted by the pandemic. These 6 offshoring disadvantages that were highlighted by the Covid-19 pandemic, which accounts for over 20%, are maybe not the biggest and most important reasons for relocation strategies. However, the pandemic and these highlighted disadvantages may cause companies to rethink their production locations and probably encourage companies to be more active when it comes to reshoring or nearshoring.

Brenton et al. (2022) reflected on the effect of Covid-19 on nearshoring and reshoring by mentioning interviews with private sector stakeholders regarding this topic. The interviews seem to be mostly concentrated on the relocation of production activities from China and the conclusion is that whoever has been considering the relocation from China before 2020 has done it. Brenton et al. (2022) also mention that Business surveys of European and US firms with investments in China indicate that **there are not going to be large reductions in the presence of those firms in China**. This may indicate that companies that have been considering a relocation, which meant reshoring or nearshoring before Covid-19 have become indecisive regarding reshoring and nearshoring. Pla-Barber et al. (2021) also mention that activities relocation, which represents a move toward a certain degree of de-globalization, have been considered by many companies in many industries even before the pandemic. According to Pla-Barber et al. (2021), the idea of de-globalization has been amplified by the pandemic and GVCs may be reconfigured to reduce risk by making them more regional or local. In addition, the effect of Covid-19 on reshoring was assessed by Somoza Medina (2022) in the Article "From Deindustrialization to a Reinforce Process of Reshoring in Europe. Another Effect of the Covid-19 Pandemic?". Somoza Medina (2022) states that we may be witnessing a new reindustrialization of the old continent. In the conclusion of the article, it is stated that research has shown that the Covid-19 pandemic has reinforced a trend of industrial relocation that started much earlier. However, it cannot be stated that reshoring cases in Europe is the consequence of the pandemic, but it is certain that the pandemic modified the perception of offshoring in companies (Somoza Medina, 2022). Findings from this article and the conclusion may serve as an answer to the question ***"Has the pandemic highlighted some problems of offshoring even more?".*** The answer would be positive and it can be stated that Covid-19 got managers of European and North American companies thinking of relocating their manufacturing activities, which includes relocating back home (reshoring). However, highlighting is the highest degree to which the pandemic affected the trend of offshoring and its reversal process - reshoring.

All these conclusions, Covid-19 highlighting the disadvantages of offshoring, and the future effect of the pandemic on the GVCs need to include the feasibility of the relocation of production of some goods from one location to another. Certain economic factors, that are specific to some supply chains, still influence the geographical location of production (Pla-Barber et al., 2021). Strange (2020) similarly stated that there will be a lot of debate, within firms and more widely, about how firms should build greater resilience through two actions - reshoring and internalizing activities. Strange (2020) concentrated more on the question of the feasibility of relocation and internalizing activities from the perspective of - resources and the reliance of firms on foreign sales. In terms of resources, there are some value chains that depend on the availability and location of some natural or other resources (Strange, 2020). On the other hand, a lot of firms rely on both domestic and foreign sales, which diversifies revenue streams, and relocating manufacturing activities back home (reshoring) may increase domestic purchase resilience but also increase the costs of foreign sales (Strange, 2020). This increase in domestic purchase resilience is also mentioned by Pla-Barber et al. (2021) in a way that the pandemic definitely increased the importance of self-sufficiency in food, pharmaceuticals, medical equipment, etc.

However, taking all of the previous statements and conclusions aside, Strange (2020) stated that the Covid-19 pandemic is a global phenomenon and that most countries experienced both health and economic shocks and crises. Companies are able to configure their GVCs in anticipation of more localized epidemics or some diseases characteristic of certain countries, with diversification into multiple countries (Strange, 2020). Since the Covid pandemic surprised all of us and it was, as Strange (2020) called it “phenomenon”, it should be treated like one and there isn’t much sense in creating a production location strategy based on a “phenomenon”. This is contrary to the findings of Somoza Medina (2022) and in some way complementary to the survey presented by Brenton et al. (2022). The effect of Covid-19 will be further analyzed from the updated European Reshoring Monitor database and further insights, from real cases, will be presented and compared to the findings and conclusions of Somoza Medina (2022), Brenton et al. (2022), and Strange (2020).

5 Chapter 5 - Empirical analysis: European manufacturing firms example

5.1 Introduction

The previous four chapters, in which the change of manufacturing locations strategy, more precisely reshoring, has been discussed and explained, have been introduced as some kind of introduction and a way to understand these processes better before the analysis. Most of the findings, hypotheses, and thoughts of other authors presented earlier will be considered and analyzed in this chapter. In Chapter 1, the phenomenon of the Global Value Chain and some basic information and facts have been presented, as well as the appearance of offshoring as a very popular manufacturing location strategy. In the same chapter, the recent trend shift from offshoring to other manufacturing location strategies, by which reshoring is mostly considered, has been presented. This shift in trend and recent change in strategies of companies is mostly encouraged and triggered by different disadvantages of offshoring. Chapter 2 mostly concentrated on explaining what exactly reshoring is, how to implement this value chain activities location strategy, and what are the reasons for reshoring. Those reasons were tightly connected to the disadvantages of offshoring. Chapter 3 and Chapter 4 are of great importance since, I can say, the main goal of this Thesis is to analyze the connection and relationship between Industry 4.0 technologies and reshoring and the effects of the Covid-19 pandemic and reshoring. Regarding this, it was crucial to review different findings and thoughts of different authors regarding these topics and the connection of reshoring with these two phenomena. To conclude this brief review, these four chapters aimed to provide a clearer picture of offshoring as a prerequisite for reshoring, reshoring itself, and other factors that may affect companies, both SMEs and MNEs, to change their manufacturing location strategy, abandon offshoring and reshore their production activities back to the home country of the company.

In this fifth chapter of the Thesis, the European Reshoring Monitor database, which contains various reshoring cases of companies from the European Union, will be used. First, the database itself will be introduced, with information regarding researchers who made the database, what was the aim of the database, and other pieces of information that will later, along with some updates and upgrades, be relevant for the creation of a sample that will be used for the analysis.

5.2 Methodology

As said in the introduction, the main focus of this Thesis is to analyze the relationship between Industry 4.0 technologies and reshoring, as well as the effect of the Covid-19 pandemic on the manufacturing location strategy, mostly reshoring since reshoring is the "newest" trend. For the analysis of the relationships and effects of these two phenomena on the reshoring, the European Reshoring Monitor database has been used. European Reshoring Monitor is an initiative from Eurofound whose aim was to identify, analyze, and summarize evidence on the reshoring of manufacturing and other activities, that are part of the value chain, back to the European Union. European Reshoring Monitor was part of the multi-annual research project on the Future of Manufacturing in Europe. European Reshoring Monitor is a product of the collaboration between Eurofound and a group of Italian universities organized in the consortium. The leading university in the consortium was the University of Udine. In contrast, the rest of the universities are the University of Bologna, the University of Catania, and the University of L'Aquila. Professors, Associate Professors, and Assistant Professors from these four universities worked together on tracking reshoring activities and the creation of the database. Some of the professors who were part of this project have been cited in previous chapters (Ancarani, Di Mauro, Fratocchi..).

How did Eurofound and a consortium of Italian universities create the database?

To get a clearer picture and understand how the European Reshoring Monitor database has been made, it is required to look at the sources used by the researchers. First of all, researchers needed to include various terms that represented the same location strategy to be able to collect data for the database. This means that besides the term ***"reshoring"***, researchers from the consortium also searched the terms ***"backshoring"***, ***"relocations"***, and ***"reverse globalization"***. This was required since there are several terms that can be used for relocating previously offshored manufacturing activities back to the home country of the company, as mentioned in Chapter 2. In Chapter 2 it is also obvious that besides the use of different terms, definitions of reshoring slightly vary depending on the author. In the process of creating the European Reshoring Monitor database, researchers included all of the mentioned terms and avoided missing and not including any case because of the use of different terms.

Researchers from different universities collected information on the individual reshoring cases from different resources. As can be seen in the database itself, in the section that includes links to the sources, researchers used different sources for gathering relevant pieces of information regarding reshoring cases. Some larger companies, usually MNEs, had news about their

reshoring published on their website, as well as on national and local websites, portals, and magazines, while information for SMEs was harder to obtain, especially detailed information. Resources used are:

- media
- specialized press
- scientific literature
- practitioner literature

Information about reshoring cases in the European Union has been entered into the online database and Eurofound used those data to make and publish annual summary reports. A complementary task of the Eurofound was also the development and update of an online database of reference material on reshoring that includes:

- research articles
- consultancy reports
- policy reports
- key media articles
- policy initiatives at regional/national/EU level
- quantitative-based analysis of reshoring data

Information about reshoring cases from mentioned sources was collected for the period of 4 years, **from the beginning of 2015 until the end of 2018**. During this period Eurofound and researchers from four Italian universities considered **two types of reshoring cases:**

1. Companies that reshore to their home country (within the EU) value chain activities previously offshored to another country (e.g. manufacturing by a German firm previously offshored to China or to France and now returning to Germany)

2. Companies that reshore to any EU country value chain activities previously offshored to a non-EU country (e.g. manufacturing by a German firm previously offshored to China and now returning to Italy)

The second type of case that was recognized and categorized as reshoring can be discussed since it fits perfectly the definition of **nearshoring** or **friendshoring.** Researchers and Eurofound may have been looking at the European Union as one "state" which will then make these relocations classify as reshoring. However, being more strict about this categorization, these cases are cases of nearshoring and only the first type of cases explained will qualify to be considered as reshoring cases. This potential classification problem will be discussed more in

detail later in the part of the Thesis that is entirely focused creation of the sample that will be used for the analysis. Now, it is required to present, explain, and briefly analyze the data that this database is composed of. Various pieces of information, that give a clearer picture of each reshoring case, are separated into sections that represent the header row of the database table.

5.2.1 Database description and sample creation

5.2.1.1 Sections of which the database is composed of

Besides the company name and name of the Group of which the company is part of, one of the first pieces of information provided for each reshoring case is the **home country of the company** and **home country of the Group** (in case that company is part of a Groupation). Below is a table providing information about how many companies from a specific country are part of the database.

Country	**Number of companies reshored**	**Country**	**Number of companies reshored**
Austria	2	Netherlands	4
Belgium	3	Norway	19
Croatia	2	Poland	6
Denmark	19	Portugal	2
Estonia	3	Romania	1
Finland	9	Slovakia	1
France	36	Spain	12
Germany	17	Sweden	17
Greece	1	Switzerland	4
Ireland	3	Taiwan	1
Italy	39	United Kingdom	44
Latvia	2	United States	2

Luxembourg	1	**TOTAL**	**250**

Table 3: An adjusted table containing number of companies in the European Reshoring Monitor database from each country

As can be seen from Table 3, there are some European countries that have a greater number of companies that decided to reshore some or all of their previously offshored value chain activities. Countries leading this list are the United Kingdom, France, and Italy. On the other hand, countries that have only one company that reshored their activities, according to European Reshoring Monitor, are Slovakia, Romania, Luxembourg, and Greece. This difference in the number of companies from European countries that reshored their activities may come from the fact that the UK, France, and Italy are more developed economies with a greater number of companies that participate in global value chains. An interesting part of this Table 3 above is the presence of the United States and Taiwan as countries that had companies that reshored their activities since this database was supposed to contain only European cases. These cases, three of them in total, probably found their place in the database since activities were reshored from Europe and since activities from other parts of the world have been relocated to an already owned site in Europe (Taiwan's company case). Whether these three cases, from the USA and Taiwan, are going to be used for the analysis in this Thesis, will be discussed later in the sample creation part.

