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"Industry 4.0 technologies within the logistics sector: the key role of innovative start-ups "

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Summary

Introduction

In this historical period, political leaders and companies worldwide have been dealing with the scale of issues which have followed the pandemic crisis, the event that highlighted the vulnerabilities of many organizations. Not only consumers have changed their behaviours, but also the whole supply chain has accelerated the adoption of agile practices and innovation processes to face what has been called the "Supply Chain Disruption".

The shortage of microchips, the collapse of ports, the increase in raw materials and the lack of transporters and, last but not least, the Ukrainian conflict, have had and are having a strong impact on companies' operations, with tremendous effects everywhere, as we live in a more and more globalized world and economy. In particular, the sector which has suffered and went into crisis more than the other, is the Logistics.

From this point, this study aims to explore how Logistics has been facing all these challenges, focusing on the role of innovation, driven by startups, that are revolutionizing this sector and the way businesses are held.

As a large funnel, this study starts with a broad presentation of Industry 4.0 and the main innovative technologies that are impacting the industries: Advanced Manufacturing, Additive Manufacturing, Augmented Reality, Simulation, Horizontal and Vertical integration, Industrial internet, Cloud, Cyber security and Big Data Analytics. For each technology, an example of brilliant Italian growing startups is also provided. In the first chapter, also a parenthesis on the challenges & issues, benefits & effects of the adoption of Industry 4.0 technologies.

Then, in the second chapter, the study will focus on the role of Logistics 4.0, beginning with the trends that are revolutionizing the sector, followed by the presentation of its most important technologies – Automatic identification, Real Time Location Systems (RTLS) and Smart sensors – and the main applications, as Resource Planning Management, Warehouse Management systems, Transportation Management System, Intelligent Transportation System and some of the best practices, based on Efficiency, Speed, Reliability and Cost controlling.

Moreover, a third chapter with the close focus on startups has been developed. First, demonstrating the impact of the startups in the sector. In fact, these agile and fast-growing companies are threatening the established players, requiring them to pursue for innovation in order to survive this epochal shift which is occurring. If in 2014 the total amount raised worldwide from logistics startups was just $ 600 millions, in 2021 it has reached $ 24 billions, an incredible increase, that the study has analyzed in detail for logistics segments and locations.

Also, the effect on the incumbents has been analyzed, from a business model point of view and to answer if cooperation may exist among these actors.

To looking for the key role of startups in the innovation of the logistics has been the goal also of the last chapter of this research. A patent analysis has been made, considering all the patents registered in Italy, after 2010, and collected under the technology class **G06Q10/08,** the one specific to *Logistics, e.g., warehousing, loading, distribution or shipping; Inventory or stock management, e.g., order filling, procurement or balancing against orders.* Orbis Intellectual Properties and Orbit Intelligence have been used to find the patents.

In this way, it has been possible to see the main actors of the logistics sector that are involved in this innovative, 4.0, process, how many are startups or incumbents, and which are the other sectors where there are relevant companies that invested in R&D in order to increase and to streamline their own logistics processes. To go deeper with the analysis, some relevant patents has been analysed with technical descriptions and images, and the most interesting innovations have been held by startups companies, as Easytrucking, Sentric and Milman.

For the future, it could be interesting to extend this study, which is an instant photography of the logistics innovation in Italy, with other European countries, as France or Germany, however having in mind that Europe is far away in terms of investments and funding compared to East Asia countries and the United States.

1. Industry 4.0: overview and main technologies.

1.1 Introduction to innovation

Since the 1800s, innovation has more and more revolutionized humans' life with some disruptive events: the industrial revolutions. These had been not simply productivity and efficiency innovation but a complete revolution on how goods were produced and how work has been done.

Firstly, the mechanics of steam engine, secondly the innovation in the assembly line, then the speed of the computer and now the Fourth Industrial Revolution, also called Industry 4.0. This is a new paradigm, which focus is the digital transformation of the manufacturing sector, innovating the value chain in order to change the way of operating and transforming the nature of organizations, which is going to be modified.

Also known as "Smart Manufacturing", it could be thought as the combination of classic concept of industry along with advanced technologies as robotics, cloud systems, simulators, big data, AI, cybersecurity, augmented reality and additive manufacturing/3D printing (Slack N. et al, 2016).

It is based on three cardinal principles[1]:

- Smart Production, in which the new technologies have to offer collaboration among all the elements present in the production: operators, machines and instruments.
- Smart Services, which are all the informatic infrastructures that allow to integrate systems but also structures that help to integrate companies at all the stages of the value chain among us and with the environment.
- Smart Energy: new approach to reduce energy consumption and wastes

To reach the integration between virtual and physical world, it is wrong thinking at the disappearance of the workforce in the factories, the physical presence of the human being is still necessary, and they are a fundamental part of the process.

Through analytics, the big amount of data collected by factory equipment and Internet of Things (IoT) devices, as ERP and CRM systems, is leveraged to improve decision-making and automation in every area of the supply chain, improving efficiency and productivity, but also useful to create new job positions and manage the human resources in the factories.

[1] https://www.visel.it/it/industria40.php

This digital transformation, indeed, promotes the company integration, and helps them to reduce the time to market, thanks to this huge quantity of information flows.
Moreover, the revolution stands also for the use of robot and sensors with whom potentiate the ability of monitoring and controlling along all the supply chain. This, together with an elaboration ability and connections that's becoming faster, generate a system that is more and more reliable and safe. Processes are so optimized, adding more efficiency and visibility at each ring of the chain in every production process. In the end, this set of new combined technologies guarantee better products and services, at lower cost for both companies and final consumers.

1.2 Technologies of Industry 4.0

Industry 4.0 is built on nine technology pillars, as defined by Boston Consulting group[2].
These are: Advanced Manufacturing solution, Additive Manufacturing, Augmented reality, Simulation, Horizontal and vertical integration, Industrial internet, Cloud, Cyber security and Big Data Analytics.
These innovations bridge the physical and digital worlds and make smart and autonomous systems possible. Businesses and supply chains already use some of these advanced technologies, but the full potential of Industry 4.0 comes to life when they're used together.
These technologies fall under two macro groups: the first one is represented by information technologies (Big Data, Cybersecurity, Cloud…) while the second one by interaction technologies (Smart Manufacturing, Automation, IoT…)

1.2.1 Internet of Things (IoT)

It is the expression utilized to identify the net of devices that are connected to the web, that are enabled to send and receive data[3]. They are equipped with sensors, microprocessors and software as fitness sensors, air-conditioning systems, home appliances… every single physical object has the potential to become smart and share data on its status or of the environment around it. Moreover, thanks to the more and more extensive and efficient wireless networks, the collection of data moves around with huge quickness and the communication between the above-mentioned devices has become extremely easy and it is linked to our daily life with dedicated mobile applications.

[2]https://www.bcg.com/publications/2015/engineered_products_project_business_industry_4_future_productivity_growth_manufacturing_industries
[3] https://www.oracle.com/internet-of-things/what-is-iot/

Basically, it is possible to connect to the network everything. The fundamental requirements are just two: a unique identification – the IP address – and the ability to exchange data through the net without the human interference. Through this automation of processes and placing at a disposal to everyone the new information systems, the goal is to simplify individual's life.

Most of the benefits arising from the use of these technologies are leveraged by the transportation and energy sectors: for example, the optimization of the power consumptions, through the warning of malfunctions and wastes. Another example in the field of transportation could be the flow of goods and people, selecting the most suitable times and routes in relation to the traffic. This gives to the economical operators the possibility to save time and money, improving the returns.
About the transportation, the connectivity among vehicles allows to select routes based on traffic information and to manage insurance, depreciation, and maintenance more precisely.
Hence, the application fields are very wide: from industrial to logistics and energy efficiency, remote assistance, or environmental protection.

Anyway, the critics that concern the IoT regard two aspects, more and more crucial nowadays: security and privacy. Most of the companies are finding solutions to make this mass of devices safer from cyber-attacks. Also, the use of data is a sensitive matter: companies, in fact, collect huge amount of data every day in order to know the habits of consumers, but this exposed them at risk.

One of the most interesting startups in IoT Italian framework is Zehus, founded in 2014. With its 9.1 million dollars raised, it is the startup that received the most substantial funding, and from 2019 is the e-mobility division of Eldor Corporation, an international group leader in the automotive industry.
It has realized an innovative hybrid bicycle (Bike+), electric and pedal assisted, which does not need charging: batteries, sensors and motor are integrated in a hub in the back of the bicycle. The batteries never run out as they use the phases in which the driver pedals downhill or with sustained stride as compensation for the energy consumed during the start and ascents[4]. This example allows us to see the variety of possibilities that, thanks to IoT, can make our daily life better and simpler.

[4] https://startupitalia.eu/54867-20170125-zehus-startup-sharing-mobility

1.2.2 Cloud systems

Cloud computing is the "great enabler" of Industry 4.0 and digital transformation. Today's cloud technology goes way beyond speed, scalability, storage, and cost efficiencies. It provides the foundation for most advanced technologies – from AI and machine learning to the Internet of Things – and gives businesses the means to innovate. The data that fuels Industry 4.0 technologies resides in the cloud, and the cyber-physical systems at the core of Industry 4.0 use the cloud to communicate and coordinate.

It is possible to identify four major benefits from cloud computing[5]:

- **Reliable:** Secure, safe, and available. Get instant cloud system access from anywhere with excellent response time. Run on secure servers with a staff of full-time security experts. Know that your data is redundant and remotely backed up.
- **Flexible:** Get the computing power you want when you need it. Add or reduce servers, networking, or storage. Get new users on board instantly.
- **Financial:** Only pay for what you need. No up-front financial expenses for hardware or facilities. Reduce IT staff time used to maintain and upgrade the systems. Instead, invest your funds and people in revenue-generating projects.
- **Up to date:** Always have the latest version of the platform, database, and software applications. Plus, take advantage of emerging technologies such as machine learning (ML), artificial intelligence (AI), Internet of Things (IoT), and more. Always stay up to date on the latest innovations.

Cloud computing is divided into three main service categories: SaaS, PaaS, and IaaS. Some providers combine these services – and others offer them independent of each other.

- With SaaS (software-as-a-service), software is hosted on a remote server and customers can access to it anytime, anywhere, from a Web browser or a standard web integration. The SaaS provider takes care of backups, maintenance, and updates. SaaS solutions include enterprise resource planning (ERP), customer relationship management (CRM), project management, and more.
- Platform-as-a-service (PaaS) is a cloud-based, application development environment that provides developers with everything they need to build and deploy apps. With PaaS,

[5] https://www.sap.com/insights/what-is-cloud-computing.html

developers can choose features and cloud services they want on a subscription or pay-per-use model.

- Infrastructure-as-a-service (IaaS) allow companies "rent" computing resources, such as servers, networks, storage, and operating systems, on a pay-per-use model. The infrastructure scales – and customers don't have to invest in the hardware.

1.2.3 Big Data

According to McKinsey Global Institute: "A system of Big Data refers to a dataset which volume is so huge that exceeds the capacity of relational database systems to capture, store, manage and analyze."

We refer to Big Data when the ensemble of data transmitted or received is so huge that it is needed the definition of new technologies and methodologies to extrapolate, manage and process information in a reasonable time. Hence, with Big Data Analytics we refer to technologies and methodologies of analysis and to massive data. The word indicates the capacity to extract, analyze and put in comparison a huge quantity of heterogeneous and not structured data and not, to make known the link between different phenomena and to be able to predict the future ones[6].

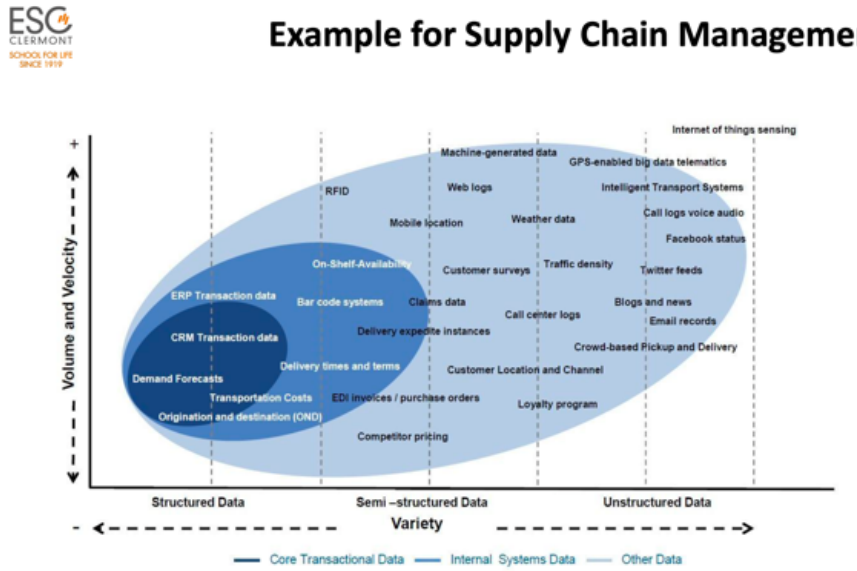


Figure 1. SCM Data Volume and Velocity vs. Variety

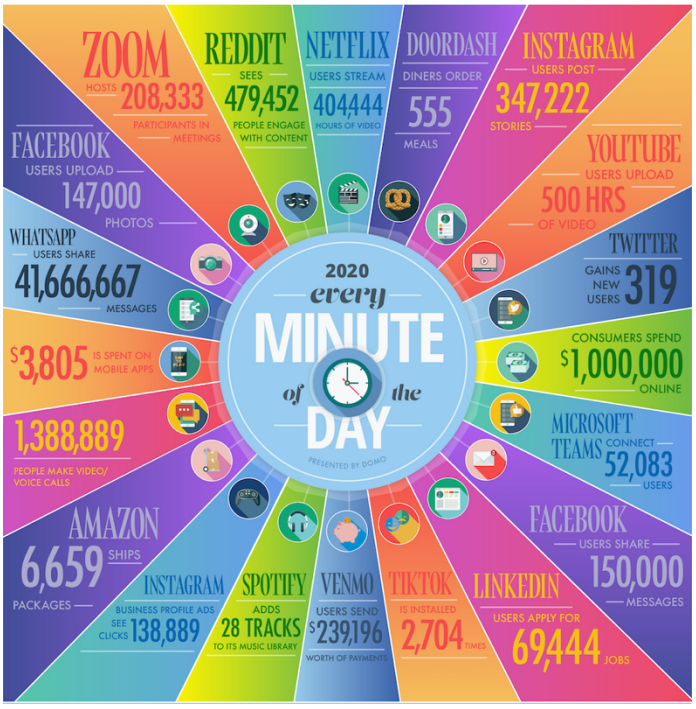
Example of Structured and Unstructured Data in Supply Chain management (© Sebastian Douaillat)

A system becomes "Big" when the volume of data increases contextually at the increase of the quickness of the flow of information that the system must deal with per second. In past decade,

[6] https://www.business-changers.it/blockchain/blockchain-e-big-data

year by year the amount of data produced in the world increased impressively and the computational power required is more and more large. In fact, Big Data don't mean only structured data as databases, but also not structured – as said before – as images, e-mail or gps. In a 2001 study, Doug Laney defined the growth model of Big Data by identifying five fundamental variables[7]:

- Volume (amount of data, structured and not, generated every second)
- Variety (different type of data generated, collected and utilized)
- Velocity (speed of generate new data)
- Veracity (measure of reliability)
- Value (ability to transform data into value)



The incredible amount of data collected every minute in 2020 [8]

It is relevant to establish and define the processes that allow to manage and transform efficiently the data set in order to use them to take proper managerial decisions.

The most important processes that make up the life cycle are basically two:

1) Big Data Management: all the actions and the technologies finalized to generate, acquire, mining, cleaning, storing of data and integration of info.
2) Big Data Analytics: the different measures used to acquire and analyze of useful info from dataset and in the lowest possible time.

[7] https://medium.com/analytics-vidhya/the-5-vs-of-big-data-2758bfcc51d
[8] https://www.datanami.com/2020/09/04/10-big-data-statistics-that-will-blow-your-mind/

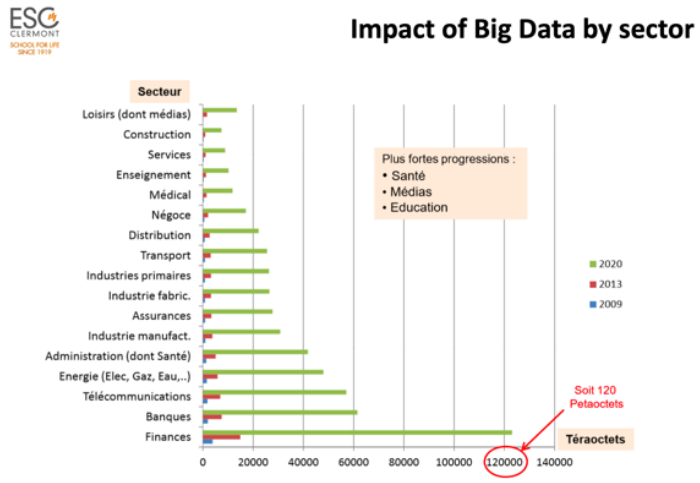
The results are classified in human generated, data machine generated data, and business generated data. The first ones are those deriving from social network platform (Facebook, Instagram, Youtube, Linkedin) or blogging, review websites (TripAdvisor), e-commerce platform (Amazon, Ebay) ecc. Instead, machine generated data are produced from sources as GPS, IoT, RFID, biomedical devices, trading systems or weather monitoring stations.
By latest, the business generated data are those of the two previous categories but generated inside a company's context. They could be historical data as payments, orders, productions data, inventory, sales, financials. Once they are collected and classified, a mining process has to be created in order to make them ready and suitable to be analyzed, meaning they have to be cleaned because they must represent only truthful information.

In the next step, it is important to organize a dataset system that first is able to store this amount of data and second to guarantee the availability and at the same time the possibility to have a quick and safe interaction with them, in effective and reliable way.
What turns out from this stage is the ideal material for the analysts' studies, in order to support and be part of the decision-making process within a company in new marketing strategies and new business development options, increasing the production processes efficiency and so on.

Business Intelligence integrate, model and present relevant data to steer the company and to allow managers to make decisions for example key performance indicators, high-level insights. Big Data on the other hand are, instead, useful to deduce rules from large sets of information through inferential statistics and non-linear systems. Moreover, they are powerful to point out relations, dependences and forecasts of results and behaviors.
Also, it is relevant to explain the difference between Data Warehouse and Data Lake. The first one is a vertical storage that collect structured data and predefined metadata (tables, fields, keys...), a relational database (Oracle, MySQL, IBM DB2…). They are set for enterprise volumes and the Business Intelligence analysis. The second one is a horizontal storage with unstructured data and live metadata (documents, files, videos...), utilized by Big Data Advanced Analytics and characterized by unlimited volumes.

The innovative aspect of Big Data is the set of possibilities that can be achieved with this huge quantity of information they contain, also thanks to Data Lake, where they are collected and saved. Until recently, million-dollar computers would have needed to process even very small

amount of data. Today, also a laptop is sufficient enough to have access to an analysis platform, thanks to a new ability to create link between information, so as to provide patterns and models of interpretation until now only imaginable.



The impact of Big Data by sector among the years (© Sebastian Douaillat)

Although the real estate sector is one of the main indicators of economic performance, it has remained for many years "unscathed" to the technological and process revolution that other sectors have already faced and that has led to profound changes in almost every area.
That's why in 2015 Patrick Albertengo founded Reopla[9], a startup that, by reworking the data of real estate sales and ad sales of buildings on the net with artificial intelligence algorithms and machine learning, is able to provide an automatic evaluation of a property. It provides automated valuation models (AVM - Automated Valuation Model) to banks, asset management companies, credit servicing or real estate appraisals.

1.2.4 Cyber-security

Thanks to the omnipresence of wireless networks and mobile devices, the connection among individuals and systems is more and more present. The access to the web gives us a world of possibilities but on the other hand it increases the vulnerability of individuals that are exposed to many types of risks, as scams or theft (identity, personal data, bank account...). But also, for what concerns big organizations, if industrial secrets, patents, innovations are theft, it could be the cause of massive economic damages. For this reason, it is now crucial for the economic growth of a country the quality of its cybersecurity systems.

[9] https://startupitalia.eu/170335-20220218-reopla-la-startup-che-ti-valuta-casa

Industry 4.0 requires an openness to the world, to allow to different systems to integrate each other. Moreover, as previous exposed, today machines with modern technologies can acquire in real time a big amount of data and share them with other information systems.
Meanwhile, it is crucial to strictly control the communication doors on the outside to be able to protect from improper uses and cyber-attacks to own proper data.

A company can face two types of threats: Internal, as a careless behavior of people in the organization, or also a malicious behavior of someone internal in the organization that has access to confidential material, which is of course difficult to secure against.
On the other end, the External Threats are the most considered ones. They are the unauthorized intrusions, as in server or data breach. These cyber-attacks may happen through Social-Engineering, meaning to deceive legitimate users so that they divulge restricted or private information (phishing attack). Another way is Backdoors, that is code expressly designed into software programs to allow access to the application by circumventing password protection. The third type of intrusion is Malware, a software that is designed to damage and destroy computers and computer systems, the most common examples include viruses, worms, Trojan viruses, spyware, adware, and ransomware.

To manage this risk, there are three approaches, according to Piccoli and Pigni (2019):

- Risk Reduction: buy or expend resources to create safeguards, to create mitigation strategies or to buy security measures, as firewalls or antivirus and spyware software.
- Risk Transference: outsource the risk to somebody else, so either paying someone else to assume the risk (insurance) or passing a portion of the risk to someone else (outsource some of the technology).
- Risk Acceptance: the idea of not investing in countermeasures and consciously taking the risk.

