Politecnico di Torino

Politecnico di Torino

Master's Degree in Engineering Management LM-31
A.A. 2021/2022
Graduation Session March/April 2022

The impacts of Covid-19 on logistics operators' business: an empirical analysis

Relatori:
Prof.ssa Anna Corinna Cagliano
Prof.re Giulio Mangano

Candidato: Benedetta Pia La Rosa

Co-autrice: Erica Zuccarelli

Abstract

In December 2019 the first suspected case of Covid-19 was discovered in China. This disease led to the biggest health, economic and social crisis in the past 100 years.

Many sectors have been affected by the mass lockdowns, including the logistics sector, which has suffered in travel and transport.

The purpose of this research is to identify what changes and impacts logistics operators have experienced in Piedmont as a result of the pandemic, both in terms of business volumes and operational organization.

To achieve this intent, a questionnaire was prepared containing 22 questions divided into two sections aimed at investigating and analyzing the performance of 3PLs during the pandemic. The first section analyses how firms are positioned in their target market, while the second section focuses on the changes that firms have experienced in the past two years. All questions are structured with multiple-choice answers; in addition, questions designed to highlight an increase or decrease in a service are scored using a Likert scale. The AIDA database has been used to select the sample of companies using the following variables: the ATECO 2007 codes, the Piedmont region and the budget of the company available for the years 2019 and 2020. The response rate to the questionnaire was high, reaching 94 responses out of a sample of 420 companies.

The companies' performance was assessed by cross-referencing the companies' performance after an initial demographic examination of the sample. Thus, identifying behavioral trends amidst novel emergency situations. Lastly, the analysis also attempted to find a correlation between performance, services offered and size of the company.

Table of contents

Introduction *1*
CHAPTER 1: The logistics sector and 3PLs *3*
1.1 Industry boundaries **3**
1.2 The 3PL nowadays **5**
1.3 The 3PL selection **6**
1.4 The logistics sector before Covid-19 ..... **8**
1.5 The 3PL during Covid-19 ..... **11**
1. 6 Supply-Chain post Covid-19: some possible scenarios **14**
1.7 Research GAP **15**
CHAPTER: 2. The methodology *16*
2.1 Questionnaire Theory **16**
2.2 Research Methodoloy **18**
2.3 The Questionnaire **19**
CHAPTER 3: Analysis of the study sample *23*
3.1 Concepts of statistics applied to data analysis **23**
3.2 The Kruskall-Wallis test **24**
3.3 The Kruskall-Wallis test applied to the sample **41**
CHAPTER 4: Conclusions *46*
4.1 The Thesis Work's Advantages **46**
4.2 Study Limitations **46**
4.3 Future Developments **47**
Bibliography *48*
Sitography *51*
Figure Index *53*
Table Index *54*
Chart Index *55*
Appendix *57*

Introduction

Between October and November 2019, the first case of SARS-CoV-2 infection is identified in the Chinese province of Hubei, specifically in the city of Whuan, a virus that will result in one of the worst worldwide pandemics in history in a matter of months.

The pandemic has fundamentally altered the organization of global market sectors, including the logistics sector, owing to border closures and trade restrictions imposed as a result of the pandemic.

The goal of this thesis is to learn about the pandemic's main effects on external logistics operators (Third Party Logistics) in the Piedmont region, as well as what modifications organizations have done to respond as swiftly as possible to these changes.

Furthermore, due to the rampant dread that gripped Italian families, who were driven to stock up on food and other supplies for fear of being isolated due to the surge in cases, there was a severe increase in demand in the food sector.

As a result of the pandemic, the organization of global market sectors has fundamentally changed, including the logistics sector, which has seen significant changes, owing to the closing of borders and the installation of trade restrictions as a result of the pandemic.

All of these factors have contributed to an increase in online shopping demand, which has resulted in the growth of e-commerce in numerous sectors during the previous two years.

The purpose of this thesis is to learn how the pandemic has affected the performance of third-party logistics (3PL) operators in the Piedmont region, as well as what modifications organizations have made to respond as rapidly as possible to these changes.

In both academic and professional domains, the first chapter provides a general overview of the role of external logistics operators. Within the same, the remedies used over the last two years of the epidemic are evaluated, and the techniques used by businesses to adjust to new consumer and supply chain behaviors are hypothesized.

The approach used to construct the questionnaire that was administered to a representative sample of the population of enterprises is the subject of the second chapter. The aims and point assumptions that underpin each survey question, as well as the procedures used to choose the sample of organizations and develop the sampling plan, are all depicted.

The statistical theories required to assess the data acquired during the survey administration phase are examined in the third chapter, and the evidence gathered is then further examined to uncover any correlations between variables.

To that purpose, the results examine the changes, investments, and technologies deployed to respond to new market needs through flexibility and adaptation throughout a particularly challenging historical time on a worldwide scale.

The study is thought to be particularly relevant because it provides a current perspective on a new topic, as well as a thorough historical background, in an attempt to represent the changes faced by businesses during the pandemic period.

CHAPTER 1: The logistics sector and 3PLs

This chapter looks at logistics and logistics operators, delving into both academic and professional domains to understand how the pandemic affected them. In addition, the pre- and post-pandemic circumstances are assessed and contrasted.

1.1 Industry boundaries

The term logistics lends itself to many and varied meanings. Many organizations have set out to clarify the boundaries. Among the many possible definitions, the one attributed to the U.S. Council of Logistics Management reads as follows: "*Business logistic is the term describing the integration of two or more activities for the purpose of planning, implementing and controlling the efficient flows of raw material, in-process inventory and finished goods from the point of origin to point of consumption. these activities may include, but are not limited to customer service, demand forecasting, distribution communications, inventory control material handling, order processing, parts and service supports, plant and warehouse site collection, procurement, packaging, return goods, handling, salvage and scrap disposal, traffic and transportation and warehousing and storage"* [1].

In addition, outsourcing of logistics activities enables firms to reduce the financial risks they might incur if they were to invest capital in distribution centers and IT networks. Disadvantages include the difficulty in selecting a good supplier, drafting a comprehensive contract, and ensuring that information and risk is shared [6].

Within the logistics macro sector, it is possible to define the 3PL as an external supplier that operates, controls, and provides logistics activities on behalf of the customer ([2]; [3]).

Logistics operators are classified according to the activities they carry out in the company [4]. For classification purposes, the term Party Logistics or PL is used, accompanied by a number denoting the services offered **(Figure 1.1)**. A relevant classification of logistics operators distinguishes companies in the sector into 5 levels. This classification is reported by [6] along with many other authors.

The first level, or also called First Party Logistics, involves outsourcing transportation activities to companies in the industry. At this level, companies that outsource the service continue to have control of the warehouse.

At the Third Level, or Third-Party Logistics, logistics operators are responsible for transportation and warehousing while managing and organizing the two cycles.

At the fourth level, or Fourth Party Logistics, they take on the role of consultants and auditors for 3PLs, with the aim of optimizing and improving operations. It is necessary to specify that operators merely provide an advisory service, but do not have a logistics infrastructure.
Lastly, at the fifth and final level, or Fifth Party Logistics, the services offered by 3PLs and 4PLs are fully integrated, thanks to their scope and experience [4].

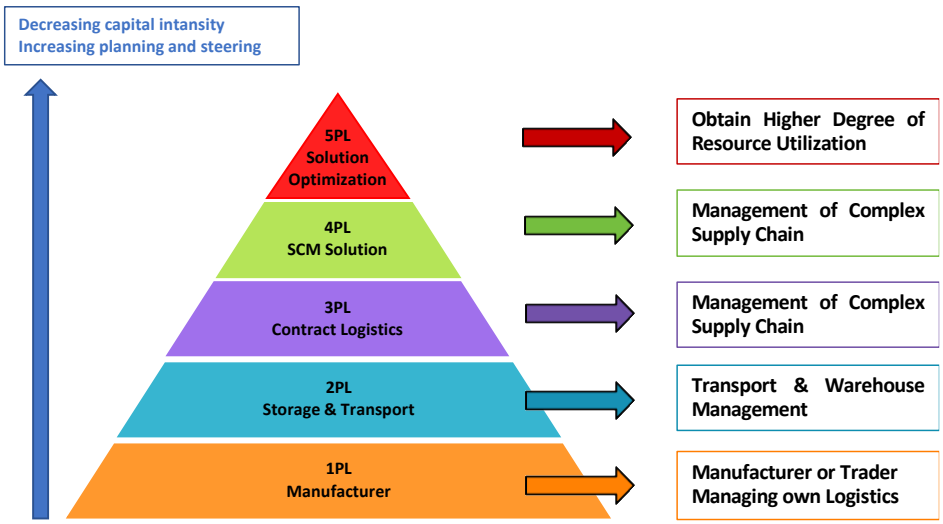

***Figure 1. 1**: PL classification pyramid [31]*

The third level, which identifies 3PLs, can in turn be classified into four distinct macro-categories. The operators belonging to the first category are defined as "*Standard 3PL providers*", as they carry out activities of material picking and packaging, storage and distribution.
In the second category, they are referred to as "*Service developers*", as they offer their customers advanced services such as tracking and tracing, cross-docking, specific types of packaging, and customized security services. This type of 3PL has a robust IT system and a focus on economies of scale and scope.
The third category is that of the so-called "*Customer adapters*", who assume complete control of the company's logistics activities, improving performance, but without implementing a new service. At last, in the fourth category there are the "*Customer developers*", which are integrated with the customer implementing a new service [6].
The main services offered can be grouped into six distinct categories: transportation, outbound logistics, warehouse management, inventory management, packaging, and reverse logistics, and each of these in turn develops into subcategories [5].

1.2 The 3PL nowadays

Collaboration with external partners is an essential element for a company's competitiveness. This is why the concept of supply chain management was born, in order to manage physical and informational exchanges while achieving cost reductions along the supply chain and simultaneously increasing the perceived value of goods [5].

3PL has been largely promoted by the outsourcing phenomenon, which companies are increasingly relying on. The growth of logistics outsourcing is mainly attributed to the benefits it brings in terms of cost reduction, improved performance and focus on its core business.

As stated by Agenzia Giornalistica Italia (AGI) in a June 2021 article, the logistics sector accounts for 9% of Italy's GDP [7].

As shown in **Figure 1.2**, the European and global logistics sector reveals a positive turnover trend in Italy (Contract Logistics Observatory, Polytechnic of Milan), this growth has a decrease in 2020, and then returns to growth in 2021 [8].

The total value of Logistics industry revenue in 2021 is reported to be €86 billion with +3.5% over 2020 and close to the value recorded in 2019 before the pandemic of €87 billion. E-commerce has played a key role in this recovery, as it has gone from being a cross-segment in the value of logistics, to being worth 20% of revenue for 60% of suppliers [8].

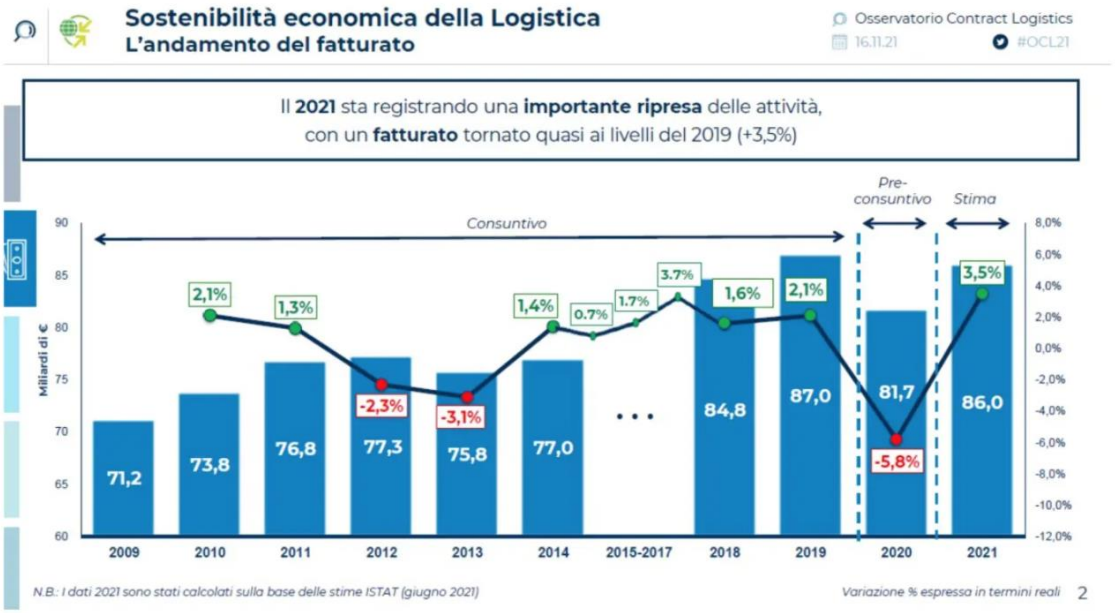

Figure 1.2: *Logistics industry growth from 2009 to 2021 [8]*

Research by the "Gino Marchet" Contract Logistics Observatory of the School of Management of the Milan Polytechnic reports that in addition to revenues, the costs incurred in this sector

have also increased, mainly those linked to production factors, such as energy (+24%), fuel (+13%) and rents (+2%), a further change in this sector is the drafting of a new national labor contract for Logistics, Freight and Shipping, which establishes salary increases for the next three years of the current salary net of seniority steps (+5%) and health care [8].

3PLs are increasingly increasing the variety of logistics operations under their purview, converting their essence from simple freight carriers to value-added strategic entities [9]. With increasing awareness of strategic logistics outcomes [10] and recognition of the benefits gained by leveraging the services of 3PLs [11], logistics researchers and practitioners consider improving the performance of 3PLs to be a high priority [12].

1.3 The 3PL selection

3PL selection is a multi-criteria dilemma, which necessitates a lengthy process that takes into account a variety of tangible and intangible variables [5].

In a study conducted by Spencer et al. [13] on 154 companies listed in the U.S. public registry of warehouses, 23 specific criteria used by companies to select their 3PL in the JIT (Just - in - time) context were identified. These criteria were listed in the following order of importance: on-time performance, performance, service quality, good communication, reliability, speed of service, flexibility, customer support, ease of work, quality of management, timely notification of disruptions, order cycle time, service customization, reputation, price, location, variety of services available, cost reduction, special skills, technical expertise, increased competition, and overall capabilities.

At the same time, Morash et al.'s survey [14] of 65 U.S. companies in the furniture industry highlighted the close dependence between logistics performance and two other factors:

- "demand capacity," specifically pre-sales and after-sales customer services, speed of delivery, reliability of delivery, and responsiveness to the target market;
- "supply capacity," which includes widespread and selective distribution coverage, as well as low total cost distribution.

However, in the exploratory study of 84 3PL users in Australia conducted by Dapiran et al. [15] and Millen et al. [16], it is cost that emerges as the most important selection criterion. Following this, the following play a second important role: creativity in problem solving, information and technology system capabilities, general reputation, reputation for continuous problem solving, compatibility of cultures, and size and ownership of assets. Lastly, international reach is identified as a criterion of third importance.

In a study of 134 companies in Hong Kong [17] it was shown that performance evaluation in transportation logistics is primarily concerned with cost and asset. The former is related to five different operations: transportation, warehousing, costs associated with the facilities and workforce used to provide services, order processing, and logistics administration; while the second was developed according to the 3 measures suggested by the SCOR model: cash-to-cash cycle time, utilization of facilities and workforce in providing services, and variety of assets available.

In the research conducted by A. Aguezzoul [5] through the extrapolation of data from 343 different studies, 11 macro categories were identified and selected the discriminating variables to be taken into account when choosing to outsource logistics services. These variables are brought back of continuation in the **table 1.1** [5], subdivided in two columns: in the first one is present the macro category, while in the second one there is one detailed description of the same one.

Category	Description
Cost	Included: price, cost reduction, low-cost deployment, expected lease cost, operations-related costs, inventory, and savings achieved.
Reletion between parts	Risk and benefit sharing and cooperation between the user and the 3PL. In addition, it allows you to control opportunistic attitudes on the part of the logistics provider.
Services	Specialized services, variety of services, customer services with pre-sales and after-sales channels, and value-added services.
Quality	Use of ISO and SQAS standards for environmental issues, risk management.
Equipment and information systems	Physical equipment, information systems held by 3PLs to facilitate communication and execution of logistics operations for their customers. EDI systems, tracking and tracing systems, technological capabilities, information accessibility, level of computerization, technical and engineering capabilities, cyber security.