Sector section of the database provides information about the sector in which a company operates and the NACE classification of economic activity for each company in the database. The database contains a few different main NACE codes that classify different industries. All these sectors have sub-sectors that give more detailed information about specific products manufactured or services provided. For now, the focus will be on the main NACE codes and those are:

- C - Manufacturing,
- K - Financial and Insurance activities,
- J - Information and Communication,
- G - Wholesale and retail trade,
- M - Professional scientific and technical activities,
- A - Agriculture, forestry, and fishing,
- B - Mining and quarrying,
- N - Administrative and support service activities,
- H - Transporting and storage,

- F - Construction

All these alphabetical denotations are complemented with different numerical denotations that together make a sub-sector NACE code from which we can see which product a company manufactures if the company's NACE code is C - Manufacturing, or what type of products/services a company provides within different sectors. Below is the table representing the number of companies from the European Reshoring Monitor database in each of the represented main NACE codes listed above.

Alphabetical main NACE code	**Number of companies**
A - Agriculture, forestry and fishing	1
B - Mining and quarrying	3
C - Manufacturing	216
F - Construction	1
G - Wholesale and retail trade	4
H - Transporting and storage	1
J - Information and communication	12
K - Financial and insurance activities	9
M - Professional scientific and technical activities	1
N - Administrative and support service activities	2
TOTAL	**250**

Table 4: An adjusted table containing number of companies in the European Reshoring Monitor database from each industry (NACE)

From Table 4, it is obvious that the majority of reshoring cases in the database are manufacturing locations, since out of 250 cases in total, 216 are cases of companies that are coded as manufacturing companies. Sub-sector section of the database contains a lot of information, usually different for each company and it is quite challenging to represent it either graphically or in a table representation. However, to make this classification as clear as possible, here are some examples of sub-sectors:

- C11.0 - Manufacture of beverages
    - C11.0.5 - Manufacture of beer
- C14.1 - Manufacture of wearing apparel, except fur apparel
    - C14.1.9 - Manufacture of other wearing apparel and accessories

However, these sub-sector pieces of information are not that important for the analysis part of this Thesis, this kind of classification can only be useful for creating a more detailed picture or even complementing the case narrative.

Reshored business functions and Reshored services/activities are two sections of the database that provide information regarding activities reshored. Below different business functions will be presented with a number of companies from the database that reshored that specific business function.

Business function	**Number of companies reshoring business function**
Administration	8
Customer services	9
Financial	4
IT	4
Logistics	1
Maintainance	1
Marketing	1
Production	208
R&D	3
not specified	11
TOTAL	**250**

Table 5: An adjusted table containing the number of companies reshoring specific business function in the European Reshoring Monitor database

These business functions that were reshored by companies from the database must be separated from the sector and sub-sector sections of the database. The distinction is made taking into

consideration the fact that companies may reshore R&D or Marketing business functions while the sector and sub-sector section for that companies may state C-Manufacturing. This business functions section is not tightly connected and dependent on the sector classification. Additionally, the reshored services/activities section is tightly connected to the reshored business functions section. Since this is not of such big importance for the analysis of the database, this reshored service/activities section will not be presented in detail. The only detail worth mentioning is that the Production business function includes activities like assembling, packaging, design, administration, and production itself.

Reasons for reshoring is one of the most important pieces of information each company provides on an individual level. This section can include one or multiple reasons for reshoring, depending on the company. Reasons for reshoring stated by each company are grouped in one table (Table 1 of this Thesis) and there are 29 reasons stated in the database. All of the reasons can be categorized as one out of five groups of reasons for reshoring (Eriksson et al., 2021) and companies were able to combine reasons from different groups to justify the change in their value chain activities location. Below is the table containing all of the reasons for reshoring that could be found in the database.

Reasons for reshoring from Eurofound cases				
Automation of the production process	Brexit	Change in taxation	Change in total cost of sourcing	Competitive pressure
Customer demands	Customer vicinity	Delivery time	Duties	Economic crisis
Exchange rate risk	Firm's global reorganization	Improvement in efficiency	Intellectual property protection	Know-how in the country
Labor costs' gap reduction	Logistics costs	Loyalty to the home country	Made-in effect	Poor quality of offshored production
Production flexibility	Proximity to customers	Proximity to suppliers	Quality control	R&D vicinity

Rationalization of costs	Size of the lots	Supply chain reorganizatio n	Untapped production capacity	

Table 1: An adjusted table containing reasons for reshoring from Eurofound reshoring cases

Since this was explained and discussed more in detail in Chapter 2, more attention will be paid to this in the process of sample creation and especially during the analysis of the Industry 4.0 and Covid-19 effects on the global value chains and companies' manufacturing location decisions.

Reshoring governance mode is a section that provides us with information on whether companies relocated value chain activities to their own facilities, which has been named ***in-house reshoring***, or companies reshored their activities and outsourced them to an external supplier, which was named ***Third-party reshoring***. A simple table is provided below to determine which of these two options is more preferred.

Reshoring governance mode	**Number of cases**
In-house reshoring	199
Third-party reshoring	22
not specified	29
TOTAL	**250**

Table 6: An adjusted table containing the number of reshoring cases for each governance mode in the European Reshoring Monitor database

Case narrative is a brief explanation of the company's actions and decisions regarding previous and current relocations of value chain activities. It provides valuable insight into every reshoring case. It gives each case a story-telling dimension in which details about previous and current location strategies that include pieces of information like which activities have been relocated, how that relocation affected the number of employees in the company, some interviews regarding the relocation from CEOs or other managers of the company, and other information that may be important for a specific reshoring case, but cannot be put into any other section and quantified.

5.2.1.2 Update of the database

Since the European Reshoring Monitor database covers a four-year period, from the beginning of 2015 to the end of 2018, it was required to make updates and clarify what happened to reshoring cases that weren't finished until the end of 2018. This update was also supposed to fill in the gaps since there were different global, regional, and national events that might have influenced companies in making their manufacturing location decisions. The most straightforward example of an event that might have influenced the manufacturing location strategy of a company is the Covid-19 pandemic which was a global phenomenon. This phenomenon and its effect on the global value chains, especially on manufacturing location decisions was discussed, in more detail, in Chapter 4. Besides Covid-19, other events, with smaller or more regionally/nationally concentrated effects, occurred and those events also might have had an effect on the location decision of some companies. On the other hand, since reshoring is a new trend, this update might give valuable insight into what happens to companies that reshored part or all of their manufacturing activities back to the home country and whether there are examples of companies that abandoned reshoring and decided to offshore again. Additionally, this update should be helpful in analyzing the implementation of Industry 4.0 technologies in reshoring cases and checking if the Industry 4.0 technologies are drivers for reshoring or tools to make reshoring as successful as possible.

The updated European Reshoring Monitor database will then be used for the creation of a more relevant and accurate sample of cases that are going to be analyzed, than a sample from the existing database would be relevant and accurate.

So, to summarize, the update of the European Reshoring Monitor is supposed to:

- Create a more relevant and accurate database that will include the effects of various global/regional/national events, that happened from 2019 onward, on the global value chains and manufacturing location decisions
- create a clearer picture of what companies do after reshoring all or part of the value chain activities and whether reshoring is getting abandoned or continues in years after the relocation
- Help answering following questions:
    - Are there cases of Industry 4.0 technologies being implemented in the beginning stages of reshoring in which those Industry 4.0 technologies may be considered as drivers?

- If these technologies haven't been implemented in the beginning stages of reshoring, have Industry 4.0 technologies been implemented in cases that haven't included those technologies in the initial stage of reshoring, and how?

How the database was updated?

Since most of the sections, that the database consists of, are not dependent on any additional and new manufacturing location decisions or are tightly connected to a first case of reshoring and any further relocations may not affect it, the most suitable way for an update was to use **the case narrative section**. For updating the database, an additional case narrative, for the period from 2019 to the middle of 2023, was created and the idea was to write a short story-telling type of text regarding any new value chain activities relocation which would include any relevant information regarding new relocations. In addition to researching if there are new relocation cases for each company, the new case narrative section was also meant to provide new information about previous reshoring cases, which was supposed to enable analyzing already existing reshoring cases during a longer period of time and analyze any possible changes from 2019. To create this new case narrative section, the idea was to use the same or similar sources that were used in the creation of the database. A priority list was created for the update of the case narrative section and that list included, by order:

1. Official websites of the companies' research, which included research of the "News", "Press", "Media", and other similar sections of the websites
2. The same journals, portals, magazines, and websites from which the information and data for the reshoring cases from 2015 to 2019 were found. These websites were mostly some specialized business/economic journals and magazines that covered topics like these, or some local/national media that provided news about a domestic company
3. Other sources - looking for any information about previous reshoring cases or new relocations by finding articles about the company from sources different from those previously used

Collected data from these sources have then been put into a new case narrative section from which other updates were made. These additional updates were made by making additional sections so that different new questions, not presented earlier, can be analyzed and discussed. These new sections, coming from the new case narratives, are more quantifiable and are going to be presented and used after the sample creation in the analysis part of the Thesis.

5.2.1.3 Sample for the Analysis

This part of the Thesis is meant to discuss and clarify decisions on the exclusion of some of the cases from the updated European Reshoring Monitor database. The necessity of exclusion of some reshoring cases comes from the different interpretations of the term "reshoring", the aim of this Thesis, and the understanding of the literature presented earlier. There are several requirements that each reshoring case should fulfill for that case to be included in the sample that will be analyzed. Below different classifications of the reshoring cases will be presented with a brief discussion and a decision on whether some cases will be excluded from the sample or not.

5.2.1.3.1 Relocation cases of companies located outside of Europe

As can be seen in the methodology part of the Thesis above, there are a few cases that include the relocation of value chain activities by companies located outside of Europe. While from this information, these cases may be immediately excluded, all these relocations include relocating those activities to a location in Europe. The cases mentioned are those of the Taiwanese company called "Pegatron Corporation" and the United States companies "Carggo" and "Jabil". As stated in the case narrative section of the database, the company from Taiwan decided to relocate production activities from China to the Czech Republic and Mexico. Despite the fact that a production site in the Czech Republic was owned by the Pegatron Corporation, this case cannot be considered as reshoring, since the reshoring, according to all authors presented in Chapter 2, is the relocation of value chain activities to the home country of the company. Since in this case, the company is stated in Taiwan and there is no mention of a separate entity in the Czech Republic, this case will be excluded.

The same is true for the two United States companies, Cargo and Jabil, which relocated their value chain activities from Russia and China, respectively. Cargo decided to relocate R&D activities from Russia to their own facilities in Lithuania, while Jabil relocated their production activities from China to their own facilities located in Poland. Although the facilities to which the relocation was made were previously owned by these companies, these two cases are the same as the case of the company from Taiwan. As the previous case presented, these two cases as well, according to different definitions of reshoring from Chapter 2, cannot be considered as reshoring and will be excluded from the sample that will be used in the analysis

5.2.1.3.2 Duplicates

The European Reshoring Monitor database includes various cases of reshoring from various companies. The database includes reshoring cases in which one company relocated their value

chain activities from one location, to which those activities were previously offshored, while there are cases of companies that relocated their value chain activities from different locations at once. Since, in these cases, one company is relocating activities from more than one offshore location it can be considered as one case, and making more cases from this may seem like the creation of duplicates. However, if one company relocates, or to be precise reshores, the same or different value chain activities from different offshore locations, all these relocations can still be considered as individual cases since even the same business function, such as production, may include different activities that are being reshored, or different requirements met and technology implemented for every individual case of reshoring. A great example of this dilemma about duplicates, from the database, is a company called "Premier Is - Mejerigaarden A/S" from Denmark which has five different reshoring cases in the database. The company decided in 2017 to reorganize its business and reshored production activities from five different countries (Poland, Slovenia, Sweden, Germany, and Ireland) back to Denmark. This is not the only example of cases like this since several companies performed reshoring from more than one offshore location at once. All these cases will be considered and included in the sample.