Moreover, for what concerns the organization security, there exist at international level some norms finalized to standardize the modality of data protection in order to protect and assure the integrity, privacy and availability of data, as the ISO norms. The ISO/IEC 27001 is a standard that provides requirements for an information security management system (ISMS). Using it and the whole family of ISO/IEC 27000 standards enables organizations of any kind to manage

the security of assets such as financial information, intellectual property, employee details or information entrusted by third parties[10].

The ISO/IEC 27032 "Information technology — Security techniques — Guidelines for cybersecurity"[11] regards specifically the requirements in the matter of cybersecurity tracing the unique aspects of such activity and its dependencies on other security domains, in particular: Security information, network security, internet security, and critical information infrastructure protection (CIIP).

This international standard includes: a Cybersecurity general view, an explanation between the relation between Cybersecurity and other kinds of security, a definition among the involved parts and a description of their roles in Cybersecurity, a guide to face the most common problems of Cybersecurity and a and a framework to enable stakeholders to collaborate in the resolution of cybersecurity issues.
Actually, this framework is provided by the US National Institute of Standards and Technology (NIST). It is a scheme of actions to be implemented to face cyber intrusions and to protect the own data and plan these five macro-processes: Identify, Protect, Detect, Respond, Recover[12].

An Italian startup [13] has been selected among the Top 100 cybersecurity companies by Gartner. Founded in 2018 by Hassan Metwalley within the incubator of the Polytechnic of Turin (I3P), *Ermes - Intelligent Web Protection* is among the most important and influential companies in the world that uses AI in cybersecurity.
Ermes' solution analyzes the behavior of web services in real time through patented algorithms, proactively blocking what presents a risk profile, regardless of the reputation of websites and overcoming the limits of traditional solutions.
Its on-device technology is complementary to any cybersecurity ecosystem and can be activated immediately, ensuring a better browsing experience for users and better device performance.

1.2.5 Simulation, Augmented & Virtual Reality

In an economic scenario more and more competitive and complex, efficiency has become more and extremely important, especially in the current situation of downturn in the whole supply chain due to microprocessors shortage, global transportation issues and the increase in raw

[10] https://www.iso.org/isoiec-27001-information-security.html
[11] https://www.iso.org/standard/44375.html
[12] https://www.nist.gov/news-events/news/2018/04/nist-releases-version-11-its-popular-cybersecurity-framework
[13] https://www.millionaire.it/ermes-esseri-umani-tramite-hacker-entrano-nei-sistemi-aziendali/

material costs. Hence, innovative techniques as simulation, augmented and virtual reality turned to be fundamental in this way.
They allow to evaluate ex-ante the complexity of systems, especially in the manufacturing sector. They allow also to simulate changes in operational strategies and verify their effects at the organizational level, reducing considerably time and costs of design and development of the product, avoiding recurrent mistakes, and optimizing the whole production cycle and reducing the time to market of a product, that in the situation described at the beginning, is really the ultimate goal in the actual catastrophic situation of the global supply chain.

Focusing on simulations and digital twins, which is a virtual model designed to accurately reflect a physical object, they both utilize digital models to replicate a system's various processes, but the latter is actually a virtual environment, which makes it considerably richer for study. The difference between them is largely a matter of scale: while a simulation typically studies one particular process, a digital twin can itself run any number of useful simulations in order to study multiple processes.
The differences do not end here. For example, simulations usually don't benefit from having real-time data. But digital twins are designed around a two-way flow of information that first occurs when object sensors provide relevant data to the system processor and then happens again when insights created by the processor are shared back with the original source object.
By having better and constantly updated data related to a wide range of areas, combined with the added computing power that accompanies a virtual environment, digital twins can study more issues from far more vantage points than standard simulations can, with greater ultimate potential to improve products and processes[14].

The Virtual Reality [15]is thought to represent virtually something that do not exist in the real world, bringing us in a totally artificial environment, while the Augmented Reality allow us to overlap digital elements to the real environment. In both of them, the individual can interact but, if in the first one our senses are misled, in the second one more information are added to what our senses can perceive.
Regarding the production world, thanks to Virtual Reality (VR), it is possible to realize a tridimensional model of the product or of the process with the goal to act preventively in order

[14] https://www.ibm.com/topics/what-is-a-digital-twin

[15] https://www.tdblog.it/realta-virtuale-e-realta-aumentata-cosa-sono-qual-e-la-differenza-e-i-migliori-dispositivi-business-in-commercio/#gref

to facilitate the design or the staff training. The instruments which are applied are the ones offered by designing programs in 3D as CAD and by projection systems based on screens or viewers, made even more efficient by new technologies that allow realistic navigation within the model

The objective of the VR is to visualize the production process through computer, to produce an overview of the operations that will be executed on a determined member, to estimate the necessary places of work and, through more sophisticated decision-making systems, carefully analyze each element of the project-manufacturing system of the product, including assembly and possible variants.

Overall, the activities supported by VR involve the layout of the factory and the positioning of its plants, process planning, staff training as well as operation, testing and process control.

If the factory model used is constantly and prompt updated with the new data generated by the analysis and technologies applied to the machines (IoT), it is possible to combine the design and the layout with the evaluation of the forecasted performance of the production system, without utilize real system that for sure are more expensive but also could involve safety or availability issues.

Instead, the objective of Augmented Reality (AR) is to add further information and dimensions to reality. Simply framing a physical object, typically through visors or smart glasses, in order to be able to obtain some related information. Of course, the application of AR is much wider. In logistics, for example, it can help in localizing the products in the warehouses and to verify the conformity of the orders in real time. In the production the operators can visualize the wastes or defective parts, while in marketing these technologies allow to see in advance some aesthetic and functional changes of products.

An interesting startup born in Italy in the large-scale distribution is VedoMarket[16], that aims to allow the customers to see in real time what they are buying through a multimedia viewer used by the operator in the store (patented technology). According to the Founder words, this is a typical win-win situation: “the large retailer operators can optimize their time but also benefit from better management of orders from online sales, eliminating all the problems related to the replacement of products not on the shelf or warehouse management, implementing sales of

[16] https://forbes.it/2022/03/04/la-startup-che-vuole-rivoluzionare-la-spesa-online-con-il-visore-mixed-reality/

fresh products online - which as we have observed are the goods purchased with the most skepticism."

In the end, the major develop of AR would be in the field of designing and maintenance, allowing companies to implement more efficient production processes, less risker to the health of the professionals (extraordinary maintenance without the need for the physical intervention of highly specialized operators) and more reliable in terms of outcomes.

1.2.6 Additive Manufacturing

Using computer aided design (CAD) or 3D object scanners, Additive Manufacturing allows the creation of objects with precise geometric shapes. These are built layer by layer, as with a 3D printing process, which is in contrast to traditional manufacturing that often requires machining or other techniques to remove surplus material[17].

There are four main different areas (Serra, 2018) of application for Additive Manufacturing:

- *Prototyping*, which allows to test different models and versions of a component. It is applied to improve the AM part's properties in order to fulfill the applicator's requirements.
- *Rapid tooling,* the realization of production tools as molds and centering. It is not the goal to obtain a final part, but a tool that provides the basis for a small or medium size batch production of final (or series) parts or products.
- *Rapid manufacturing,* the direct production of final products, ready to be commercialized. The goal is to obtain final (or series) parts with properties equal to traditionally manufactured (non-AM) products.
- *Spare parts,* the realization of components allocated for post-sales of machines and plants, with the advantage to stamp whenever you need.

The AM process directly delivers a geometrically exact and scaled physical facsimile of the virtual data set. But this process also comes with some disadvantages.

AM processes:

- work with process – and consequently with machine – depending on materials and restrictions in terms of color, transparency, and flexibility.
- show almost no cost reduction with an increasing production volume.

[17] https://www.twi-global.com/technical-knowledge/faqs/what-is-additive-manufacturing

- are rather expensive when used to make many copies and especially for series applications.

To overcome these problems, AM parts can be regarded as master models and then used for subsequent copying or reproduction processes. The principle behind this is often called "the splitting of capabilities": the geometrical exact part is quickly obtained from the AM process, while the desired quantity, and properties such as color and so on, come from a subsequent copying process (Gebhardt, 2012).

But on the other hand, this technology offers the possibility to turn a digital idea into the product without much intermediate processes. Actually, it is still quite long but improving time by time. In the future, companies will be able with extreme promptness to produce tailor made products, finally freeing of the limits of the traditional workings, bound to the old techniques based on geometric elements and connected to the removal of material, instead of the addition (Serra, 2018). Through additive manufacturing so, we will be able to realize items with innovative design, to reduce storage costs and to produce a high personalization on mass products. Moreover, there will be others benefits for this new technology: the highest freedom in the generation of shapes and structures related to the components, with a substantial reduction in terms of costs and development time. It would be possible to produce whenever it is necessary, positively impacting the whole supply chain, with great benefits in terms of stocks' reduction and related costs.

Additive technology is so competitive because it starts from the redesign of the design of objects in such a way as to exploit their potential, providing them with greater added value and leaving behind the outdated techniques of production where the realization of a piece started from the replication or modification of already existing things, result of planning according to compromises between productive processes and desired characteristics.

One of the most interesting startups in Italy regarding AM is Roboze [18], founded in 2013 by Alessio Lorusso. Roboze aims to redesign the global supply chain through its patented ultra-precise 3D printing technology for super materials. The idea is to create a new sustainable and circular production model, bringing production closer to the point of use, reducing transport and related CO2 emissions, delivering just in time and on-demand parts, avoiding unnecessary

[18] https://www.roboze.com/it/

waste. It can show off main clients as Airbus, General Electrics, Dallara Automobili, Bosch, and IVECO-CNHi[19].

1.2.7 Horizontal and vertical integration

Integration is a term used in Industry 4.0 context to refer to the adoption of specific information systems able to interact with the operators of the supply chain both upstream and downstream. When the exchange is with suppliers and customers, we are in the case of a Vertical Integration process, while when it happens between companies operating at the same level of the supply chain, even if apparently competitors, it is a Horizontal Integration.

As for horizontal integration, Industry 4.0 provides connected networks of cyber-physical and corporate systems that introduce new levels of automation, flexibility and operational efficiency unprecedented in production processes. This horizontal integration can be carried out on several levels:

- Within the same production line/plant: always connected machines and production units each become an object with well-defined properties within the production network.
  They continuously communicate their status and, together, independently respond to dynamic production requirements. The goal is to make an interconnected production line able to respond dynamically to the state of each machine, in order to increase the efficiency by reducing downtime.
- Across multiple production lines/facilities: for a multi-plant enterprise, Industry 4.0 encourages horizontal integration between Production Management Systems. In this scenario, the data of the production structures (inventory levels, delays and so on) are shared seamlessly throughout the entire company and, whenever possible, production activities are automatically moved between facilities to respond quickly and efficiently to changes in production.
- Across the entire supply chain: Industry 4.0 promotes data transparency and high levels of automated collaboration between the upstream supply chain (which feeds the production process) and the downstream logistics chain (placing finished products on the market). Suppliers of raw materials and commercial parts, together with service providers, must be safely incorporated into the company's production control systems and logistics.

[19] https://forbes.it/2021/12/10/nuovi-investitori-di-lusso-per-roboze-ce-anche-il-presidente-di-ita-airways-alfredo-altavilla/

Vertical integration in Industry 4.0 allows to connect all the different levels within your organization, from after-sales, to production, R&D, quality control, product management, sales and marketing, and so on. Data flows freely and transparently up and down these levels so that both strategic and technical decisions can be addressed by data. The vertically integrated Industry 4.0 enterprise has a crucial competitive advantage by being able to respond appropriately and with agility to the changing signals of the market and new opportunities[20].

Product Life Management (PLM) software is useful to facilitate the management of the product life cycle with the aim of optimizing each phase. These systems are based on shared access to a common source from which to draw data, information and processes related to the product concerned. In the beginning, the Computer Aided Design (CAD) software was used to digitally manage product drawings and validations, while the Computer Aided Manufacturing (CAM) applications managed the production and processing cycles of the parts.
The PLM is therefore a management and storage system in a single centralized database of CAD and CAM files, related to the same product, which shows all the information related to its lifecycle from design to automated production, to service and disposal, all in terms of cost-effectiveness of the business and allowing to progressively acquire the best practices and the most efficient methodologies (David et Rowe, 2015).
The focus of PLM technologies is therefore mainly aimed at the product, unlike what happens with Enterprise Resource Planning (ERP) software, which are aimed at managing the various businesses in an enterprise. These advanced systems therefore allow to keep an eye on the production process and to ascertain the quality of the production, tracing each operation and providing in real time indications about the trends, to assess in advance any deviations and take the right measures (Serra, 2018).
Therefore, PLM systems are the most advanced IT tool to support the creation of complex products in demanding markets, evaluating their life cycle to reduce production time and costs and accelerate their time to market.
The company is required a workflow defined as "collaborative" between the various departments, promoting a unification of parameters in the achievement of results, measured through shared indicators, the so-called KPIs. PLM systems therefore offer the tools to

[20] https://www.key-4.com/lintegrazione-verticale-e-orizzontale-nellindustria-4-0/)

centralize product data and standardize business processes, speeding up the exchange of information between the various design teams.

1.2.8 Advanced automation and robotics

Robots which collaborate with human being in the production processes' execution could be and will be a fundamental element in the industry 4.0 framework. The new robotics solution will allow to make the production system more and more flexible and efficient, improving the competitiveness manufacturing companies that use them.

A robot is a versatile machine that, thanks to a quite basic programming is able to perform a huge quantity of tasks from welding, to painting, to handling of pieces for loading and unloading, up to the visual inspection and finishing objects.
Many companies entrust even complex tasks to robots, eliminating risky, heavy or even boring operations, reducing development times and increasing production capacity as well as safety at work. These machines are equipped with their own intelligence, therefore they are part of the so-called digital factory, where thanks to the Iot and Big Data, they are able to interact with each other and those who program them, as well as with workers with whom they work side by side every day. The implementation of robotics in industries is the result of a process in which the companies analyze and break down every single step of the production process to identify all the activities and decide which ones to automate, mainly the most tiring for man and the riskiest for his health. Furthermore, it should be advisable to identify those passages where an increase in productivity could be achieved and in which robots are capable to increase the efficiency and the effectiveness[21].
The main characteristics of a robot are (Serra, 2018):

- the load capacity, that is the maximum load that it is able to carry at the workplace.
- the number of axes of which it is composed, direct function of the level of complexity of the movements it must perform.
- the range of action, that is the maximum extension that the robot will have to reach and for this reason it will have to be considered both the capacity and the distances that it must cover.
- repeatability, that is the accuracy with which the machine performs a task, expressed as the ability of a robot to reach exactly the same position each time a cycle of work is completed that is very important if the tasks are of extreme precision and importance.

[21] https://www.bcg.com/publications/2019/advanced-robotics-factory-future

- the speed and acceleration, instead, refer to the performance of the robot in terms of time required to perform a given operation and to move from one environment to another, essential elements in case of deadlines and rigid working time.
- the mass and overall dimensions on the ground indicate the robot's characteristics, such as shape and weight, which must be compatible with the type of flooring and the space available in the robotic cell.

The robots, mainly thanks to the Cloud technologies, will be strongly connected each other and will be able to collect information from the environment to be an active part of the production process. What will guide robotics in Industry 4.0 will therefore be the integration in automation processes, made possible using standard languages to instruct and program robots. Collaborative robotics concerns those forms of robots that are perfectly integrated in a digital factory context using the above technologies (Iot, Big Data and Cloud). These robots are equipped with advanced sensors necessary to better coordinate the activity of men and machines within the same environment, making the production process more efficient.

Then, there are autonomous vehicles, thin and complex forms of automation, which are able to move goods inside the factory and are the closest thing to the cinematic idea of the robot, much more than the anthropomorphs themselves. In fact, these machines interact with each other and with man, they can reconfigure their trajectories in the production premises according to the process requirements, adapting to the normal flow of workers in production environments.
For example, Amazon introduced automated guided vehicles and robot sorters developed at its European Operations Innovations Lab in Italy in the past year. The new support technologies include item sorters that Amazon claims wall reduces muscle strain by removing the need for an employee to rummage through boxes, to look for items; automated pallet movers that remove the need for forklifts; and machines that lift large boxes and place them on conveyor belts automatically. There will also be automated guided vehicles that drive around the site carrying items, which are equipped with sensors and follow pre-programmed routes to avoid bumping in to people or machinery. The tech giant claims smaller robotic arms will eliminate repetitious tasks for employees, such as lifting, stacking, and turning[22].
But robotics is not aimed only to the industrial sector, it can have a useful social impact too. For example, the young company Pixies[23], based in Rome and composed of a team of under 35,

[22] https://www.bcg.com/publications/2019/advanced-robotics-factory-future
[23] https://startupitalia.eu/2021/04/13/pixies-il-robot-a-energia-solare-che-pulisce-le-citta

has created a robot powered by solar energy able to collect and differentiate, for 12 hours, urban waste (for now plastic bottles and unsorted waste) with the guidance of artificial intelligence, and then return to recharge at the starting point. The three founders built the prototype in September 2020, thanks to a 3D printer that uses recycled plastic filaments. In fact, the idea is to build other objects from the waste they collect, in a circular economy perspective. Also, thanks to its invention, last December, during the National Award for Innovation 2021, it received the award "Best innovative young startup" of Confindustria.

1.2 Industry 4.0 Challenges and Issues

According to Pereira et al. (2017), it is essential to develop a prompt strategy for all the actors that are involved in the entire supply chain, in order to face the diverse technological challenges that result by the application of Industry 4.0 technologies.

The adoption of new manufacturing processes requires a new approach concerning the skills and the qualifications of their workers, as the collection, processing, and visualization of manufacturing process data (Hendrik et al., 2017). Other challenges are issued by the innovation of technological components, digital transformation advancements and the rising of interconnectivity developments, that is why it is relevant to involve the entire value chain and to integrate the digital ecosystems.

Though, according to a McKinsey company study (2015), most of the companies, especially the small and medium-sized enterprises in the industry, seem rather unwilling to start the digital transformation process and the hesitation has to do with several implementation barriers faced by manufacturers with no/limited progress in Industry 4.0 (D. Küsters et al., 2017).

The implementation of these systems requires huge investments. This could be a limit in the Italian industrial scenario, in which there are few big players that are able to guide the transformation of manufacturing, and an entrepreneurial system mainly formed by small and medium-sized companies. Especially the fact that these smaller companies face some difficulties and longer adjustment times, make it necessary also a sensitive intervention of the State to precisely support these realities, to allow the development of a more homogeneous and technologically advanced economic structure, able to compete even outside the borders. In this context, there is a need to define a kind of guide for the development of the complex transformation project involving the public and private sectors (Mohamed, 2018).

1.3 Industry 4.0 effects and benefits

Thanks to the different technologies previously exposed, Industry 4.0 companies develop flexibility in manufacturing process and are able to analyze large amounts of data in real time. This allows them to improve strategic, operational decision-making and to develop connected system, resulting in the so-called smart factory.
To digitalize the company doesn't mean only to acquire these new technologies but also to activate a process of change that, in fact, affects the management of the company, that must be able to adapt to the speed, quality and productivity standards required in order to compete.
Meanwhile, greater flexibility in schedules and performance, as well as the development of new skills and knowledge, combined with a greater level of involvement and participation of workers in production processes, will be required.

The development of Industry 4.0, confirming the organizational impact, requires a simplification of processes, the reduction of waste and activities without added value, recalling the concept of Lean Production. It dues its spreading thanks to the Toyota Production System and is based on a streamlined and efficient management of design, production and quality control processes whose main objective is to minimize the costs related to such operations.
A 4.0 company must be able to vary its production plans and processes to adapt to changing market demand and changing preferences. Along the entire supply chain, the imperative will be the efficiency in the use of the resources to benefit of the chain of the value in terms of returns for customers and the other stakeholders (Serra, 2018).
The organization of the work must be such as to ensure the development of adequate professional skills such as teamwork, continuous training, and an ever-improving productivity, for example by implementing a Kaizen philosophy, a concept again from Toyota, where the total quality control, the just in time, the feedback system and the technological progress have been for many the fundamental reasons of the productive increase of the Japanese industrial system.

Digital technologies that can provide a large amount of customer data, are extremely useful to meet the demand for customization of products by consumers, making it possible to more accurate definition of the needs of the same, activating dedicated and customized solutions for individuals, with a consequent influence on the entire production chain, from planning to production, in terms of customization and quality of products with greater value for use.

The new technological solutions also allow the exchange of real-time data on the production capacities of a multiplicity of connected companies, thanks to which it is possible to identify new partners and integrate with those with whom there are already collaboration, reducing cost and response time. In fact, value chains tend to be increasingly interconnected, integrated and projected on the market.
Another benefit is the increased speed in the transition from prototype to series production through innovative technological solutions so that design and production's processes become much more integrated, ensuring greater speed and consequently a lower time to market.

In terms of productivity, however, there is a greater efficiency of the processes achieved through less adaptation and replacement of tools and equipment, the reduction of margins of error and downtime, the increase in overall reliability of the production systems and the higher quality of the product obtained.
The best quality standards are obtained through the production of a lower amount of waste material, with a sensor that allows to control in real time the production process, implementing a systematic monitoring of the quality itself.
Such advantages consist in systems of supplying and logistics rendered more efficient from the new technologies that support them, with a better management of the warehouse and the orders, optimizing the relationships with the suppliers inside collaborative ecosystems. Another positive aspect regards the increased safety of the workplace.
Finally, further positive elements regarding environmental sustainability and corporate social responsibility, two topical issue and now a source of competitive advantage. In fact, the reduction of energy consumption and emissions has direct consequences on the entire life cycle of the product, greatly reducing the overall environmental impact.