Flexibility	Ability to adapt and change based on customer demands and varying circumstances, ability to grow the customer's business, speed of response to different market targets, ability to meet future requirements, ability to manage specific business requirements.
Distribution	Distribution timing, on-time shipping and delivery performance, speed of delivery.
Experties	Knowledge of services offered punctuality and degree of attention to customer needs, experience and expertise.
Financial position	Continuity of service with the customer, continuous updating of equipment and services used in logistics operations.
Place location	Referring to distribution coverage radius, specialization and geographic coverage, market coverage and international coverage, and remote shipments.
Reputation	Customer satisfaction with 3PLs. Extremely important indicator in the customer's choice of 3PL.

***Table 1.1**: Macro Categories of variables used to select the 3PL [5]*

1.4 The logistics sector before Covid-19

As quoted in an article of Sole 24 Ore: "*In our country the logistics [...] has always been daughter of a minor god: considered an accessory sector if not marginal for decades by the politics and by the national manufacture, even if it represents the 9% of the GDP. Italy is alone to the 19th place in the Logistics Performance Index of the World Bank [...]. Yet, the Italian logistics has numbers of all respect: approximately 90 thousand enterprises and more than 1 million workers, of which 347 thousand in the road haulage. The weak point is represented from the dimensions: 90% of the enterprises has less than 10 addressees. These are often undercapitalized realities, which do not have the strength nor the possibility to invest in digital transformation and training*" [18].

In recent years, the effort to integrate physical systems with digital systems, through the development of Industry 4.0, has become increasingly concrete. In a n article from 2018, written in collaboration with Accenture [19] in the magazine "Logistics and Management", emerges the ability of this phenomenon to lead to a rapid evolution of companies of all sizes in the definition of competitive factors, making logistics increasingly important in the classification of business models.

Several factors can be identified that have contributed to the reputational growth of the logistics industry. First and foremost is undoubtedly the expectation of population growth. In fact, estimates made on this indicator foresee the reaching of 9 billion people by 2050. For this reason, this phenomenon is proving to be increasingly decisive in long-term strategic choices. Furthermore, it has to be considered that population growth is accompanied by increasing urbanization, consequently logistics has to be able, in the not-too-distant future, to operate even in remote areas of emerging countries, which for the moment are characterized by the presence of suboptimal infrastructures [19].

The rebalancing of forces in favor of demand, as a result of customer empowerment, is a second decisive element. In reality, consumers are becoming increasingly demanding and want to be continually updated, particularly about delivery dates, locations, and charges [19].

A final factor that should be mentioned is instability. In fact, flexibility and adaptability are becoming more and more important in the marketplace in order to respond more quickly to consumer demands. This leads to the emergence of new opportunities, while at the same time making it more difficult to predict all possible scenarios [19].

Logistics, in recent years, has increasingly contributed to the development of e-commerce, in which the key factors to consider are the accentuated search for high quality standards, delivery services and customer satisfaction, both for research and for customer loyalty [19].

Technological developments, as well as market trends, have been fundamental in changing the perception of logistics, which from being simply considered a cost center has also become an essential factor for business growth, ending up as an element of differentiation of the supply-chain [19].

In addition, the study shows how by 2025 certain technology areas will have a major impact on the entire supply-chain. The first technology analyzed are Uber-like Platforms. These are being leveraged to address the rising costs of logistics. Companies are looking to give real-time visibility into the competitiveness of their pricing. This is made possible by ensuring absolute market transparency through an emerging technology that connects supply and demand. Uber-like platforms were initially created to avoid empty trips.

According to a study conducted by the leading start-up in this field (Chronotruck), one in four trucks in Europe travels without freight [19].

The idea behind these platforms is very simple: if a company wants to send a product, it has to find a driver who has scheduled a trip on that same route. These business models, also known as sharing economy models, are becoming more and more important as the value shifts from the company's assets to those of the platforms. It is also important to emphasize the ability of these platforms to provide flexibility, scalability, transparency, speed of process, significant reduction in fixed costs and offer a high level of digitization of the service, which allows for geolocation, monitoring and tracking of the trucks for which drivers have activated the sharing option.

A second subject of study is IoT, Tracking and Cloud Technology. This technology allows to address the need for protection of loads and goods that is becoming a pivotal topic in logistics. In fact, in the goods transportation industry, there is an increasing demand for greater transparency and focus on on-time delivery.

The implementation of digitized transactions through the use of IoT technologies, certified by the use of the Blockchain, allow for better visibility and access to the flow of information with greater reliability, security and speed, reducing the risks associated with the non-transmission of transport data. Sensors are used to collect information regarding the weather conditions the goods have been subjected to during transport and information regarding the impacts, tampering and movements the cargo has undergone. Before the deployment of the Blockchain, this data could be easily modified, while the presence of this new technology does not make it easy to tamper with this data. The Cloud is also becoming of particular importance as it deals with collecting and organizing large amounts of data in order to monitor and automate the Blockchain. This will allow all the players in the supply chain to communicate in the Cloud allowing perfect transparency from the order phase to the delivery phase [19].

Another technology employed is Artificial Intelligence, which extends from robots to cognitive processes. In fact, e-commerce is slowly leading the industry towards implementing consumer-driven pull strategies. This has led businesses to a greater quest for automation. The use of robots for highly standardized processes has been integrated, and transportation integration and planning in customer billing processes will gradually follow. In addition, virtual agents, equipped with cognitive intelligence are being considered for use in customer service systems. Artificial intelligence will be able to understand and analyze systems in order to actually improve them. This implementation could provide reduced labor costs and more reliable demand data [19].

Lastly, one of the technologies under study is Machine Learning: the use of Big Data today is not only limited to the collection of information, but also aims to facilitate real-time decision-making and prevent possible incidents that could slow down the operational process. This brings great benefits, especially in the management of the last mile, through a real time adaptation of the routes, based on geographical factors and the demands of the end customer. This technology is also developing in the shipping system, no longer based only on orders received, but also on demand forecasting. All these elements lead to the increasingly emerging need for collaboration, which is considered equally important by all players in the chain [19].

1.5 The 3PL during Covid-19

The spread of the Coronavirus starts between Codogno and Lodi, therefore, in the central hub of Milanese logistics. The area that includes the Lombard provinces of Milan, Monza e Brianza, Lodi, Pavia, Como, Varese, Bergamo and extends up to Novara and south-east with Piacenza, also known as Rlm (Region of Milan Logistics), is the pole of Italian logistics that has over 1,500 logistics service companies and over 15,000 trucking companies, which make about 20 billion euros a year, about 24% of the Italian market. This pole has a directional role on a large part of the national logistic flows; therefore, many large companies have chosen it as an area for the distribution of goods over a large part of Italy, not to mention the presence of the airport cargo station such as the cargo city of Malpensa that moves about 53% of Italian air traffic [20]. According to various studies and authors in the sector, logistics is considered the lifeblood of the economy, as it plays a fundamental role in the survival of all other sectors, thus sealing a relationship of dependence with them.

For this reason, in the early days of the pandemic, when non-essential businesses were forced to suspend their operations, the transportation and logistics sector remained among the few that contributed to the survival of the world economy and designated as a "critical infrastructure industry" [56].

The pandemic situation has caused absenteeism among the employees of the various companies due to the fear of contagion, with the risk of a slowdown in the entire distribution chain [21].

In order to deal with this situation, safety measures were adopted inside the warehouses, such as separating the goods receiving and shipping areas, i.e. the areas that have the most contact with the outside world, from the other parts, also trying to divide the work over several shifts, so that people had less contact with each other. Movement between the warehouse and other departments was also forbidden, and it was mandatory from the outset to respect the meter distance. Lastly, the entry of drivers was limited to one person at a time [7].

The pandemic has made it clear just how crucial efficient logistics are to ensuring the supply of essential goods, food and healthcare.

At the beginning of the pandemic, Uniontrasporti [20] proposed three scenarios based on the situation in Lombardy:

1) "Base scenario", which showed the growth in the value of production of the logistics system in Lombardy in the absence of the pandemic situation;
2) "Low-impact scenario", in which it was assumed that the pandemic situation would cease after 2 months and with it also the social restrictions would disappear, with a return to normality in the second half of 2020;
3) 'High-impact scenario', in which it was assumed that containment measures would continue for 6 months, returning to normal in the first half of 2021.

These scenarios suggest a contraction in the value of logistics and transport production to 15% in the "base" scenario, with a loss of wealth of 4.4 billion euros, rising to 35% in the "high impact" scenario with a loss of wealth of 9.6 billion euros, inevitably leading to an increase in unemployment in this sector [20].

On the contrary, according to the study published by Muhammad Hasan Ashraf and Mehmet G. Yalcin, Jiayuan Zhang, Koray Ozpolat in 2021 [21], custom plans such as UPS premier and FedEx Special Operations were required to cope with increased volumes transported during the 2019 Coronavirus outbreak (COVID-19) ([22]; [23]). Making such strategic or tactical changes in business has proven to be essential for short-term competitiveness and long-term survival [24].

In this scenario of change, there is a place for what is referred to in technical jargon as "paradox". Paradox is defined as a contradiction embedded in a statement [25], human emotion [26] or organizational practice [27].

Through studies conducted on paradoxes, tensions appear from an alternative perspective, exploring how organizations simultaneously address conflicting needs [28].

However, these changes have often not been described as successful [29]. Generally, employees, especially in the 3PL setting, which is considered attached to past practices and inflexible, usually resist change [30]. Sudden changes, such as the introduction of new services dedicated to different levels of customers, can trigger discomfort and confusion, with the possibility of hindering, or even paralyzing, the decision-making process [24]. However, extrapolating the tensions from the changes can help managers implement strategic changes. According to the results of research conducted by Muhammad Hasan Ashraf et al. [21] the new paradoxes that have emerged during the past two years are actually caused by the disruptions

due to the COVID-19 outbreak and are mostly related to one particular category: performative paradoxes.

Maintaining safety distance between employees while complying with introduced regulations and simultaneously sustaining a high order service capability is an example of a performance paradox that 3PLs have faced. In addition, situations where employees needed to take sick leave when the hub was at full capacity also hindered the performance of the 3PLs themselves [21].

The paradox of safety and production being the protagonists can be considered as a historical paradox, constituting the world of management [32]. This paradox was exacerbated during COVID-19, when the unpredictable increase in the volume of e-commerce placed 3PL companies in front of a difficult balance between new employee hires and the safety of the workers themselves. The situation was managed by 3PL managers by promoting a culture of safety and health for their employees, who were considered the primary driver of the production process. To this end, new practices were implemented by the human resources team with the goal of maximizing efficiency and ensuring employee safety [33].

To effectively manage a large volume of packages from origin to destination, 3PL companies use a network of hubs [34]. This network consists of various sorting hubs and large consolidation centers and is considered one of the most important aspects of 3PLs for the development of a successful logistics system [35]. Since the beginning of the pandemic, 3PLs have found themselves operating at the limit of maximum hub capacity. Most reported daily volumes exceeded the required amount during seasonal peaks. Under these circumstances, 3PLs did not have enough capacity to process all of the volume they received on a daily basis. Therefore, a larger workforce was needed to ensure the organizational standard. However, managers could not hire enough workers due to safety guidelines. Therefore, they were forced to hire temporary workers [36].

A COVID-19 workplace trends survey conducted by Gartner [53] says nearly one in three companies have hired more temporary workers to achieve greater flexibility in workforce management while maintaining employee safety. Hiring this type of worker has been a key factor in making it easier for logistics companies to cope with sudden spikes in demand, while minimizing the risk of employees contracting illness. However, in cases where the volume to be processed was too high to meet the sorting time managers were forced to expand the time window rather than hire new workforce within the hub.

As demonstrated by the previously mentioned studies, overall, it can be said that the most common approaches used by 3PLs to manage paradoxes include modifying operational plans, improving workforce communication, investing in employee training, optimizing the hub

network, modifying policies carried out by human resources, modifying or introducing new operational methods, and promoting a safety culture within hubs [21].

1. 6 Supply-Chain post Covid-19: some possible scenarios

The article published on September 17, 2020 by Logistics and Management [37] about 6 months after the first lockdown highlighted the actual response recorded after the first months of the pandemic. During the panel discussion organized by Generix Group, data on e-commerce and how it had grown during the first months of the pandemic, in which about 1.3 million Italians began using this mode of purchase, was analyzed.

The growth of e-commerce has had impacts on the entire supply-chain, due to an increase in requests for customized transportation and packaging and the search for new warehouses in areas in close proximity, especially for the agri-food sector. In addition, remote delivery solutions have been increased, through the installation of pick-up points in offices or inside buildings.

Retail in the period from February 2020 to May 2020 recorded a 4.2% increase in sales, and in the same period, e-commerce recorded a 145% increase, especially in food and home and personal care products. Logistics initially struggled to respond to exponentially growing demand, facing doubled delivery times; in fact, only 70% of shipments were delivered in March, despite a 43% increase in shipments. Instant delivery increased by 300% in the same period and door-to-door service grew by 900%. The "*Click & Collect*" service, which allows you to order online and pick up at a store, also saw growth. Home delivery became easier, as it benefited from decreased traffic due to lockdown and recipient availability at the home. There was also an increase in delivery responsiveness due to the discontinuation of the "*Proof of Delivery*" service, which allowed delivery activity to be controlled and monitored electronically.

All of these factors contributed to the definition of logistics as an "essential public service," [21], as actors in the supply chain risked their lives personally to allow primary goods, such as food and pharmaceuticals, to continue to be distributed. The need to meet the numerous online requests has highlighted the shortage of drivers in this sector. To date in Italy there is a shortage of about 5 thousand truck drivers, with a forecast of the next few years of 17 thousand drivers to be hired [18].

The importance of the role of carriers within this difficult scenario is highlighted in an article by Euromerci [38], which states that every aspect of society has undergone a major shift following the deployment of COVID-19, and the logistics sector has played a key role in supply chain management. Its tools have proven to be fundamental in managing health emergencies

and ensuring the use of medicines, medical devices, vaccines, test kits, PPE. Until June 2021, DHL has distributed more than 200 million doses of the licensed vaccines in over 120 countries, involving over 9 thousand flights and 350 facilities. In an interview, Mario Zini, CEO of DHL Global Forwarding, said, "*The logistics industry and supply chain play a key role in pandemic management, keeping a fast and effective supply chain in place to ensure delivery of essential health supplies has left us with valuable lessons for the present and future*". The logistics industry was able to cope with difficult transport conditions: the unprecedented transportation of the vaccine at temperatures as low as -70°. Despite this obstacle, distribution was three times faster than standard timelines [38].

1.7 Research GAP

Qualitative research offers the opportunity to gain fruitful insights into supply chain management during the period of health emergency that Italy, along with other nations, has been involved in over the past three years.

Different opinions have evolved as a result of studies conducted in academic and professional domains, indicating the subject's debatability and ambiguity regarding future prospects. In fact, while it was predicted at the start of the pandemic period that the value of logistics production and transportation would drop by 15% in the absence of a pandemic situation, it could rise to 35% if the situation lasted six months after the lockdown began in March 2020, following a study conducted in 2021, an increase in volumes transported during the virus's spread and thus the introduction of customized plans to cope with the huge need [20, 22, 23].

The increase in volumes has led to a consequent increase in temporary workers, in order to achieve greater flexibility to ensure safety within the workplace. However, as reported by Il Sole 24 Ore [18], the inability to cope with growing demand due to the limited number of transport workers has remained evident. This phenomenon, already present before the outbreak of the pandemic, has become even more prevalent, underscoring the need for more training for transporters and the need to establish bilateral agreements between governments. At the same time, the scarcity of resources in this area has not slowed the speed of distribution of goods, which has been three times faster than standard times, thanks to the reduction in traffic for last-mile deliveries and the easy availability of customers at their homes.

All of these elements underscore the ongoing study and change of events, the consequences of which on the entire supply chain will be highlighted at the actual conclusion of the pandemic period.

CHAPTER: 2. The methodology

The objective of this chapter is to present the analysis and structuring of the questionnaire administered, as well as the tools and methods of administration used to investigate the impacts of COVID-19 in terms of business management and fleet management for external logistics providers.