5.2.1.3.3 Reshoring or Nearshoring

At the very beginning of this Thesis, in Chapter 1 and Chapter 2, there was a brief discussion about the differences between reshoring and nearshoring. Reshoring was, just to remind ourselves, been defined as the relocation of previously offshored value chain activities to the home country of the company, while nearshoring has been defined as the relocation of previously offshored value chain activities to a country closer/near to the home country of the company. This distinction made in this Thesis clearly wasn't a big concern for the universities' consortium researchers since the European Reshoring Monitor database contains cases that will, according to the definition of both reshoring and nearshoring, be classified as nearshoring. This potential problem was also previously mentioned at the beginning of the methodology part of this Chapter. The table below shows how many cases are there in the database that fall under the definition of reshoring and how many of them fall under the definition of nearshoring. This table was made simply by comparing the company's home country with the country to which the value chain activities were relocated.

Type of relocation (reshoring or nearshoring)	Number of cases
Nearshoring	18
Reshoring	232
TOTAL	**250**

Table 7: An adjusted table containing the number of cases of reshoring and nearshoring in the European Reshoring Monitor database

This table contains three cases of companies, whose home country is outside of Europe, relocating their value chain activities to countries in Europe and those three cases are already excluded from the database, Table 7 can be adjusted as follows.

Type of relocation (reshoring or nearshoring)	Number of cases
Nearshoring	15
Reshoring	232
TOTAL	**247**

Table 8: An adjusted table 7 for three cases already excluded

Obviously from Table 8, we are left with 232 reshoring cases that fulfill the requirements of three previously presented classifications. Up to now, three cases have been excluded since the home country of the company was outside of Europe, and an additional fifteen have been excluded since those cases fall under the definition of nearshoring because the relocation was performed to a country that is not the home country of the company. After getting these 232 real reshoring cases, only one additional condition will be introduced for these cases to be part of the sample that will be used in the analysis.

5.2.1.3.4 Reshored business function

Lastly, when it comes to the creation of the sample that will be used in the analysis, there is one more condition for each reshoring case to be included in the sample. Since this Thesis aims to analyze **reshoring cases of manufacturing companies**, the final exclusion of ineligible reshoring cases will be discussed in detail and the final sample will be created. The exclusion of the non-manufacturing reshoring cases from the sample can be considered from two different standpoints. The first standpoint is looking only for companies that were classified with NACE code C - Manufacturing. After the exclusion of 18 cases, which was explained previously, and getting a sample of 232, below is a table representing how many companies for which reshoring cases were made are now with the NACE code C - Manufacturing.

Sector (NACE code)	Number of cases
A - Agriculture, forestry, and fishing	1
B - Mining and quarrying	3
C – Manufacturing	**201**
F – Construction	1
G - Wholesale and retail trade	4
H - Transporting and storage	1
J - Information and communication	10
K - Financial and insurance activities	8
M - Professional scientific and technical activities	1
N - Administrative and support service activities	2
TOTAL	**232**

Table 9: An adjusted table containing the number of cases including companies with different NACE codes in the European Reshoring Monitor database

These 201 cases that include companies with NACE code C - Manufacturing could be used as a sample for the analysis of the reshoring cases of manufacturing companies. However, from these 201 cases, not all include reshoring of production activities and there are cases that include reshoring of other business functions, from Table 5, other than production. Other Business functions that were reshored by some of the companies with C - Manufacturing NACE code are R&D, Administration, Logistics, and Maintenance. There are also some blank business function reshored fields included, which even further decreases the number of manufacturing companies reshoring production business function activities since from the case narrative of each case it was obvious that the reshored function wasn't production. The solution for this issue was to consider only companies that reshored production business functions by using the 'Reshored business function' column of the database. Filtering the database only for cases that have 'production' stated in the Reshored business function column gave 194 reshoring cases. Since there were blank cells in the 'Reshored business function' column for some cases, case narratives were analyzed and five of those cases have been including reshoring of production activities. Adding these additionally analyzed case narratives, the number of reshoring cases that were eligible for the sample that will be used in the analysis increased to 199 cases. However, another potential issue appears. Out of these 199 reshoring cases that include reshoring of exclusively production business function, 8 cases include companies with NACE codes that are not C - Manufacturing, which means that companies in those 8 cases probably

aren't manufacturing companies. Table 10 below shows which NACE codes and home many cases including companies with those codes are included in the sample of 199 cases.

NACE codes (Sectors) of companies reshoring production business function	Number of cases (companies)
A - Agriculture, forestry, and fishing	1
B - Mining and quarrying	1
C – Manufacturing	191
F – Construction	1
G - Wholesale and retail trade	2
J - Information and communication	3
TOTAL	**199**

Table 10: An adjusted table containing the number of cases for reshoring of production business function with different NACE codes in the European Reshoring Monitor database

All these 199 cases, as previously said, have "Production" written in their Reshored business function column and as it can be seen 8 of them aren't cases of manufacturing companies. To verify that these 8 cases have production activities, despite being classified as cases of companies from different sectors, case narratives were analyzed.

The analysis of the case narratives showed that out of these 8 reshoring cases that include companies with NACE codes other than C - Manufacturing, 6 cases actually include production of some sort and those are eligible for the sample, while there are 2 cases for which, probably by mistake, Reshored business function column was filled with "production" since these two cases do not include any production activities, according to the case narratives. These two cases, that will be the final exclusions from the sample are those of the companies Deanta (J - Information and communication) and Viking Genetics (A - Agriculture, forestry, and fishing). Deanta is excluded from the sample since it offers publishing production management services and Viking Genetics is excluded because they provide breeding services and services of genomic testing of animals. After the exclusion of these two cases, because of the reasons stated above, Table 11 shows the number of cases with different NACE codes is presented below.

NACE codes (Sectors)	Number of cases (companies)
B - Mining and quarrying	1
C – Manufacturing	191
F – Construction	1
G - Wholesale and retail trade	2
J - Information and communication	2
TOTAL	**197**

Table 11: Number of cases for reshoring of production business function with different NACE codes from the final sample

Finally, the sample of reshoring cases that will be used for the analysis is made and it contains 197 reshoring cases of European manufacturing companies.

5.2.2 Research questions and research methodology

This Thesis will focus on three research questions, where two out of the three questions come from the discussion in Chapter 3 regarding the Connection between Reshoring and Industry 4.0 technologies, while the one remaining question comes from Chapter 4 and the discussion regarding Covid-19 effect on global value chains and reshoring. The first two research questions, which will focus on the relationship between reshoring and Industry 4.0 technologies, are presented and explained first (Q1 and Q2), while the research question regarding the connection between Covid-19 and Reshoring comes last and will also be explained and presented more in detail.

From the entire discussion presented in Chapter 3, one main question arises, and answering this question might provide us with insight into the relationship between two important global economic phenomena.

The first research question will focus on the examination of the tendencies of companies to implement Industry 4.0 technologies while reshoring.

This question mostly reflects on the arguments by Ancarani et al. (2019) regarding different competitive priorities of companies and their effect on the level of implementation of new technologies and regarding empirical analysis findings of Fratocchi and Di Stefano (2020) regarding the relationship between reshoring and implementation of new technologies and the fact that 12.7% of reshoring decisions were motivated by the adoption of automation and/or innovative product/process technologies. During the analysis and providing an answer to this question, the importance of the effect of competitive priorities of a company for the

implementation of new technologies for reshoring will be disregarded, since from the discussion in Chapter 3 it is obvious that three out of four priorities may/do require some level of investment in new technologies and it can be taken as an assumption that most of the companies in the sample have at least one out of four competitive priorities.

Analysis and answering of this first research question will take into consideration **two different timings of the implementation of the Industry 4.0 technologies**. This first research question will take into consideration both the original case narrative and new case narrative, from the updated database. For the analysis of these two periods combined, it will be possible to see whether companies are implementing Industry 4.0 technologies in parallel with reshoring or in the period after the reshoring. For this first research question, there will be no distinction between these two different times of occurrence.

For analyzing this question, **quantitative analysis will be performed**. The concept of Reshoring will be used as an independent variable since all of the cases are cases of reshoring, while the concept of implementation of Industry 4.0 technologies will be considered as a dependent variable and the analysis will try to establish the relation between these two variables. Since the main sources of data are going to be case narratives, both from the original database that covers the period until 2019 and the updated case narrative that covers the period from 2019 to June 2023, **new columns within the database are created. The purpose of these new columns is to quantify data and simplify the analysis**. The first column that was added is named "Industry 4.0 technologies implemented during reshoring (2014-2018)" and it will contain simple "yes" or "no" categorical values, depending on whether there is a case of implementation of new technologies that can be detected from the case narrative that covers the period from 2014 up to 2019. The second column is named "Industry 4.0 technologies implemented after reshoring (2019-2023)" which will also contain "yes" or "no" values. Whether a company implemented new technologies in the period after reshoring (from 2019 until mid-2023), will be determined by examining an updated case narrative, that covers the stated period of time. All the data for two new columns will be analyzed in the **cross-tabulation way of analysis**.

For more detailed information and greater insight into the reshoring cases that include the implementation of Industry 4.0 technologies, additional analyses were performed. First of these additional analyses will focus on the location to where and from where production activities were reshored. This might provide information regarding the tendencies of companies from different countries to implement Industry 4.0 technologies while reshoring. For this analysis, cross-tabulation way of analysis is used. The second additional analysis tends to show whether

the size of the company affects the implementation of Industry 4.0 technologies while reshoring. As previously, cross-tabulation way of analysis is used as well.

In an attempt to analyze whether the implementation of Industry 4.0 technologies can be considered as a driver for reshoring or a means of achieving competitive priorities after the reshoring, the implementation will be split into two timeframes. From this attempt, another research question, finding the relationship between reshoring and Industry 4.0 technologies, is made:

The second research question tends to evaluate whether companies are more likely to implement Industry 4.0 technologies in parallel with reshoring

For analyzing this question, **quantitative analysis will be performed**. The concept of Reshoring will be used as an independent variable again, since all of the cases are cases of reshoring, while the concept of implementation of Industry 4.0 technologies will be considered as a dependent variable. The dependent variable will be also analyzed through the perspective of the time of occurrence of implementation - whether the implementation occurs in parallel with the reshoring or in years after reshoring. Same columns, that were created based on case narratives in the database, are going to be used for this research question as well. All the data for two new columns will be analyzed in the **cross-tabulation way of analysis**. Findings regarding the number of cases indicating the implementation of Industry 4.0 technologies in parallel with reshoring are going to be compared with the number of cases in which the implementation of technologies came in the year after reshoring.

As for the first research question, additional analyses are conducted for this research question as well. Quantitative analysis showing the locations where production activities are reshored to and from where the production activities are reshored from will be presented. This analysis will provide more details about the home countries of companies that implemented Industry 4.0 technologies either in parallel or in a period after reshoring. Results showing countries with the highest number of Industry 4.0 technologies implemented with reshoring, in both periods of implementation, will be analyzed and discussed afterwards.

The third research question of this Thesis is related to the effects of Covid-19 on the global value chains and whether the pandemic influenced production activities and location decisions. Since the updated European Reshoring Monitor database will be used, it contains only reshoring cases which prevents any analysis of whether the Covid-19 pandemic was a driver for reshoring. However, based on the available database, the following question will be analyzed:

The effect of Covid-19 pandemic on the location strategies of companies that already started or finished the process of production activities reshoring

For analyzing this question, **quantitative analysis will be performed**. Similarly to the first research question, for analysis of this topic, an additional column within the database is created. The new column is named "Changes of location strategies due to Covid-19" and the column will contain either "yes" or "no" categorical values that will further be analyzed in the **cross-tabulation analysis**. Values provided in the newly created column are coming from the updated case narrative column that covers the period from 2019 onwards. Since the updated case narratives include the effects of other regional or global events on the location strategies of companies, some of those events are analyzed in addition. For the differences between effect of different global and regional events, **a brief qualitative analysis is performed** and the results are presented.