In the end, this chapter focus has been to explain the different technologies that are the pillars of Industry 4.0, understanding the benefits but also the complexity of the processes, along with some concrete examples of innovative startups, that are contributing to develop and enhance the digitalization process in the Italian market.

2. Logistics role in Industry 4.0

In the past century, Logistics has seen three revolutionary changes: the first innovation (Logistics 1.0) has been caused by the "mechanization of transportation" between the late 19th and early 20th century. Then, a second innovation (Logistics 2.0) has been driven by the "automation of handling system" from the 1960s. “The system of logistics management”, instead, is the representation of the third innovation (Logistics 3.0) from the 1980s. Now, we are witnesses of the fourth innovation of Logistics, which is called Logistics 4.0, which main driven force is IOT&S (Internet of Thing and Service).

Logistics 4.0 paradigm, as for Barreto et al. (2017), can be summarized as the optimization of inbound and outbound logistics which must be supported by intelligent systems, embedded in software and databases from which relevant information is provided and shared though Internet of Things (IoT) systems, in order to achieve a major automation degree. Additionally, Logistics can be seen as a network where all processes can communicate with each other, as well as with humans for enhancing their analytical potentialities throughout the supply chain.

Logistics 4.0 stands in a broader sense of Industry 4.0 including five functional areas valid across businesses, namely, data collection and processing, assistance systems, networking and integration, decentralization and service orientation, self-organization and autonomy.

These functional areas are supported by mechanisms of horizontal integration through value networks facilitating inter-corporation collaboration, end- to-end integration creating integrated networks of stake- holders, products and equipment along the product life cycle.

The key logistics activities of transport, inventory management, material handling, supply chain structure and information flow are affected in Logistics 4.0. Following examples can be used to describe the Logistics 4.0 processes, exploiting the technologies presented before:

a) Real-time big data analytics of vehicle, product and facilities locations can find optimal routing for material and product transportation.
b) On-site, on-demand, rapid manufacturing reduce the need for storing products.
c) In warehouses, autonomous robots and vehicles along with tracking and decision-making systems keep control over inventory.
d) Real-time exchange of information among different actors removes the traditional boundaries of logistics, which enables reduction in bullwhip effect.
e) Smart products and cloud-supported network keep the information flow intact.

In practical, the evolution of IoT&S and Big Data is already reducing the work that requires humans' intervention in each step of the supply chain and new technologies such as automatic guide vehicle (AGV) and warehouse robot are replacing the process which is operated and decision-making by the humans.

At the same time, the supply chain management is becoming a big network where all the stakeholders, form suppliers to final customers, are able to access it through an online platform where all the orders from the customers/suppliers can be managed in real time.

In Logistics 4.0, the intralogistics or the movement of goods inside the factory are completely automated with autonomous forklifts, AGVs and robots with a routed program that is based on the predictive inbound logistics. All activities in logistics will come from the information received from the internet platform used by all the stakeholders.

Also, the warehouses expenses can be reduced to the minimum or might disappear completely because the customers' orders and the orders to the suppliers will be processed at the same time. Fleet vehicles will have a routed program using the internet platform from where the necessary information will be taken. The customers and suppliers will be able to track the vehicles, which have GPS/RTLS in order to location its position in real-time.

2.1 Trends affecting Logistics 4.0 and implications on business models.

In order to comprehend the challenges and opportunities that arise around the logistics process in the world-economy, and particularly how it influences and how it is influenced by the greening of business around the world, the study now focuses on identify which are the most important trends that are affecting Logistics 4.0 and which are the consequences and implications on the business models.

a) *Personalization*: a growing trend in the past 10 years, with multiple implications. Like the individualization of the demand, but also production and marketing personalization, to reach every customer's need and desire, there is also the delivery personalization: the delivery of products by choosing different distribution routings has enabled individual deliveries, but only at selected time windows and selected products (milk, newspapers, etc.). In the future, autonomous vehicles as drones will enable personalized deliveries at the next level.

b) *Servitization*: the value is no more perceived through the product being purchased or its ownership, but rather through the performance or utilization of that product. Services are also provided in production related processes, including various design services, simulation services, computing services etc., and thus creating a concept of everything

as a service (EaaS) under the umbrella of Internet of service (J. O. Strandhagen et al., 2017).

c) *Accessibility*: in the context of Logistics 4.0, it means to provide products or services to the customers at anytime, anywhere and in any form which is traditionally not possible due to various barriers such as remoteness of location, environment etc.

d) *Autonomy*: many companies are today using autonomous transportation within their warehouses for the placement of goods. This is enabled by AGV, autonomous industrial robots and flexible manufacturing system. Several other identification technologies such as Auto ID and RFID are used for autonomous tracking like inventory control. In the future we will witness autonomous transportation using global positioning system and real-time big-data analytics.

e) *Digitization*: nowadays pure digital business models are growing, both for new products emerged by digitalization itself, but also by the digitalization of physical products. Digital technology can delete the need for physical distribution of music and TV by offering streaming services. Internet and networking technology allow business models to share information about physical products or services. One example is Uber, sharing information about available personal transport services.

f) *Green logistics/circular economy*: In Logistics 4.0, the circular economy aims at increasing efficiency by incorporating technology and production systems, shutting down material loops into an economical system. Big data analytics along with smart products and cyber-physical systems provide an assessment of end-of-life recovery, through various stages such as return, inspection and sortation, disposal, repair, recycling, reuse and refurbishment.

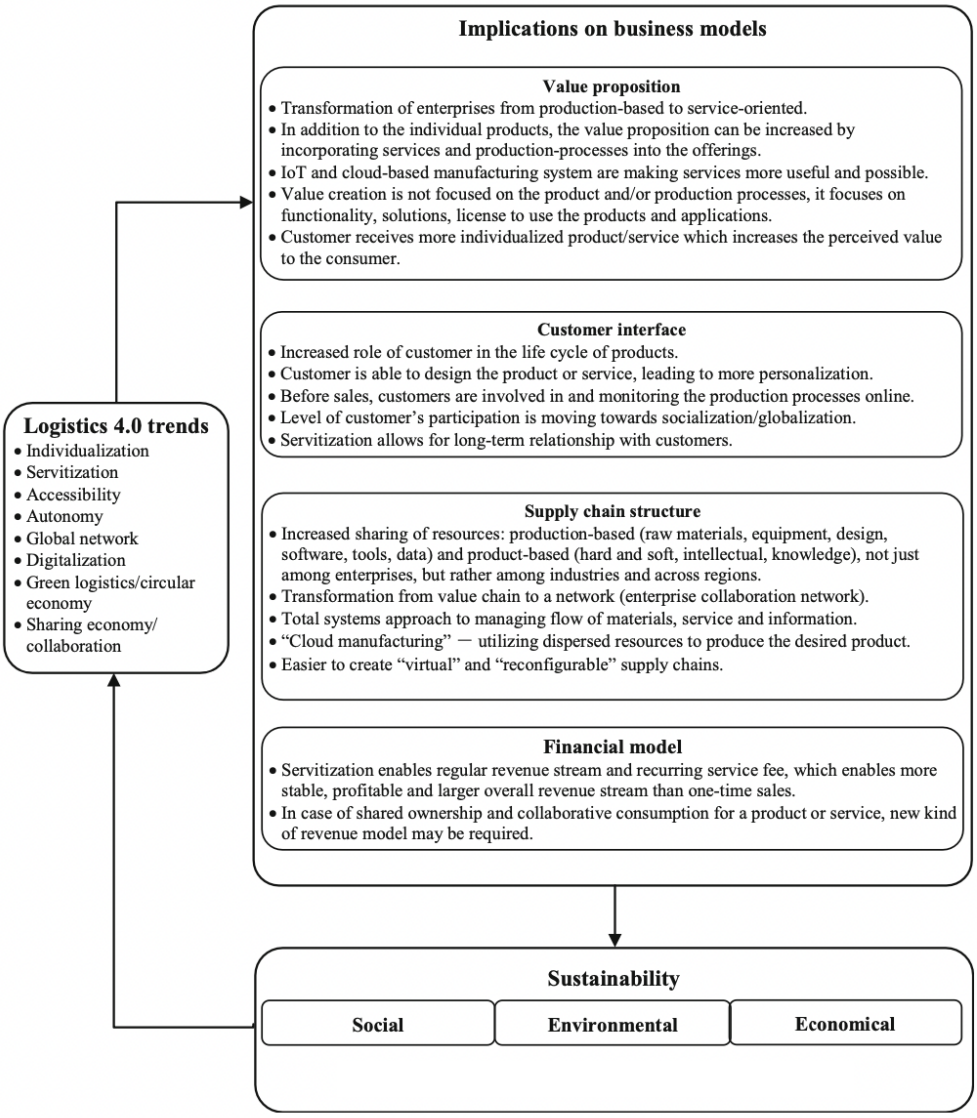
g) *Sharing economy***:** The idea of a sharing economy allows individuals to share resources and services through the sharing of digital information. Current examples are the sharing of modes of transport such as cars, facilities such as homes and tools such as the lawnmower.

All these trends related to Logistics 4.0 have a combined effect which is rapidly changing the way of doing business, according to J. O. Strandhagen et al. (2017). In fact, businesses are moving towards a more service-oriented logic, where the customer is also involved in the design of the product or service. These types of changes are facilitated by the technologies of Industry 4.0: CPS, IoT, Internet of services, smart products and smart processes are adding value and support a service-orientation of the business.

First, 3D printing, and on-demand production enable customers to customize their products and improve value propositions; whereas on the other hand, customers are also able to monitor the online production process via CPS and IoT. The socialization of clients through shared ownership and/or servitization also changes the financial model of businesses.

Moreover, improving business models based on Logistics 4.0 trends can enable a broader social or environmental focus. Businesses can assume a stewardship role and become more accountable for the health of customers, employees, society and the environment. Cyber-physical systems, real-time big data and smart processes can support choice publishing, which means selectively eliminating products that are no longer suitable for consumption or even for the disposal of non-environmental processes. Moreover, society and businesses are encouraged to increase their capacity for consumption and production and to reduce the premature disposal of products before their useful life.
Economically, Industry 4.0 technologies have the potential to facilitate value creation from waste and create more business opportunities for businesses in used markets. Drones and 3D printing can also help businesses meet the needs of poor countries, open new markets and help them become more socially responsible.

As Figure below suggests, Logistics 4.0 trends, business models and sustainability have a circular relationship, which means that sustainability itself affects, and can even generate, Logistics 4.0 trends. Changing needs or requirements for sustainability can be a driver for new logistics solutions, and this can be applied for all three aspects of sustainability, which are social, environmental and economical. Finally, the economic aspect of sustainability can definitely generate Logistics 4.0 trends, as the competitive pressure in the industry today constantly requires improvements to logistics solutions. Thus, the three aspects of sustainability lead to new trends in logistics, and in this circular relationship, new logistic trends, business models and sustainability are continually intertwined and changing.



2.2 Basic technical components of Logistics 4.0.

Logistics 4.0 needs support from the rapid developsment of many technologies, in this section, we are not to introduce all of them, since the already wide presentation of the first chapter, but we are going to focus only on the basic technical components, which are:

a) **Automatic identification**

Automatic identification for the development of a highly automated data collection technology relies on information technology, optics, mechanics, electrical, communications and other technologies. It automatically acquires object recognition information by applying some of the identification devices to provide a technique for the background processing system to supplement the related tracking processing. It can help people quickly, accurately and

automatically enter big data, and transportation, storage, distribution and other aspects which have been used extensively.

Today, bar code technology is the most used automatic identification technology. Radio frequency identification (RFID) technology has been developed in recent years, the modern automated identification technology, which is the use of induction, radio waves or microwave technology for the radio frequency label reader for touch-free reading, in order to achieve the goal of automatic data acquisition. It can identify rapidly moving objects and you can read several objects with sturdy, strong security features. With the development of the RFID technique, it became increasing possible to acquire real-time production and logistics data. However, it is far from sufficient for the company only to collect the massive amounts of RFID data and do the track and query. RFID data-based decision-making will provide more value to the company and improves the production and logistics efficiency.

b) Real-time locating systems (RTLS)

Real Time Location Systems (RTLS) are applied to automatically identify and track the location of objects or persons in real time, generally within a building or other confined area. Wireless RTLS tags are attached to objects or worn by people, and in most RTLS, fixed reference points receive wireless signals from tags to determine their location.

Event and products identification is often associated with recording the place of identification, real-time locating systems (RTLS) have to be distinguished from identification.

c) Smart Sensing

Smart sensors are used to detect the state of goods or changes in its environment and then provide a corresponding outcome for decision-making purposes. Typical sensors used in Logistics are:

- Temperature sensor;
- Humidity sensor;
- Ethylene sensor;
- Active RFID transponders

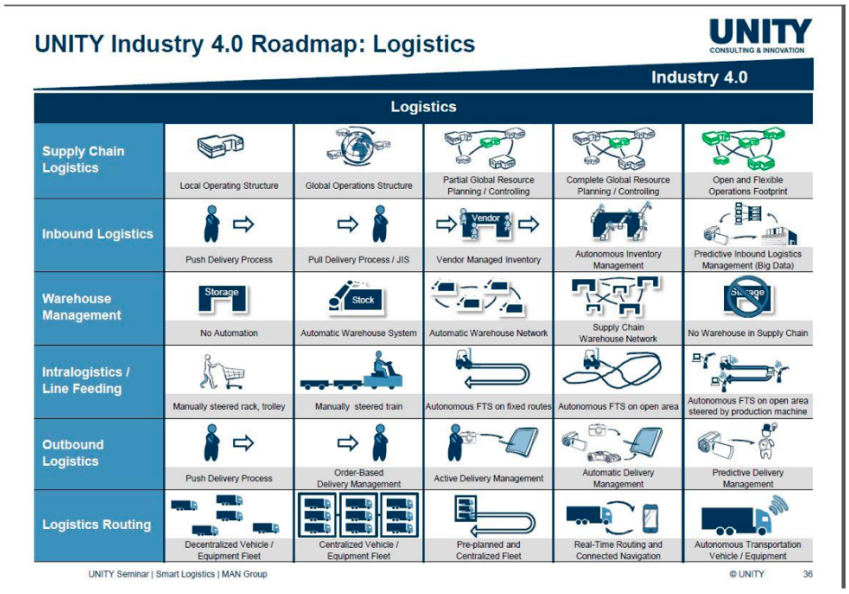
The combination of the three technologies RFID, RTLS and smart sensors fulfil an order function for the requirement of the “7R” in logistics. The “right product” has been identified, “right time”, “right quantity”, “right quality”, “right price” and “right location” have been recorded and the “right condition” has been checked through smart sensors.

2.3 Logistics 4.0 applications

Industry 4.0 revolution's aim is to interconnect and improve communications among individuals and machines, as seen in the previous chapter, in order to make them able to use the huge amount of data and information for faster and more correct decision-making processes.

Now, it is the turn to focus on the impact of these technologies on the logistics function, giving space to some applications, where efficiency, cost reduction, flexibility, quickness, and integration of the processes are fundamental in order to be competitive. Companies need, at the same time, to properly adapt because customers are more and more demanding in terms of quality, diversity and speed of delivery.

The diversity of products being handled, the new techniques and technologies introduced in production and service, the operation of the various networks and the need for globalization make it necessary to increase the complexity of logistics systems while ensuring the transparency of such systems. This can be solved only with automated and optimized complex structures, processes, and subprocesses.



Logistics 4.0 innovation processes (Unity)

The demand for high-individualized products and services is continually increasing. Thus, inbound and outbound logistics have to adapt to this changing environment, as seen in the above picture, which shows the innovation in all the logistics sector's area, due to Industry 4.0 technologies and, in fact, due to its increasing complexity, it cannot be handled with ordinary planning and control practices.

"Smart Logistic" is a logistics system that allows a company to be closer to the customer needs by enhancing flexibility, the ability to adjust to the market changes. This is going to make

possible improving the level of customer service, the optimization of the production and lower the prices of storage and production.

This new paradigm is the result of the increased use of Internet that enables real time communication between machines, humans and the use of what is known as advanced digitalization. An efficient and strong Logistics 4.0 system must rely on and use, in Barreto et al. (2017) point of view, the following technological applications:

a) The *resource planning management* procedures allow to enhance the overall productivity, flexibility and agility required for the changes that might occur in the supply chain. An adequate forecast of the resources, possible with a proper alignment and integration between the main actors among with a high level of visibility and transparency will potentiate the optimization of resources/processes, time to market alignment and raise the asset employment.

b) The introduction of 'smart' management throughout the proper adoption and implementation of a *Warehouse Management Systems* (WMS) will guarantee to the warehouse activities to be able to meet the future requirements of the inbound logistics according to the Industry 4.0 paradigm. Therefore, as an example, transports will be able to communicate their position and predicted arrival time to the intelligent warehouse management system, which will be able to select and prepare a docking slot, optimizing just-in-time and just-in-sequence delivery. Simultaneously, the RFID sensors will reveal what has been delivered, and send the track-and-trace data to the entire supply chain. The WMS will automatically attribute storage space according to the delivery specifics and request the appropriate equipment to move the goods to the right location autonomously.

c) A *Transportation Management System* (TMS) is part of supply chain management (SCM) centered on transportation logistics. This kind of system allows interactions between an order management system (OMS) and distribution center (DC) or a warehouse. A TMS is able to help companies in:

- Controlling and managing ever-higher, as seen in previously, freight costs.
- Integrating with other supply chain technologies (like Warehouse Management Systems and Global Trade Management Systems).
- Handling electronic communications with customers, trade partners, and carriers.
- Offering better end-to-end supply chain visibility among SMEs, increasing the upper end of ROI

d) *Intelligent Transportation System* (ITS) is a novel field that operates among different fields of transportation systems such as transportation management, control, infrastructure, operations, and control methods. Thanks to the adoption of new technologies as computing hardware, positioning system, sensor technologies, telecommunications, data processing, virtual operation, and planning techniques, it allows an increase in safety and reliability, travel speeds, traffic flow and in the same way a reduction in risks, accidents rate, carbon emissions and air pollution.

   The most recent generation of ITS, "generation 4.0", is able to create a multimodal system by incorporating personal mobile devices, vehicles, infrastructure and information networks, so it plays an important role with the to support and the enhancing of the logistic process and also in terms of sustainability.

   An ITS using real time and in-line data gathered through VANET Systems (vehicular ad-hoc network), sensor networks, drone points and business intelligence systems, will increase the quality of management decision-making processes, which become more and more flexible and efficient, thus allowing to improve the efficiency of logistics through the convergence of Machine to Machine (M2M) communication and cooperative systems technologies.

Big Data, as seen in chapter 1, allow 4.0 companies to analyze the data in a more advanced level, processing and combining data collected in various and incompatible systems.

An interesting example use of this technologies in the logistics field is DHL, which implemented an instrument – called "Resilience360" – which has been thought and designed to manage risk in the supply chain, not only protecting but also improving its operational efficiency, while providing the opportunity to explore new business models.

Through Big Data analysis, DHL is able to forecast the planning volume of parcels for transport, improving customer service, promptness and flexibility in dealing with breaks in the production.

The same company obtains evaluation and detailed analysis of complex geographic data thanks to another implemented instrument – called "DHL Geovista" – which facilitates logistics service providers to anticipate and forecast the sales figures of SMEs, having access to retailers, transport, invoices information and data from customer profiles and orders. Using customer data in order to analyze information from the delivery system, retailers can meet the expectations of customers by anticipating their behavior.

2.4 Logistics 4.0 best practices

According to Lee et al. (2014), the logistics sector either can be viewed as part of the "smart factory" model, where virtual copies of the physical processes are created, integrated and monitored by computer systems and where everything is linked with each other.
There are several different ways in which the advent of new 4.0 technologies are affecting the logistics, and the main example of this section can be only the world delivery's giant, Jeff Bezos's creation:

1. **Faster Speed: delivery services conducted by drones or delivery robots.**
   Since 2013, Amazon has been developing a program called "Amazon Air Prime"[24], in which the company is exploring the use of drones for delivering small packages. Actually, it was supposed to be officially launched in 2018 but now it is planned to start in the third quarter of this year, after some regulations and legislation issues, but it can be really innovative and revolutionary among the 3PL sector.
   Always Amazon, in addition, in 2014 filed a patent called "anticipatory shipping", with the idea to use predictive analytic tools in order to analyse customer's shopping history along with others to be able to predict what they may need, In theory, anticipatory shipping would enable Amazon to ship products (possibly by drones) to consumers even "before" they even order them (Kopalle, 2014).

2. **Higher Reliability: storage and retrieval systems using robots**. Kiva[25] is a system acquired for 775 million dollars in 2012 from Amazon in order to automate storage and retrieval operations in its fulfilment centres. It must be highlighted how Amazon firstly, already in 2012, invested a significant amount in Industry 4.0 technologies, even before many of its competitors, and this is one of the main reasons of its sensational success.
   The system increased productivity in their centers by recording, tracking items and by brining products directly to the employees to be picked, packed and shipped.
   The development of robotics and automation systems in the logistics can help employees to improve speed and reliability of their pick and pack operations, also reducing repeated motion injury in the workplace (Ashley, 2017).

3. **Lower Operating Cost: inventory monitor and replenishment systems using smart sensors**. Real time information about inventory is not always easy to obtain, this often

[24] https://www.businessinsider.com/amazon-prime-air-attrition-drone-delivery-employee-turnover-2021-2022-5?r=US&IR=T
[25] https://www.ilpost.it/2016/07/28/amazon-ha-cambiato-anche-la-robotica/

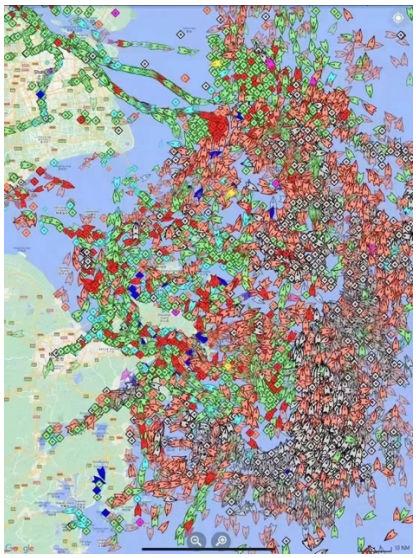
is inaccurate and costly. A new opportunity so, it is to develop an innovative system based on weight sensors that can monitor the quantity of items on the shelves, with an immediate notifying system that help the employees with replenishment.