2.1 Questionnaire Theory

Some research highlights that the use of the questionnaire is one of the methods used to collect data both in a structured way through an interview and through self-completion [39].

The survey's goal is to gather measurable data from a specified group of people. The effectiveness of a survey can be estimated using the response rate, which is the number of people who actually respond to the survey, as reported in the paper "Formatting a Paper-based Survey Questionnaire: Best Practices" [40], the content of which primarily features studies conducted by social-science researcher Don Dillman [41]. In order to increase the response rate, the questionnaire has to be written and presented in a way that exploits the interest of the respondent, thus resulting in an increase in motivation. The researcher states that the degree of an individual's intention to respond to the survey is related to Social Exchange Theory, which asserts that through the activity of answering the questionnaire, respondents will feel fulfilled, satisfying some of their social needs.

Another important aspect to consider when drafting a questionnaire is the proper placement of the instructions for completing the questionnaire, so as to reduce the user's apprehension about the tasks they have to complete. This, during the completion phase, allows the respondent to focus on providing the necessary information while also improving the response rate [54].

In addition, the body of the survey is critical to extracting the information of interest from the respondents. Elements used to facilitate completion of the survey include: cover, directions, page design, question ordering, question grouping, survey path, and survey length [41, 55].

The purpose of the cover page is to attract and motivate respondents so that they are inclined to participate in the survey. To do this, it is advisable to opt for a short and simple title [41].

The guidance is useful to support the respondent in completing the survey. In this section you can include space for the respondent if they have additional questions or concerns about how to complete the survey, what the purpose of the survey is, how the study will be implemented, or what confidentiality agreements exist between the parties. For example, it is good practice to include a due date for completing the survey on the front cover, while instructions on what

to do next after completing the survey should be included on the back cover at the end of the survey. In addition, it is important that information about a question be placed in its proximity so that the respondent does not have to search for it within the document, and it is important to assess the appropriate syntactic complexity based on the target audience [41, 54, 55].

The order of the questions is another aspect that should be given particular attention, since it determines the logic of the questionnaire. Specifically, the first question is important, as it has to be simple, but at the same time distinctive of the subject matter; furthermore, it has to be easy and quick to fill out, in order to attract respondents to continue. For these reasons, it is advisable to include at the beginning of the survey a question of a personal nature, a question designed to elicit confidential information, or a question of a demographic nature [41, 54].

The order of the subsequent questions is also not random, as humankind is affected by cognitive and normative influences. Cognitive influences cause a user to try to answer the questions rationally, while normative influences refer to the influence the previous question exerts on the answer, from the human brain's unconscious attempt to balance positive and negative responses, and the influence the first answer given in the survey exerts. To minimize these effects, it is important to group questions by taking into account the appropriate variables: response methodology, so as to avoid confusion during compilation; specific content, so as to allow the respondent to focus on one topic at a time in logical order [41].

For questions that belong to the same group, i.e. the set of questions belonging to the same category, it is possible to use different colors in order to divide the different groups.

In order for a questionnaire to be considered effective, and therefore able to generate accurate and consistent data, a few main aspects have to be considered [41]:

1. What is the purpose of the questionnaire;
2. What are the high and low level topics in the questionnaire by defining a scale;
3. What is the length of the questionnaire, as if too long it may decrease the response rate, while if too short it may not be effective in obtaining consistent data.

2.2 Research Methodoloy

The first phase of the study is configured with the extraction of data of logistics companies for third parties in Piedmont through the use of the database Analisi Informatizzata delle Aziende Italiane (AIDA) which was accessed using the institutional address of the Politecnico di Torino. The research was conducted considering three different criteria:

1. Piedmont Region;
2. ATECO Code 2007;
3. Companies with available budgets for the years 2019 and 2020.

As reported on codiateco.it "*ATECO codes are alphanumeric codes that identify an economic activity. The letter indicates the macro sector, while the numbers, represent, with different degrees of detail, the subcategories*".

As mentioned above, the analysis was based on the ATECO 2007 classification, which came into force on January 1, 2008 and was approved by ISTAT (National Institute of Statistics).

The section, or rather the letter characterizing the sector, is H, which identifies companies that deal with transport and storage.

The codes included in the study are listed below:

- 49 - Land transportation and transportation by pipeline;
    - 49.2- Rail freight transportation;
    - 49.41 - Freight transportation by road;
- 50 - Sea and water transportation
    - 50.2 - Sea and coastal freight transportation;
    - 50.4 - Inland water transportation of freight;
- 51 - Air Transportation;
    - 51.21 - Freight transportation by air;
- 52 - Warehousing and transportation support activities;
    - 52.1 - Warehousing and storage;
    - 52.21.1 - Operation of freight handling centers (interports);
    - 52.24 - Goods handling;
    - 52.29.1 - Freight forwarders and customs operations agencies;
    - 52.29.2 - Transportation brokers;
- 53 - Postal and courier activities

The survey has led to the identification of 1370 companies, extracted through a Boolean search taking into account the three characteristics mentioned above. For each company has been

identified, through the contact section of their websites, a<nd associated an e-mail to which the questionnaire can be administered.

The sample obtained numbered 420 companies, from which it was possible to acquire 94 responses, achieving a response rate of 22.3%. This percentage is sufficient for the preparation of an analysis, in accordance with that obtained in similar studies, such as "*Likelihood of Participating in Mail Survey Research*" [43] for which a response rate of 25% was obtained.

2.3 The Questionnaire

The questionnaire was designed with the objective of understanding the impact that COVID-19 has had on third-party logistics service provider firms.

The survey consists of two sections:

- Section 1, includes information regarding the operator's role, size, and location of the firm. The purpose of this section is to typify the respondent and understand how firms are positioned in the market.
- Section 2, aims to capture information regarding the impact of COVID-19 on businesses and how they have changed during the pandemic. This section was written from several initial assumptions that can be viewed in the table below (**Table 2.2**)

Companies were classified into four categories based on their size, as indicated in **table 2.1** [44], according to the Commission Recommendation "Rec. 6 May 2003, No. 2003/361/EC" addressing the classification of micro, small, and medium-sized enterprises.

Business Type	Number of employees	Revenue
Micro-Enterprise	Less than 9 employees	Less than 2 Million Euros
Small Business	10-49 employees	Less than 10 Million Euros
Medium Business	50-249 employees	Less than 50 Million Euros
Big business	More than 250 employees	More than 50 Million Euros

***Table 2.1**: Company size based on number of employees and turnover [44]*

In the questionnaire, respondents were asked to indicate the **number of employees** so that the size of the firm could be identified. However, the questionnaire was administered in such a way as to ensure complete anonymity and therefore did not include any method of identifying the

firm. All questions presented multiple-choice answers, both categorical and ordinal in nature, to facilitate the completion of the survey [45].

All questions presented multiple-choice answers, both categorical and ordinal in nature, to facilitate the completion of the survey.

Questions of an ordinal nature, for which evidence was available on possible ranges of values and for which it was therefore possible to obtain a consistent ordering of responses, were evaluated using the Likert scale, defined as a psychometric technique for measuring attitude, which finds its foundation in the concept of defining positive or negative statements towards the specific object of evaluation. The sum of these ratings will be able to delineate the subject's attitude toward the object reasonably accurately [46].

In the questionnaire responses administered to companies, 5 different levels were defined: *much increased, little increased, unchanged, little decreased and much decreased.*

The categorical questions, which included an understanding of new technological implementations or percentages, were screened as completely as possible, including all the options deemed essential to obtain a thorough and complete view of the subject matter.

Underlying assumptions	Questions
The number of deliveries or pickups varied Demand from multiple customers was concentrated in a single trip	1. Was there any change in the total number of deliveries per month from 2019 to 2020?
The quantity of goods transported has varied Demand from multiple customers was concentrated in a single trip. The number of customers has varied.	2. Has there been any change in weight to volume ratio transported per month by the vehicle fleet from 2019 to 2020? This is defined as the ratio of the weight of products to the volume they occupy.
Average distances traveled by vehicles varied	3. Has there been any change in the distances traveled in a month by the vehicle fleet from 2019 to 2020?
As a result of new regulations to prevent workplace contagions, there have been slowdowns in the steps between requesting a shipment and delivering the order to the recipient	4. Have there been any changes in the average time elapsed from the time a shipment request is received until the related goods are delivered to the recipient (including loading/unloading means of

	transportation)? This always means changes from 2019 to 2020
The average size of the order has varied In order to face the emergency an increase of the final demand has been verified leading to a variation of the quantity of demand for the outsourcing service	5. Was there a change in order size, defined as the average number of units for which customer handling is required, from 2019 to 2020?
The level of service related to the correctness of the order remained constant following the emergency	6. If you had to assign a percentage to evaluate the performance of correctness of a delivery, understood as delivery without damage and without errors in the related products, in 2020 what would it be?
There have been changes in the above indicator compared to the pre-emergency situation	7. In reference to the previous question, has there been any change in the delivery accuracy indicator since 2019?
The level of service relating to the punctuality of order delivery remained constant following the emergency	8. If you had to assign a percentage to evaluate the on-time delivery performance of an order, meaning delivery occurred on time with the customer in 2020, what would it be?
There have been changes in the above indicator compared to the pre-emergency situation	9. In reference to the previous question, has there been any change in the on-time delivery indicator since 2019?
To cope with the health emergency there has been a greater final demand resulting in new investments to ensure a greater area of stock	10. Have there been any changes in the investments prepared for the increase in stock area, understood as the purchase or lease of new logistics branches, from 2019 to 2020?

Business costs have increased (e.g., fuel, highway, salaries)	11. Were there any changes in the costs incurred for pickup and delivery of goods, due to an increase in business or external costs, from 2019 to 2020?
New technology solutions for order management had to be implemented	12. Which of the following technology solutions for managing transportation services and possible third-party inventory management were implemented in 2020 as a result of the pandemic?
New technologies have allowed companies, during the period of the health emergency, to increase the level of service offered in terms of correctness, punctuality and average order processing time.	13. In reference to the previous question, the technological solutions implemented have improved performance related to: • Correctness of service provided • Punctuality of the service offered • Average order processing time
As a result of the emergency, the fleet of vehicles, with a total mass less than or equal to 3.5 tons, is varied	14. Has there been any change in the number of vehicles with a gross vehicle weight rating of 3.5 tons or less from 2019 to 2020?
As a result of the emergency, the fleet of vehicles with a mass greater than 3.5 tons varied	15. Has there been any change in the number of vehicles with a gross vehicle weight rating greater than 3.5 tons from 2019 to 2020?
Layoffs or hires have been arranged as a result of the pandemic	16. Have there been any changes in staffing levels from 2019 to 2020?

Table 2.2: *Hypotheses underlying the relative questions*

The tool used for the administration of the questionnaire was Google Forms, which allows to be able to choose and therefore draft the questions in different types and to obtain an extraction of the answers on Excel documents and an easy organization of the data collected in pie charts, very useful in a first phase of analysis to obtain a representation of the sample.

Moreover, thanks to this tool, the dissemination of the survey has been facilitated by accessing it through a link, avoiding the difficulties caused by the paper compilation of the questionnaire and shipping by courier or by sending the text via e-mail, but in pdf format.

It is possible to view the complete text of the questionnaire in the Appendix section **(Appendix 1)**.

CHAPTER 3: Analysis of the study sample

The statistical analysis of data connected to the sample extracted from the population and discussion of the same in relation to the evidence acquired from the scientific research addressed in the first chapter are the goals of the following chapter.

3.1 Concepts of statistics applied to data analysis

As reported in the book "*Statistical Methods for Experimentation*" by Vicario and Levi [47], the term "**statistical inference**" refers to the study of a representative sample of the entire population in order to make assumptions and predictions about the latter, since studying the entire population is expensive both in terms of means and time.

The sample drawn from the population has to be random and made up of elements that are unrelated to one another; in this way, each element of the sample becomes the realization, or determination, of a random variable with the same distribution as the population [48].

The **population** is the set of statistical units that have at least one characteristic in common, this can be finite or infinite, depending on the number of statistical elements that compose it, also the attribute common to the elements is generally represented by a numerical value, the elementary unit extracted from the population takes the name of **statistical unit** [49].

The **sample** corresponds to the set n (sample width, size, or numerosity) of statistical units representing the population according to the common characteristic that need to be studied [49].

The **median** is the value of the random variable that satisfies the following inequalities (1) (2):

$$P[X \leq med(X)] \geq \frac{1}{2} \; e \; P[X \geq med(X)] \geq \frac{1}{2} \qquad \textit{discreet} \qquad (1)$$

$$\int_{-\infty}^{med\,(X)} f_x(x)dx \; = \int_{med(X)}^{+\infty} f_x(x)dx \qquad \textit{continuous} \qquad (2)$$

3.2 The Kruskall-Wallis test

The Kruskal-Wallis test is a nonparametric statistical test that evaluates whether two or more samples come from the same distribution [51].

Nonparametric tests, unlike parametric tests, such as the t test, are primarily used when the sample does not follow a normal distribution and the sample size is not large (n less than 25 statistical units).

Hypothesis testing is a statistical test in which two opposing hypotheses are formulated, a null hypothesis that is tested and an alternative hypothesis that cannot be rejected at the time the null hypothesis cannot be accepted.

The hypothesis is built by defining the parameter of the population that has to be tested, defined this element it is possible to define the null hypothesis and the alternative hypothesis; moreover, it is necessary to define the level of risk α of error of first kind in which it is possible to incur, this is also called level of significance and its choice concerns also technical and economic reasons.

The test performed involves studying the null hypothesis of the test that all samples come from the same distribution, versus the alternative hypothesis that at least one sample does not belong to the same distribution. Assuming that there are k samples, each of which contains a set of values, to perform the Kruskal-Wallis test it is necessary first to classify together all the values without considering which sample they belong to. Next, it is necessary to calculate the sum of all ranks of the values within each sample, such that each sample has its own sum of ranks. If there is no equality in all values, the test statistic is (3):

$$H = \frac{12}{N(N+1)} \sum_{i=1}^{k} \frac{R_i^2}{n_i} - 3(N+1) \qquad (3)$$

where N is the total number of values in all samples, n_i is the number of values contained in the i-th sample, and R_i is the sum of ranks in the i-th sample.

Following the calculation of H, this value is, compared with the value $\chi^2_{\alpha;\, k-1}$, a value that can be found in the chi-square distribution tables, with k - 1 degrees of freedom and α as the significance level chosen for conducting the test. If (3) $H \geq \chi^2_{\alpha;\, k-1}$ the hypothesis can be rejected; if not, the hypothesis cannot be rejected.

The Kruskall-Wallis test performed in the present study involves testing the null hypothesis that the medians of each data sample were equal, against the alternative hypothesis that at least one median was different. A p-value of 5% was considered, i.e., a value below which the null

hypothesis can be rejected. It is possible to view the Kruskall - Wallis tests performed on the sample under analysis in the appendix **(Appenxid 2)**.

3.3 Sample Analysis

The questionnaire was sent to a sample of 420 companies, from which it was possible to acquire 94 responses, reaching a response rate of 22.3%. An initial analysis of the demographic data shows that 62 elements of the sample, or 66% of the 94 respondents, cover the role of "manager" within the company and 32 elements of the sample, representing 34% of the respondents, cover the role of "administrative employee" **(Chart 3.1)**.

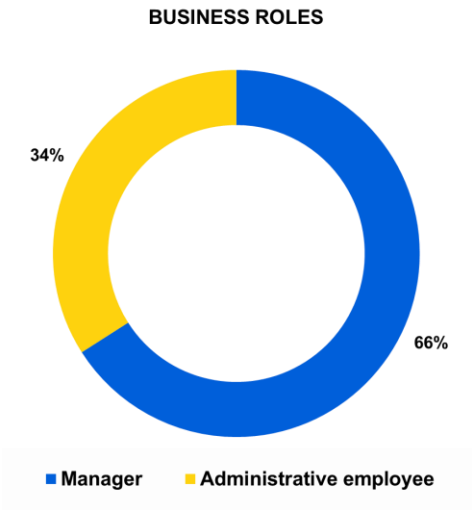

Chart 3.1: *Percentage business roles of the response sample*

The results show that 22.3% of respondents work in micro enterprises, 47.9% in small enterprises, 18.1% in medium-sized enterprises and 11.7% in large enterprises **(Chart 3.2)**.