5.3 Analysis

As was in detail discussed in the 'Research questions and research methodology' part of this Chapter, there are three research questions that will be in the focus of this Thesis. The first part of the Analysis will analyze the connection and relation between reshoring and implementation of Industry 4.0 technologies. The interest in this relation comes from previously mentioned, standpoints and findings of different authors that covered this topic and in this Thesis, their findings, statements, and opinions will be analyzed on the updated European Reshoring Monitor database. The relation between the phenomenon of reshoring and the outburst of Industry 4.0 technologies implementation in manufacturing will be analyzed by answering two partially connected questions. For the end of the analysis section of this Chapter, the third research question regarding the potential effect of the Covid-19 pandemic on the location strategies of manufacturing companies. The interest in this relation comes from the fact that a lot of things worldwide were, temporarily or permanently, changed by Covid-19 and the effect could be seen on the Global Value Chains as well. The biggest question, for which there is no precise answer, is whether Covid-19 affected companies to reconsider their production location strategy and make some changes. This third research question will also be analyzed from the updated European Reshoring Monitor database.

5.3.1 Tendencies of companies to implement Industry 4.0 technologies while reshoring

With the European Reshoring Monitor database that was created by a consortium of researchers from different Italian universities, it was possible to analyze different reshoring cases within European Union (some included companies from different continents) through the all relevant information regarding reshoring like reasons for reshoring, countries reshored from, countries reshored to, case narrative, business function reshored, etc. However, since all pieces of information were until 2019, it was required to update the findings and the most feasible way was to update the case narrative. This way of updating provided the opportunity to provide information on whether companies from original reshoring cases continued reshoring their activities, abandoned reshoring as a location strategy, and most importantly for this Thesis, have companies implemented any Industry 4.0 technology after reshoring. Since the implementation of Industry 4.0 technologies was already mentioned in case narratives for cases including the implementation, this update of the case narrative provided a great opportunity to analyze this question. The two different timings of implementation of Industry 4.0 technologies connected

to reshoring are the reason why it was said that this research question will consider two different timings of implementation.

First of all, let's take a look at how many reshoring cases from the sample have implementation of Industry 4.0 technologies included. This insight into the overall implementation of Industry 4.0 technologies by manufacturing companies may provide an initial answer to how closely Industry 4.0 technologies and reshoring are connected.

Cases with implementation of Industry 4.0 technologies	Number of cases
Yes	62
No	135
TOTAL	**197**

Table 12: Number of reshoring cases from the sample that include implementation of Industry 4.0 technologies

Table 12 clearly shows that the majority of reshoring cases haven't included any implementation of Industry 4.0 technologies. Putting this finding into the percentages, it shows that 31.5% of reshoring cases include the implementation of Industry 4.0 technologies at some point in time, either at the same time as reshoring happened or in some short period of a few years after reshoring. For 62 cases from Table 12 that have implementation of Industry 4.0 technologies included, a distinction between different technologies hasn't been made. The following are mostly implemented technologies:

- Automation
- Robotization
- AI
- Smart Factory
- 5G technology

Automation of production lines is the most stated term when it comes to sources from which original and updated case narratives were made in these previously mentioned 62 cases of reshoring that include these new technologies. Artificial Intelligence and Robotization are terms used in only a few cases, but it is important to mention that there are cases including these new technologies. Building a Smart Factory may include the implementation of various Industry 4.0 and other technologies and this was stated only in one out of 62 cases. Lastly, 5G technology is the crucial technology in Industry 4.0 since it enables connectivity and communication

needed for the implementation of other technologies. This technology was mentioned only in one of 62 cases.

To provide more details about these 62 reshoring cases that include the implementation of Industry 4.0 technologies, other cross-tabulation analyses were conducted. The aim is to use the contexts, available for each of these 62 cases from the case narratives, to see whether there are some patterns in the implementation of Industry 4.0 technologies connected to reshoring and provision of different categorizations. The first and most simplest cross-tabulation analysis will be used to analyze how many cases there are for each country represented in the 62 reshoring cases that include the implementation of Industry 4.0 technologies. The results are provided in the Table below.

Home country of the company/ Country reshored to	Number of cases
France	11
Norway	11
Italy	9
United Kingdom	7
Spain	5
Sweden	5
Germany	4
Denmark	3
Poland	3
Belgium	1
Netherlands	1
Switzerland	1
Finland	1
TOTAL	**62**

Table 13: Number of reshoring cases from the sample that include implementation of Industry 4.0 technologies from each country

From the Table 13 it can be seen that there are two countries with highest number of reshoring cases that included implementation of Industry 4.0 technologies in parallel with reshoring or in period of few years after reshoring. These two countries are France and Norway, with 11 cases

each. Following these two leaders, there are Italy and the United Kingdom with 9 and 7 cases including the implementation, respectively. Countries with only one reshoring case that includes the implementation of these technologies are Belgium, Finland, Netherlands, and Switzerland. To determine whether higher numbers for Norway and France are simply due to a large number of cases, each of these two leading countries, according to the number of cases that include the implementation, will be analyzed separately.

First is Norway which it was presented that has 11 reshoring cases that include the implementation of Industry 4.0 technologies. The sample created for this Thesis, which was created from the European Reshoring Monitor database, contains 197 reshoring cases. Out of those 197 cases, there are 16 cases of reshoring to Norway. Analyzing only the sample created for this Thesis, 11 out of 16 production business function reshoring cases have included the implementation of Industry 4.0 technologies, which represents 68.75%. This result shows that the majority of companies from Norway that reshored their production activities decided to implement some of the Industry 4.0 technologies. Before the Sample was created for the analysis, a number of cases from each country from the original European Reshoring Monitor database was presented, and there it can be seen that Norway has 19 cases in the original European Reshoring Monitor. The difference between the original database and the sample is that 3 cases of reshoring from Norway were excluded simply because two of them were reshoring of IT business function, while the last one was reshoring of Administrative business function. Considering also that there are 19 cases for reshoring to Norway, regardless of the business function reshored, the percentage of those cases that include the implementation of Industry 4.0 technologies is almost 58%.

Since France has the same number of reshoring cases that include the implementation of Industry 4.0 technologies as Norway, it is time to analyze French reshoring cases more in detail. The Sample created for this Thesis contains 33 reshoring cases in France and out of those 33 production business function reshoring cases, 11 include the implementation of Industry 4.0 technologies, which means that every third company from France, that is reshoring production functions, implements at least one of Industry 4.0 technologies. The original European Reshoring Monitor database contains 36 cases from France and the difference between that database and the Sample in this Thesis is three excluded companies, because those three cases included reshoring of business functions other than Production. The percentage of overall reshoring cases, considering the original database, from France in which companies have implemented Industry 4.0 technologies is 30.55%. Taking into consideration both the original

database and the Sample, results for companies implementing Industry 4.0 technologies in France are lower than those in Norway.

Out of the leaders in terms of the number of reshoring cases that include the implementation, reshoring cases/companies from Norway showed that the majority of production business functions reshored to Norway include Industry 4.0 technologies implementation and that the implementation is at a higher level than in France. The same analysis as the one for Norway and France was done for the rest of the reshoring cases, which include the implementation of Industry 4.0 technologies, from other countries presented in Table 13 above.

Home country of the company/ Country reshored to	Number of reshoring cases that include the implementation of I4.0 technologies (1)	Number of reshoring cases in the Sample (2)	% (1/2)	Number of cases in the original European Reshoring Monitor database (3)	% (1/3)
Belgium	1	2	50%	3	33%
Denmark	3	15	20%	19	16%
Finland	1	7	14%	9	11%
Germany	4	10	40%	17	24%
Italy	9	32	28%	39	23%
Netherlands	1	2	50%	4	25%
Poland	3	6	50%	6	50%
Spain	5	7	71%	12	42%
Sweden	5	15	33%	17	29%
Switzerland	1	1	100%	4	25%
United Kingdom	7	36	19%	44	16%

Table 14: Percentage of overall reshoring cases from Sample that include I4.0 technologies implementation

From the Table 14 it is obvious that Norway doesn't have the highest result when it comes to companies implementing Industry 4.0 technologies while reshoring production business function. Since there is an example of Switzerland, for which there is only one case of reshoring of production business function and that case includes the implementation of Industry 4.0 technologies, the result is insignificant. The same can be said for the cases from Belgium and Netherlands since there are only two cases of production business functions reshoring and for

both countries, the results are that 50% of those cases include the implementation of the Industry 4.0 technologies. Because of this, for making any relations and any conclusions regarding the connection between reshoring and Industry 4.0 technologies implementation, only countries with the higher number of cases should be considered. From the Table above those would be Denmark, Germany, Italy, Spain, Sweden, and the United Kingdom. Of course, Norway and France are included previously. Out of these previously mentioned countries, from where there are more cases available for the analysis, there is only one country whose companies, that reshored production business function activities, have a greater percentage of cases that implemented Industry 4.0 technologies (71%) than Norway and that is Spain. However, considering the overall number of reshoring cases in the original database, the percentage of those cases that include the implementation of these technologies falls to 42%. Despite this, focusing only on the implementation of mentioned technologies in cases of production business functions reshoring, Spain can be considered as the country whose companies that reshored some production activities have a high percentage of implementation of Industry 4.0 technologies. Also, it is possible to add Germany to this group since 40% of production activities reshoring cases include the implementation of Industry 4.0 technologies, as well as Sweden with 33% of cases. On the other hand, companies from Italy, Denmark, and the United Kingdom show a bit different results with the percentages of production activities reshoring cases that include the implementation of Industry 4.0 technologies are 28%, 20%, and 19%, respectively. This shows that these percentages are below the total percentage of the implementation that considered 62 cases including the implementation in the entire sample of 197 cases. Cases from Italy and the United Kingdom are especially interesting since these are the countries with the highest number of reshoring cases in the original database, 39 and 44 respectively. Number of the cases from Italy that are included in the Sample used in the analysis is 32, while the number of cases from the United Kingdom in the Sample is 36. Considering all of this, it can be said that companies from Italy and the United Kingdom do not tend to implement Industry 4.0 technologies while reshoring, and their results are below the result of the sample which showed that 31% of production activities include the implementation of at least one of the Industry 4.0 technologies.

This part of the analysis provided a great insight into the implementation of Industry 4.0 technologies in different countries that have their companies (reshoring cases) in the Sample and the result shows that companies from some countries have higher rates of implementation while there are also countries with lower rate of companies implementation of Industry 4.0 technologies. Since the geographical aspect, of the home country of the company is taken into consideration, a similar analysis may be performed to determine whether there is a correlation

between the size of the company and the implementation of Industry 4.0 technologies. For the determination of the size of the company, another column provided in the original database was used - the number of employees. Since the number of employees can be used for determining the size of the company, this will be done and then the number of reshoring cases that include the implementation will be allocated to one of the categories. Table 15 below will be used to determine whether small, medium, or large companies are more likely to implement Industry 4.0 technologies while reshoring. Since the Sample used for the analysis consists of reshoring cases and there is a possibility that there is more than one case of reshoring for one company, the first step was to exclude any duplicates, more than one reshoring case coming from one company, from the 62 reshoring cases. This resulted in 54 reshoring cases (companies) left. Companies with **up to 50 employees were considered as small companies**, while companies with **between 50 and 250 employees were considered as medium companies**. All companies with **more than 250 employees have been considered as large companies**. Also, since the number of employees that were provided in the original database is from the period from 2014 up to 2018, and there is some blank field in the sense that there are no data regarding the number of employees for some companies in that period, it was practically impossible to find accurate data about the number of employees in the period from 2014 to 2018 for the majority of those companies. Taking a current number of employees may give inaccurate results since companies may have, in the period from 2019 up to now, increased or decreased their number of employees and those companies may be classified incorrectly. To avoid misclassifications, no updates on the number of employees were made and the Table will contain companies without data regarding the number of employees.