In a related development, AWM Smart Shelf uses cameras mounted on its smart shelves, gather data on shopper behavior, and can develop personalized videos to display on its smart shelves, according to age, gender or ethnicity, offering additional value beyond logistics (Horowitz, 2019). Similar, but addressed to final customers, are Samsung's smart fridges, with cameras that can be used by individuals to monitor the inventory, expiration dates etc..

Finally, with real time inventory information at different warehouses, an online retailer can make real time decisions about product price and the warehouse from which an incoming order is filled (Lei et al., 2018).

4. **Improve Efficiency: Container shipping enabled by blockchain.** As seen at the beginning of chapter 1, ocean freight operations were (and are) one of the most relevant issues in the current Supply Chain Great Disruption. In fact, they involve so many organizations (exporters, terminal operators, trucking companies, customs officers, freight forwarders, ocean carriers, insurance companies, banks, importers, etc.), lots of paperwork (bill of lading, invoice, certificate of origin, freight shipping forms, inspection certificate, export packing list, insurance certificate, etc.) and many processes are still done manually, resulting in long and uncertain delays that are commonly observed. To understand the importance and criticality of Logistics, we just need to think to the enormous consequences in all our global economy after the rise of container-freight costs, due to Covid conditions in China, as in the below picture, where it is possible to notice how a Global container-freight cost increased by 4-5 times its previous value during the pandemic.

When e.g., the container ship MSC Zoe lost containers in front of Dutch and German coast in 2019, it took them weeks before knowing the exact number of lost containers. The same happened when China has shut down a key terminal at its Ningbo-Zhoushan port[26], the third busiest port in the world, after one worker was found to be infected by Covid and fifty thousand of containers were blocked there, as it is possible to see in the below picture. This caused delays and increasing costs for millions and millions of dollars.



Shanghai port 2021 shutdown (via Twitter)

[26] https://www.cnbc.com/2021/08/13/chinas-zero-covid-strategy-to-disrupt-shipping-as-ningbo-zhoushan-port-shuts-.html

3. The impact of digital logistics start-ups on incumbent firms.

Logistics service sector is undergoing rapid changing and development from 2014, especially thanks to the role played by startups. In fact, these agile and fast-growing companies are threatening the established players, requiring them to pursue for innovation in order to survive this epochal shift which is occurring. This will be the focus for this chapter, analyzing how startup are innovating and changing the sector, looking at the amount raised from venture capital funds, in order to understand the magnitude of their impact, and on the dynamics that their presence implies for the incumbents, following the "cooperate or compete" dilemma.

3.1 Startup funding in logistics

The greatest economic consequence due to the Covid-19 pandemic has been the global rise of e-commerce – which grew by over 25 percent, meanwhile the problems in air and ocean transportations – as saw in previous chapter – seems to have renewed the focus on the role of logistics, increasing the desire for greater visibility across the whole supply chain, after that its vulnerability has been seen across all the world. Investors in the logistics industry have become more aware of the challenges, and the corresponding opportunities for growth, and are investing in new ventures with larger funding rounds.[27]

Oliver Wyman reports [28]that "around every fifth day, a new logistics startup is founded" and warns that "these agile, innovative startups are disrupting logistics service industry along its entire value chain from freight forwarding, brokerage, and long-distance transportation, to warehousing, contract logistics, and last-mile delivery." These companies are leveraging the high amount of data that is handled and generated by logistics player, with the goal to develop a wide range of technology solutions for the pain points of the sector. Five major clusters dominate the landscape: online platforms, asset management solutions, robotics/autonomous vehicles, shipping execution & tracking, and data & analytics solutions. Furthermore, the topic is interesting because the race for the leading market position of tomorrow have seen the entrance of a magnitude of players of several different industries, from Amazon to Daimler.

[27] https://www.mckinsey.com/industries/travel-logistics-and-infrastructure/our-insights/startup-funding-in-logistics-focused-investment-in-a-growing-industry

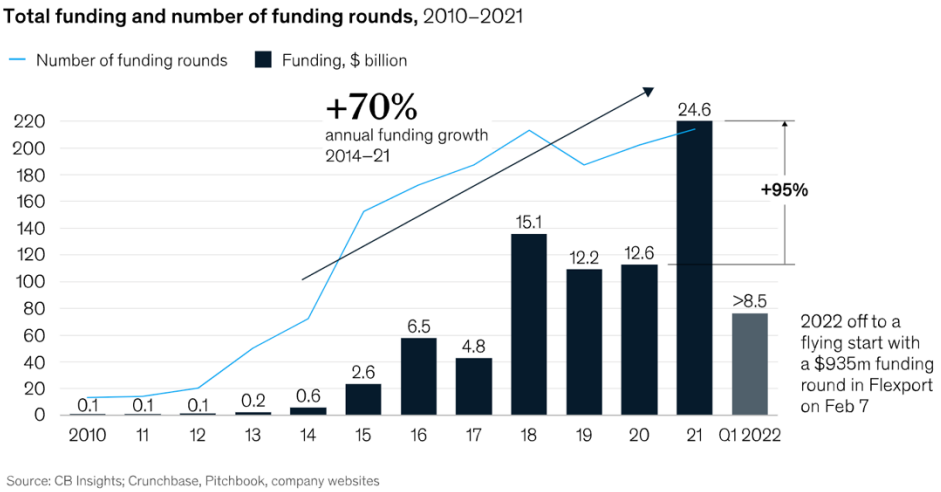
[28] https://www.oliverwyman.com/our-expertise/insights/2017/sep/oliver-wyman-transport-and-logistics-2017/innovations/how-start-ups-digitalize-logistics.html

Startups always arise bringing to the table some new solution to old problems and these companies are growing so fast in the logistics because this sector is full of inefficiencies from everywhere you look, as confirmed also by a McKinsey study[29].

In fact, if you think that a simple cross-country trade has to go through more than ten different parties, each with multiple touch points, it cannot be stated something different. From customs to terminals, to shipping lines, forwarders or authorities, shippers and consignees need to interact with up to 25 different entities.

In addition to this high number of breakpoints, this sector is characterized by many other inefficiencies, that are then the cause of such a quick development of new solutions, as complex pricing rules, little standardization of data – 50% of the US' largest importers still manage their complex international supply chain with spreadsheets[28]. Moreover, a high degree of market fragmentation into micro-businesses that fierce the competition combined with a lack of transparency, keeps the prices down, forcing the sector, in some past years, to operate below the break-even point, according to the report.

This low profitability has slowed down the innovation, curbing them from testing radical solutions on these known issues, but industry's customers have remained quiet due to the decreasing prices. However, on the other hand, consumers have experienced changes in many other industries (travel, retail, mobility) and higher their expectations on the logistics sector by putting pressure on the incumbents. And their rigidity facing drastic changes has boosted the rise of a new generation of logistics startups.



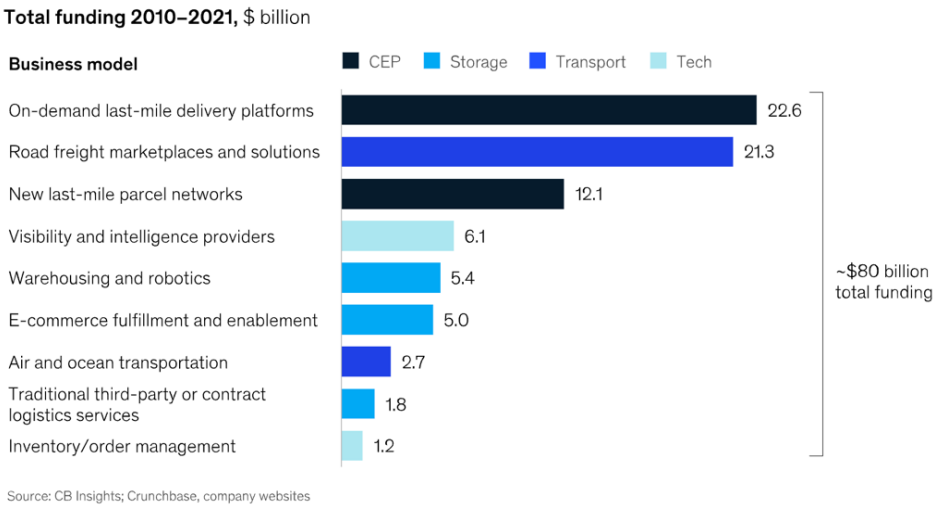
[29]https://www.mckinsey.com/~/media/mckinsey/industries/travel%20logistics%20and%20infrastructure/our%20insights/startup%20funding%20in%20logistics/startup-funding-in-logistics-new-money-for-an-old-industry.pdf

As in the picture, the growth of investments is huge: around USD 79 billion have been invested in the last decade and if only USD 600 million were raised in 2014, it is impressive the increase from 12.6 of 2020 to 24.6 (almost the double) in 2021. As it has been happening in other industries, the funds are highly concentrated, with the ten best-funded companies that have received about 46 percent of the total, and the top 20 that accounted for 66 percent.

Private equity (PE) funds are also entering the arena and increasing the drive to fast and successful exits—through IPOs, for example. Analysis of the startup sample shows that PE funding increased by 167 percent between 2020 and 2021, far above the overall funding increase of 95 percent[27].

Segments

A large percentage of new logistics start-ups are focused on online platforms and data-driven services – areas that are easily scalable and require little fixed-cost investment. But rapid technological evolution means that all identified start-up clusters are seeing a steady stream of new entrants. In fact, among the sectors, the most funding, around USD 22.6 billions, was raised by startups offering last-mile delivery services to retailers and individuals. This segment has benefited from the growth of the e-commerce logistics, which CAGR from 2017 to 2023 is 8/9%. The second one in terms of funding are freight platforms, especially on road transportation, which have collected about USD 21.3 billions. These platforms improve the pricing transparency and the shipper carrier exchange, focusing on handling the existing amount of data to clean up the inefficiencies and, in the end, improving the sustainability of the transportation, a trend that is becoming more and more central.



Location

Shifting the focus on the global distribution, funding has been concentrated in the Chinese area, which force is driven by a fast-innovation tendency and a willingness to try new business models, accelerated by an overall economic growth. One way to see how this manifest is the huge demand growth in e-commerce, reflected also in Premier Li's program "Internet Plus", which goal is to "boost the integration of logistics and internet technology, lower the cost for enterprises, and make people's lives more convenient"[30].

China is already one of the greatest incubators of many disruptive digital innovators and is also leading the logistics sector with six of the top ten best founded startups. The first one is Manbang, an online platform for trucks, formed by the merger of Yunmanman and Huochebang in 2017, which has received USD 1.9 billion, in the single largest round for a logistics startup, led by SoftBank's Vision Fund as well as the China Reform Fund Management, with other investors, including Google's Capital G, Tencent Holdings, Sequoia Capital, and others. On June 22, 2021, Manbang was listed on the New York Stock Exchange and raised $1.6 B. However, just a couple of weeks later was caught, in China's Cyberspace Administration's data security crackdown and submitted to a national security review, causing the stock price to tumble over 25% from its IPO price.[31]

Shifting to Europe, which is far away from the possibility to compete again Asian and US peers, accounting only for a 5 percent of the cumulative logistics funding.

Of course, the European area does not see its own Silicon Valley or Shenzen, meaning a tremendous, innovative, and disruptive area. This is one explanation. However, if we compare this 5 percent share with the 15 percent, which is the share of VC funding share of Europe across all the industries, it is even smaller.

The main significant reasons are actually two: first one is that the traditional manufacturing companies have relied on incumbent services for decades, so they are not open to use new services or try new alternatives, having barricaded themselves in long and strong relationships to their logistics partners. On the other end, and this goes for every European market, startups have a big disadvantage when it comes to go over national boundaries, facing problems with language, national barriers and, in the end, find themselves to compete in a smaller market.

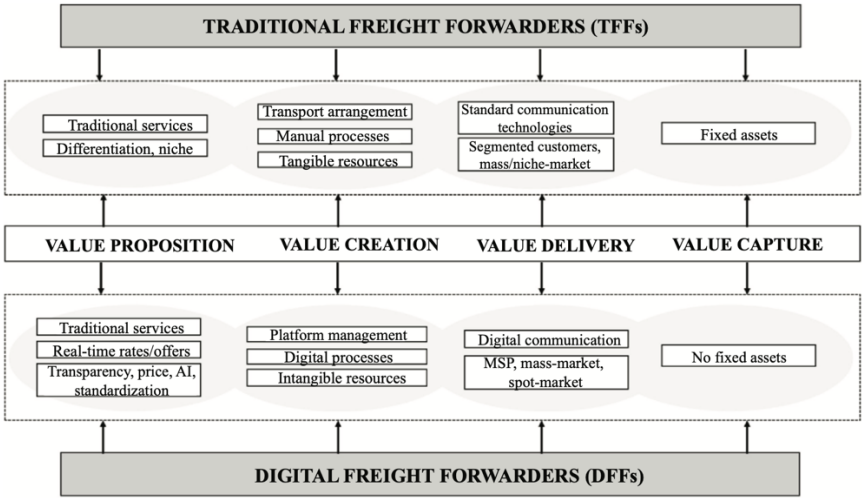
[30] http://english.www.gov.cn/premier/news/2016/07/21/content_281475398667727.htm
[31] https://supchina.com/company-profiles/manbang-group/

3.2 The impact of digital logistics start-ups on incumbent firms.

Digital logistics startups arise with the promise to provide better and more cost-efficient, real-time and on-demand transport services. These companies are challenging incumbent LSPs in two ways: the first ones are the digital, cloud-based, intermediation platforms, which have zero physical assets, and are extremely focused on matching supply and demand for logistics services, creating full price transparency and providing more efficient solutions. The other one is that these platforms have a second competitive advantage being able to use advance algorithms to calculate and predict rates, capacities, and means of optimization to a more extensive network of carriers and 3PLs.

Also, some successful VCs funds believe that established logistics companies need to rethink at their business models. In fact, startups offer scalability in large market segments and a higher customer lifetime value. Incumbents must adapt, starting from having a mentality more focused on toleration of uncertainty and risk, more flexible and less conservative[27].

In this regard, an interesting study conducted by Mikl et al. (2021), published on The International Journal of Logistics Management, aimed precisely to see whether Digital Startups are having an impact on incumbent from a business model point of view, comparing DFF (Digital Freight Forwarder) with TFF (Traditional Freight Forwarder), as seen in the below picture. While the latter have already implemented digital services and innovating their processes, the SMEs are not able to provide this kind of services, due to a lack of resources. The first conclusion is this one: the smaller the TFF, the higher the threat of a DFF, due to the incapacity to develop digital solutions. These small companies, in order to survive, must look for new opportunities such as alliances, joint venture or other partnerships.



Business model differences (Mikl et al., 2021)

Second: the strength of TFFs is also due the fact that they can offer to customers different type of products, satisfying multiple niches, whereas startups must focus on one standardized service or one specific niche. Hence, from the managerial point of view, incumbents should seek further differentiation strategies, as the more they are specialized, the less to influence of DFFs is felt. Third key point of the study is that there are differences in the levels of digitalization in the different means of transportation: DFFs have a higher impact on TFFs in the sea, air and rail industries than in the tracking one (Cichosz et. al; 2021).

LSPs have joint the competition for logistics innovations, establishing their own intermediation platforms, promoting their own digital assets (as DP-DHL's Saloodo or DB Schenker's Drive4Schenker) and this is just the first approach for incumbents to defend their competitive advantage. But overall, the competition is more fierce than ever also due to the rush for best partnerships and targets, which regards all the sectors, also outsider the transportation and logistics. Tech giants as Amazon or Alibaba are investing in startups to innovate their last-mile delivery, but also mobility providers as BMW and Daimler are developing smart and autonomous solutions for passengers and cargo transport platforms.

Logistics incumbent should pay attention to VC's trends because startups can quickly signal which will be the next changes that are worth pursuing and which are not, having the flexibility and agility to test, to take risk and try different innovative solutions. The key challenge for them in fact may be that they are not integrating and adapting to technological disruptive solution quick enough to capture competitive opportunities before outside investors do. In this sense, startup investments are a focal point to follow also for large logistics organizations, that can later leverage and focus on the surviving trends, optimizing their operations.
By the way, with the digital capabilities that startups have brought to the table, incumbents are already investing heavily to catch up and fulfill shippers' requirements for transparent, seamless digital booking. For example, almost all of the larger forwarders, as well as carriers of air and ocean freight, now offer shippers instant quotations and bookings, something that rarely existed in the market previously[26].

3.3 LSPs' Cooperation with Start-ups

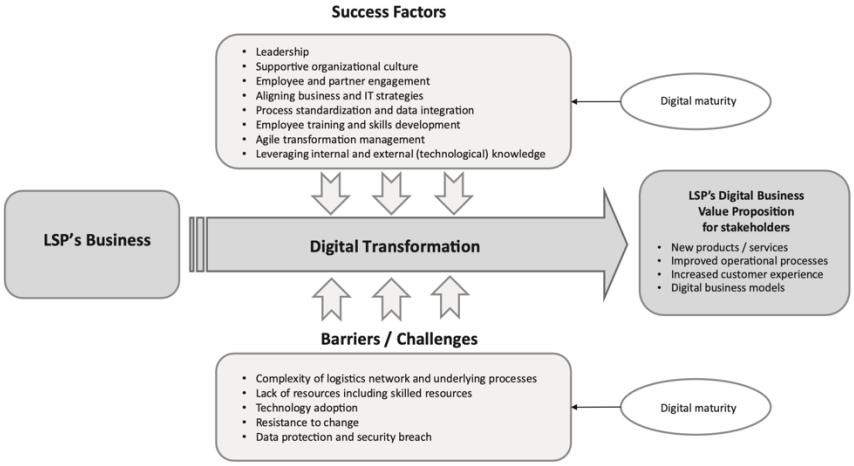
It could be more on the latter's interest, but cooperation and partnerships between incumbents and startups appear to be a win-win solution. Incumbents must shift their approach, do not be

afraid to lose their legacy and start to see the complementary of the collaborations. It's vital to theme to take advantage of the current situation, or they will undergo the risk to meet these new entrants head-to-head as competitors in the future instead of being partners who can support their improvement in the operational efficiency and transparency, elevating the customer service, thanks to the agility and flexibility that very often these large companies are missing. Meanwhile, startups need incumbents' experience and to be able to find primarily financial resources, mentoring, learn better execution procedures, always paying attention to maintain their own autonomy to develop and do not let them interfere with the entrepreneurial spirit and innovation culture.

The cooperation can take several forms. UPS, for example, has developed a Strategic Enterprise Fund in order to invest in startups that are strategically relevant, supporting them innovating in different technologies, as 3D printing, Artificial Intelligence, Automation, Collaborative consumption, IoT, Smart cities and Sustainability transportation. Already in 2016, they had spent USD 600 million across a total of 24 investments. DP-DHL also move in the same direction, with their own, in-house, accelerator program, called Start-up Lab, with the aim to support selected startups seeking for innovative solution to the industry challenges, focusing on solar energy utilization, digital manufacturing, or inventory management (Cichosz, 2021).

Another way of cooperating is through partnerships: UPS implemented a relevant one in 2019, with the agreement with drone startups Matternet, an innovator in drone logistics network.
Another one was made by DP-DHL, that at the end of 2018 announced USD 21 million venture into Resilience360, the supply chain risk management startup with a mobile app for tracking earthquakes, wildfires, cyberattacks, and anything that disrupts supply chain operations (Cichosz, 2021).
Overall, incumbents are here to stay. At least for now, in fact, their network, assets and relationships are not going to be disrupted, not in the major markets. As of now, no new entrant has enough control over its network to ensure a globally integrated, seamless transportation.
On the other side, startups have been eating away incumbents' growth prospects and future potential growth, managing markets and problems that incumbents have long ignored, due to their focus on profits. Some startups have already improved operationally and are expanding, also hiring specialized and expert staff from the incumbents, causing other threats for these companies. To avoid the entrance of new actors, and do not lose the second wave of growth, incumbents need to review their business model, being able to be more globally present and

focusing on customer satisfaction across current services and new one, such as increasing the sustainability of the operations.



Model of barriers and success factors to digital transformation at LSPs (Cichosz, Wallenburg, Knemeyer; 2019)

But overall, the best alternative is to connect startups with incumbents, which can unlock great opportunities in terms of digital transformation, as for the above picture, for all the stakeholders. In this way, LSPs can learn and get new ideas from smart and agile companies, become more dynamic, and develop digital skills to link their physical network with customers; startups, on their side, can improve their credibility and brand awareness, as well as having multiple access to customers.

4. Logistics 4.0 patent analysis

After a general overview of what is Industry 4.0, its main technologies, the ones implemented in the Logistics sector and an overview of the investments in the Logistics startups, to demonstrate the magnitude of the phenomenon, at this point, in order to demonstrate and understand where the innovation is in the Logistics, this chapter aims to analyse all the patents, related to this sector, registered in Italy.

4.1 Research methodology

In order to have access to the list of patents and companies for the analysis, the databases used are Orbis Intellectual Properties, from Bureau van Dijk, and Orbit Intelligence, a Questel software. In the following section there is an overview of these tools.