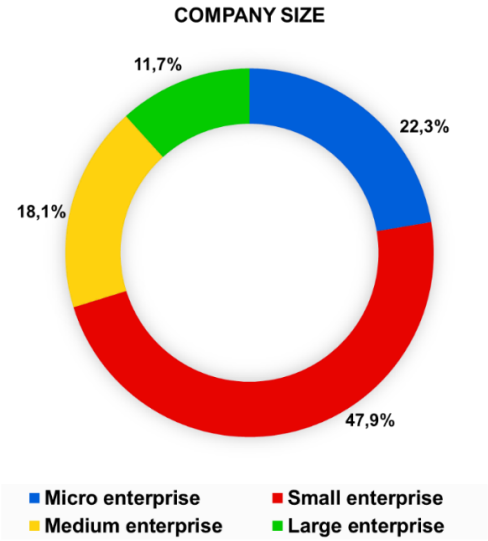

Chart 3.2: *Percentage representation of responding company types by size*

The final demographic analysis of the sample was related to the market. In fact, respondents were asked to identify the type of clientele based on the exchange relationships along the value chain, i.e., whether the service offered was Business to Business or Business to Consumer. The result obtained from the analysis of the sample turns out to be 74.5% Business to Business, understood as commercial transactions between companies, while 25.5% belong to Business to Consumer, understood as commercial transactions between a company and an individual consumer/client **(Chart 3.3).**

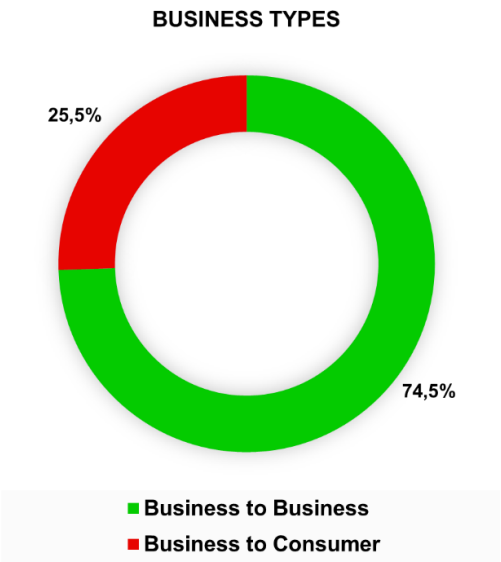

Chart 3.3: *Percentage representation of responding business types*

In terms of the **total number of deliveries per month** from 2019 to 2020, significant changes were noted for 33% of users. In contrast, 12.8% noted no change. In each case, the number of firms that observed a decrease in deliveries, presenting 17% with marginal decreases and 18.1% with substantial decreases, remains lower than the percentage of firms that reported an increase in deliveries (52.1%) **(Chart 3.4)**.

Consistent with what was previously discussed, the increase in the total number of deliveries per month can be linked to the e-commerce phenomenon. In fact, it has gone from being a transversal segment in the value of logistics, to being worth 20% of turnover for 60% of suppliers, as reported in a study by the Contract Logistics Observatory, of the Polytechnic of Milan [8].

With respect to the **load carried by the truck fleet**, in terms of weight-to-volume ratio more than half of the responding sample (52.1%) reported no change from 2019 to 2020. 14.9% reported a slight decrease, while 10.6% reported a major decrease. Conversely, 12.8% claimed a large increase, along with 9.6% who showed a slight increase **(Chart 3.5)**.

Based on the evidence gathered, for most companies, it can be assumed that the nature of shipping remained the same from 2019 to 2020.

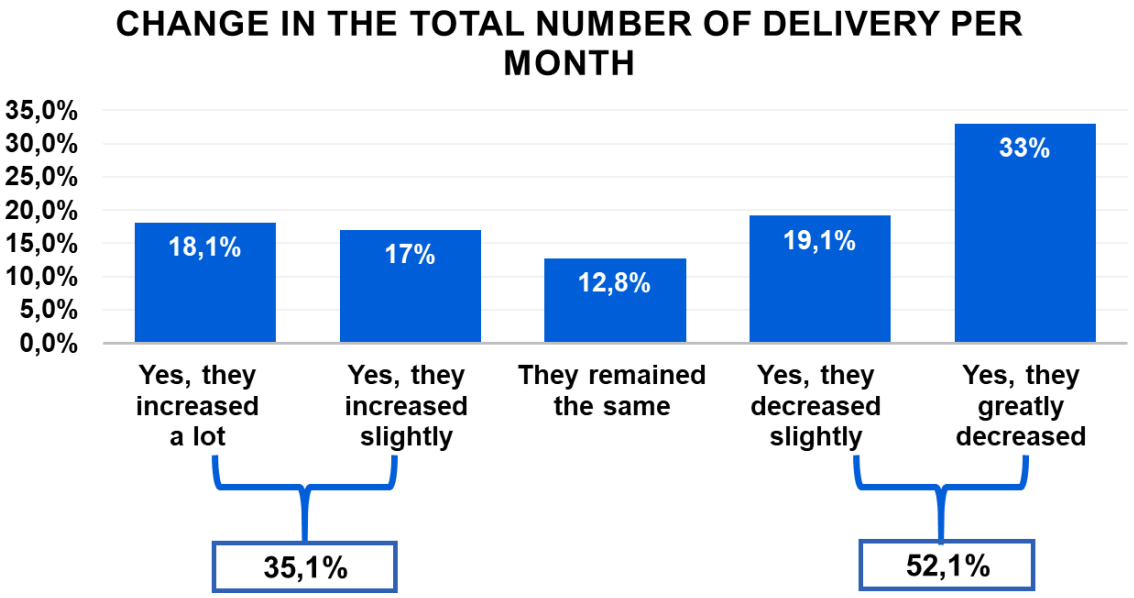

Chart 3.4: *Percentage representation of the total number of deliveries per month*

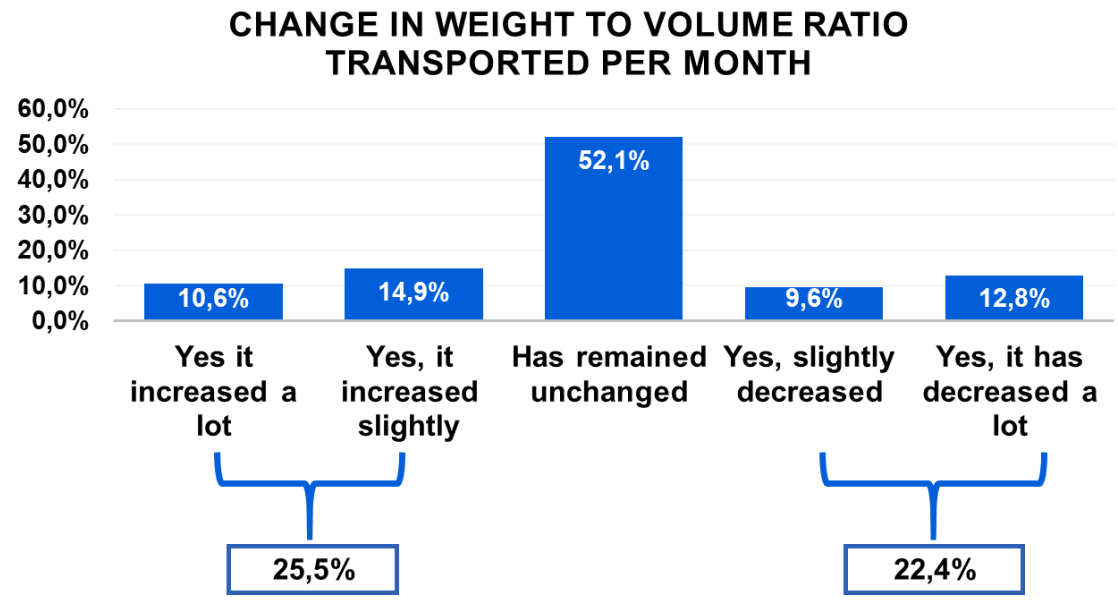

Chart 3.5: *Percentage representation of change in weight/volume transported per month from 2019 to 2020*

As can be seen in **chart 3.6**, 35.1% of respondents did not experience a change in reference to the **average distances traveled in a month** by their fleet of vehicles. However, it appears that 37.2%, broken down into 26.6% slight increase and 10.6% large increase, respectively, felt an

increase in distances traveled, compared to 27.7% who observed a decrease in distances traveled (14.9% slightly decreased, 12.8% greatly decreased).

The increase in the distances covered in a month by the fleet finds correspondence with the data on the increase in the number of orders; in fact, a greater number of deliveries corresponds to a probable increase in requests for shipment. The segment of customers who used home services, such as online shopping, actually increased considerably during the pandemic period, for example elderly people less accustomed to using e-commerce systems.

As reported in an article in Il Sole 24 Ore on March 11, 2020 (first week of lockdown), wait times for online shopping exceeded ten days, so much so that customers were limited to one order every seven days. The Coop Lombardia, in that same week, had reached an average of nine hundred orders per day, that is +90% compared to the same week of the previous year [52].

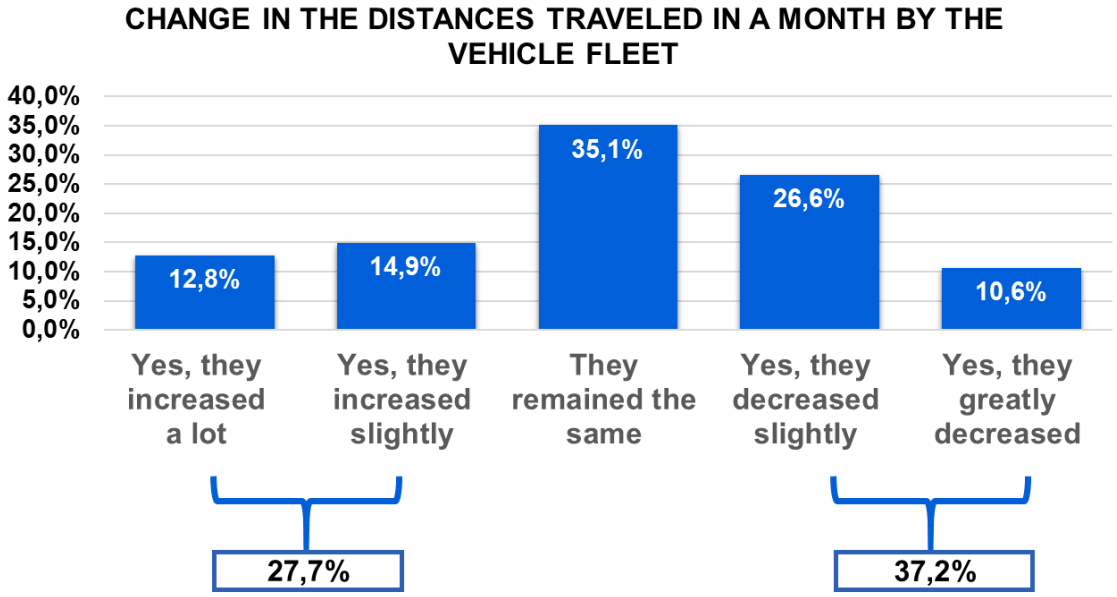

Chart 3.6: *Percentage representation of change in average distances traveled per month from 2019 to 2020*

The **average time elapsed from receipt of a shipment request to delivery of the relative goods to the recipient** (including loading/unloading of the means of transport) is unchanged for 51.1%. On the whole, 41.5% of respondents noted an increase, and it is important to highlight that of these, 17% of companies recorded a significant increase. This percentage leads to the perception that the boom in requests, due to the pandemic period, has had an impact in terms of cost and time on logistics operators, clearly suffering in the operations branch. Consistent with what has been discussed above, the restrictive measures regarding safety distances introduced following the deployment of COVID-19, such as the separation of goods

receiving and shipping areas, the division of activities into multiple shifts, and the limitation in how one driver can enter the plant at a time, have contributed to the extension of the time spent processing an order.

On the other hand, the decrease in average shipment time was not very significant, with 5.3% of respondents claiming a slight decrease and as many as 2.1% of companies reporting a large decrease **(Chart 3.7)**.

In conclusion it is possible to deduce that the objective of the logistic operators in terms of quality of service offered to the customer has been that to maintain constant the performance of the times of shipment, rather than to improve it.

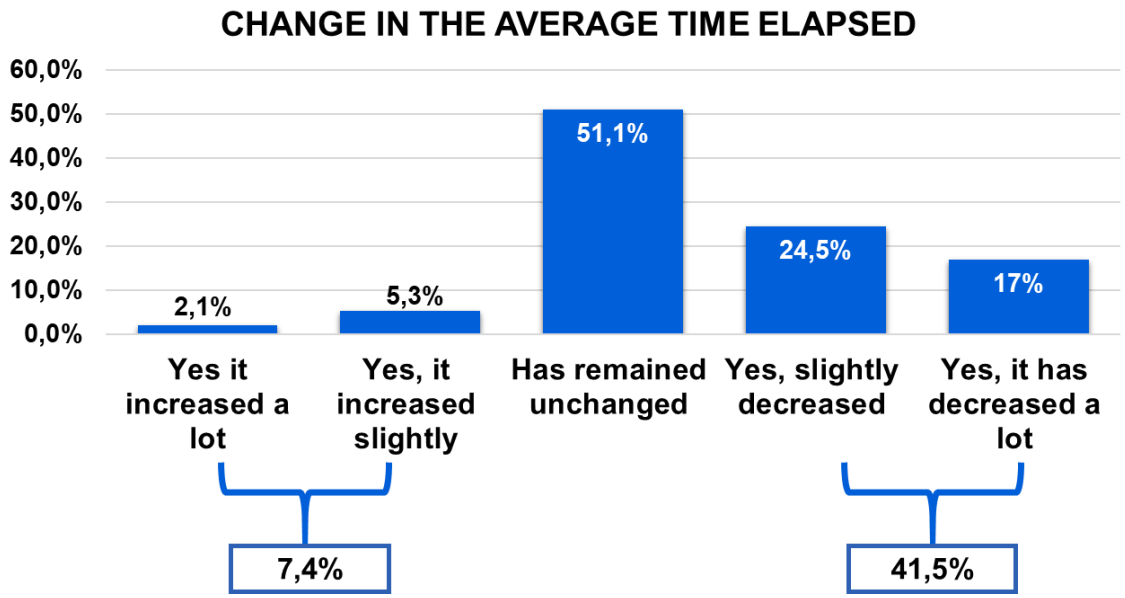

Chart 3.7: *Percentage representation of change in average time to delivery from 2019 to 2020*

As far as **order size** is concerned, understood as the average number of units for which handling by the customer is required, 30.9% of companies perceived no change, while for 14.9% it increased a great deal and for 25.5% it had a slight increase. Smaller percentages were registered, however, for a slight decrease of 20.2 percent and a large decrease of 8.5 percent (**Chart 3.8**). This substantial increase can also be linked to the phenomenon of e-commerce, which is responsible for the increase in demand for online products.

This raise in order size seems to be shared by both types of business surveyed. Considering that the total sample of the respondents is subdivided in Business to Business (B2B), that they represent 74,6% and Business to Consumer (B2C), that they represent 25,5% of the respondents, it is possible to notice from the **table 3.1** that both the types of business have had

an increase of the order dimension. In particular, the B2C has recorded a preponderant increase (54,2%) regarding the B2B that reports an increase of 35,7%. The prevalent increase by B2C may again be related to the increase in people's online purchases during the lockdown period.