Company size	Number of companies that implemented I4.0 technologies while reshoring
Large	31
Medium	6
Small	6
unknown	11
TOTAL	**54**

Table 15: Reshoring cases including implementation of I4.0 technologies categorized by size of the company

From Table 15 it is obvious that the majority of companies that implemented Industry 4.0 technologies while reshoring are large companies (in terms of number of employees) with more than 250 employees. Taking into consideration those companies for which it wasn't determined

whether they are small, medium, or large 54 companies are presented and 31 out of those 54 are large companies. In terms of percentages, it means that 57.4% of companies that implemented Industry 4.0 technologies while reshoring are large companies. Those 11 companies without available data regarding the number of employees can also be excluded and then 43 companies would be analyzed. The number of small, medium, and large companies would stay the same and the result, in terms of percentage, would increase. Out of 43 companies that implemented Industry 4.0 technologies, 72% (31 companies) are large companies while the rest of 28% is split evenly between small and medium companies. From these results, it is obvious that companies that implement Industry 4.0 technologies while reshoring production business functions are predominantly large companies.

5.3.1.1 Conclusion

Looking simply at the number of reshoring cases in the sample created that include implementation of Industry 4.0 technologies, shows that there is some connection between reshoring and Industry 4.0 technologies. However, this relation cannot be considered as strong, and in terms of the research question "***Do companies tend to implement Industry 4.0 technologies while reshoring?***" the answer is - **No**. This is the answer only because 31% of cases that include the implementation of Industry 4.0 technologies don't show general tendencies of all or most companies that are relocating their manufacturing activities back home to implement these technologies. However, putting this percentage of 31% in the context of a possible implementation of Industry 4.0 technologies by companies that are planning to reshore their production in the future, the implementation may be an important factor and general implementation of these technologies, especially in relation with reshoring, may increase rapidly.

Whether these 31% of reshoring cases, which include implementation of these new technologies, show a positive or negative change in relation to these two phenomena, is hard to tell. To find out whether there is an increasing or decreasing number of reshoring cases that include implementation of these technologies, a same or quite similar analysis as this one must be made in the future (or should have been done in the past) to compare these findings.

However, further analysis conducted showed that within those 31% of reshoring cases that implemented Industry 4.0 technologies are some differences, considering the location of reshoring and size of the companies that perform reshoring together with implementation of Industry 4.0 technologies. First of all, **the highest rates of implementation of Industry 4.0 technologies together with reshoring is present among companies from Norway and**

Spain. Results similar to those of the entire Sample are shown by companies from France, Germany, and Sweden, while **companies from Italy, Denmark, and the United Kingdom show below-average implementation of the Industry 4.0 technologies in process/because of reshoring.** Reasons for the difference between rates of implementations of Industry 4.0 technologies in the reshoring process at different locations cannot be determined with certainty.

Similarly to the analysis regarding the companies' locations and locations of reshoring, an analysis was conducted to determine companies of which size (small, medium, large) are more prone to the implementation of Industry 4.0 technologies while reshoring production functions. The results showed that those **companies that implemented Industry 4.0 technologies while reshoring production business functions are mostly large companies since 72% of the companies for which the number of employees was available are large companies.** This may be due to the fact that large companies have more assets and greater investment capacity which enables them to implement these new technologies. This assumption cannot be proven from the Sample used for this analysis.

5.3.3 The Likeliness of companies to implement Industry 4.0 technologies in parallel with the reshoring

Analysis conducted in the previous part of the Chapter, the Table presented and the Conclusion all come from the consideration of the implementation of Industry 4.0 technologies that are connected with reshoring in two different ways, or better to say - two different timings of the implementation considered together. The first research question combines the implementation of Industry 4.0 technologies in parallel with the reshoring and implementation of technologies in the period after reshoring.

Taking these two different timings of implementation separately will provide a better insight into whether Industry 4.0 technologies are more likely to be considered as drivers/motives for reshoring or are more likely to be considered as means and tools for achieving competitive priorities after reshoring was already performed. Since the updated European Reshoring Monitor database, as well as the sample created includes two case narratives, these two different timings of implementation are going to be separated that way. First, the original case narrative, which covers the period from 2014 until 2018 will be used for the cases including Industry 4.0 technologies implementation and implementation in this period will be considered as implementation parallel with reshoring. On the other hand, an update of the database was performed by creating an additional case narrative that covers the period from 2019 until mid-2023, and implementation of Industry 4.0 technologies from these case narratives, in this period, will be considered as implementation after reshoring.

Below a Table is provided that shows a few possible scenarios and how the additional columns, added after the update and creation of a new case narrative section, were prepared for the analysis of the first and especially second research question.

Case narrative (2014 - 2018)	**Case narrative (2019-2023)**	**I4.0 technologies implemented during reshoring**	**I4.0 technologies implemented after reshoring**	**I4.0 technologies implemented overall**
Does mention the implementation of some Industry 4.0	**Does not mention** the implementation	YES	NO	YES

technology	of any Industry 4.0 technology			
Does not mention the implementation of any Industry 4.0 technology	**Does mention** the implementation of some Industry 4.0 technology	NO	YES	YES
Does not mention the implementation of any Industry 4.0 technology	**Does not mention** the implementation of any Industry 4.0 technology	NO	NO	NO

Table 16: Representation of the preparation of additional columns

While the column on the far right has been used for the analysis of the first research question, the third and fourth columns from the left, which are highlighted with light orange, are going to be used for separating the implementation into two different time frames.

As mentioned previously, Industry 4.0 technologies implemented during or parallel with reshoring will be considered as drivers/motives for reshoring, and results of the analysis for this timeframe are going to be compared with the results obtained by Fratocchi and Di Stefano (2020) in their empirical analysis. On the other hand, a potentially higher number of reshoring cases that include implementation of Industry 4.0 technologies after reshoring, compared with a number of cases that include implementation in parallel with reshoring, will provide some sort of empirical background for considering Industry 4.0 technologies as a means for reaching the companies' goals in terms of competitive priorities. It will be hard to use these findings in terms of statements provided by Ancarani et al. (2019) that highlighted that the implementation of Industry 4.0 technologies depends on companies' competitive priorities. However, from Chapter 3, it can be seen that three out of four competitive priorities may require the implementation of Industry 4.0 technologies in the process of reshoring. Analysis in this Thesis will not be able to separate the implementation of new technologies based on four competitive priorities.

The first highlighted column from Table 16, represents how many cases, out of the overall 197 reshoring cases, included the implementation of Industry 4.0 technologies in parallel with the process of reshoring. The results are in the Table below.

Does the reshoring case indicate the implementation of Industry 4.0 technologies in parallel with reshoring	Number of cases
Yes	33
No	164
TOTAL	**197**

Table 17: Number of reshoring cases indicating implementation of Industry 4.0 technologies in parallel with reshoring

This result of the analysis, represented in a Table 17, shows that 33 reshoring cases have implementation of Industry 4.0 technologies included during/in parallel with reshoring. Looking simply at the number of cases that do and do not include the implementation of these new technologies, it can be said that most of the reshoring cases, usually one case representing one company (with few exceptions), do not include any implementation of Industry 4.0 technologies. However, this result needs to be put into the right context to see the real meaning of these 33 cases. First, let's compare this result with the one from Fratocchi and Di Stefano (2020). ***Fratocchi and Di Stefano (2020) have proved that 12.7% of reshoring decisions were motivated by automation and/or other innovative product/process technologies (excluding 3D printing/additive manufacturing)***. Since automation is the most used term from all Industry 4.0 technologies in the updated database, these technologies stated by Fratocchi and Di Stefano (2020) may also be substituted with the term Industry 4.0 technologies. Results from the updated database and this analysis, when 33 cases are presented in percentages, show that ***16.75% of reshoring cases are motivated/driven by the implementation of these technologies***. This comparison shows similar results of this analysis with the empirical analysis of Fratocchi and Di Stefano (2020). This result can also be compared with other reasons/motives for reshoring that were stated in the database for each reshoring case. Following are a few reasons for reshoring that may be considered as one of the most important for abandoning offshoring and bringing production back home and percentages representing how many cases of reshoring have that reason stated:

- Delivery time 13.2% - for which it can be said that it is one of the four competitive priorities stated by Ancarani et al. (2019).
- Made in effect 21.8%
- Poor quality of offshored production 7.6%

Considering these reasons for reshoring, that may be categorized as some of those connected closely to competitive priorities, and comparing them to the number of reshoring cases that

were driven/motivated by the implementation of Industry 4.0 technologies, a conclusion can be drawn that implementation of Industry 4.0 technologies is equally represented reason for reshoring as some other reasons that may be more tightly connected to competitive priorities and that might be considered as most relevant ones.

This comparison shows that implementation of technologies that fall under the category of Industry 4.0 technologies are a represented reason for reshoring in the sample that is analyzed as some other more discussed and reasons more attention is paid to.

Since the original database includes a 'Reasons for Reshoring' section which states each reason why the company decided to fully or partially reshore their production activities and since most of these 33 cases have "automation of production process" stated as one of the reasons, an additional analysis was conducted to analyze what was the most stated reason in combination with automation. Since there are some cases, out of these 33, for which "Automation of production process" is not stated as one of the reasons for reshoring, but the automation and implementation of any other Industry 4.0 technology are mentioned in the case narrative for this period, it was considered as omission and all 33 cases will be analyzed as if all of them have "Automation of production process" as one of the reasons for reshoring. Since the reasons for reshoring, stated in the section of a same name, may be firm-specific and in that case, only one out of 33 cases include this reason and because of simplifying the analysis, only those reasons stated in several out of these 33 cases will be presented.

Reasons for reshoring stated alongside "automation of production process" reason	**Number of cases including the reason**
Delivery time	15
Poor quality of offshored production	9
Untapped production capacity	6
Implementation of strategies based on product/process innovation	5
Made in effect	5
Proximity to customers	4
Government support to relocation	3
Firm's global reorganization	3
Know-how in the home country	2

Production flexibility	2
Quality control	2

Table 18: Cases with the number of different reasons for reshoring stated with "Automation of production process"

From the Table 18 it is obvious that by far the most stated reason for reshoring, in cases that include the implementation of Industry 4.0 technologies in parallel with reshoring, alongside "Automation of production process" is "Delivery time". Almost half of these reshoring cases that include the implementation have "Delivery time" stated as one of the reasons for reshoring. The second most stated reason is "Poor quality of offshored production", with 9 out of 33 cases including this reason. So, from Table 18, it can be concluded that Automation of the production process is most tightly connected with solving problems with delivery time and poor quality of offshored production. The implementation of Industry 4.0 technologies for the sake of increasing the quality of products seems like a logical step and a way in which it can be achieved in the easiest and most effective way possible. Because of this, the implementation of these technologies for higher quality of products seems logical and the correlation between two reasons for reshoring, Poor quality of offshored production and Automation of the production process, is understandable and clear since Industry 4.0 technologies can surely increase the quality of the product and help companies solve the disadvantage of lower quality of offshored production. However, Delivery time, which is the most stated reason for reshoring alongside "Automation of production process", is not directly affected by the implementation of these technologies. Ancarani et al. (2019) stated that reshoring on its own solves delivery problems and that there is no incentive to invest in further technologies that may improve delivery reliability and speed. In this case, it can only be assumed that one of the reasons, either "Delivery time" or "Automation of production process", was the primary reason for reshoring while the other one was the consequence or the way of solving other problems that may occur with reshoring. This is practically impossible to analyze and make a clear conclusion, especially from this database, without ranking the reasons for reshoring, and without analyzing each of these 15 cases, that include both reasons, separately.

Another analysis conducted on these 33 cases of reshoring that include the implementation of Industry 4.0 technologies in parallel with reshoring is analyzing the countries from which and to which reshoring was performed. The same analysis was conducted on the cases that include implementation of those technologies in the period after reshoring and the result will be compared in the conclusion for this research question. The results of the analysis are presented in Table 19 below.