4.1.1 Orbis Intellectual Properties

Orbis is a database of Bureau van Dijk – a Moody's Analytical company, a major publisher of business information, and specialised in private company data combined with software for searching and analysing companies. The first one is the company's flagship database, with information on more than 400 million companies worldwide, also allowing the possibility to compare them in order to have meaningful insights. Orbis captures and blends data from more than 160 different sources and treats it so it's standardized and comparable.[32]

In the specific, Orbis is a great tool to verify a company exists and to source company reports, providing comprehensive company reports, financial strength indicators and ownership information to help to research a company and assess risk associated with it. Moreover, it gives tools to analyse groups of companies, so finding peer groups and comparing companies easily, thanks to graphs, dynamic company structures, pivot analyses and other types of visualization tools.

The scenario of information provided by Orbis is very wide:

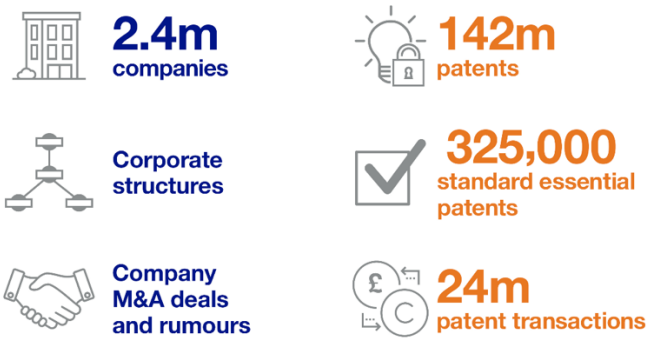
- Credit risk: the globally comparable financial strength metrics and standardized financials help in assessing customers, partners, or suppliers
- Compliance and financial crime thanks to the extensive corporate structures and beneficial ownership data combined with information on PEPs, sanctions, and adverse news.
- Supplier risks: with an extensive offer of financial risk metrics, is possible to find new suppliers and assess existing suppliers for both financial and reputation risk.

[32] https://www.bvdinfo.com/it-it/

- Transfer pricing analysis: find comparable companies and create a financial analysis of the peer group for tax compliance.
- Business development and strategy: the analysis of new markets and regions helps in efficiently creating business plans
- M&A and corporate finance: find targets/sellers, analyse peer groups and use M&A data to help with the valuations. A standard financial report includes 26 balance sheet items, 26 P&L account items and 33 ratios. Listed companies are in a more detailed format.

In particular, we used Orbis Intellectual Properties, strictly focused on Patents. This service allows:

1) To link 110 million of patents applicants with the vast universe of companies present on Orbis.
2) To provide an ownership timeline of all the live patents, giving access to the transactions in order to assess the trends and commercial appeal of a new technology
3) To track M&A transactions so that it is possible to monitor the patent ownership changes when they are sold as intangible asset in an M&A deal.
4) To deliver the portfolio and patent evaluations for all granted live patents and tracking valuation trends over time.
5) To identify the Standard Essential Patents (SEPs) to identify high-quality patents in a company's portfolio, or see which companies own the foundation technology patents.[33]



The numbers of Orbis Intellectual Properties (https://www.bvdinfo.com/en-gb/our-products/data/international/orbis-intellectual-property)

4.1.2 Orbit Intelligence

Orbit Intelligence is a software provided by Questel, which is an end-to-end intellectual property solutions French provider serving 20,000 organizations in more than 30 countries for the optimal management of their IP assets portfolio. Whether for patent, trademark, domain

[33] https://www.bvdinfo.com/it-it/

name, or design, Questel provides its customers with the software, tech-enabled services, and consulting services necessary to give them a strategic advantage. They use state-of-the-art technology such as artificial intelligence, big data, or blockchain, powered by an unparalleled network of international experts, to optimize the maintenance of any IP asset while streamlining the internal processes of our corporate and law firm clientele.[34]

Beyond Questel, their product Orbit Intelligence is a leading global intellectual property intelligence software dedicated to patent research and analysis. The platform is trusted by more than 100,000 users and delivers access to the largest accurate patent database and scientific literature database. Its technology helps top management, IP specialists and legal professionals turn data into actionable insights to solve their strategic questions.[35]

4.2 Introduction to data

Before explaining the process of patent analysis of this study, it is important to explain how the sample of meaningful patents has been identified.

The first parameter has been to select the IPC, of Logistics, which is G06Q10/08. According to WIPO, the World Intellectual Property Organization, description, the International Patent Classification (IPC), established by the Strasbourg Agreement 1971, provides for a hierarchical system of language independent symbols for the classification of patents and utility models according to the different areas of technology to which they pertain. A new version of the IPC enters into force each year on January 1. [36]

The class of the interesting patents for this research is **G06Q**: *Data processing systems or methods, especially adapted for administrative, commercial, financial, managerial, supervisory or forecasting purposes; systems or methods specially adapted for administrative, commercial, financial, managerial, supervisory or forecasting purposes*.[37]

In the specific, **G06Q10/08** is the one specific to Logistics, e.g., warehousing, loading, distribution or shipping; Inventory or stock management, e.g., order filling, procurement or balancing against orders.[38]

In Orbis Intellectual Properties database there are around 42 thousands of patents related to this technology class. Since our academical objective is to understand the nature of innovation in the sector in Italy, it has been added a second parameter to the research, the localization. In this way only 201 patents resulted.

[34] https://www.linkedin.com/company/questel/about/
[35] https://www.questel.com/ip-intelligence-software/orbit-intelligence/
[36] https://www.wipo.int/classifications/ipc/en/
[37] https://www.wipo.int/classifications/ipc/en/ITsupport/Version20170101/transformations/ipc/20170101/en/htm/G06Q.htm
[38] https://www.wipo.int/classifications/ipc/en/ITsupport/Version20170101/transformations/ipc/20170101/en/htm/G06Q.htm

Then, also a third parameter has been added, the Priority date, because it is the closest date to the date of invention among those disclosure in the process of registration of a patent. In our specific sample, it has been selected 01/01/2010 as Priority date, as the beginning of first technologies related to Industry 4.0. As a result, the sample that has been analyzed as a purpose for this study is of 119 patents.

In order to avoid any type of doubts, it is useful also to present the different dates that regard a patent life:

- *Application date* is the date on which the patent office received the patent application.
- *Publication date* is the date on which the patent application is published (i.e. the information is available to public). This normally occurs 18 months after the priority date.
- *Priority date* is the first date of filing of a patent application, anywhere in the world (normally in the applicant's domestic patent office), to protect an invention. The priority date is used to determine the novelty of the invention, which implies that it is an important concept in patent procedures. For statistical purposes, the priority date is the closest date to the date of invention.
- *Granted date* is the date when the patent office issues a patent to the applicant. On average it takes three years for a patent to be granted at the USPTO and five years at the EPO.

4.3 Presentation of some relevant patents

In order to demonstrate the presence of Industry 4.0 technologies in the patent object of the study, in the following section there will be presented some of the most relevant patents among the sample of 119. These are the ones registered in Italy, after the 1st January 2010 and belonging to the technological class G06Q10/08, which stands for *Logistics, e.g., warehousing, loading, distribution or shipping; Inventory or stock management, e.g., order filling, procurement or balancing against orders.*

This study will now introduce some examples of relevant patents both from Logistics companies and Integrated Logistics Systems companies, with a strong focus on the first one.

4.3.1 Logistics companies' patents

a) *GI.BI.EFFE s.r.l*

Gi.bi.Effe, founded in 1988, is a company that directs its activities to the study and design of innovative paper converting solutions.[39] Over time, it has developed numerous patents for the pharmaceutical market and for other product sectors. Among these, one of our interests is:

- number EP2949587A, published on 02/12/2015, which title is "Package provided with a traceability and originality verification code, its production method and method for tracing it"

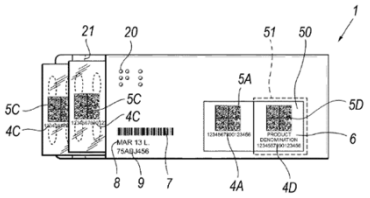


Fig. 3

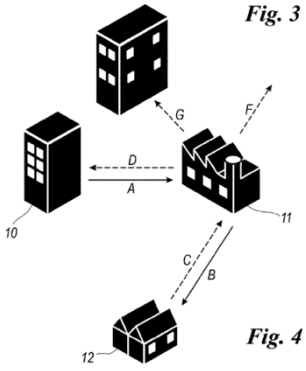


Fig. 4

EP2949587A drawing (Orbis Intellectual Properties)

The technology behind this patent is related to an IoT technology, able to track and monitor the delivered boxes and as shown in Chapter 1, this is one of the main 4.0 technologies. 55

[39] https://www.gibieffe.it/societa.html

b) IVECO S.P.A.

Iveco S.p.A., acronym of Industrial Vehicles Corporation, is an Italian company, part of Iveco Group, specialized in the production of commercial vehicles. They design and build light, medium and heavy commercial vehicles, quarries/construction sites, urban and intercity buses and special vehicles for applications such as firefighting, off-road missions, defense and civil protection.

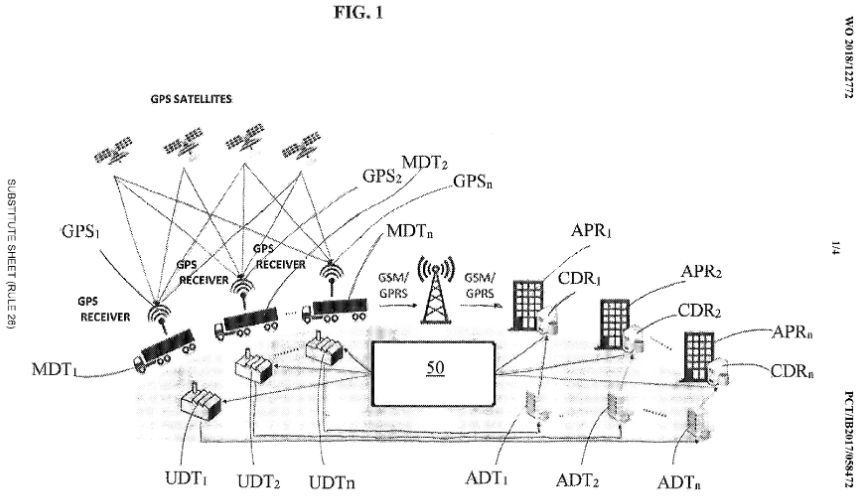
The name had its origin in 1975 from the merger of Italian, French and German brands. It has production facilities in Europe, China, Russia, Australia, Africa, Argentina and Brazil and is present in over 160 countries, with about 5,000 points of sale and service. The world production is around 150,000 commercial vehicles per year with a turnover of about 10 billion euros.[40]

Since they build commercial vehicles, in this study it is considered a Logistics' companies supplier. Iveco on 23/12/2015 published a patent (number WO 2015193855 A1), interesting for this study, which is worth $31 thousand. Its title is "Vehicular system for assisting the delivery of goods". From Orbis Intellectual Properties[41], is it possible to see also the complete abstract, useful to understand better the innovation: "A vehicular system for assisting the delivery of goods, said goods being defined by a plurality of parcels to be delivered, adapted to acquire an image of a parcel introduced in a vehicle loading compartment and to display said image upon reaching a delivery place corresponding to said parcel". This is an image recognition and detection system, attributable to a machine learning algorithm, so an AI technology.

c) Easytrucking s.r.l.

EasyTrucking[42] is an Italian startup that developed a web platform that aims to connect customers and transporters directly. Customers have the option to ship the goods by the nearest means directly synchronized with the platform through the GPS signal. The company was founded in 2016, and they registered a patent (number WO2018122772A1) to protect the platform on 05/07/2018, which title is "Method and system for coordination and optimization of services offered by company for goods transport on road".

[40] https://it.wikipedia.org/wiki/Iveco
[41] https://orbisintellectualproperty.bvdinfo.com/version 2022713/orbispatents/1/Patents/Report/InternalId/130130450
[42] https://www.easytrucking.it/



WO2018122772A1 scheme (Orbis Intellectual Properties)

The platform is another example of IoT technology and RTLS system: it starts, as seen in the below picture, from the entry of the data relating to the routes planned for transport of vehicles (MDT1, MDT2…) which belong to the same transport companies (ADT1, ADT2…) in a database at an operation center (50), and the collection of data relating to the geolocation of transport vehicles via GPS devices mounted on these vehicles and connected with the collection centers (CDR1, CDR2..) via mobile communication devices. The platform is also enabled to receive the transport service requests from the users (UT1, UT2...) whose requests are compared with the data relative to the programmed routes and geolocation of transport vehicles in order to coordinate the collection of goods for the execution of the received transport service requests by the transport vehicle which show the planned route and/or the geographical position most suitable for carrying out the collection.[43]

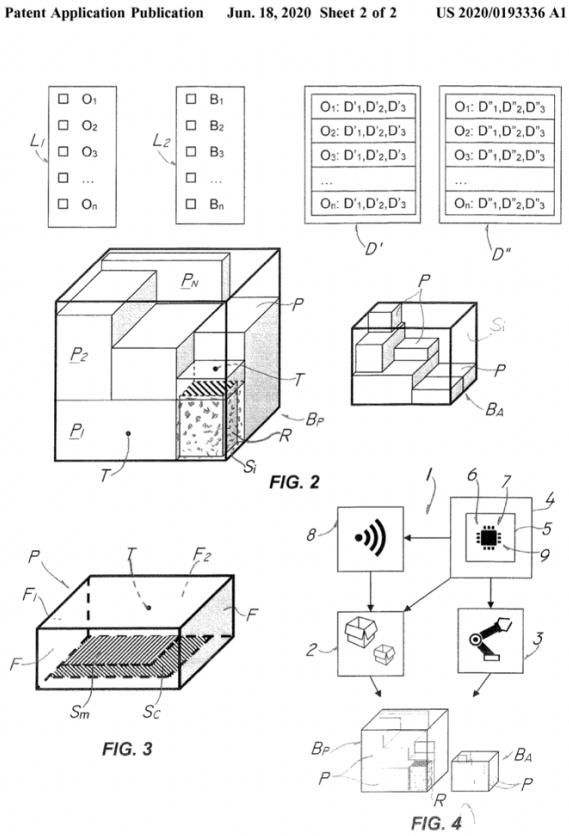
d) Panotec s.r.l. and *Università degli Studi di Padova*

Panotec[44] is a company founded in 1986 which has registered the first patent and made the first machine for the production of custom boxes. A know-how that embodies the spirit of an Italy that affirms itself in the world with the quality of its precision mechanics at very high performance. In particular, they developed and registered, on 15/07/2020, a patent which title is "Method and system for optimized positioning of items in at least one box" (EP3679529A1), in joint research with University of Padua. It is interesting to see University research that combines with companies' R&D department, making profitable relationships for both sides.

According to the abstract, this AI innovation starts from providing a list of items, a list of boxes, dimensional data for each item, position-restricting data for each item, a system for assembling

[43] https://orbisintellectualproperty.bvdinfo.com/version-2022713/orbispatents/1/Patents/Report/InternalId/129850455
[44] https://www.panotecmeccanicheitaliane.com/it

the boxes, a system for placing each item into a main box and also a control unit connected having an algorithm for selecting the box and how the items are introduced into the box. Then, applying the algorithm to select a main box having a minimum size sufficient to contain the items is possible to minimize the empty space and to determine the order of introduction, position and rotation of the items. Applying the algorithm includes also calculating the contact surface areas of each item to maintain the contact surface area above a minimum threshold, thereby ensuring stable positioning and reducing the volume of the filler.[45]



EP3679529A1 illustration (Orbis Intellectual Properties)

e) Sentric s.r.l.

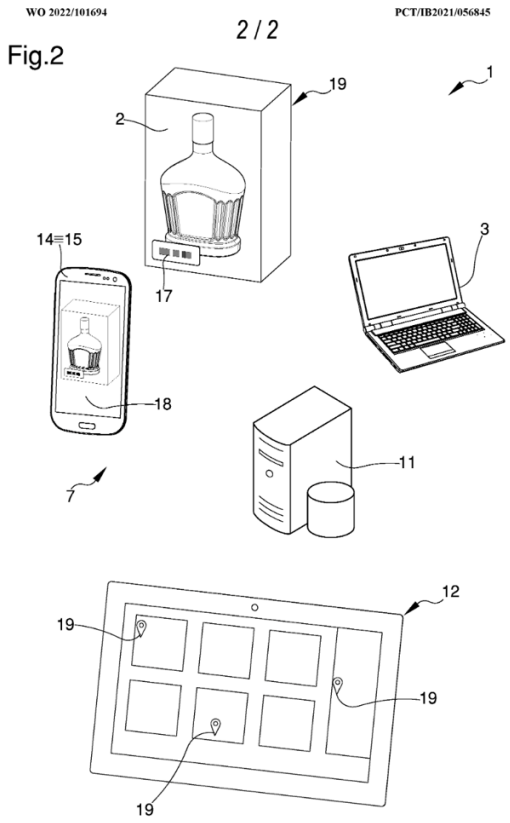
Sentric is an Italian software startup that aims to support the commercial activities in the process of loading the online product offer.[46] Through their software, they help the stores by providing them with photos, descriptions and many other information of the items they have for sale through a quick and easy barcode scanning.

Sentric is one of the companies in our sample with more than one patent registered. In fact, they registered two patents, both regarding the Internet of Things world and RTLS system, in

[45] https://orbisintellectualproperty.bvdinfo.com/version-2022713/orbispatents/1/Patents/Report/InternalId/57523153
[46] https://www.sentric.it/

particular product tracing and mapping, in a short period of time. In fact, one (WO2022101694A1) has been published on 19/05/2022 and the other one (WO2022118092A1) on 09/06/2022.

The title of the first one is “System for digitizing and tracing products”. As for the abstract[47], and the below picture, the system (1) of digitization and traceability of products includes: at least one digitization unit (7) equipped with: an acquisition medium (14) of at least one product identifier (2) for digitize such identifying data; means of storage (3) of identifying data; means (15) to obtain at least one additional product reference characteristic (2) of which the identification code has been acquired; a computerized means (11) to associate additional data to the identifier, the storage media (3) being able to store the identification data accompanied by an additional data.

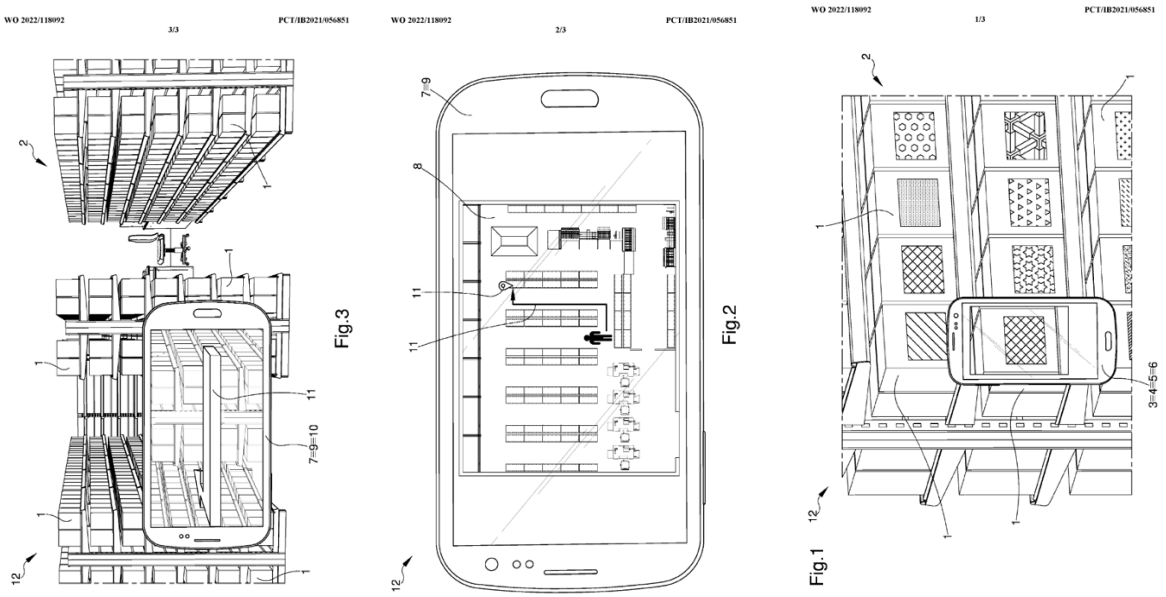


WO2022101694A1 scheme (Orbis Intellectual Properties)

[47] https://orbisintellectualproperty.bvdinfo.com/version-2022713/orbispatents/1/Patents/Report/InternalId/146088768

The second one's title is "Method for product mapping". According to the abstract[48], this method comprises at least the phases of:

- supply of a plurality of products (1) on a display for sale distributed inside a display area (2);
- acquisition of images of the products (1) on display;
- attribution to the acquired image of each product (1) at least one position datum defining the location of the same inside the display area (2);
- tracing of at least one of the products (1) on display depending on said attributed position datum.



WO2022118092A1 scheme (Orbis Intellectual Properties)

f) Crosstec s.r.l.

Crosstec[49] was founded as a service company for CIM SpA, one of the most developed interposing Italian and prince reference for the North-West. It develops technology and solutions for the various areas of logistics and creates software products, network infrastructure, tools for computer security, also provides assistance, moreover it supplies complete and total assistance the freight village and the settled companies. They developed *LISA (Logistic Integrated Service Application)*, a web system for the management of a Railway Terminal, developed through an analysis supported by fleet disposers, terminal operating staff, apron

[48] https://orbisintellectualproperty.bvdinfo.com/version-2022713/orbispatents/1/Patents/Report/InternalId/146645583
[49] https://www.crosstec.it/

operators, railway undertakings and ship traffic operators. The interface is intuitive and easy to use, and the operation is entirely managed by modules connected to each other.