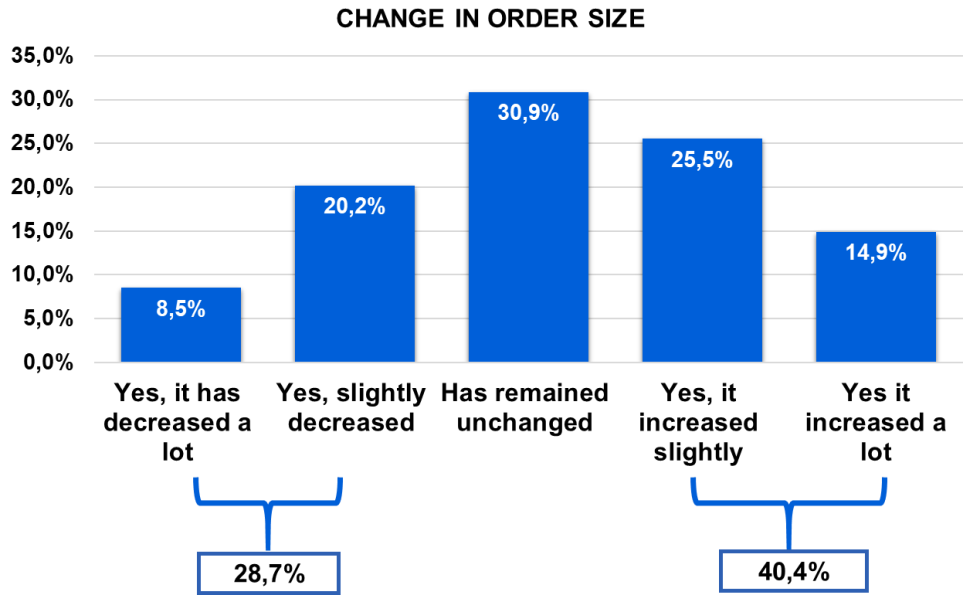

***Chart 3.8**: Percentage representation of change in order size, understood as average number of units from 2019 to 2020*

	Decrease	Unchanged	Increase	Grand Total
Business to Business	32,9%	31,4%	**35,7%**	100,0%
Business to Consumer	16,7%	29,2%	**54,2%**	100,0%

***Table 3.1:** Percentage representation of the change in order size from 2019 to 2020 by Business type of the firm*

Analyzing the size of the company, it appears that all the companies surveyed except for the small companies perceived an increase in the size of the order for the most part, recording 63.6%, representative of large companies, 41.2% of medium-sized companies and 47.6% of micro companies, respectively. In contrast, the majority of small businesses did not perceive a change (37.8%) **(Table 3.2).**

The **performance of correctness** of a delivery in 2020, understood as delivery without damage and without errors in the related products, results for the majority (56.4%) within the range of 98-100% of deliveries. While 23.4% of respondents claim to have guaranteed the correctness of delivery with between 95% and 97% of deliveries. Smaller percentages claimed to have recorded 92-94% correctness of deliveries (9.6% of the sample), and for both ranges of 89-91% of deliveries and less than 89% of deliveries, even smaller percentages (5.3%) were recorded

(Chart 3.9). Thus, it could be inferred that there was no impact from the standpoint of order correctness.In contrast, the situation in the previous year (2019) appears to have remained the same for 79.8% and for a small percentage (8.5%) appears to have decreased a lot **(Chart 3.10)**.

	Decrease	Unchanged	Increase	Grand total
Large enterprise: from 250 employees	9,1%	27,3%	**63,6%**	100,0%
Medium enterprise: from 50 to 249 employees	29,4%	29,4%	**41,2%**	100,0%
Microenterprise: up to 9 employees	33,3%	19,0%	**47,6%**	100,0%
Small business: from 10 to 49 employees	31,1%	**37,8%**	31,1%	100,0%

Table 3.2: *Percentage representation of change in order size from 2019 to 2020 by firm size*

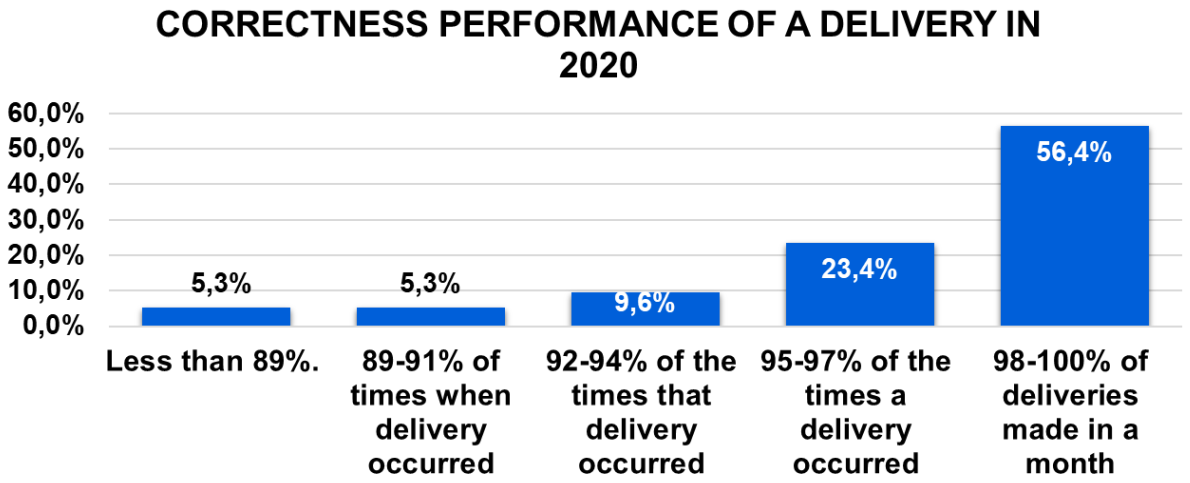

Chart 3.9*: Percentage representation of delivery correctness in 2020*

The data in aggregate **(Chart 3.11)** shows that for any percentage of correctness of service offered, the response that was most recorded related to there being no significant change in the service offered.

On the other hand, with reference to the **performance of order punctuality** in 2020, understood as delivery within the time established with the client, the majority of the sample (46.8%) affirmed that they maintained a punctuality range of 98 - 100%, followed by 27.7% with the range of 95 - 97% of deliveries and lastly 14.9% with 92 - 94%. Smaller percentages, 4.3% and 6.4% respectively, were reported for the range between 89% and 91% and for the range less than 89% **(Chart 3.12).**

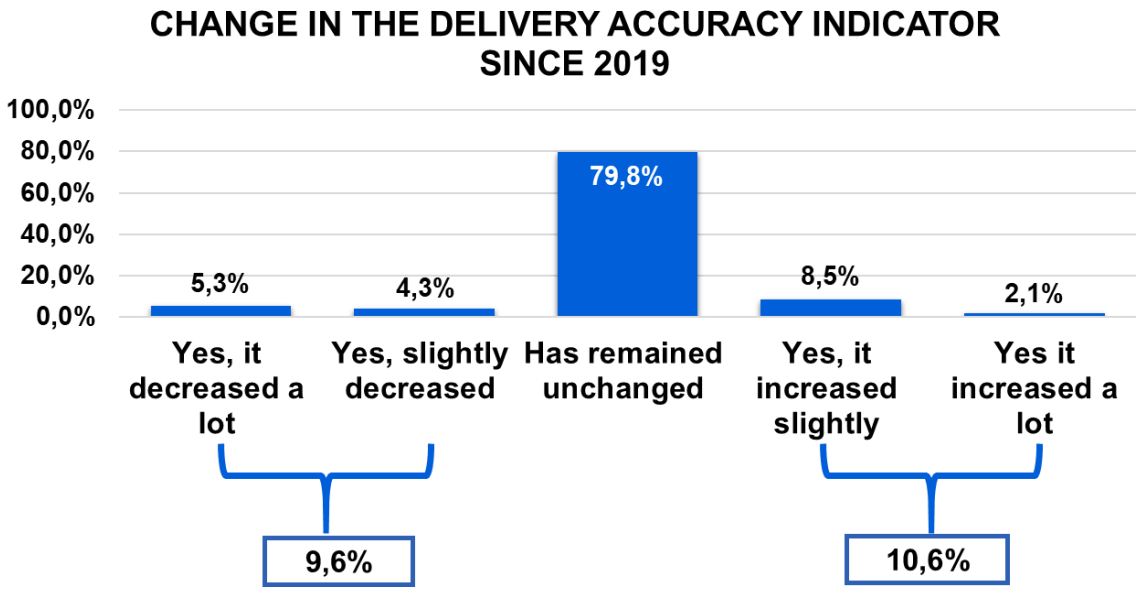

Chart 3.10: *Percentage representation of the change in the fairness indicator from 2020 to 2019*

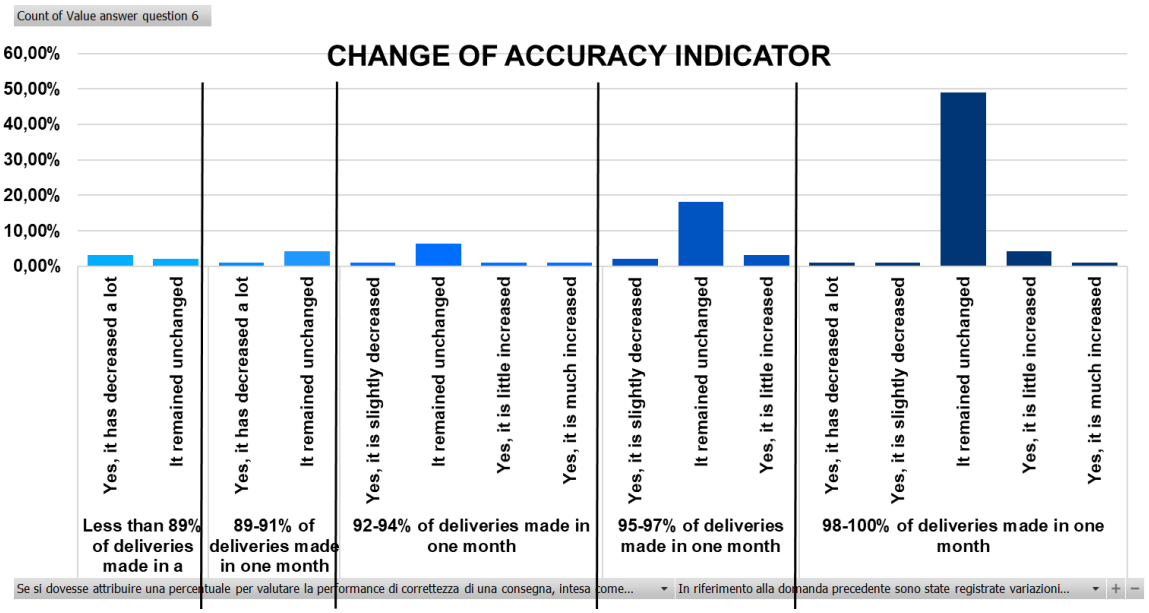

Chart 3.11: *Representation of the change in the fairness indicator from 2019 to 2020 for the various range categories*

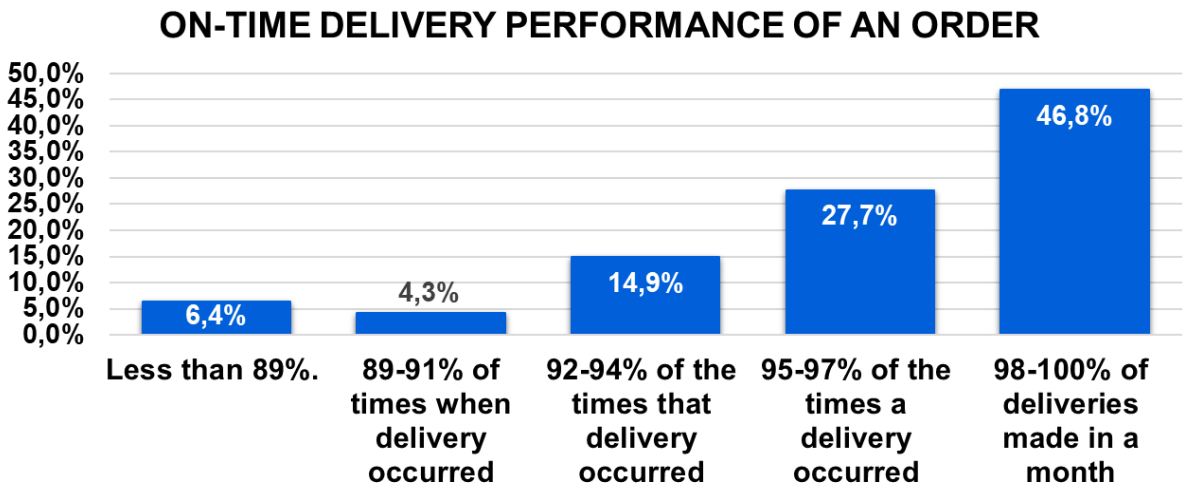

Chart 3.12: *Percentage representation of the order punctuality indicator in 2020*

The change in this data from the previous year (2019) is depicted in **Chart 3.13**. For 57.5% of the respondents, the punctuality indicator remained unchanged; for 17%, it increased slightly, and conversely, for 16%, it decreased slightly. In addition, as can be deduced from the percentages obtained there were no significant changes in the indicators, in fact only 2.1% of respondents recorded a significant increase in the variation of this indicator and only 7.4% recorded a significant decrease in the same.

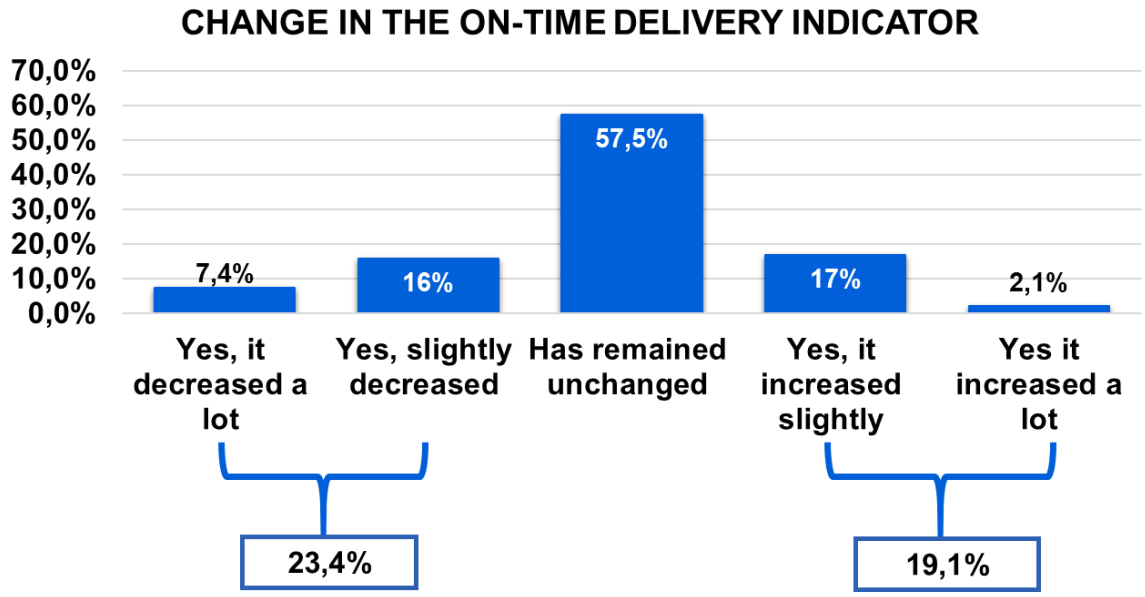

Chart 3.13: *Percentage representation of the change in the punctuality indicator from 2020*

The **chart 3.14** extension in aggregate the level of service offered in the punctuality of delivery and for every range considered they are present the recorded variations.