Countries to where the production activities were reshored to, that include the implementation of I4.0 technologies being implemented in parallel with reshoring	Number of cases	Countries from where the production activities were reshored, that include the implementation of I4.0 technologies being implemented in parallel with reshoring	Number of cases
Norway	10	China	11
United Kingdom	5	Poland	7
France	4	Czech Republic	1
Germany	3	Lithuania	1
Italy	3	Mexico	1
Denmark	3	Morocco	1
Sweden	2	Netherlands	1
Poland	1	Bulgaria	1
Switzerland	1	Romania	1
Belgium	1	Russia	1
		Serbia	1
		Slovakia	1
		Sweden	1
		Taiwan	1
		Thailand	1
		Tunisia	1
		Ukraine	1
TOTAL	**33**	**TOTAL**	**33**

Table 19: Number of reshoring cases that include the implementation of Industry 4.0 technologies in parallel with reshoring based on countries reshored to and reshored from

As for the overall number of reshoring cases that include implementation of Industry 4.0 technologies, here Norway and France are leaders as well. On the other hand, the country from where the production activities were most commonly relocated is China. 33% of the reshoring cases that include implementation of Industry 4.0 technologies being implemented in parallel with reshoring are relocations from China. The second place on this list belongs to Poland, with 7 cases including the reshoring of production activities from Poland. The interesting fact is that

there are only two countries, within these 33 reshoring cases, that are represented in both lists of countries to which activities were reshored to and the list of countries from which activities were reshored from, are Poland and Sweden.

However, let's see whether companies are more likely to implement Industry 4.0 technologies in parallel with reshoring or in a few years after reshoring.

Since the implementation of technologies in parallel is already presented in Table 17, following Table 20 represents the number of cases including the implementation of Industry 4.0 technologies after reshoring.

Does the reshoring case indicate the implementation of Industry 4.0 technologies after reshoring	Number of cases
Yes	33
No	164
TOTAL	**197**

Table 20: Number of reshoring cases indicating implementation of Industry 4.0 technologies after reshoring

This Table 20, shows that in the sample, made from the updated European Reshoring Monitor database, 33 reshoring cases have the implementation of Industry 4.0 technologies in years after the relocation of manufacturing activities to home country was performed. Representing this result in the percentage of overall cases that include implementation of these technologies after reshoring - ***16.75% of reshoring cases include implementation of some Industry 4.0 technology after reshoring***. Comparing this result, with the findings regarding the implementation of technologies in parallel with reshoring, it can be seen that ***results are exactly the same and that this sample, used for this analysis, has the same number of cases with implementation of Industry 4.0 technologies in the parallel with reshoring and in period after reshoring***.

The same analysis conducted on the reshoring cases that include the implementation of Industry 4.0 technologies in parallel with reshoring, was conducted on these reshoring cases that include the implementation of these technologies after reshoring. The results of the analysis, showing the countries from where and to where activities were reshored, are presented in the Table below.

Countries to where the production activities were reshored to, that include the implementation of I4.0 technologies being implemented after reshoring	Number of cases	Countries from where the production activities were reshored, that include the implementation of I4.0 technologies being implemented after reshoring	Number of cases
France	7	China	10
Italy	6	Germany	4
Spain	5	Poland	3
Sweden	4	United Kingdom	3
United Kingdom	3	Italy	2
Denmark	2	Lithuania	1
Poland	2	Netherlands	1
Finland	1	Finland	1
Germany	1	Romania	1
Netherlands	1	Serbia	1
Norway	1	Spain	1
		Sweden	1
		Taiwan	1
		India	1
		Vietnam	1
		unknown	1
TOTAL	**33**	**TOTAL**	**33**

Table 21: Number of reshoring cases that include the implementation of Industry 4.0 technologies after reshoring based on countries reshored to and reshored from

As said, this is the same analysis, conducted on the reshoring cases that include implementation of Industry 4.0 technologies in different periods. As obvious, the leading countries, with the most cases of reshoring of production activities that included Industry 4.0 technologies implementation after reshoring, are Italy and France. While France was one of those countries with a high number of cases including implementation in parallel with reshoring, Italy did not have a high number of cases that included implementation of those technologies in parallel with reshoring. Also, different results can be seen in the case of Norway. Norway had the highest number of reshoring cases that included the implementation of Industry 4.0 technologies in

parallel with reshoring, while there is only one reshoring case from Norway that included the implementation of Industry 4.0 technologies after reshoring. The country with the highest number of cases of production activities being reshored from is China with ten cases and this means that China is a leading country when it comes to production activities being reshored from and those reshoring including the implementation of Industry 4.0 technologies. China has the highest number of cases regardless of the period of implementation of Industry 4.0 technologies.

However, this number of reshoring cases that include implementation of these technologies after reshoring, also include implementation at other manufacturing locations that are not connected to previous reshoring of manufacturing activities. Trying to take into consideration only cases that include clear implementation of Industry 4.0 technologies at the location to which reshoring was performed, the results are as follows.

Categories of cases including implementation of Industry 4.0 technologies after reshoring	**Number of cases**
Clear implementation after reshoring	15
Uncleared details - period of implementation, location, whether the implementation is done, etc.	8
Implementation at another offshore location - subsidiaries or multiple offshore manufacturing locations	10
TOTAL	**33**

Table 22: Categories of reshoring cases that include implementation of Industry 4.0 technologies after reshoring

As shown in Table 22 above, there are ***only 15 reshoring cases that include implementation of Industry 4.0 technologies at the location to which reshoring was performed***, while 18 out of the 33 reshoring cases that include implementation of these technologies after reshoring, do not suggest that the implementation was performed at the location to which manufacturing activities were reshored. ***These 15 reshoring cases for which can be said to clearly include the implementation of Industry 4.0 technologies after reshoring at the location to which manufacturing activities were reshored to, according to the original case narrative, represent only 7.6% of overall reshoring cases in the sample***.

After the exclusion of reshoring cases that include the implementation of Industry 4.0 technologies in a period after reshoring but at another location (not the location to which

activities were reshored to) and the exclusion of cases with unclear details of the implementation of these technologies in the period after reshoring, the same analysis showing countries with a number of cases reshored from and reshored to was conducted.

Countries with reshoring cases including clear implementation of Industry 4.0 technologies in period after reshoring	Number of cases	Countries from where activities were relocated, with reshoring cases including clear implementation of Industry 4.0 technologies in period after reshoring	Number of cases
Italy	3	China	6
Spain	3	Finland	1
Sweden	3	Italy	1
Denamrk	1	Lithuania	1
Finland	1	Poland	1
France	1	Serbia	1
Norway	1	Sweden	1
Poland	1	Taiwan	1
United Kingdom	1	Vietnam	1
		unknown	1
TOTAL	**15**	**TOTAL**	**15**

Table 23: Number of reshoring cases that include the clear at home implementation of Industry 4.0 technologies after reshoring based on countries reshored to and reshored from

Results of the same analysis regarding the locations affected, but on the sample of reshoring cases that have clear information regarding the implementation of Industry 4.0 technologies in period after reshoring, show that Italy, Spain, and Sweden are countries with highest number of reshoring cases that include clear implementation of Industry 4.0 technologies in period after reshoring at the location to where activities were reshored to. Cases that include companies from France obviously included the implementation of Industry 4.0 technologies at locations different from the location activities were reshored to, as well as the implementation of those technologies for which there is no detailed information. China is a mostly represented country when it comes to from where production activities were reshored, with six out of fifteen cases, which means China is still a country from where activities were mostly reshored from, despite the exclusion of unclear implementation of technologies in the period after reshoring.

5.3.3.1 Conclusion

Looking at the number of cases that include the implementation of Industry 4.0 technologies in parallel with reshoring, which represents 16.75% of overall reshoring cases and, as said before, can be included equally with other reasons for reshoring, it can be said that companies are driven to some extent to reshore, their previously offshored manufacturing activities, because of the Industry 4.0 technologies and their implementation at the production sites located at home. Clearly, there are reshoring cases that do not include the implementation of any new technologies while reshoring, and previously the analysis was supposed to show whether there are, and how many, cases include the implementation of Industry 4.0 technologies after reshoring was performed. ***Results show that the number of cases including the implementation of Industry 4.0 technologies in each timeframe is the same, with 33 reshoring cases for both implementation in parallel with reshoring and also for the implementation after the reshoring***.

In terms of the locations affected in the process of reshoring of production activities, Norway has the highest number of reshoring cases (10) that include implementation of Industry 4.0 technologies in parallel with reshoring. Countries with the second and third highest number of reshoring cases that include the implementation of Industry 4.0 technologies in parallel with reshoring are the United Kingdom and France with five and four cases, respectively. On the other hand, countries from where production activities were mostly reshored, while those reshoring cases include the implementation of Industry 4.0 technologies in parallel with reshoring are China with eleven cases and Poland with seven cases. Comparing these results with the results of the same analysis conducted on the reshoring cases that include the implementation of Industry 4.0 technologies in the period after reshoring shows that companies from other countries were more prone to implement Industry 4.0 technologies after reshoring rather than in parallel with reshoring. **The country with the highest number of reshoring cases that include the implementation of Industry 4.0 technologies in the period after reshoring is France, with seven cases, while the second place belongs to Italy, with six reshoring cases**. The third place belongs to Spain with five cases. The country from which the highest number of reshored production activities, which include the implementation of Industry 4.0 technologies after reshoring, comes from China with 10 reshoring cases.

While France is one of the countries with the highest number of reshoring cases that include implementation of these technologies both in parallel and in the period after reshoring, **reshoring cases from Italy and Spain suggest that companies from these countries are more prone to implement Industry 4.0 technologies in the period after reshoring, while**

companies from Norway if decide to implement these technologies, tend to implement Industry 4.0 technologies in parallel with reshoring. This difference cannot be seen in the case of location from where production activities were reshored, since China is the number one country in both reshoring cases that include the implementation in parallel and in the period after reshoring.

However, reshoring cases that include implementation of Industry 4.0 technologies after reshoring, do not include implementation exclusively at the location to which activities were previously reshored to. A total of 33 cases which include the implementation of these technologies after reshoring also contain implementations at other offshore locations, and implementation for which is unclear where and when happened. After the exclusion of all of the cases with unclear and insufficiently detailed information, 18 of them in total, **15 reshoring cases, that clearly show the implementation of Industry 4.0 technologies at the location to which activities were previously reshored, were left**. Compared to the previous 33 cases, before the exclusion of some, this is less than half of those cases, and only 7.6% of overall reshoring cases making the sample are those that include the implementation of Industry 4.0 technologies after reshoring. Considering these 15 cases, as the final number of cases for the implementation after reshoring and comparing them to 33 cases of reshoring that include implementation in parallel with reshoring, it can be concluded that **companies (represented through reshoring cases) are more likely to implement Industry 4.0 technologies in parallel with reshoring rather than in the period after reshoring.**

This exclusion also changed the further analysis conducted. France has the highest number of reshoring cases that include the implementation of Industry 4.0 technologies (regardless of the location of the implementation and available information about which technologies) after exclusion has only one reshoring case including the implementation of Industry 4.0 technologies in the period after reshoring at the location activities were reshored to. **Countries from where companies tend to implement Industry 4.0 technologies after reshoring the most are Italy, Sweden, and Spain.** While these are the leading countries to where activities were reshored, together with the implementation of Industry 4.0 technologies after reshoring, **the country from where most of these production activities were reshored is China, with 40% of the reshoring cases that include clear implementation of Industry 4.0 technologies after reshoring coming from China.**

5.3.4 The effect of the Covid-19 pandemic on the location strategies of companies that already started or finished the process of production activities reshoring

Chapter 4 of this Thesis focused on the Covid-19 pandemic and its effects on the Global Value Chains and the manufacturing location decisions of companies, both SMEs and MNEs. Within the Analysis part of this Thesis, the same sample that was used for the analysis of two previous research questions will be used to determine whether there is evidence that the Covid-19 pandemic affected the location strategies of companies. Since this sample contains only cases of reshoring in the period from 2014 to 2018, the updated case narrative will be used for examining the relationship between Covid-19 and manufacturing location strategies.