They also registered a patent (number WO201409778A1), on 16/01/2014, which title is "Method and system to handle a container in a storage area", in which handling means moving containers from a pickup area to a delivery area and in which an IT system memorizes the position of containers. The position in which the container is stored is then linked to the position of the handling means which is acquired when the container is released and is memorized in an IT system to allow the tracking of the container, creating what is a IoT system, based on RTLS technology.

g) Datalogic s.p.a.

Datalogic[50] is a global technology leader in the markets of automatic data acquisition and industrial automation, with a total turnover from 2021 of 685 million $. The company, founded in Bologna in 1972, specializes in the design and manufacture of barcode readers, mobile computers, sensors for detection, measurement and security, RFID, laser vision and marking systems. Its state-of-the-art solutions help increase the efficiency and quality of processes in the retail, manufacturing, transport, logistics and healthcare sectors across the entire value chain.

Datalogic is the most present company in our patents list, with three patents registered since 2010, all under the category of data collection and automation systems:

1) "Ultra-wideband location engine for self-shopping devices" (WO 2016106194 A1)[51]. It is a $191 thousand worth patent, based on real-time locating systems (RTLS) for self-shopping systems that utilize a dual technology approach: self-shopping terminals are equipped with a passive or active ultra-wideband (UWB) tag that includes a UWB backscatter module or a UWB transmitter, respectively, as well as a standard wireless communication transceiver, such as a Wi-Fi or UHF-RFID transceiver, that enables communication over the wireless communication channel. Readers fixed within a shopping environment activate the UWB tag of a selected one of the self-shopping terminals by addressing the self-shopping terminal using the standard wireless communication channel. Once activated, the UWB tag of the selected self-shopping terminal transmits UWB signals which are received by a plurality of the readers and used to determine the location of the UWB tag and hence the location of the self-shopping terminal. A messaging system may

[50] https://www.datalogic.com/ita/azienda-co-4033.html
[51] https://orbisintellectualproperty.bvdinfo.com/version-2022713/orbispatents/1/Patents/Report/InternalId/128481093

send messages to the self-shopping terminal for presentation to the customer on a display of the self-shopping terminal

2) "Drive-through automated supermarket" (US11049196[52]). It is a $222 thousand worth patent, in which it is described a store, including an ordering interface, a storage area, automated vehicles, and a central processing system. The ordering interface accepts selections of items for purchase from a shopper. Instead, the storage area, stocking items for sale, is separate from the area containing the ordering interface and the automated vehicles retrieve items from the storage area.

   According to the abstract, and the pictures above, the central processing system is configured to: check-in the shopper; assign an order fulfilment module to the shopper; receive selections of items from the ordering interface in real-time, as the shopper selects the items for purchase; send the selections to the order fulfilment module for retrieval in real-time; check-out the shopper when the shopper is finished selecting items; and arrange delivery of the completed order to the shopper. The order fulfilment module assigns automated vehicles to retrieve the items for purchase in real-time.

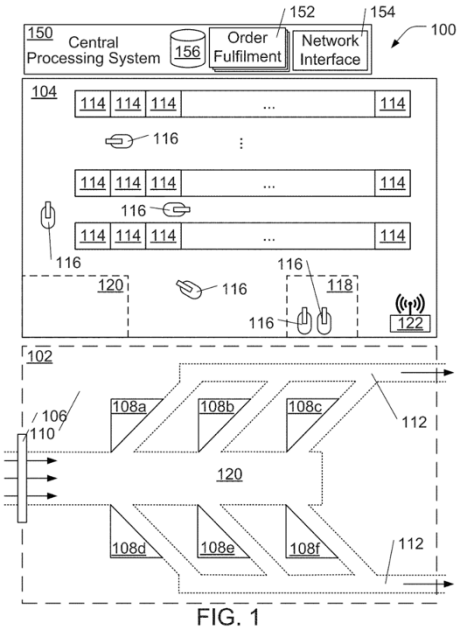


FIG. 1

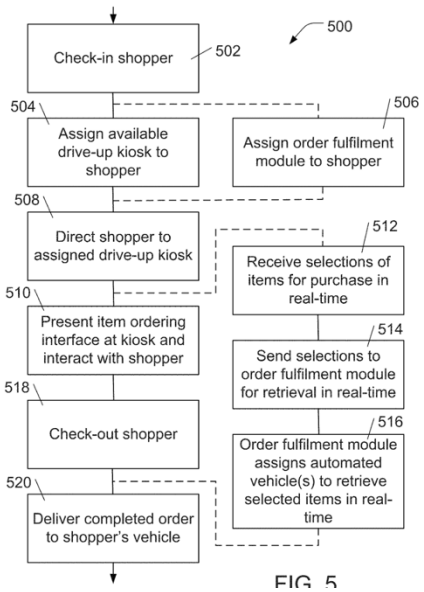


FIG. 5

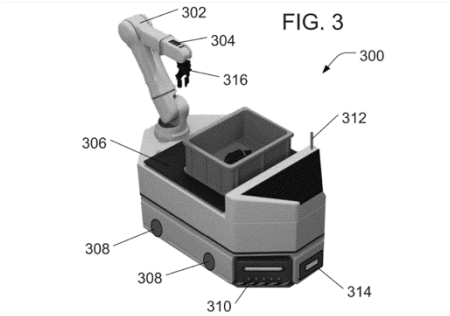


FIG. 3

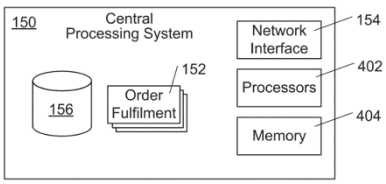


FIG. 4

[52] https://orbisintellectualproperty.bvdinfo.com/version-2022713/orbispatents/1/Patents/Report/InternalId/139694056

3) "System and method for selecting a quality grade metric profile for assuring optimal control of symbol quality in a dpm process" (WO2019129632[53]). As for the abstract on Orbis Intellectual Properties, the computer-implemented system and process of producing a metric quality grade profile for use during inspection of DPM symbol marked on parts may include storing average metrics measured in a controlled environment for a "golden" sample. Measurements of the DPM symbol of the "golden" sample may be performed and also of its metrics in an uncontrolled environment. Average metrics from the uncontrolled environment may be calculated and compared. The user may be enabled to set an acceptable grade for the individual metrics, and these are then used as a profile of the DPM symbol in memory.

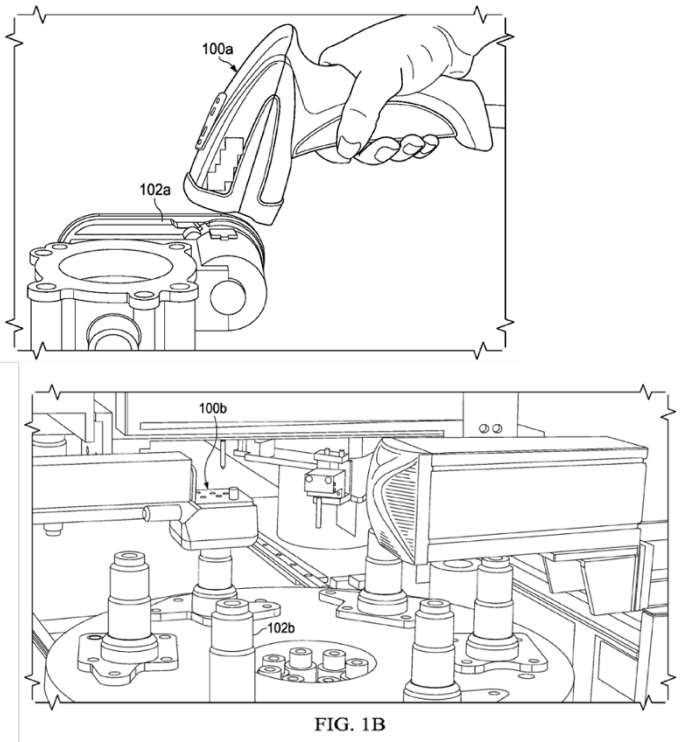


FIG. 1B

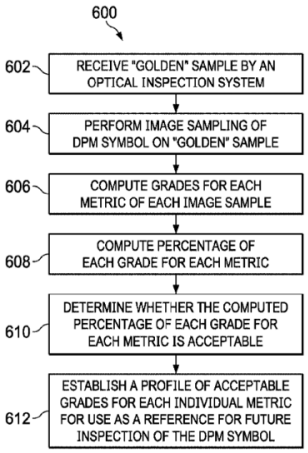


FIG. 6

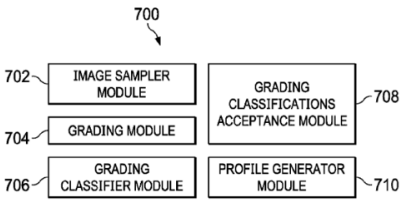


FIG. 7

WO2019129632 illustrations (Orbis Intellectual Properties)

h) CNR (Consiglio Nazionale delle Ricerche) e Vitrociset s.p.a.

Vitrociset[54] was an Italian company operating in the field of information and communication technologies and logistics. It mainly managed electronic and computer systems in the civil and military fields for companies, public administrations, government agencies and organizations. It is also in charge of defense systems, air traffic control systems, satellite technologies and telecommunications, transport and infomobility, ICT and integrated logistics. In September 2018 the Leonardo group, which already held a 1.46% stake, bought Vitrociset exercising the

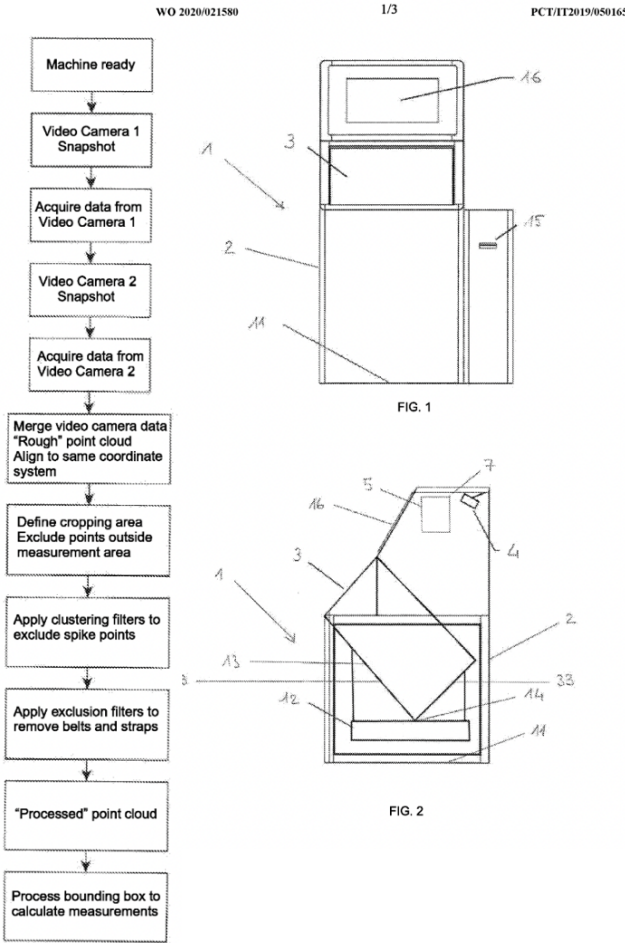
[53] https://orbisintellectualproperty.bvdinfo.com/version-2022713/orbispatents/1/Patents/Report/InternalId/130457073
[54] https://it.wikipedia.org/wiki/Vitrociset

right of pre-emption on the purchase of 98.54% and thereby undermining the offer of Fincantieri and Mer Mec.

In 2015, Vitrociset[55] developed in collaboration with CNR – the Italian National Council of Researches – a RFID system, patented, with the title of "System for verifying the number of containers present in a stack of containers and related verification method". The present invention is related to a system that is able to verify the number of containers of at least one stack of containers (Pi,P2...PN) in a storage area (A), where each stack of containers comprises at least one container and is disposed on a respective portion (Ci,C2...CN) of said storage area (A), considering that the containers of the same stack of containers (Pi,P2...PN) have a same predetermined height.

i) Airlogs s.r.l.

Established in 1996, joined ECS Group in 2012, Airlog[56] s.r.l., acts as cargo office on behalf of the represented airlines and provides them with operational and administrative support related to airport supervision on both, import and export activities. In this activity, the firm registered a patent in 2020 (WO202021580), which title is "Apparatus and method for automatically checking a piece of baggage". This apparatus, an example of the visual recognition technology, with a 3D scanner device, comprises - as in the picture on the right - a containment structure (2) provided with an opening (3) for insertion of a piece of baggage; at least one three-dimensional scanning device (4) positioned inside said containment structure (2) and suitable for supplying a three-dimensional reconstruction of the piece of baggage; a processing unit (5) connected to the scanning device (4) for calculating the dimensions of the piece of baggage starting from the three-dimensional reconstruction of the piece of baggage.



WO202021580 illustrations (Orbis Intellectual Properties)

[55] https://orbisintellectualproperty.bvdinfo.com/version-2022713/orbispatents/1/Patents/Report/InternalId/55581093
[56] https://ecsgroup.aero/company/italy-air-log/

j) Milkman s.p.a.

Milkman[57] is one of the most interesting companies of the sample. It is an Italian startup founded in 2015 by two experts of vehicle routing optimization and GPS tracking, Antonio Perini and Tommaso Baù. In 2019 they partnered with Poste Italiane (Italy's National Post) to provide same-day and Scheduled deliveries to their Clients at National level.

Milkman now counts €35 million in funding and a growing full-time staff of 70+ professionals, coming from all over Europe, and has been named as a Sample Vendor in 2020 and 2021 Gartner Reports for Supply Chain Technologies and TMS provider. They developed a customer-centric supply chain management software that enables Retailers with a fleet, Carriers and Third-party logistics providers to be at the forefront of last-mile innovation.

This platform has been patented in 2019, with patent number EP3572990, which title is "Method for delivery and service scheduling". It allows to have:

- Commerce and logistics integration at the point-of-sale which is enabling dynamic choice of convenience and cost
- Deep business insights, which are driving better planning of last-mile logistics and transportation
- An effective communication based on the customer's unique needs and preferences driving for a better experience from purchase to delivery

k) Stetel s.r.l.

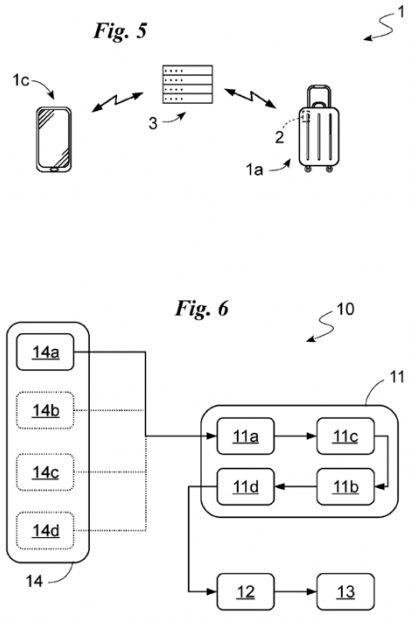
Founded 30 years ago, Stetel[58] is a company of IT professionals deploying their skills to deliver end-to-end solutions in the fields of mobile applications and Internet of Things. Today, Stetel is a major player in the technology arena, employing its know-how in two main sectors: the development of mobile applications development and the production of IoT enabling devices.

In the mobile applications sector, Stetel cooperates with major Mobile Operators with the development of customer facing applications, enabling Rich Communications Services (RCS) and running across the three major operating systems: Android, iOS and Windows 10.

The addition of Internet of Things to Stetel's portfolio was an easy and natural move, in line with new projects requiring deep expertise in the Telco/Networking field. Stetel has come a long a way since the development of its first IoT device and it has implemented numerous solutions enabling Machine to Machine communications (M2M).

[57] https://www.milkmantechnologies.com/
[58] https://www.stetel.com/

Their patent in the study's sample is part of their IoT portfolio. The title is "Tracking device for tracking objects" (WO2019180512), and it consists[59] of a tracking device for tracking objects comprising a control unit, which itself comprises means for exchanging data via the mobile network, a mobile network database associating a first geolocation with each mobile network and a local network database associating a second geolocation with each local network.



WO2019180512 illustration (Orbis Intellectual Properties)

[59] https://orbisintellectualproperty.bvdinfo.com/version-2022713/orbispatents/1/Patents/Report/InternalId/129183882

4.3.2 Integrated Logistics Systems patents

In this specific section, we are going to provide some patents as examples among the fifty-one that have been registered by companies that are not directly of the logistics sector, but that developed patents for their own integrated logistics system.

a) Pharmathek s.r.l. (it), Essegi Software s.r.l. (it), SOL gmbh (DE)

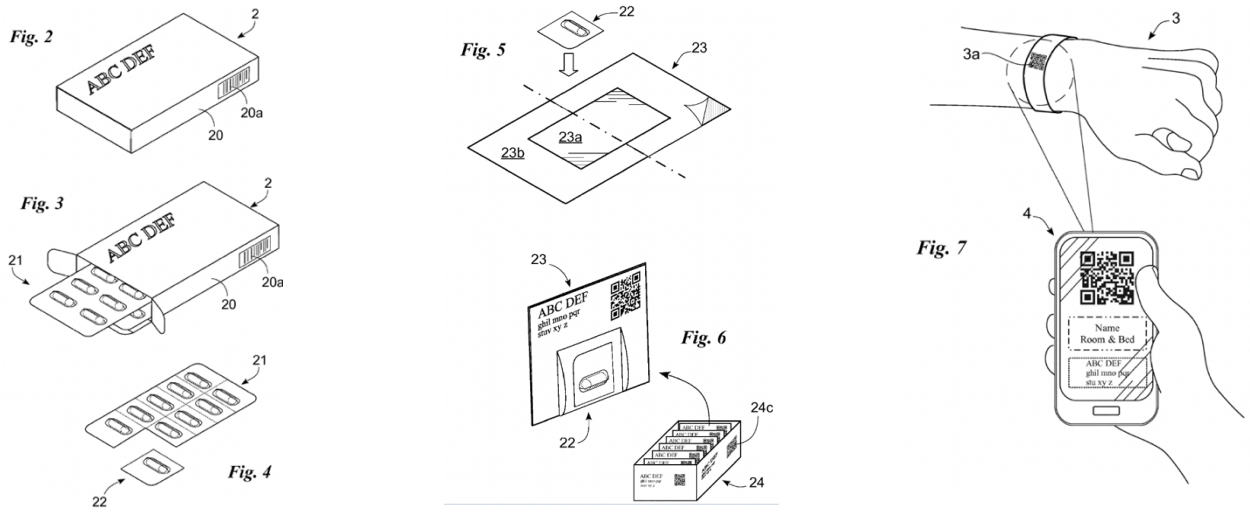
Pharmatek - PMC[60], founded in 2003, with a production site of only 400 m2 in the Milan hinterland, manufactures and manufactures medical and surgical devices, cosmetics, and medical devices for third parties. Over the years, they have continued growing and transforming themselves, always giving priority to research and development, today their first strength, and the well-being of our employees and the environment.

Essegi[61], instead, is a software company which is warehouse solutions oriented from 1997. The third company involved, SOL Gmbh[62], is a leader in Italy in the production and marketing of technical, industrial, pure and special gases and medicines.

This is one of the few cases of three different companies that are co-owners of a patent, and it is interesting to see when companies from different sectors join together to research and develop innovative solutions. In this case, the result is patent number EP3246862A1[63], which title is "Dispensing process of medical products in a healthcare facility". The dispensing process, according to the abstract and to the below pictures, includes:

- at least one step of monitoring the stocks of medical products
- at least one step of supplying the related pharmacy with the medical products
- at least one step of storing the medical products in the related pharmacy
- at least one step of releasing the medical products in at least one ward of the healthcare facility
- at least one step of sorting the medical products to at least one destination patient in the wards of the healthcare facility.

[60] https://pharmatek-pmc.it/
[61] http://www.essegisoftware.it/
[62] https://www.sol.it/it/dove-siamo/sol-deutschland-gmbh
[63] https://orbisintellectualproperty.bvdinfo.com/version-2022713/orbispatents/1/Patents/Report/InternalId/56380794



EP3246862A1 illustrations (Orbis Intellectual Properties)

b) "*Biomed s.r.l., Cephello Esual Ltd, Sefero s.r.l.*"

Biomed[64] is an Italian company that in recent years has specialized in the production of pure Colloidal Supplements and concentrates of Vitamins, Minerals, Metals and other fundamental components for the human body such as collagen and hyaluronic acid. Sefero[65], instead, is a company, born in 2016 in Padua, focused on the development, design, industrialization and marketing of devices, systems and services aimed at the storage and transport of biological and/or perishable material, including a chain of custody and a remote control of all stages of transport. These two complementary companies, together with Cephello Esual Ltd developed a new system for transporting goods, based on RTLS technology, patented (EP3429344) in 2016.

The system[66], as for the picture, includes one or more containers (1) which are adapted to contain goods, which containers communicate with a remote unit (3). Each container (1) has a housing compartment (11) for goods, which housing compartment (11) is delimited by one or more walls and has at least one opening (12), which is closed by a cover element (2). This one includes at least one sensor for detecting the accelerations acting on the container (1), said cover element (2) having at least one transmit/receive unit for communication with said remote unit (3)

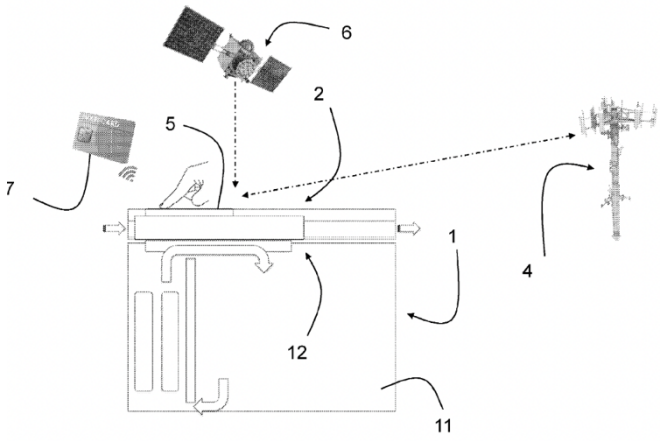


Fig. 1

EP3429344 illustrations (Orbis Intellectual Properties)

[64] https://www.biomedsrl.net/
[65] https://atoka.io/public/it/azienda/sefero-srl/7d824ab40ec7
[66] https://orbisintellectualproperty.bvdinfo.com/version-2022713/orbispatents/1/Patents/Report/InternalId/57332067

c) Anzani Machinery S.r.l.