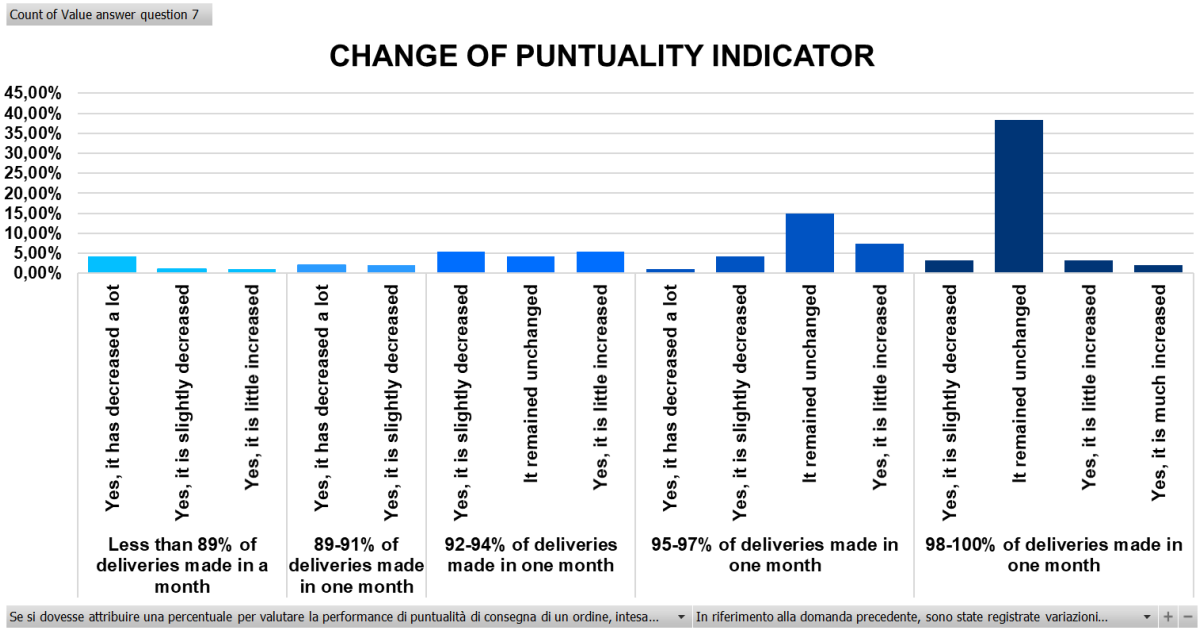

Chart 3.14: *Percentage representation of the change in the punctuality indicator from 2020 to 2019*

When analyzing **investments to increase stock areas**, it appears that for 19.1 percent of respondents they increased a lot from 2019 to 2020 and for 24.5 percent they increased slightly, reaching in aggregate a value of 43.6 percent, compared to 41.5 percent for whom they remained the same and 14.9 percent for whom they decreased (9.6 percent a lot, 5.3 percent a little) **(Chart 3.15).** It is interesting to note that for 43.6% of the companies, there has been a slight or substantial increase in investments for the expansion of the storage area. These investments can be considered medium/long term investments, as they often imply rent contracts, involving a deferment of the investment over the years. An important percentage such as 43.6%, leads to hypothesize the existence of a trend. It can be seen, similarly to the case of the delivery correctness indicator, that the variation in this value has remained unchanged.

From a cost perspective, with specific reference to the **costs incurred for the pickup and delivery** of goods, changes due to an increase in business costs or external costs from 2019 to 2020 were perceived by the majority to have increased, for 39.4% of respondents to have increased a little and for 35.1% to have increased a lot, while for 19.1% they remained the same and only 6.4% decreased **(Chart 3.16).**

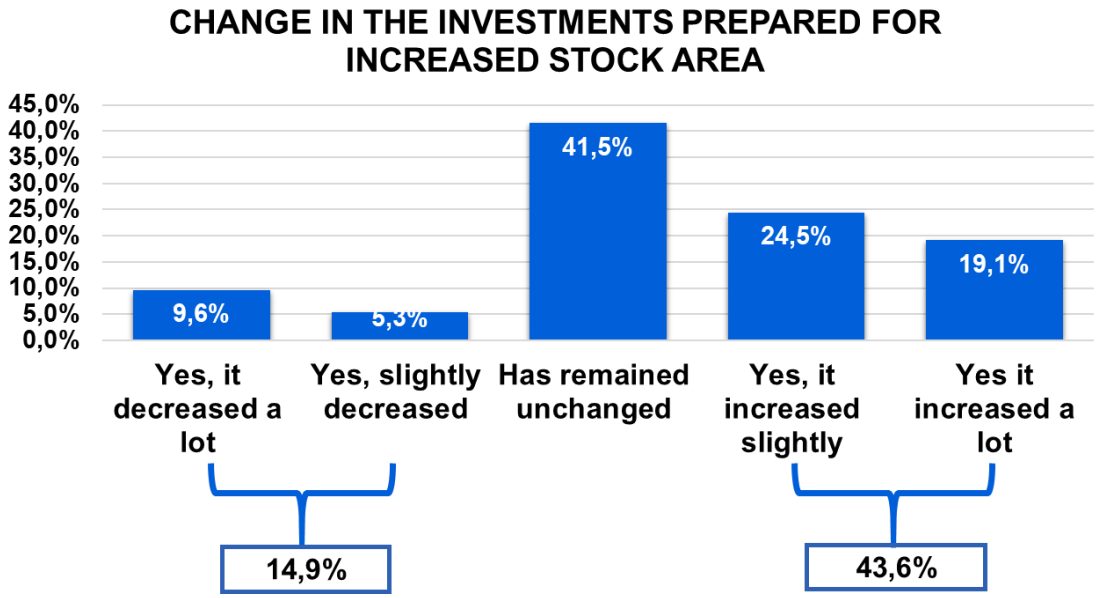

***Chart 3.15**: Percentage representation of change in investments made from 2019 to 2020 aimed at increasing stock area*

It can be hypothesized that the greater investments in stock areas, previously analyzed, have contributed to the increase in company costs. As can be seen from graphs 3.21, 3.22 and 3.23, respectively representing the change in vehicles with mass less than or equal to 3.5 tons, the change in vehicles with mass greater than 3.5 tons and the change in personnel, these have also increased and are therefore consistent with the increase in company costs.

The increase in all these factors is due to the need for companies to increase resources in various areas in order to cope with the sudden explosion in demand for goods through the e-commerce service.

In terms of the **technologies implemented in 2020** as a result of the pandemic, as can be seen in **Chart 3.17**, the Warehouse Management System (a software solution that provides visibility into the entire inventory and manages order fulfillment operations), along with the web portal for shipment management, tracking and invoicing appear to be the technologies implemented by the majority of companies (18.1%), followed by the Transportation Management System (a software system for transportation planning) with 17%, while 50% of respondents say they have not implemented any technology.

The most successful implementations are those related to order management, transportation, warehousing and the entire supply chain. Once again, this is consistent with the need for greater control over online orders and their relative increase in the pandemic period.

On the whole, the propensity to invest in new technologies seems to be reduced, evidence in agreement with the hypothesis that during the pandemic, logistics operators aimed to maintain performance rather than improve it.

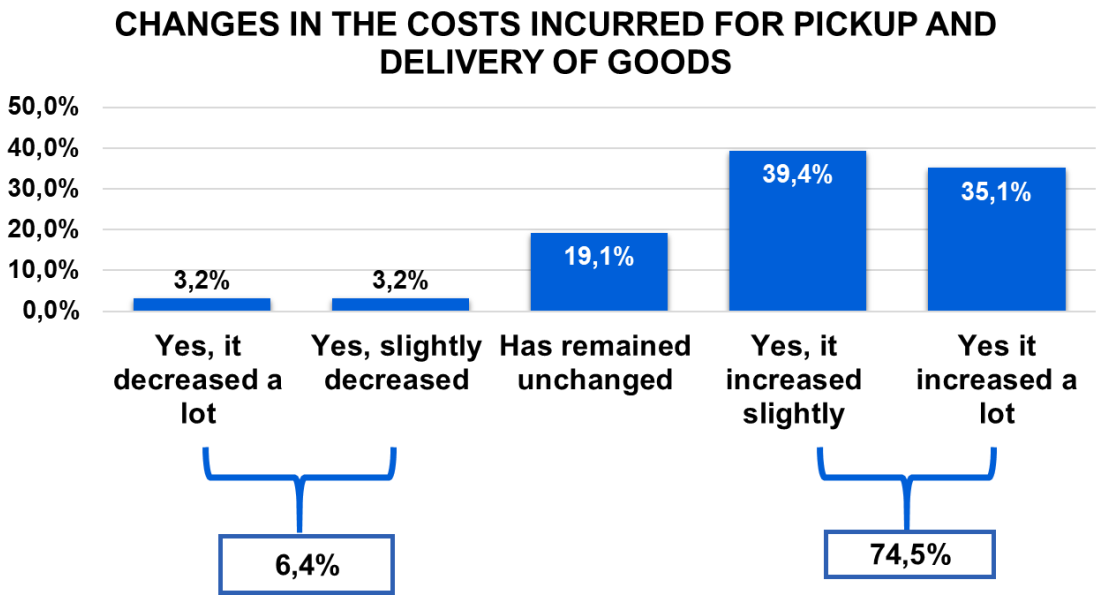

Chart 3.16: *Percentage representation of the change in the cost of delivering assets from 2019 to 2020*

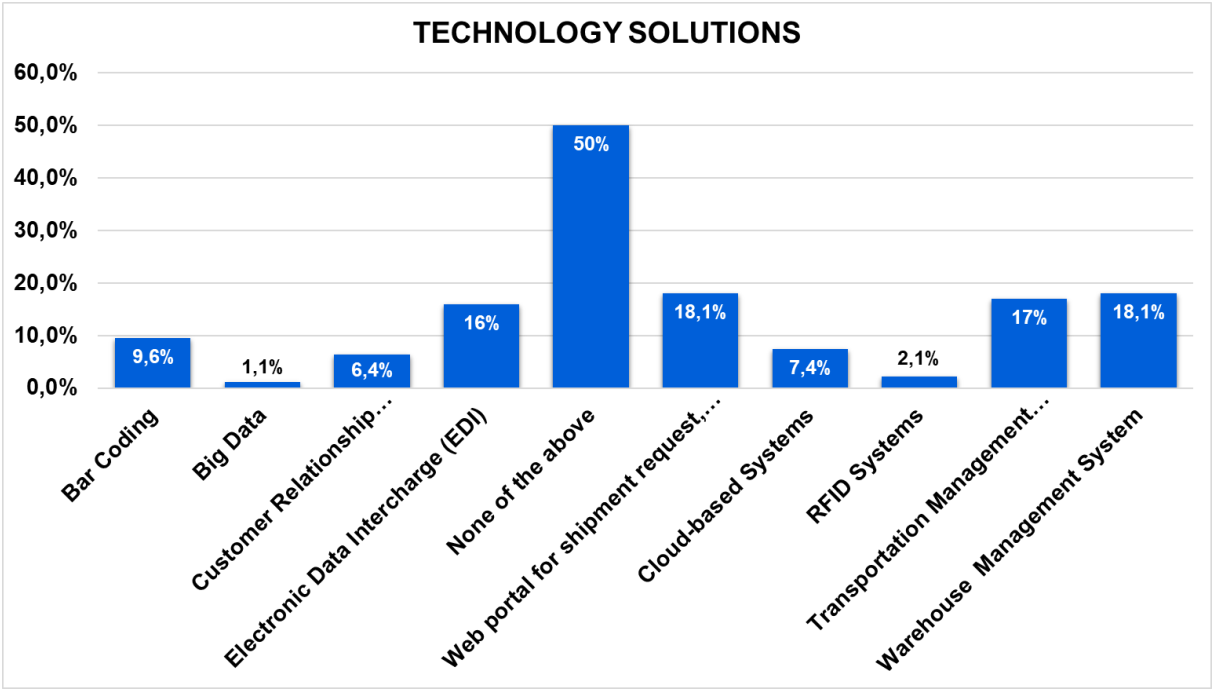

Chart 3.17: *Percentage representation of technologies implemented in 2020*

Respondents were asked to rate whether the technology implementations had improved the level of service provided to the customer.

As shown in **Figure 3.18**, for the **increase in correctness of delivery** as a result of the technology implementations, the majority of respondents (54.3%) did not notice significant changes, while the positive changes were greater than the negative ones; in fact, the responses "much increased" and "little increased" were selected by 17% and 21.3% of respondents, respectively, while, in aggregate, only 7.4% of respondents recorded the decrease in the indicator.

The fact that the majority of companies (54.3%) did not perceive a change is consistent with companies that showed in the survey that they had not implemented any new technology (50%). This leads to the inference that those who took advantage of the new technologies had a benefit in the performance of order fulfillment correctness.

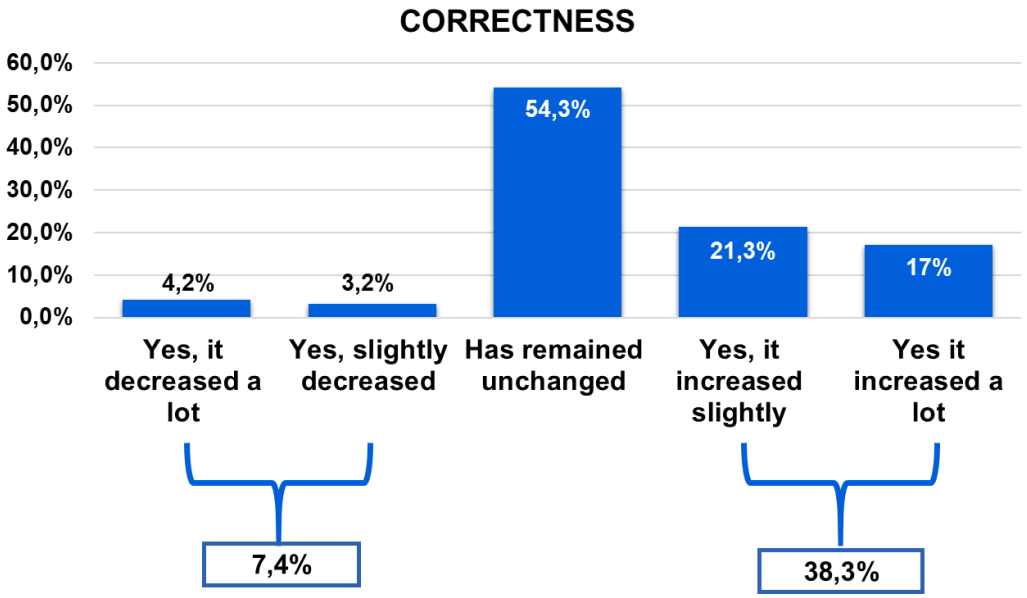

Chart 3.18: *Percentage representation of the correctness indicator as a result of the use of technologies implemented in 2020*

The level of service linked to the **punctuality** of delivery, as represented in **chart 3.19**, shows that also in this case the respondents did not notice significant variations and considered, with the same percentage obtained for the fairness indicator, that this value remained unchanged. 11.7% noted a significant increase in punctuality and 26.6% a slight increase, while, in aggregate, only 7.4% noted a decrease. Here, too, the same considerations hypothesized for the correctness indicator can be applied.

The last variation that has been considered, following the installation of the technological implementations is relative to the **average time of escape of the order**.

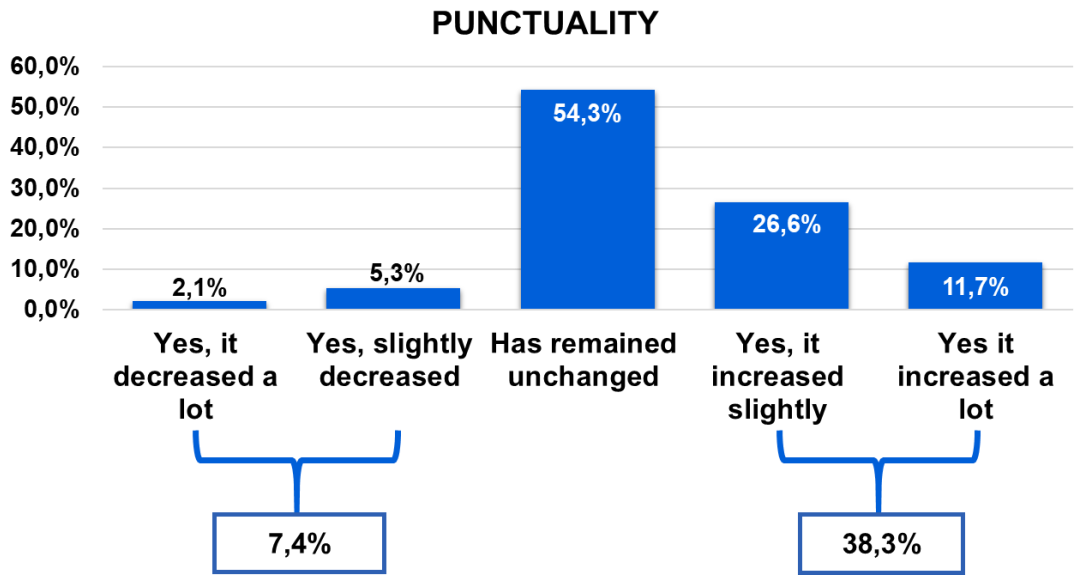

Chart 3.19: *Percentage representation of the timeliness indicator following the use of technologies implemented in 2020*

As was highlighted through **Chart 3.20** 51% of respondents experienced no change in this indicator, while 18.1% experienced a significant increase and 14.9% experienced a slight increase. Significantly, 16% of respondents reported a decrease in order processing time. The increase in order processing time, as mentioned earlier, is due to the rules imposed on health and safety in the workplace. However, it is important to note that the 16% decrease can be linked to the increase in technology implementations for transportation and warehouse management.