The same updated case narrative that was used for the creation of additional columns that were analyzed for previous research questions, was also used for the creation of another additional columns related to the Covid-19 effect on location strategies. The additional column is named "Changes of location strategies due to Covid-19". Simple "yes" and "no" values are assigned in this column for each reshoring case. For a more detailed description, some of the "yes" and "no" values have brief descriptions and notes with the purpose of making each reshoring case and the Covid-19 pandemic effect as clear as possible. The Following Table represents a number of reshoring cases from the sample that have, in the updated case narrative covering from 2019 onwards, indications of Covid-19 effect on the location strategy of a company represented in that reshoring case.

Has the Covid-19 pandemic affected the location strategy of a company represented in the reshoring case?	**Number of cases**
Yes	4
No	193
TOTAL	**197**

Table 24: Number of cases with Covid-19 effect on the location strategy

From the entire sample created out of the European Reshoring Monitor, out of 197 reshoring cases only 4 of them have in their updated case narrative indication that the location strategy of manufacturing activities has been affected directly by the Covid-19 pandemic. This means that

only 2% of the cases, from which the sample is composed, indicate that manufacturing location strategies have been altered because of the pandemic. This change doesn't even mean that companies closed production site at one location and relocated those activities somewhere else, since two out of these four cases include reduction of production capacity at one location and assigning those activities to be performed somewhere else. This will be discussed more in detail soon.

Firstly, let's focus on the 193 reshoring cases that do not indicate any Covid-19 pandemic effect on the manufacturing location strategy. One of the most obvious reasons that some companies haven't been affected by Covid-19 when it comes to their manufacturing activities location, is that a lot of companies from the sample finished their reshoring process in the period prior to the pandemic and all of their activities have been reshored already. This scenario can also, in most cases, be used for SMEs since their production activities are usually at one or a few locations without great global presence and great disbursement of manufacturing locations. What can be seen from the sample, but doesn't need to be a rule, is that SMEs do not have tendencies to change manufacturing locations so easily and quickly. Since our sample includes cases of companies that have only one or few manufacturing locations and may be categorized as SMEs based on this, and the fact that many of those SMEs within the sample have already fully reshored their manufacturing activities, it explains why Covid-19 hasn't been affected their manufacturing location strategy. On the other hand, there are MNEs with a lot of manufacturing locations. Analyzing their updated case narratives (which were made by collecting information and data from websites of those companies, media, portals, and other available sources) showed that their manufacturing location decisions in most cases haven't been influenced by the pandemic. This inaction by companies represented in some of the reshoring cases may be due to the fact highlighted by Strange (2020) that Covid-19 is a global phenomenon and that companies are able to configure their Global Value Chains only in anticipation of more localized pandemics. From the large number of companies, that have been classified as MNEs because of their number of manufacturing locations and global presence, that haven't changed their manufacturing locations because of Covid-19, this statement of Strange (2020) may be verified and it seems like companies have been aware of this fact. Another fact stated in some of the reshoring cases' narratives is the war between Russia and Ukraine which led some companies to relocate their production and other activities from Russia to other locations, including manufacturing sites back home. This shows a prompt reaction of companies that have or had manufacturing activities in Russia to a more localized crisis.

Focusing now on the four reshoring cases that have Covid-19 indicated as a motive for the change of manufacturing location, another Table is provided below with all those cases presented with the description and explanation of how the Covid-19 pandemic affected manufacturing location decisions.

Company name	Number of reshoring cases related to that company	A brief description of Covid-19 effect on the manufacturing location/s
Renault	2	Despite the effort of the French government to help French companies reshore their manufacturing, Renault decided to cut employment in France in 2020 and in that way decreased domestic production. This can be categorized as offshoring since production activities have been the same or increased somewhere else.
Skako	1	Skako is a Danish company that at the beginning of Covid-19 decided to acquire another Danish company and in that way managed to increase production volume in Denmark. Shortly after, they sold one of their companies from Switzerland, which can also be characterized as some kind of reshoring. According to sources used for the case narrative, Covid-19 was a trigger for the acquisition of another Danish company in 2020, but it is unclear how and why that decision was made.
Schaeffler	1	This German company that produces automotive components, had some difficulties caused by the Covid-19 pandemic in the beginning and decided to accelerate the transformation and strengthen competitiveness. The company decided to consolidate locations and expand the capabilities of those

		locations. This decision announced in September 2020, resulted in investments in existing plants in Germany, Hungary, and China. The investment was also supposed to lead to a cut in employment mostly in Germany. From the sources used, it can be concluded that Covid-19 led this company to stop offshoring and focus on the expansion of capabilities at current sites.
TOTAL	**4**	

Table 25: Cases indicating Covid-19 effect on the location strategy

While analyzing all of the 197 production activities reshoring cases, another reason, besides Covid-19, that affected the global presence of companies and location of their production activities is the **Russian-Ukrainian war**. This unfortunate event in Ukraine affected some of the companies that are represented in the sample and **four reshoring cases are directly affected by the conflict**. All four reshoring cases affected by this war, include closure of production plants in those countries and relocation of those activities somewhere else, not necessarily back home. Even though there are the same number of reshoring cases that are affected by the Covid-19 and Russian-Ukrainian war, there are few important differences in how these two events affected production activities and production locations of represented companies. These differences are presented in bullet points.

- **Production activities relocation** - In the case of Covid-19 and four reshoring cases affected by this phenomenon, it is noticeable that there is no direct relocation of production activities from one location to another. Covid-19 affected the production locations of these companies mostly in terms of lower employment at some locations, lower production capacity at some locations, and sale of foreign subsidiaries. On the other hand, the Russian-Ukrainian war directly affected the production locations of companies represented in these four reshoring cases mentioned before. Russian-Ukrainian war made companies affected by the conflict to close production plants in those countries and relocate those activities somewhere else.

- **Number of companies affected** - While the Russian-Ukrainian war hasn't affected all of the companies from the sample since most of them do not have any production activities located in any of these two countries, Covid-19 was a global phenomenon and affected practically every business on the planet, especially companies with production activities located at different locations. This difference shows that a smaller, in terms of

geographical presence, and larger event have affected same number of reshoring cases (companies).

5.3.4.1 Conclusion

Since there are only four cases in which Covid-19 had any effect on the manufacturing location strategy of companies represented in the updated European Reshoring Monitor database, it can be concluded that ***the Covid-19 pandemic hasn't affected the location strategies of companies that started or finished their process of reshoring of production activities***.

This result of the analysis may be, to some extent, caused by the fact that a large number of cases in the sample are of companies that finished their reshoring shortly before the pandemic. Since the Covid-19 pandemic was supposed to highlight some well-known problems of offshoring, companies represented in this sample have already reshored all or part of their manufacturing activities back home and already solved those problems or minimized their effect. Besides companies that finished their planned reshoring of manufacturing activities, there are large MNEs presented in the sample, that have their activities spread globally in many different countries. Analyzing case narratives, the impression is that those large MNEs have been making their manufacturing location decisions based on some other factors and not Covid-19, which may be because Covid-19 was a global phenomenon and crisis that was felt worldwide.

Additionally, another event that affected production locations was noticed in the case narratives and it was analyzed and effects of this event on the production locations are compared to the effects of Covid-19 on production locations. This second event affecting production locations is the Russian-Ukrainian war. There is the same number of reshoring cases affected by the Covid-19 and Russian-Ukrainian war, but there are key differences between these two events and in which way they affected the production activities of companies. Firstly, it is obvious that Covid-19 and the Russian-Ukrainian war have different scopes and that Covid-19 had more global effects, while the war is a regional phenomenon, despite the indirect effects it may have worldwide. Looking at how companies from the sample reacted to the global pandemic, it can be seen from the number of reshoring cases, that have some effects of the Covid-19 on the production location strategy, that companies haven't changed their production locations because of the pandemic. There are several reshoring cases in which companies stopped their production or lowered production capacity/employment for a short period of time, but there are no cases in which companies decided to relocate production activities from one location to another because of the pandemic. On the other hand, more regional setbacks, the Russian-Ukrainian war, have directly affected the production locations of some companies, because

some companies decided to stop their production activities in these two countries and relocate somewhere else. This comparison may serve as proof for the previously mentioned fact that the Covid-19 pandemic is spread worldwide and there hasn't been one unaffected country, while the more regional event (Russian-Ukrainian war) doesn't necessarily have to have any direct effects on many parts of the world.

Summing up everything said previously, it can be concluded that **Covid-19 hasn't affected the location strategies of companies that started or just finished reshoring of the production activities**. One of the possible reasons for this is the worldwide spread of the pandemic and the fact that there were no unaffected countries, while other possible reasons are impossible to identify and analyze. The geographical scope of the pandemic and why it may be the reason for the pandemic not having any effect on the production location strategies may be found in the example of the more regional event that had a greater effect on the production location strategies.

5.3.5 Limitations

The main idea of this Thesis was to analyze reshoring in the context of two phenomena - Industry 4.0 technologies and Covid-19 and to analyze how these phenomena affected Global Value Chains and what is their connection with reshoring. Since the European Reshoring Monitor database includes cases of reshoring up to 2018 and the fact that this Thesis was written 5 years after the last case, it was obvious that the database must be updated and the case narrative was perceived as the field with the largest possibilities for an update. However, this created the first limitation of the database which was reflected in the analysis.

- Lack of information - which is mostly connected with reshoring cases of SMEs. During the analysis of the original case narratives, there was a great number of cases that for the source used local media of those SMEs since their reshoring was a big news for the local community and may that part/region of a country. Updating the case narrative for companies in this category has been practically impossible since there are no further informations about what happened with the manufacturing activity of those companies and if there were any additional investments or relocations. This was even more complicated taking into consideration the fact that some companies, for which there is a reshoring case, do not have their own website. Lack of information also refers to incomplete information about the investments made by companies in new technologies. This was the problem in the process of determining whether there was implementation

of Industry 4.0 technologies and not just purchase and installation of "regular" equipment and machinery, that doesn't fall under Industry 4.0.

The first stated limitation created a lot of problems in the process of updating the case narrative and collecting information for the analysis of the research questions. However, there is another limitation of the database, which affected the analysis and probably the results from a different perspective.

- Too many relocations of manufacturing activities in some cases - totally opposite from the first limitation, this one is mostly connected to the presence of MNEs in the reshoring cases. Having MNEs represented caused a lot of problems since at the time the original European Reshoring Monitor was created, it was planned for the database to include only reshoring cases. Updating case narratives led to having cases of MNEs that, in a period of 5 years for which the update was made, included a lot of relocations of manufacturing activities, including offshoring as well. This is best shown by the fact that out of 33 cases that have implementation of Industry 4.0 technologies after reshoring included in the case narrative, 18 of them are the implementation at a global level or some offshore production site. This fact highlights the problem of MNEs since, despite the reshoring case in the original database, a lot of cases for MNEs in other offshored locations, which created problems during the update and caused possible inaccuracy of the results of the analysis. This limitation mostly created problems with the analysis of the relationship between reshoring and implementation of Industry 4.0 technologies in the period after reshoring.

The third limitation also comes from the content of the original European Reshoring Monitor database.

- The disparity between reasons for reshoring and the original case narratives that were available in the database - There were some reshoring cases for which one of the reasons for reshoring was "Automation of production" while there wasn't any information regarding the automation or any other specific Industry 4.0 technology implemented during the process of reshoring. Since the updated case narrative was used for the determination of whether there was Industry 4.0 technology implemented, the same was done with the original case narrative, instead of just taking information from the reasons for reshoring.

The fourth limitation is noticeable mostly in the analysis of the Covid-19 effect on the production location strategy but may be applicable in the overall database.