Anzani Machinery[67] is a manufacturer of machinery for shoes, bag and clothing factories. The core business is the production of conveyors for assembly, for sewing and heat treatment machines: humidification, ironing, stabilization of shoes, drying and reactivation of the glue. The production also includes machines of different types, such as rotating warehouses for the storage of shapes and materials, robotic systems, and special conveyors to produce vulcanized shoes.

In 2016, they developed a system for the movement of containers, patented with number (EP3098674)[68]. According to the picture below, a method (100) for the movement of containers of semi-finished products on automated systems involves RTLS technology, and includes the steps of: - checking containers (102) entering the storage area; - code reading (104) and opening the storage area; - storage (108) of the position and of the storage area of disposition of the container; - availability check (110) of the storage area; - checking containers being requested (112) by the workstations PL; - extracting container (122) and sending to the requesting workstation PL; - checking further containers being requested (124) by the workstations PL; and comprising the further steps of: - selection criterion (116) for sending containers; - assignment of a score (118) of the container code; - one or more checking steps (106, 120) of the score of the container code that is higher than the others.

Fig. 1

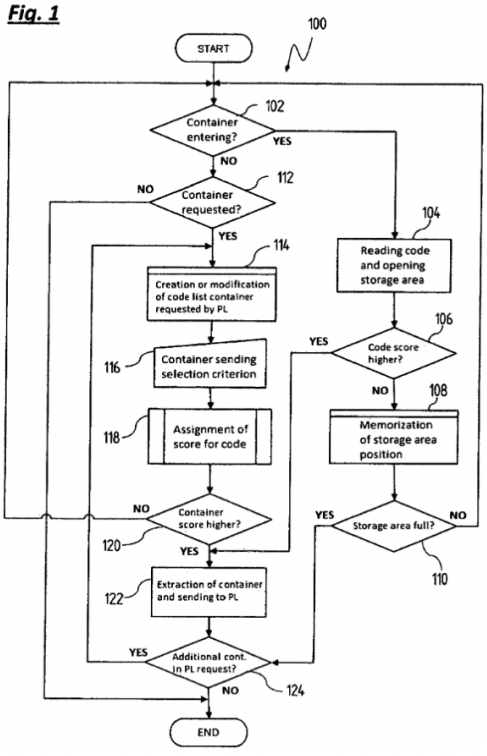
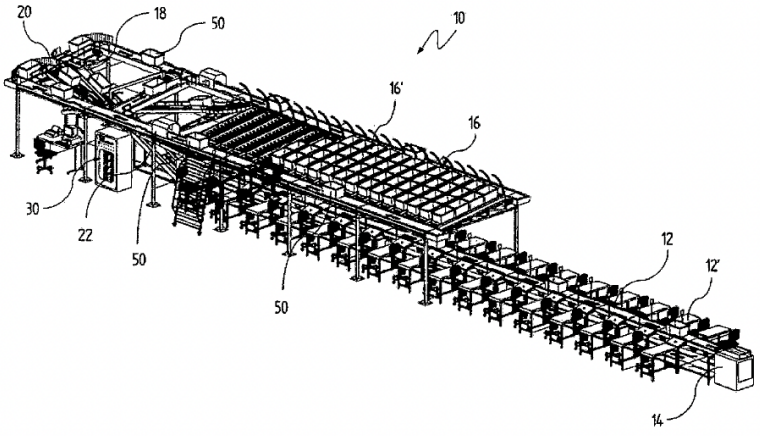


Fig. 2



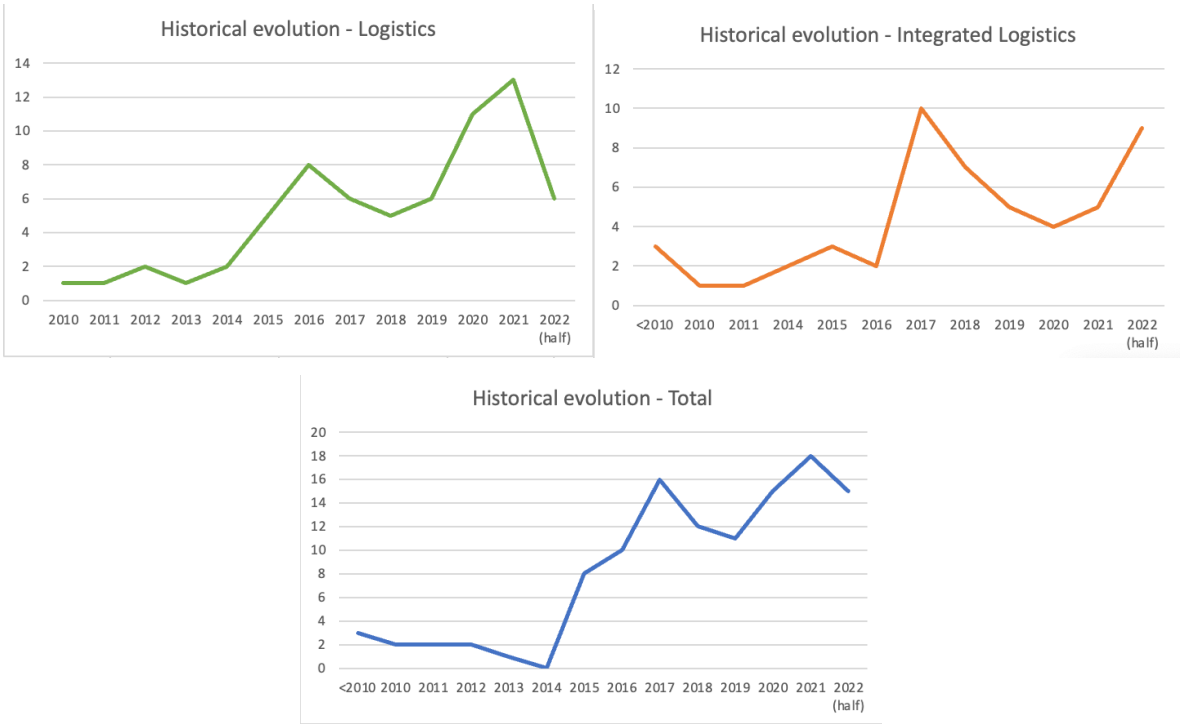
[67] https://www.anzanimachinery.it/it/index.html
[68] https://orbisintellectualproperty.bvdinfo.com/version-2022713/orbispatents/1/Patents/Report/InternalId/57789736

4.4 Patent collection results

4.4.1. Evolution over time

For what concerns the evolution over time, looking at the publishing date of the sample of patents, it is possible to see a first, strong, increase between 2016 and 2018, with an average of 13 patents a year, compared to the 2.2 per year of 2010-2014. This was possible thanks to Industry 4.0 plan, drawn up by the Italian former MISE (Minister of Italian Economic development) minister Calenda, which had as results a +11% in investments in Italy, in the period.[69]

There are some differences, in terms of peaks, between Logistics sector companies and Companies with Integrated Logistics Systems, as it is possible to see in the graphs below, but the overall result reflects what has just been said and the recent peak due to the number of investments in startups, presented in chapter 3.



Historical evolution Logistics patents 2010-2022

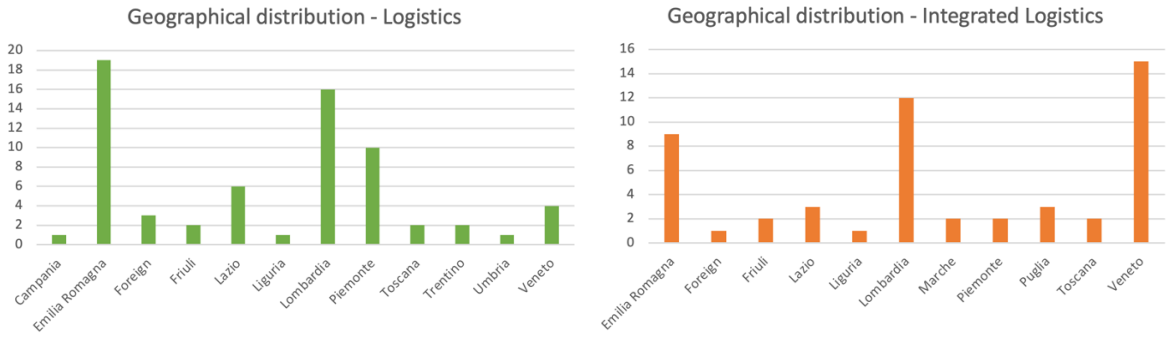
4.4.2. Geographical distribution

Looking at the geographical distribution among Italian regions, there is a strong difference between North and Middle/South of the country: the 80% of the patents has been registered by companies settled in North Italy. This is not surprising, considering the fact that three of the

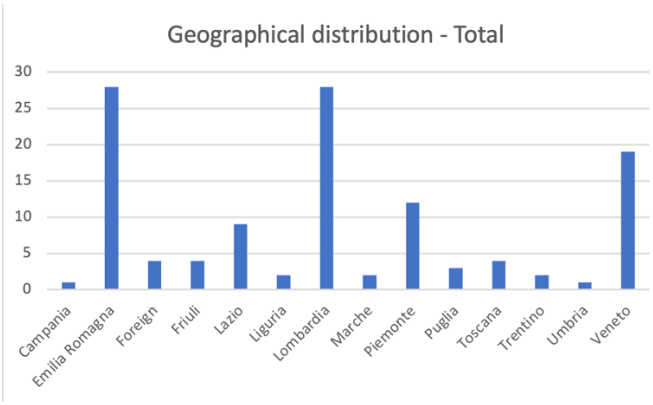
[69] https://www.impresa40.it/scenari-cisco/piano-calenda-da-industria-4-0-a-impresa-4-0-con-focus-sulla-formazione/

first five Italian regions for number of innovative startups are Lombardia, Emilia Romagna and Veneto, the most present also in our patent.

In fact, among the logistics companies, most of the patents have been registered by companies settled in Emilia Romagna, with 18. Instead, among the companies with Integrated Logistics systems, the richest region is Veneto, with 15.



If we look at the total graphic for Geographical distribution, the first one tier regions are Emilia Romagna and Lombardia, with 28, followed by Veneto with 19 and Piemonte with 12.



Geographical distribution Logistics Patent in Italy

4.4.3. Patents' collaboration

As presented in the previous section, there are some companies with more than one patent registered. These are: *Pirelli, Stevanato Group, Y.E.S. s.r.l. young ecology society* and *SISSPRE – Società Italiana Sistemi e Servizi di precision s.r.l.* with two, whereas *Datalogic* is the only one with three.

Looking at the collaboration between companies, the last remarkable result to be presented is that, again, as for some cases presented in the previous section, 12 patents – from the total

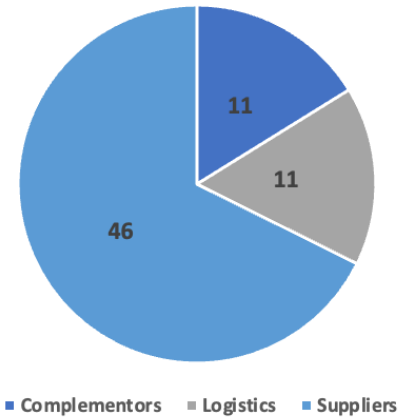
sample of 119 – have been registered by two or more co-owners. It's very interesting to see different companies of completely different sectors that joined together their competences and skills in order to pursue for innovation. In the majority of this cases, the companies involved are a software company and a company that wants to innovate its integrated logistic system; these represent four cases, all from the medical/pharmaceutical sectors. Another important presence, with three cases in our sample, are the research institutions: Politecnico di Milano, Università degli Studi di Padova and CNR – Centro Nazionale di Ricerca.

4.5 Analysis of patent results

As seen in the previous sections of this chapter, the patents can be divided in two categories: the ones registered by Logistics companies and the one registered by companies which are not properly Logistics related but that developed patents for their own integrated logistics systems.

4.5.1 Logistics companies

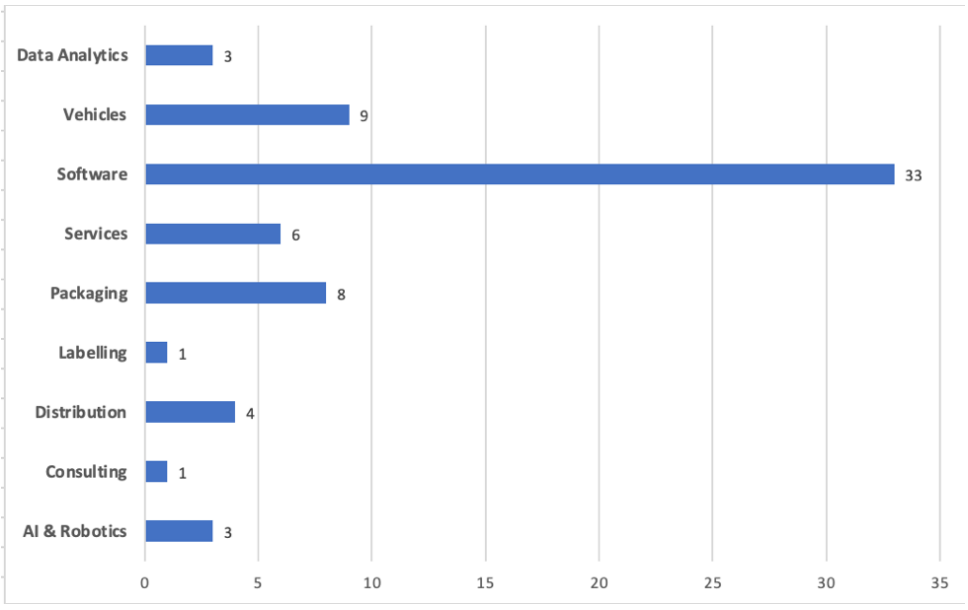
From our sample of 119 patents analysed, only 68 – the 57 percent – have been registered by companies which directly operates in the logistics sector as logistics companies, suppliers or complementors. In particular, among those, the distribution of the actors is as follows:



Whereas, about the type of companies involved, these are the results:

- Incumbent: 48
- Startup: 20

Our analysis pursued also to see which the different Logistics area are considered. To better visualize the distribution, see the above table:



Looking at the data showed in the previous tables, the first main takeaway is that suppliers are the principal actors leading the innovation in the sector, in fact 46 of the 68 companies analyzed are suppliers of Logistics companies, whereas only 11 are properly into logistics and 11 that act as complementors.

The other main result is that there is a strong presence especially of those providing software, with 33 patents of the 68 under observation. The second and third activity involved are vehicles, with 9 patents and packaging with 8.

4.5.2 Integrated Logistics systems

Although there are 51 patents which have been excluded from the previous sample because they have been registered by companies that are not properly of the logistics sector, but in most of these companies developed some technologies that serve their own integrated logistics system. So, it is useful to see also which are the most important sectors that are involved in innovating the Logistics in Italy.

Also, for this sample, a startup vs incumbent analysis has been made, as for the following table:

Sector Summary	Incumbent	Startup	Total
Advisory	1		1
Constructions	1		1
Cosmetics	1	1	2
Design	1		1
Fashion	2		2
Fintech		1	1
Food	1	1	2
Healthcare	4	1	5
Manufacturing	8		8
Mining Industry		1	1
Motorcycle	1		1
National Defense	1		1
Packaging	2		2
Pharmaceutical	3		3
Publishing		1	1
Recycling		2	2
Research	1		1
Safety, Software	1		1
Service (marketing)	1	2	3
Smart Mobility		1	1
State Enterprise	1		1
Technological system	6		6
Telecommunications	2		2
Tobacco	1		1
Videogame	1		1
Total	**40**	**11**	**51**

It's quite evident that these 51 companies belong to several different sectors, very different: from Advisory, to Design, to Cosmetics, to National Defense or from Tobacco industry.
Also, among these, the most important industries, driving innovation for the logistics, are Manufacturing, with 8 patents, Technological Systems, with 6 patents, Healthcare with 5 and Pharmaceutical with 3.

4.5.3. Startups results

The focus of this study is to search where is the innovation in the logistics sector, focusing on the 4.0 technologies implemented the registered patents and the companies behind these technologies; these are, as in the previous sections, for the majority, Internet of Things, Artificial Intelligence, Automation, Virtual Reality and Cloud systems innovations.
In the end, of course, it has to be highlighted also the impact of the start-ups in the innovation in the logistics sector, which is the aim of the study.

If we consider that only the 3.6%[70] of the new Italian limited companies are innovative startups, although this sample is small, the fact that 20 of the 68 patents – the 29 percent of the sample – have been registered by startup companies, tell us that innovation in the logistics sector, in Italy, is strongly startup driven. This percentage goes down a bit when we shift to the non-logistics companies, the second sample of our analysis, including companies especially from Manifacturing, Technological Systems, Healthcare and Pharmaceutic sectors, in some cases also linked together or with a software startup, in order to develop the innovation.
In this sample 11 of 51 companies are actually startups, the 21 percent, but still the conclusion is the same: startup have a relevant impact in driving the innovation in the logistics sector in Italy.

Moreover, as seen in the third chapter, these fast-growing companies are innovating the sector in two ways: the first one is that they do not own any physical asset. This is demonstrated also from MISE data of the fourth quarter in 2021: 45.21% of the new born innovative startups are active in the software sector[71]. And this is demonstrated also in our sample: the majority, is a digital company, cloud-based or intermediation platforms. In fact, 16 of the 20 startups in the first sample are software companies, and one is in the AI sector. So, these companies have a

[70] https://www.mise.gov.it/index.php/it/notizie-stampa/startup-innovative-tutti-i-dati-al-1-gennaio-2021
[71] https://www.wired.it/article/startup-italia-dati-2021-servizi/

strong competitive advantage, being able to grow faster than the other companies in the sector, and they are able also to provide more efficient services.
As previously it has been said that 80% of the logistics patents has been registered by companies North Italy based, this is still valid for the startups: 15 of the 20 startups are located in Veneto, Emilia-Romagna, Lombardia, Piemonte, Friuli and Trentino Alto Adige. Innovation still resides in the North of the country.

In the end, still referring to third chapter's conclusions, also from our sample dynamics, it results that the cooperation is the best strategic move for an incumbent, in order to faster its innovation process, maintain the market share, and not be outclassed by these dynamic competitors that, thanks to their agile organization, can grow really quickly.

Conclusion

This study's aim has been to investigate which has been the startup role in the innovation processes into the Logistic sector. To achieve this goal, a theoretical analysis of the whole Industry 4.0 in general, and Logistics 4.0 in the specific – with technologies, applications and best practices – has been developed. Then, it has been provided a focus on startups growth, quoting the amount of funds collected by these types of companies, and their effect on the incumbents, especially highlighting which is the best strategies and consequences among a cooperate – compete dilemma.
Furthermore, thanks to a complete and detailed patent analysis selecting all the patents registered in Italy from 2010 up to nowadays, into the logistics technology class (G06Q10/08), it has been possible to make an instant photograph of the whole situation, reported in the last chapter.

The total sample has been of 119 patents collected: 68 – the 57 percent – have been registered by companies which directly operates in the logistics sector as logistics companies, suppliers or complementors. Among those, 48 are incumbents in their activities while 20 are startups.
If we think that just the 3.6% among the new founded s.r.l. in Italy are innovative startups, although this sample is small, among the 68 above-mentioned, the 29% of the patents analyzed in this study have been registered by startup companies. Consequently, it is possible to state that in Italy startups are strongly driving the innovation in the logistics sector.
In addition, among the 51 patents analyzed in this study which companies are not directly actor of the logistics sector, this percentage lower to 21%, but still, it is relevant for this study's thesis.

Innovation is a focal point in this study, also because most of the companies involved in the patent registration processes are software suppliers. In fact, as for the results in 4.5, 33 of 68 companies in the first class of our sample, are software companies. Also, looking at the main technologies which are at the base of the patents' sample, and the most useful in terms of Logistics innovation, these are AI and IoT, with RFID and RTLS systems. These innovations resulted fundamental to build or coordinate delivery system, product and devices tracking, containers organization at an exchange point or storage area.

According to the sample, moreover, the majority of the patents in Italy has been registered in the North of the country. In fact, Emilia Romagna, Lombardia, Veneto and Piemonte are the first regions in both the classes of the sample. Whereas, for what concerns the distribution over

time, there have been registered two picks: the first one is the increase between 2016 and 2018, with an average of patent registered per year which is ten times more compared to 2010-2014. A second one is occurring nowadays, thanks to the huge amount of capital invested, as presented in chapter 3.

Then, some patents have been jointly registered by incumbents and suppliers, the 10% according to chapter 4.4.3. This also supports the conclusion of the third chapter, in which the *compete vs cooperate* debate has been introduced. In fact, last chapter suggests, also confirming what the literature says, that the best alternative is to connect startups together with incumbents, in order to unlock great opportunities for all the stakeholders, and consolidate knowledge sharing practices among the actors, which is a key factor to increase, faster and make more efficient the innovation processes.

In the end, according both to the literature of chapter 3 and to the patent analysis of chapter 4, startups are growing faster, either in terms of market share or impact, either in terms of financial fundings. And, even in Italy the process still requires more time compared to other European countries, startups are revolutionizing the sector, being able to have the courage to make difficult decisions, sometimes wrong, but with the awareness to trying to change the sector, thanks the development of innovative technologies.