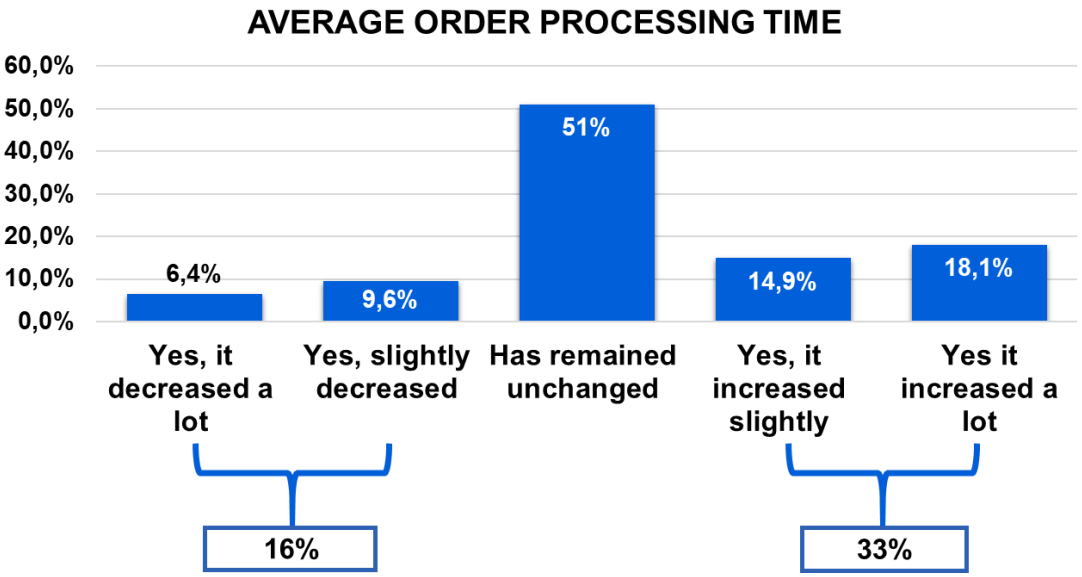

Chart 3.20: *Percentage representation of the timeliness indicator following the use of technologies implemented in 2020*

Respondents were also asked whether investments had been made in the fleet of vehicles and personnel.

With regard to **light trucks**, with a gross vehicle weight less than or equal to 3.5 tons, as shown in **Chart 3.21**, 60.6% of respondents have not made investments for this type of truck. However, the increases have been greater than the decreases; in fact, 9.6% of respondents claim to have invested a great deal in expanding their fleet of light vehicles and 22.3% claim that the number of vehicles of this type has increased little, while, in aggregate, only 7.5% claim that it has decreased. This suggests a propensity to increase the number of small vehicles. The same question was asked in order to assess changes related to **heavy trucks.**

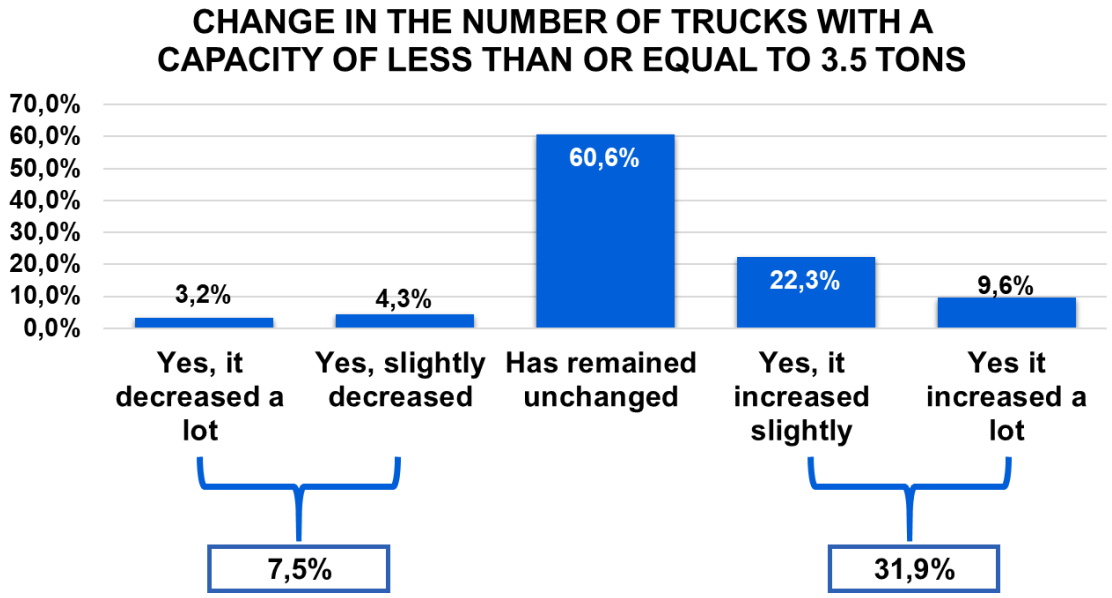

Chart 3.21: *Percentage representation of changes in vehicles with mass less than or equal to 3.5 tons*

As depicted in **Chart 3.22**, the percentages change significantly from the previous chart. In fact, less than half the respondents (40.4%) reported no change, while 12.8% claimed a substantial increase and 30.9% a slight increase.

The percentages showing a decrease are also higher: 11.7% sustained a slight decrease in the number of vehicles of this type and 4.2% sustained a significant decrease. In conclusion, the number of vehicles seems to have increased predominantly for vehicles with a total mass greater than 3.5 tons (43.7%), compared with vehicles with a mass of less than 3.5 tons, for which there was a smaller percentage increase (31.9%). In agreement with the deductions made thus far, the increase in the number of vehicles is also clear evidence of the increase in demand and the need for companies to increase the means to meet it. However, this phenomenon does not correspond

to the insufficient number of transport workers highlighted by the sector in an article in Sole 24 Ore Economy [18].

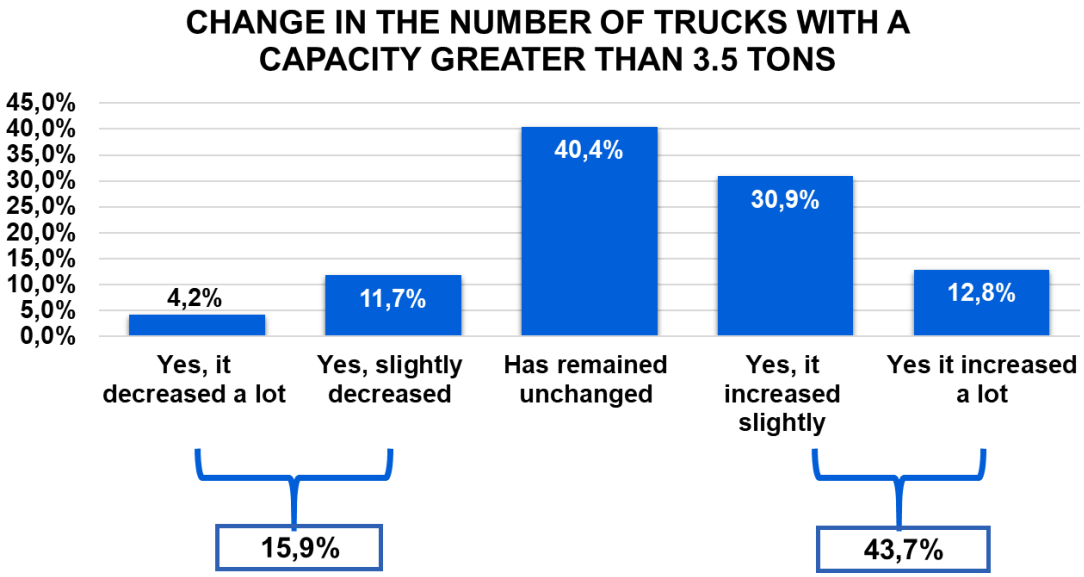

Chart 3.22: *Percentage representation of changes in vehicles with mass greater than 3.5 tons*

The **firm's workforce** did not remain unchanged in most cases, as shown in **Chart 3.23** 31.9% reported no change, while to a greater extent, 39.4% of cases reported slight positive changes in staffing levels; 11.7% reported a large increase in staffing levels, 13.8% said it had decreased slightly and only 3.2% said it had decreased a great deal.

It can be hypothesized that the increase in staffing is a result of the increased number of shifts and also from the quarantine imposed by the rules due to social distancing when coming into contact with a positive person or testing positive for the SARS-Cov-2 virus.

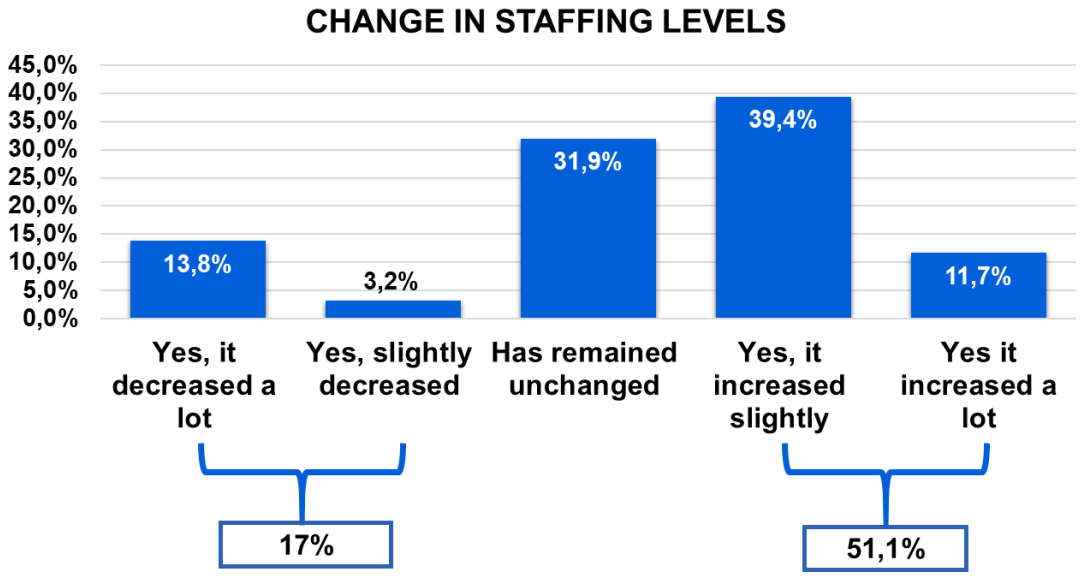

Chart 3.23: *Percentage representation of changes in staffing levels*

3.3 The Kruskall-Wallis test applied to the sample

As mentioned in paragraph 3.2, the Kruskall-Wallis test was carried out on the sample of businesses that responded to the questionnaire.

Since the answers to the questionnaire were evaluated using a Likert scale, the data obtained are qualitative, and for this reason the test was constructed taking this factor into account and working on the concept of median rather than average.

The variables on which the test was carried out, for each question involving answers constructed on a Likert scale, were: company size **(Table 3.3)**, business position of firm **(Table 3.5)** and business position occupied by the respondent **(Table 3.7).**

The null hypothesis (H_0) that all medians of the different variables could be considered equal was tested against the alternative hypothesis (H_1) that at least one median could be different. The p-value below which the null hypothesis could be rejected was 5%.

As it is possible to notice from the table 3.3 for all the tests executed on the dimension of the enterprise it is not possible to refuse the null hypothesis that the medians are equal. They turn out therefore equal for all dimensions firm the frequencies of answer to the variations, rendering evident that the obtained answers do not depend on the dimension firm and that the variations are instead to changes that have been observed in the world of the logistics during the pandemic period.

This argument, however, cannot be applied to the variation in the number of vehicles with mass less than or equal to 3.5t. For this test, it is not possible to accept the null hypothesis that all firms, regardless of size, observed the same variations. Note that in Table 3.3 the p-value associated with this test is 0.019, i.e. less than 5%, which is the limit for rejecting the null hypothesis.

In **table 3.4** it is possible to observe in detail the percentage variations in the number of vehicles with mass less than or equal to 3.5 tons with respect to the size of the firm.

As shown by the data in **Table 3.4**, the companies that have been most affected by the change in this type of vehicle are the large companies, for which there has been an increase of over 50% by respondents, followed by the medium-sized companies with 35%. These results can be traced back to a greater need for small vehicles, therefore more suited to the city, for last-mile deliveries, in order to respond to the growing demand for online shopping in the emergency period.

As far as micro and small enterprises are concerned, it can be seen that they have experienced both an increase and a decrease in this type of vehicle. The increase can be attributed to the

greater need for this type of vehicle in order to respond to the increase in the number of last-mile shipment requests. On the other hand, the decrease in this type of vehicle in small businesses can be linked to a difficulty, as already mentioned in an article in the Sole 24 Ore in paragraph 1.7 of the first chapter, entitled "Research gap", in finding substitutes for transport workers during the pandemic period. This may have caused a contraction of this type of means in small businesses that could not count on a large number of departing employees.

Question	Company size				
	Micro enterprise	Small Business	Medium enterprise	Large enterprise	p-value
Variation in the number of deliveries	4	3	4	5	0,181
Variation in weight/volume	3	3	3	3	0,8
Variation in distances covered	3	3	3	4	0,413
Variation in average shipping time	3	3	3	3	0,293
Variation in order size	3	3	3	4	0,148
Variation in correctness indicator	3	3	3	3	0,659
Variation in punctuality indicator	3	3	3	3	0,921
Variation of the investments for the increase of surface of stock	3	3	3	4	0,276
Variation in costs incurred for collection and delivery	4	4	4	4	0,135
Improvement in correctness performance	3	3	3	3	0,49
Improvement in punctuality performance	3	3	3	3	0,712
Improvement in average order processing time	3	3	3	3	0,843
Change in number of vehicles <= 3.5 t	3	3	3	4	**0,019**
Change in number of vehicles > 3.5 t	3	4	4	3	0,113
Change in number of staff	3	4	3	5	0,057

Tabella 3.3: *Output test di Kruskall-Wallis su dimensione di impresa*

	Decrease	Unchanged	Increase
Big enterprise: from 250 employees	0%	45,5%	54,5%
Medium enterprise: from 50 to 249 employees	0%	64,7%	35,3%
Small enterprise: from 10 to 49 employees	8,9%	55,6%	35,6%
Micro enterprise: until 9 employees	14,3%	76,2%	9,5%

Table 3.4: *Percentage changes in the number of vehicles with mass less than or equal to 3.5t*

As it can be observed in **table 3.5** also regarding the position of business of the enterprise it is possible to notice the null hypothesis cannot be refused, except for the case of the variation of the distances covered in a month by the fleet of vehicles.

In **Table 3.6**, it is possible to observe what variations increased, remained the same, or decreased by business location.

While firms that offered a Business to Business service equally observed an increase and decrease in distances traveled, firms that offered a Business to Consumer service in the pandemic period only experienced an increase in this variable.

In fact, as previously mentioned, there has been an increase in online orders by the end customer and an exploitation of the e-commerce service in the period of the health emergency that has led more people to exploit this type of sales channel, since the restrictions imposed the obligation to be able to move with the sole purpose of recovering food goods, forcing all stores that did not deal with items considered essential goods to close.