- Effects of phenomena only on the production location strategies of companies that already started/finished reshoring all or part of their production activities - Since the database contains only cases of companies that started, and some of them finished, full or partial reshoring, this limits the analysis only to the companies that already reshored or are in process to finish previously started reshoring. The database used and the sample created from it prevents having an insight into how Covid-19 and other events may affect the production location strategies of companies that haven't decided and haven't started the reshoring process before the pandemic and other similar events.

These limitations of the database have directly affected the way in which reshoring cases were analyzed and the results of the analysis. Since the database was originally focused exclusively on reshoring and updating database was aggravated by the lack of information for some cases, the changing locations strategies of some companies, the global presence of MNEs included in the database, and incomplete information from available sources, the results for the period from 2019 to mid-2023 may be inaccurate and provide results different from the reality.

6 Chapter 6 - Conclusion: The Effect of Industry 4.0 and Covid-19 on the Reshoring of Production Pctivities

An Analysis composed of three research questions has been presented in Chapter 5 and insights into different information and perspectives are provided. Since every research question analyzed has its own conclusion, Chapter 6 will sum up all of the findings provided in Chapter 5 with the aim of explaining the effects of Industry 4.0 and Covid-19 pandemic on the relocation, more precisely reshoring, of production activities of European manufacturing companies.

Firstly, the tendencies of European manufacturing companies to implement Industry 4.0 technologies while reshoring were analyzed. This tendency to implement these technologies was determined by looking if the companies represented in reshoring cases have implemented Industry 4.0 technologies in the period while reshoring (2014-2018) or in the period shortly after reshoring (2019-2023). The quantitative analysis conducted shows that **31.5% of production functions reshoring cases for European manufacturing companies include the implementation of one or several Industry 4.0 technologies**. The information available for these reshoring cases, through case narratives and other sources used for the update of the case narratives, suggest that **most commonly companies are implementing automation**. Besides automation, there are a few other implemented technologies, within these 31.5% of reshoring cases, that fall under the term Industry 4.0 technologies, and those are **Robotization, AI, Smart Factory, and 5G technology**. After determining this, additional quantitative analysis was conducted to determine from where are companies that have the most cases of reshoring with the implementation of Industry 4.0 technologies included. The result of this analysis showed that **there are 11 reshoring cases from both Norway and France, and these two countries can be leaders when it comes to companies from those countries implementing Industry 4.0 technologies while reshoring production activities**. For getting a more detailed and precise insight, the results of this analysis were presented in percentages, to show how many reshoring cases, from the Sample, from each country have the implementation of Industry 4.0 technologies included. In the case of companies from Norway, there are 16 reshoring cases in the Sample created and as said before, 11 out of those 16 reshoring cases include the implementation of Industry 4.0 technologies, which means 68.75% of cases include the implementation of these technologies. France, on the other hand, despite being one of the leaders in terms of a number of cases, has a bit lower percentage, since the total number of reshoring cases to France in the Sample is 33. **11 reshoring cases from France that include**

the implementation, out of the 33 total reshoring cases available in the Sample, represent 33.33%, which is significantly lower compared to reshoring cases from Norway. From the same analysis, another country that stands out is Spain. There are 7 reshoring cases in total from Spain that are represented in the Sample. **5 out of those 7 reshoring cases from Spain, from the Sample, do include the implementation of Industry 4.0 technologies. This means that 71.4% of reshoring cases from Spain include the implementation of some Industry 4.0 technologies**.

There are two countries with a large number of reshoring cases that need to be mentioned as well, those are Italy and the United Kingdom. The United Kingdom and Italy have 36 and 32 production activities reshoring cases in the Sample created, respectively. **In the case of Italy, only 28% of production activities reshoring cases include the implementation of Industry 4.0 technologies, while in the case of the United Kingdom, only 19% of reshoring cases from the same include the implementation of Industry 4.0 technologies**. Since out of the entire Sample, 31.5% of cases include implementation, the results for Italy and the United Kingdom may be characterized as below-average implementation rates.

Because of everything presented, Spain can, alongside Norway and France, be characterized as a leader when it comes to countries with the highest numbers of reshoring cases that include the implementation of Industry 4.0 technologies. In the case of Norway and Spain, it can be said that companies from those countries tend to implement one or more Industry 4.0 technologies while reshoring. On the other hand, countries with a large number of production activities reshoring cases but below average rates of the implementation of Industry 4.0 technologies are Italy and the United Kingdom. Italy and the United Kingdom, alongside France and other countries that are represented in the Sample analyzed, show that companies do not tend to implement Industry 4.0 technologies while reshoring. Overall results, taking into consideration the entire Sample, show that one out of three companies that reshore production activities will implement Industry 4.0 technologies. This cannot be characterized as a tendency.

Within the 62 production activities reshoring cases that include the implementation of Industry 4.0 technologies, there are 54 individual companies. This difference comes from the fact that one company may have more than one reshoring case if that company reshored production activities to the same location from several different countries. After the analysis based on home countries represented in the reshoring cases, another analysis aiming at providing insight into the relation between the size of the companies and the implementation of Industry 4.0 technologies while reshoring was conducted. The size of the company was determined based

on the number of employees and the information regarding this was available in the original database. Because data regarding the number of employees is from the period 2014 to 2018, and some companies are missing this information, this section hasn't been updated. Without the update, the results of the analysis show that **31 out of 54, or 57.4% of the companies that implemented Industry 4.0 technologies while reshoring are large companies**. Since there are 11 companies without information regarding the number of employees, the number of large companies that implemented Industry 4.0 technologies while reshoring can be even larger, which may increase results in percentages up to 78%.

Results of this analysis show that ***out of the companies that decide to implement Industry 4.0 technologies while reshoring production activities, the majority are large companies (with more than 250 employees)***.

The second research question focused on the period of the implementation, which included two possible scenarios. The first scenario is the implementation of Industry 4.0 technologies in parallel with reshoring. In this case, the implementation of these technologies is considered as a reason for reshoring. The second scenario covers the implementation of Industry 4.0 technologies in the period of a few years after reshoring. Because of the time difference between reshoring and the implementation, in this case, the Industry 4.0 technologies cannot be perceived as reasons for reshoring, but as a means of achieving competitive priorities. ***Results of the quantitative analysis showed that there are the same number of reshoring cases (33) that include the implementation of Industry 4.0 technologies in parallel with reshoring and in the period after reshoring***.

Since the first scenario, taking into consideration the implementation in parallel with reshoring is considering the Implementation of Industry 4.0 technologies as a reason for reshoring, a number of cases that include implementation of these technologies will be compared with the number of cases that include other reasons for reshoring. Some well-known reasons, available in the database, have been taken into consideration and the comparison shows that ***more reshoring cases include the implementation of Industry 4.0 technologies in parallel with reshoring (16.75%) than they include Delivery time (13.2%) or Poor quality of offshored production (7.6%) as a reason for reshoring. Made in effect is one of the few reasons for reshoring that is represented more frequently in reshoring cases than Implementation of Industry 4.0 technologies***.

However, within the second scenario that is taking the implementation of these technologies in the period after reshoring into consideration, there are cases that include the implementation of

Industry 4.0 technologies at a location different from the location of reshoring. In addition, this second scenario also includes the implementation of these technologies for which there is not enough detailed information like location, which technology, and whether it is just a planned or started/finished process. Because of these reasons, more than half (18) out of the 33 reshoring cases that include the implementation of Industry 4.0 technologies in the period after reshoring were excluded. Excluding these 18 reshoring cases enabled analyzing only 15 cases left, those that include the implementation of these technologies at the exact location where production activities were reshored to. The exclusion of 18 reshoring cases from the second scenario has altered the results, since now there are more than double reshoring cases that include the implementation of Industry 4.0 technologies in parallel with reshoring compared to reshoring cases that include the implementation of Industry 4.0 technologies in the period after reshoring. While 16.75% of reshoring cases from the Sample include the implementation of Industry 4.0 technologies in parallel with reshoring, only 7.6% of reshoring cases from the Sample include the implementation of Industry 4.0 technologies at the location of reshoring in the period after reshoring. From these differences, ***it can be said that companies tend to implement Industry 4.0 technologies in parallel with reshoring rather than in a period after reshoring.***

Additional analysis was conducted to show whether there are geographical differences when it comes to the implementation of Industry 4.0 technologies in parallel and in the period after reshoring. **The country with the highest number of reshoring cases that included the implementation of Industry 4.0 technologies in parallel with reshoring is Norway with 10 cases**. Following Norway on this list are the United Kingdom with 5 cases and France with 4 cases that include the implementation of Industry 4.0 technologies in parallel with reshoring. The second timeframe analyzed, the implementation of these technologies in the period after reshoring gave different results. **Countries with the highest numbers of reshoring cases that included the implementation of Industry 4.0 technologies in the period after reshoring are Italy, Spain, and Sweden, all with 3 reshoring cases**. As it is obvious, companies from different countries have different tendencies when it comes to the period of the implementation of Industry 4.0 technologies in cases of production activities reshoring. The reasons for these differences are unknown and cannot be analyzed and determined within this Thesis.

Analysis conducted, with the aim of answering the first two research questions, provided a few important insights that may show the effects of Industry 4.0 on the production activities reshoring. First of all, more than 30% of all production activities reshoring cases include the implementation of Industry 4.0 technologies, either in parallel with reshoring or in the period after reshoring. Although from this percentage it cannot be said that companies tend to

implement Industry 4.0 technologies while reshoring, Industry 4.0 technologies still represent an important factor in the process of reshoring. When the implementation was split into two timeframes, this was even clearer. Since the implementation in parallel with reshoring has been characterized as one of the reasons for reshoring and the analysis showed that 16.75% of the reshoring cases from the Sample include the implementation of these technologies in parallel with reshoring, it was clear that without any doubts belongs to other reasons for reshoring since the presence of some other reasons was even lower. The comparison of results regarding different timeframes also showed that more cases of reshoring include the implementation of Industry 4.0 technologies in parallel with reshoring than there are cases that include the implementation of these technologies in the period after reshoring at the location where production activities were reshored to. The exact reasons for these different results cannot be determined. Different timeframes of implementation also had different results when it came to the geographical locations of the implementation both in parallel with reshoring and in the period after reshoring. Norway is the leader when it comes to companies reshoring production activities to some countries and implementing Industry 4.0 technologies in parallel. On the other hand, Italy, Spain, and Sweden have the most cases out of the total reshoring cases that included the implementation in the period after reshoring. Reasons for this cannot be determined from the available Sample and the European Reshoring Monitor database. More in-depth qualitative research may provide these reasons. **Everything mentioned shows that the emergence of Industry 4.0 has, to some extent, affected the companies' decisions to reshore production activities that were previously offshored. While it cannot be said that Industry 4.0 plays a key role in the process of reshoring production activities, it can be considered as an important factor and a way in which some of the companies, that decide to reshore, are enabled to perceive their competitiveness in the process and after reshoring.**

Lastly, the third research question analyzed focused on the Covid-19 effect on the companies' decision to reshore production activities. As stated in Chapter 4, the Covid-19 pandemic started after the original European Reshoring Monitor database was created and it was necessary to update the available case narrative. The update of the case narratives showed that only 4 out of 197 production activities reshoring cases included further relocation of production activities that was caused by the pandemic. For the comparison, the example of another event that was also mentioned in updated case narratives was used and that event is the Russian-Ukrainian war. The Russian-Ukrainian war had an effect on the same number of reshoring cases as Covid-19, despite the fact that the mentioned war is more of a regional matter and that only some companies from the Sample have their production activities in that region. This last sentence may also be the reason why regional events, like the Russian-Ukrainian war, had more effect

on the production location strategies of companies. This comes from the fact that companies whose production activities were affected by the war were able to find another location for production sites and continue their operations, while in the case of Covid-19, it was practically impossible to find a country worldwide that hasn't been affected by the pandemic and restrictions of different scale and scope. **The characterization of the Covid-19 pandemic as a worldwide phenomenon may be the right way to explain why it hasn't affected the production location strategies of companies.**

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