Appendix: patents collection and analysis

1) Logistics companies

Sector	Actor	Role	Title	Publishing Date	Owner	N°	Italian region
Packaging	Complementor	Incumbent	Packaging comprising a case and a product contained therein, both having and identification code, and a method for making it	22/10/15	GI.BI.EFFE S.R.L. (IT)	WO 2015159252 A1	Emilia Romagna
Packaging			Package provided with a traceability and originality verification code, its production method and method for tracing it	09/08/11		(EP2949587)	Emilia Romagna
Vehicles	Supplier	Incumbent	Vehicular system for assisting the delivery of goods	23/12/15	IVECO SPA (IT)	WO 2015193855 A1	Piemonte
Software	Logistics	Startup	Method for tracking the movement of objects through a plurality of exchange stations spaced from each other	07/01/16	JOIN P S R L	WO 2016001798 A1	Lombardia
Services	Supplier	Startup	An anti-counterfeiting method in which a product code is associated to a dynamic code	01/09/16	M.V.H. S.R.L.	WO 2016135682 A1	Veneto
Software	Supplier	Startup	Device and method for monitoring a liquid foodstuff	29/09/16	WENDA S.R.L. (IT)	WO 2016151434 A1	Emilia Romagna
Software	Supplier	Startup	Device for acquisition and processing of data concerning human acticity at workplace	29/12/16	LIN UP SRL (IT)	WO 2016207920 A1	Campania
Software	Supplier	Incumbent	Improved apparatus and method for the traceability of objects or sectors in a complex arrangement, in particular of agriculturale products from the plant to a storage container, and related means	26/01/17	UNISET S R L (IT)	WO 2017013569 A1	Emilia Romagna
Services	Supplier	Incumbent	System for managing the pick-up and delivery of at least one object, preferably of a key of a vehicle and method for renting vehciles by means of said system	21/06/17	PHONETICA LAB S.R.L. (IT)	EP 3182350 A1	Lombardia
Software	Supplier	Startup	Method for the selection and the purchasing of products, as well as a computerized system and a program that can be executed by a computer for the implementation of such method	21/09/17	EASYFORYOU S R L (IT)	WO 2017158531 A1	Veneto
Software	Supplier	Incumbent	A computer system for dynamic vehicle insurance billing	04/01/18	OCTO TELEMATICS S.P.A. (IT)	WO 2018002894 A1	Lazio
Software	Supplier	Startup	Method for managing a store and corresponding management apparatus	08/02/18	TWL SYSTEMS SRL (IT)	WO 2018025077 A1	Friuli
Software	Logistics	Startup	Method and system for coorrdination and optimization of services offered by company for goods transport on road	05/07/18	EASYTRUCKING SRL (IT)	WO 2018122772 A1	Trentino
Software	Supplier	Incumbent	Device for detecting the presence of consumer products and automatically managing the relative purchases	18/10/18	NAUTONNIER SRL (IT)	WO2018188783A1	Lombardia
Packaging	Complementor	Incumbent	Method and system for optimized positioning of item in at least one box	15/07/20	Panotec SRL (IT) and Universita' Degli Studi Di Padova (IT)	EP3679529A1	Veneto
Services	Supplier	Incumbent	Method and system for the certification of a product to be shipped	14/04/21	CERTILOGO S.p.A. (IT)	EP 3803735 A1	Lombardia
Software	Logistics	Startup	System and method for monitoring the deliveries of a truck	26/12/19	GLOBE SOCIETÀ COOPERATIVA (IT)	WO 2019243985 A1	Lazio
Software	Supplier	Startup	Payment notification and collection method and system	14/05/20	PAYCITY S.R.L. (IT)	WO 2020095150 A1	Umbria
Vehicles	Supplier	Incumbent	Method for managing the storage of elements positioned on collecting members and management system for elements positioned on collecting members	17/06/21	PIRELLI TYRE S.P.A. (IT) and POLITECNICO DI MILANO (IT)	WO 2021116966 A1	Lombardia
Vehicles			A method for organising an exhibitor	14/06/12	PIRELLI	(WO201277018)	Lombardia
Software	Logistics	Startup	Method for planning the handling path of an object in an urban area and computer program suited to implement said method	08/07/21	TWICKY S.R.L (IT)	WO 2021137045 A1	Veneto
Vehicles	Supplier	Incumbent	Freight vehicle with driver's cab	20/08/21	FAYMONVILLE DISTRIBUTION AG (LU) COMETTO S.P.A. (IT)	IN 202114005865 A	Piemonte
Delivery	Logistics	Incumbent	Home delivery system of consumer goods	23/12/21	ALFA HOLDING DI ANNARITA CAPONI E C. SAS (IT)	WO 2021255716 A1	Toscana
Software	Supplier	Startup	System for digitizing and tracing products	19/05/22	SENTRIC S.R.L. (IT)	WO 2022101694 A1	Emilia Romagna
			Method for product mapping	09/06/22		WO 2022118092 A1	Emilia Romagna
Software	Supplier	Incumbent	System and method to guarantee the authenticity and ownership of an item	09/06/22	THEMIS S.R.L. (IT)	WO 2022117609 A1	Piemonte
Delivery	Logistics	Incumbent	Method and apparatus for tracking postal articles delivered through a "door to door" postal distribution	08/11/13	ITALIA DISTRIBUZIONI	(EP2850567)	Lombardia
Consulting	Supplier	Incumbent	Manufacturing collaboration hub data exchange interface	17/06/10	ACCENTURE GLOBAL SERVICES ACCENTURE INTERNATIONAL	(EP2199960)	Foreign
Services	Supplier	Incumbent	A method for replacement conservation of paper documents relating to transport of products among a plurality of users	07/05/14	CREDEMTEL TECHNOLOGY SOCIETA PER AZIONI DI TESI	(EP2728525)	Emilia Romagna
Software	Supplier	Startup	Method and system for electronic payment of a purchase subject to the receipt of the purchased goods	23/09/21	PAYDO S P A	(WO2021186213)	Lombardia
Labelling	Complementor	Startup	Innovative method of coupling different print shapes on a single coil	01/01/20	LABELADO	(EP3588403)	Piemonte
Vehicles	Supplier	Incumbent	Method and system for identification and delivery of lost objects	03/08/17	MMX	(WO2017130226)	Emilia Romagna
Software	Supplier	Incumbent	Electronic system, and relating method, for monitoring the condition of products and/or goods during their transport, through the measurement and storage of physical and environmental parameters	14/05/15	SECOM	(WO201567992)	Lazio
Software	Supplier	Incumbent	Method and system to handle a container in a storage area	16/01/14	CROSSTEC	(WO201409778A1)	Piemonte

Vehicles	Supplier	Incumbent	Equipment library with link to manufacturer database	09/11/17	AUTONOMOUS SOLUTIONS CNH INDUSTRIAL Italia SPA	(EP3452963)	Piemonte
Data	Supplier	Incumbent	Ultra-wideband location engine for self-shopping devices	30/06/16	Datalogic	WO 2016106194 A1	Emilia Romagna
Data			Drive-through automated supermarket	02/07/20		(US11049196)	Emilia Romagna
Data			System and method for selecting a quality grade metric profile for assuring optimal control of symbol quality in a dpm process	04/07/19		(WO2019129632)	Emilia Romagna
AI & Robotics	Supplier	Incumbent	System for autonomous operation of multiple hybrid unmanned aerial vehicles supported by recharging station to perform services	07/05/20	ARCHON TECHNOLOGIES ARCHON TECHNOLOGY HYUNDAI MOTOR KIA	(US20220066476)	Lombardia
Packaging	Complementor	Incumbent	System and method for optimizing the wrapping of palletized loads with film and wrapping method for a wrapping machine	13/01/19	AETNA AETNA GROUP	(EP3652074)	Emilia Romagna
Software	Complementor	Incumbent	System and method for ordering elements, specifically for packaging	10/09/17	SYSTEM LOGISTICS	(EP3426578)	Emilia Romagna
Software	Supplier	Incumbent	System for tracking the position of persons or items in structures provided with rooms intended to receive persons or items, such as ships, buildings or offshore platforms	12/02/15	MARTEC S P A	(EP3031039)	Lombardia
Software	Logistics	Incumbent	System for verifying the number of containers present in a stack of containers and related verification method	15/05/15	CNR - CONSIGLIO NAZIONALE DELLE RICERCHE VITROCISET	(EP3069099)	Lazio
Software	Supplier	Incumbent	Method for disseminating software contents through a telecommunication network	04/02/22	GUGLIELMO	(EP3992779)	Emilia Romagna
Software	Supplier	Startup	A computer implemented method for the generation and management of codes.	23/12/21	BRINGING INNOVATION INTO TECHNOLOGY 256	(WO2021255668)	Lazio
Software	Supplier	Incumbent	Method and token for certifying products	18/11/21	NOLECOM	(WO2021229366)	Piemonte
Vehicles	Complementor	Incumbent	An autonomous-drive or remote-controlled electric vehicle, for distributing food products and/or medicines and/or consumer articles	03/10/21	INTERACTIVE FULLY ELECTRICAL VEHICLES	(WO2021198893)	Piemonte
Software	Supplier	Incumbent	System and method for collecting and returning luggage at public transportation systems	24/06/21	HCL TECHNOLOGIES ITALY	(US20210192655)	Lombardia
Vehicles	Supplier	Incumbent	System for signalling the space available in a place for the stopping or transit of people	15/05/21	ITALDESIGN GIUGIARO	(WO202195019)	Piemonte
Packaging	Complementor	Incumbent	Method and apparatus for boxing ice cream type products	02/11/20	CT PACK S.R.L.	(EP3733535)	Emilia Romagna
Vehicles	Supplier	Incumbent	Maintenance system for controlling maintenance of a vessel	22/05/20	ZF FRIEDRICHSHAFEN ZF PADOVA	(WO202099366)	Foreign
AI & Robotics	Supplier	Incumbent	System for controlling and managing a process within an environment using artificial intelligence techniques and relative method	15/04/20	LASER NAVIGATION	(EP3867841)	Lombardia
Packaging	Complementor	Incumbent	Method of transferring and system to transfer loose materials for the production of ceramic articles	26/03/20	SACMI	(WO202058846)	Emilia Romagna
Services	Logistics	Incumbent	Apparatus and method for automatically checking a piece of baggage	23/01/20	AIRLOGS	(WO202021580)	Foreign
Delivery	Logistics	Startup		27/11/19	MILKMAN	(EP3572990)	Lombardia
Distribution	Logistics	Incumbent	Integrated system for monitoring and checking the validity of suppliers	21/09/19	INNOVA	(EP3769274)	Lazio
Software	Supplier	Incumbent	Tracking device for tracking objects	19/08/19	STETEL	(WO2019180512)	Toscana
Services	Logistics	Incumbent	An apparatus for automatic dispensing of products, in particular pharmaceutical and/or parapharmaceutical products	21/01/18	CYBER	(EP3270360)	Emilia Romagna
Software	Supplier	Incumbent	Handling system for depositing and picking non-homogeneous articles in a warehouse	11/05/16	ELDECO	(EP3018080)	Piemonte
Software	Supplier	Startup	Robust anti-counterfeit method with dynamic codes and corresponding system	10/03/16	DIGICANDO	(WO201635012)	Trentino
Software	Supplier	Incumbent	Method of optimization and adjustment of an operating parameter of an industrial machine and related system	19/12/20	CAMOZZI DIGITAL MARZOLI MACHINES TEXTILE	(IT201900009465)	Lombardia
Software	Supplier	Startup	Logistics method for a product supply and distribution chain	29/01/21	CELERYA	(WO202119428)	Piemonte
Software	Supplier	Incumbent	Method and system for controlling the handling of products	29/12/21	Ubiquicom s.r.l.	WO 2022144800 A1	Lombardia
Packaging	Complementor	Incumbent	Tracking system for the certification of the origin of an article or a series of new and/or used articles, from a certain production source	02/06/22	REM	(WO2022112819)	Lombardia
AI & Robotics	Supplier	Startup	Automated predictive maintenance method of vehicles	10/02/22	AI PARTS	(WO202229808)	Emilia Romagna
Software	Supplier	Incumbent	Process and system for computing the cost of usable and consumable matrials for painting of motor vehicles, from the analysis of deformations in motor vehicles	09/08/16	UESSE	(EP3455799)	Liguria
Software	Supplier	Startup	Method for providing a workspace with a real-time location system	27/04/22	ENGYNYA	(EP3988965)	Emilia Romagna
Packaging	Complementor	Incumbent	Telematic risk management system	08/08/12	F I M LEGNO F I M LEGNO S P A	(EP2485201)	Lombardia

2) Integrated Logistics systems

Role	Sector	Title	Publishing Date	Owner	N°	Italian Region
Startup	Mining Industry	Method for certifiying and verifying the authenticity of an object	12/11/15	Ferdiam S.r.l. (IT)	WO 2015170290 A1	Veneto
Incumbent	Packaging	Methods and systems for selectively providing information to a targeted community of people	31/07/19	Stevanato Group S.p.A. (IT)	ZA 201706004 B	Veneto
Incumbent	Packaging	Methods and systems for linking specific information to individual product units	23/07/20		US 2020234236 A1	Veneto
Incumbent	Technological system	Method for the correct implementatiton of a planogram inside a point of sale	25/10/17	CEFLA SOCIETA' COOPERATIVA (IT)	EP 3236402 A1	Emilia Romagna
Incumbent	Service (marketing)	System for the monitoring and analysis of the behaviour of at least one individual in a shop	02/11/17	GROTTINI LAB SRL (IT)	WO 2017187251 A1	Marche
Incumbent	Pharmaceutical	Dispensing process of medical products in a healthcare facility	22/11/17	PHARMATHEK S.r.L. (IT), ESSEGI SOFTWARE S.r.L. (IT), SOL GmbH (DE)	EP 3246862 A1	Lombardia
Incumbent	Fashion	Apparatus for making a goods sales offer	29/03/18	OVS S.P.A. (IT)	WO 2018054586 A1	Veneto
Incumbent	Manifacturing	Method for retrieving information about a welding wire, computer-implemented method for retrieving information about a welding wire and system for retrieving information about a welding wire	30/05/18	SIDERGAS SpA (IT)	EP 3327639 A1	Veneto
Incumbent	Technological system	Refrigerated showcase and method for managing a fleet of such showcases	07/06/18	C-LED S.R.L. (IT)	WO 2018100519 A1	Emilia Romagna
Startup	Recycling	Glass collection and treatment systems and methods	18/12/19	Y.E.S. S.R.L. YOUNG ECOLOGY SOCIETY (IT)	KR 20190139948 A	Emilia Romagna
Startup	Recycling	System and method for collecting and processing glass	12/10/18		(EP3609630)	Emilia Romagna
Incumbent	Food	Machine and production system for making liquid or semi-liquid food products	18/09/19	Ali Group S.r.l. - Carpigiani (IT)	EP 3540663 A1	Emilia Romagna
Startup	Smart Mobility	System and method to control the position of a plurality of shared vehicles in a service area	04/08/21	ZEHUS S P A (IT)	EP 3768584 B1	Lombardia
Incumbent	Telecommunications	Method and systems for tracking cable drums and length of cable on the drum	02/07/20	Prysmian S.p.A. (IT)	US 2020210941 A1	Lombardia
Incumbent	Technological system	Equipment for aiding the traceability of agri-food products	29/07/21	SISSPRE - SOCIETA' ITALIANA SISTEMI E SERVIZI DI PRECISIONE S.R.L. (IT)	SG 11202106882S A	Lombardia
Incumbent	Technological system	Sealed sensor assembly for an equipment for aiding traceability of agri-food products	16/06/22		(WO2022123524)	Lombardia
Incumbent	Technological system	Method to manage a remote computer database	16/02/22	Inglass S.p.A. (IT)	EP 3953878 A1	Veneto
Startup	Healthcare	Incentive systems for the use of returnable empty bottles	02/06/22	VIVOGREEN S.R.L. (IT)	WO 2022113133 A1	Lazio
Incumbent	Safety, Software	Method for tracking sanitary materials and goods with rfid identification system; containment area and/or structure actuating said method	06/08/14	DEENOVA INGEGNERIA BIOMEDICA SANTA LUCIA SANTA LUCIA PHARMA APPS	(EP2954469)	Emilia Romagna
Incumbent	Telecommunications	A method, system and computer program product for accounting access by users to data networks	26/07/07	TELECOM ITALIA	(EP1980052)	Piemonte
Incumbent	Manifacturing	Presentation system for compression train configuration information	07/08/02	NUOVO PIGNONE	(EP1229479)	Toscana
Incumbent	Healthcare	Electronic tracking and monitoring of transit and condition status of biological products	17/08/17	HAEMOKINESIS	(EP3381007)	Foreign
		Identification system for luggage	17/10/10	BALZARINI	(EP2431930)	Lombardia
Incumbent	Advisory	Predictive method for analysing a menu	19/05/22	MAIORA SOLUTIONS	(WO2022101691)	Lombardia
Startup	Service (marketing)	System and method for controlling the distribution of informational or mail items, in particular advertising flyers	17/03/22	NEWAYS	(WO202253942)	Veneto

Startup	Cosmetics	A system for monitoring and managing cosmetic product dispensing devices	26/01/22	LEB	(EP3944168)	Puglia
Incumbent	Design	Improved workbench	29/08/21	HSIGN	(WO2021161071)	Marche
Incumbent	Manifacturing	Computerised system for accessing to a vehicle and related method	27/07/21	KEYLINE	(WO2021152451)	Veneto
Incumbent	Technological system	System for the compaction and management of recyclable waste and related incentive system	12/04/18	HTS	(WO201866009)	Friuli
Incumbent	Manifacturing	System and method of consultation and selection of hardware components for realization and composition selecting automatic measuring of geometric parameters of interior furnishings	05/02/17	KITCHEN LIFTING	(WO201721838)	Puglia
Startup	Publishing	Computerized system for the distribution of a multi-platform digital publishing product and relative method	29/01/15	SORRIDI EDITORE	(US20150032657)	Lombardia
Incumbent	Pharmaceutical	Method and system for dynamic identification and tracking of packages	12/06/14	PHARMADAY	(WO201491428)	Lombardia
Incumbent	Videogame	Measuring apparatus	21/06/18	MILESTONE	(EP3339866)	Lombardia
Incumbent	Tobacco	Food products packaging automatic plant	20/03/18	GD SPA	(EP3515826)	Emilia Romagna
Incumbent	State Enterprise	Product authentication system	05/09/16	ST POLIGRAFICO E ZECCA DELLO STATO	(EP3065091)	Lazio
Incumbent	Motorcycle	Motorcycle with system of authorization control	17/11/17	PIAGGIO PIAGGIO & C SPA	(EP3458314)	Toscana
Incumbent	Cosmetics	System and method for the transport of goods	18/09/17	BIOMED CEPHELLO ESUAL L Limited by Share Ltd SEFERO	(EP3429344)	Veneto
Incumbent	Healthcare	System and method for the association of results of analysis performed on biological samples, in particular biological samples subjected to clinical investigations, with pre- analytical variables to which those samples are exposed	01/09/17	D P MEDICAL THEMIS	(WO2017149468)	Piemonte
Incumbent	Manifacturing	Optical assembly for use in an object handling station	16/06/22	STEELCO SPA	(WO2022123609)	Veneto
Startup	Service (marketing)	System for monitoring the expiry date of bottled or canned food products	27/04/22	H24INVENT	(EP3989146)	Veneto
Incumbent	Research	Assurance module	19/01/22	ADVANCED LABORATORY ON EMBEDDED SYSTEMS (ALES s.r.l.)	(EP3940672)	Lazio
Startup	Fintech	Method and apparatus to process data	09/02/21	MODEFINANCE	(EP4010860)	Friuli
Incumbent	Healthcare	Wearable personal protection device and system for managing wearable personal protection devices	24/11/20	ANTIS GROUP	(WO2020240371)	Lombardia
Incumbent	Manifacturing	System for controlling and managing a chain of energy products and related process	02/02/20	SGM ENERGY	(EP3830768)	Puglia
Startup	Food	Method for exchanging information concerning a product and a corresponding system	28/03/19	ENOSOCIAL	(EP3462400)	Veneto
Incumbent	Manifacturing	Automated plant for cutting and operating flat slabs and process	04/04/19	GRANITIFIANDRE	(EP3466627)	Emilia Romagna
Incumbent	Pharmaceutical	Method and system for providing an information to a person belonging to a targeted community of people	20/07/17	NUOVA OMPI	(WO2017121777)	Veneto
Incumbent	Constructions	Kit for monitoring protective devices	12/04/17	COOP EDILE APPENNINO SOCIETA COOP A RESPONSABILITA LIMITATA	(EP3153042)	Emilia Romagna
Incumbent	Fashion	An improved display unit for products for sale, in particular spectacles	27/03/15	SAFILO SAFILO SOCIET AZIONARIA FABBRICA ITALIANA LAVORAZIONE OCCHIALI	(WO201544883)	Veneto
Incumbent	National Defense	Storage system for artillery ammunition	08/12/11	OTO MELARA	(EP2395312)	Liguria
Incumbent	Healthcare	Method for classifying, identifying and finding automatically, by means of informatic devices and systems, of surgical instruments of various kind, and for processing and managing data relating to the automatic classification, identification and finding of surgical instruments, obtained by means of such informatic devices a	29/05/08	MEDIC INSTRUMENTS DI FARABOLA JUAN	(EP2092471)	Veneto
Incumbent	Manifacturing	Method implemented by a processor for the movement of containers of semi-finished products and related apparatus	30/11/16	ANZANI MACHINERY SRL	(EP3098674)	Lombardia

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