Question	Business type		
	Business to business	Business to consumer	p-value
Variation in the number of deliveries	3	4	0,077
Variation in weight/volume	3	3	0,127
Variation in distances covered	3	3,5	**0,033**
Variation in average shipping time	3	3	0,781
Variation in order size	3	4	0,09
Variation in correctness indicator	3	3	0,331
Variation in punctuality indicator	3	3	0,649
Variation of the investments for the increase of surface of stock	3	3	0,231
Variation in costs incurred for collection and delivery	4	4	0,971
Improvement in correctness performance	3	3	0,501
Improvement in punctuality performance	3	3	0,897
Improvement in average order processing time	3	3	0,797
Change in number of vehicles <= 3.5 t	3	3	0,132
Change in number of vehicles > 3.5 t	3	3	0,421
Change in number of staff	4	3,5	0,535

Tabella 3.5: *Output test di Kruskall-Wallis sulla posizione Business dell'impresa*

	Decrease	Unchanged	Increase
Business to Business	34,3%	32,9%	32,9%
Business to Consumer	8,3%	41,7%	50,0%

Table 3.6: *Variation percentages of the distances covered from the means*

As can be seen in the last output table **(Table 3.7)**, it is not possible to reject the null hypothesis that the median of the responses is equal for all variations based on the respondent's business role. This result shows that the data obtained did not undergo important variations based on the

role covered by the respondent within the company, but rather by the different size of the company and the business position occupied by the company.

Question	Company role		
	Director	Administrative employee	p-value
Variation in the number of deliveries	4	3	0,475
Variation in weight/volume	3	3	0,914
Variation in distances covered	3	3	0,98
Variation in average shipping time	3	3	0,597
Variation in order size	3	3,5	0,168
Variation in correctness indicator	3	3	0,711
Variation in punctuality indicator	3	3	0,656
Variation of the investments for the increase of surface of stock	3	4	0,398
Variation in costs incurred for collection and delivery	4	4	0,377
Improvement in correctness performance	3	3	0,842
Improvement in punctuality performance	3	3	0,486
Improvement in average order processing time	3	3	0,842
Change in number of vehicles <= 3.5 t	3	3	0,053
Change in number of vehicles > 3.5 t	3	3	0,113
Change in number of staff	3	4	0,767

Table 3.7: *Output test of Kruskall-Wallis company position occupied from the respondent*

CHAPTER 4: Conclusions

4.1 The Thesis Work's Advantages

The current study, which was based on a sample of responses from workers in the logistic field and was limited to the Piedmont region, provides evidence of the effects and changes that occurred throughout the pandemic era on business volumes.

The coherence with the logistic phenomena evidenced in the first chapters and present in the analyzed studies in the academic and professional circles, such as the growth of the demand in e-commerce and the necessity to respond to it, and the increase of temporary workers, emerges from the analysis of the results.

As one might expect, the Coronavirus has wreaked havoc on every industry, bending supply networks and infiltrating parts of business that are not only economic, but also social and psychological.

E-commerce has become the focal point of many activities, necessitating the involvement of third-party logistics providers in warehousing, transportation, and associated activities. The pandemic situation has altered the current purchasing process, focusing it more and more on home delivery, hurting both industrial and agri-food industries.

As a result, the findings of the study are consistent with what has been found in both academic and professional literature, assisting in the expansion of data and scope of analysis on a topic that has yet to be thoroughly explored.

4.2 Study Limitations

It might be argued that the SARS-CoV-2 virus has significantly changed people's habits, forcing businesses to adapt and respond to these changes in order to meet client expectations.

The economic and social consequences of the transmission of a pandemic-causing virus are a topic that has received little attention in recent literature, and for which there is also a paucity of evidence. Even if the virus had impacts after this period of examination, the study was limited to a two-year time span.

Furthermore, because the study would only take six months to complete, it was decided to limit the scope to third-party logistics providers based in the Piedmont region in order to complete data analysis within the timeframe required for a master's thesis.

4.3 Future Developments

The impact of the Coronavirus on the various sectors affected is a vast topic that requires more research and advanced data collection, taking into account a longer period of time, a larger geographic area, and thus a larger number of companies, in order to more accurately represent the overall population.

Qualitative hypotheses have been replaced for quantitative hypotheses since quantitative hypotheses are impossible to form with the data now available. In fact, this thesis was designed as the first qualitative layer of a larger study that may be broadened and deepened in terms of data and evidence in the future. Furthermore, the research may be improved in light of new technical developments and the benefits that these could provide organizations in terms of improving the level of service provided to customers.

Bibliography

[1] Bradimarte, Paolo e Giulio Zotteri. "Logistica di Distribuzione". Torino: C.L.U.T. Editrice, 2017.

[2] Hertz, Susanne, and Monica Alfredsson. "Strategic development of third party logistics providers." Industrial marketing management 32.2 (2003): 139-149.

[3] Evangelista, Pietro, and Edward Sweeney. "Technology usage in the supply chain: the case of small 3PLs." The International Journal of Logistics Management (2006).

[5] Aguezzoul, Aicha. "Third-party logistics selection problem: A literature review on criteria and methods." Omega 49 (2014): 69-78.

[6] Vasiliauskas, Aidas Vasilis, and Gražvydas Jakubauskas. "Principle and benefits of third party logistics approach when managing logistics supply chain." Transport 22.2 (2007): 68-72.

[9] Jayaram, Jayanth, and Keah-Choon Tan. "Supply chain integration with third-party logistics providers." International Journal of production economics 125.2 (2010): 262-271.

[10] Cheng, Liang-Chieh, and Curtis M. Grimm. "The application of empirical strategic management research to supply chain management." Journal of Business Logistics 27.1 (2006): 1-55

[11] Stank, Theodore P., et al. "Logistics service performance: estimating its influence on market share." Journal of business logistics 24.1 (2003): 27-55.

[12] Griffis, Stanley E., et al. "Aligning logistics performance measures to the information needs of the firm." Journal of business logistics 28.2 (2007): 35-56.

[13] Spencer, Michael S., Dale S. Rogers, and Patricia J. Daugherty. "JIT systems and external logistics suppliers." International Journal of Operations & Production Management (1994).

[14] Morash, Edward A., Cornelia LM Droge, and Shawnee K. Vickery. "Strategic logistics capabilities for competitive advantage and firm success." Journal of business Logistics 17.1 (1996): 1.

[15] Dapiran, Peter, et al. "Third party logistics services usage by large Australian firms." International Journal of Physical Distribution & Logistics Management (1996).

[16] Millen, Robert, et al. "Benchmarking Australian firms' usage of contract logistics services: a comparison with American and Western European practice." Benchmarking for Quality Management & Technology (1997).

[17] Lai, Kee-hung, Eric WT Ngai, and T. C. E. Cheng. "Measures for evaluating supply chain performance in transport logistics." Transportation Research Part E: Logistics and Transportation Review 38.6 (2002): 439-456

[21] Ashraf, Muhammad Hasan, et al. "Is the US 3PL industry overcoming paradoxes amid the pandemic?" The International Journal of Logistics Management (2021).

[24] Lüscher, Lotte S., and Marianne W. Lewis. "Organizational change and managerial sensemaking: Working through paradox." Academy of management Journal 51.2 (2008): 221-240.

[25] Murnighan, J. Keith, and Donald E. Conlon. "The dynamics of intense work groups: A study of British string quartets." Administrative science quarterly (1991): 165-186.

[26] Vince, Russ, and Michael Broussine. "Paradox, defense and attachment: Accessing and working with emotions and relations underlying organizational change." Organization studies 17.1 (1996): 1-21.

[27] Eisenhardt, Kathleen M., and Brian J. Westcott. "Paradoxical demands and the creation of excellence: The case of just-in-time manufacturing." (1988).

[28] Smith, W.K. and Lewis, M.W. (2011), "Toward a theory of paradox: a dynamic equilibrium model of organizing", Academy of Management Review, Vol. 36 No. 2, pp. 381-403.

[29] Taylor-Bianco, Amy, and John Schermerhorn. "Self-regulation, strategic leadership and paradox in organizational change." Journal of Organizational Change Management (2006).

[30] Ropo, Arja, and James G. Hunt. "Entrepreneurial processes as virtuous and vicious spirals in a changing opportunity structure: A paradoxical perspective." Entrepreneurship Theory and Practice19.3 (1995): 91-111.

[31] Slide Della Chiara Bruno, Caballini Claudia et al., "Sistemi di trasporto e logistica esterna", 2019-2020

[32] Hu, Xiaowen, Tristan Casey, and Mark Griffin. "You can have your cake and eat it too: Embracing paradox of safety as source of progress in safety science." Safety Science 130 (2020): 104824.

[34] McWilliams, Douglas L., Paul M. Stanfield, and Christopher D. Geiger. "The parcel hub scheduling problem: A simulation-based solution approach." Computers & Industrial Engineering 49.3 (2005): 393-412.

[35] Zhang, Dezhi, et al. "Joint optimization of logistics infrastructure investments and subsidies in a regional logistics network with CO2 emission reduction targets." Transportation Research Part D: Transport and Environment 60 (2018): 174-190

[39] Taherdoost, Hamed. "How to design and create an effective survey/questionnaire; A step by step guide." International Journal of Academic Research in Management (IJARM) 5.4 (2016): 37-41.

[40] Fanning, Elizabeth. "Formatting a paper-based survey questionnaire: Best practices." Practical Assessment, Research, and Evaluation 10.1 (2005): 12.

[41] Dillman, Don. "Constructing the questionnaire. Mail and internet surveys." (2000): 79-140.

[43] Greer, Thomas V., Nuchai Chuchinprakarn, and Sudhindra Seshadri. "Likelihood of participating in mail survey research: Business respondents' perspectives." Industrial Marketing Management 29.2 (2000): 97-109.

[45] Stehr-Green, Jeanette K., et al. "Environmental health investigations: Conducting traceback investigations." FOCUS on Field Epidemiology 3 (2005): 1-3.

[46] Joshi, Ankur, et al. "Likert scale: Explored and explained." British journal of applied science & technology 7.4 (2015): 396.

[47] Vicario, Grazia e Levi, Raffaello. “Metodi statistici per la sperimentazione”, Esculapio, Cap. 9, 2011

[48] Vicario, Grazia e Levi, Raffaello. “Metodi statistici per la sperimentazione”, Esculapio, Cap. 7, 2011

[49] Vicario, Grazia e Levi, Raffaello. “Metodi statistici per la sperimentazione”, Esculapio, Cap. 4, 2011

[50] Vicario, Grazia e Levi, Raffaello. “Metodi statistici per la sperimentazione”, Esculapio, Cap. 2, 2011

[51] Guo, Suxin, Sheng Zhong, and Aidong Zhang. "Privacy-preserving kruskal–wallis test." *Computer methods and programs in biomedicine* 112.1 (2013): 135-145.

[53] Gartner, “Gartner Identifies Nine Trends for HR Leaders That Will Impact the Future of Work After the Coronavirus Pandemic”
Url: https://www.gartner.com/en/newsroom/press-releases/2020-05-06-gartner-identifies-nine-trends-for-hr-leaders-that-wi. Visitato il: 17 marzo 22

[54] Babbie, Earl R. Survey research methods. Wadsworth, 1973

[55] Bradburn, Norman M., Seymour Sudman, and Brian Wansink. Asking questions: the definitive guide to questionnaire design--for market research, political polls, and social and health questionnaires. John Wiley & Sons, 2004

Sitography

[4] 3PL: i vantaggi di esternalizzare la logistica.
Url: https://www.mecalux.it/blog/3pl. Accessed 17 March 22

[7] "La logistica contribuisce per il 9% al Pil, serve un piano nazionale"
Url: https://www.agi.it/economia/news/2021-06-19/logistica-pesa-9-pil-serve-piano-nazionale-12969731/#:~:text=Vitamina%20E-,La%20logistica%20contribuisce%20per%20il%209,Pil%2C%20serve%20un%20piano%20nazionale&text=AGI%20%2D%20%C3%88%20un%20puzzle%20di,settore%2C%20di%20un%20tavolo%20interministeriale. Accessed 17 March 22

[8] "Logistica 4.0, in Italia giro d'affari da 86 miliardi. Digitale e green accoppiata vincente"
Url: https://www.corrierecomunicazioni.it/digital-economy/logistica-4-0-in-italia-giro-daffari-da-86-miliardi-digitale-e-green-accoppiata-vincente/ . Accessed 17 March 22

[18] Morino M., Il Sole 24 Ore Economia, La logistica resiste alla pandemia ma soffre per la carenza di autisti
Url: https://www.ilsole24ore.com/art/la-logistica-resiste-pandemia-ma-soffre-la-carenza-autisti-AEqcE4q?refresh_ce=1 Accessed 17 March 22

[19] Torresani G., Milano A., Pinto F., Accenture, Logistica Management, "I trend futuri della logistica secondo Accenture"
Url:https://www.logisticamanagement.it/it/articles/20180718/i_trend_futuri_della_logistica. Accessed 17 March 22

[20] Morino M., Il Sole 24 Ore Economia, "Effetto Covid sulla logistica: a rischio 9,6 miliardi di ricavi"
Url:https://www.ilsole24ore.com/art/effetto-covid-logistica-rischio-96-miliardi-ricavi-ADuFISE. Accessed 17 March 22

[22] "UPS mobilizes against coronavirus in collaboration with global customers and U.S. Agencies"
Url: https://about.ups.com/be/en/newsroom/press-releases/local-community-engagement/ups-mobilizes-against-coronavirus-in-collaboration-with-global-customers-and-u-s-agencies.html Accessed 17 March 22

[23] "UPS healthcare announces UPS premier"
Url:https://www.globenewswire.com/news-release/2020/05/28/2040252/0/en/UPS-Healthcare-Announces-UPS-Premier.html. Accessed 17 March 22

[33] Smith, L., 2020 "Tips for HR in the supply chain and logistics industries post-COVID"
Url: https://hrdailyadvisor.blr.com/2020/09/02/tips-for-hr-in-the-supply-chain-and-logistics-industries-post-covid/. Vis Accessed 17 March 22

[36] Garrett, K., (2020) "How COVID-19 is redefining the logistics workforce"
Url: https://www.supplychainbrain.com/blogs/1-think-tank/post/32162-temp-to-perm-how-covid-19-is-redefining-the-logistics-workforce. Accessed 17 March 22

[37] Logistica Management, “Supply Chain Post Covid-19: alcuni scenari possibili”, https://www.logisticamanagement.it/it/articles/20200917/supply_chain_post_covid_19_alcuni_scenari_possibili. Accessed 17 March 22

[38] “Covid 19 e i suoi effetti sulla logistica, li ha studiati DHL”
Url:https://www.euromerci.it/le-notizie-di-oggi/covid-19-e-suoi-effetti-sulla-logistica-li-ha-studiati-dhl.html. Accessed 17 March 22

[42] “Codici ateco”
Url: https://www.codiceateco.it/sezione?q=H. Accessed 17 March 22

[44] “Racc. 6 maggio 2003, n. 2003/361/CE”. Raccomandazione della Commissione relativa alla definizione delle microimprese, piccole e medie imprese
Url: https://www.cliclavoro.gov.it/normative/raccomandazione_06_05_2003_n.2003-361_ce.pdf. Accessed 17 March 22

[52] Il sole 24 ore, “Coronavirus, è boom di spesa online con consegna a domicilio”
Url: https://www.ilsole24ore.com/art/coronavirus-e-boom-spesa-online-consegna-domicilio-AD3rKdC. Accessed 17 March 22

[56] Jones, J. (2020), “6 ways a 3PL can help mitigate risk in the wake of COVID-19”
Url: https:// multichannelmerchant.com/blog/6-ways-3pl-help-mitigate-risk-in-the-wake-of-covid-19/ Accessed 17 March 22

Figure Index

FIGURE 1. 1: PL CLASSIFICATION PYRAMID [31] 4
FIGURE 1. 2: LOGISTICS INDUSTRY GROWTH FROM 2009 TO 2021 [8] 5

Table Index

TABLE 1.1: MACRO CATEGORIES OF VARIABLES USED FOR 3PL SELECTION [5] 8
TABLE 2.1: COMPANY SIZE BASED ON NUMBER OF EMPLOYEES AND TURNOVER [44] 19
TABLE 2.2: ASSUMPTIONS UNDERLYING THE RELATED QUESTIONS 22

TABLE 3. 1: PERCENTAGE REPRESENTATION OF THE CHANGE IN ORDER SIZE FROM 2019 TO 2020 BY TYPE OF BUSINESS OF THE COMPANY 29
TABLE 3. 2: PERCENTAGE REPRESENTATION OF CHANGE IN ORDER SIZE FROM 2019 TO 2020 BY FIRM SIZE 31
TABLE 3. 3: KRUSKALL-WALLIS OUTPUT TEST ON ENTERPRISE SIZE 42
TABLE 3. 4: PERCENTAGE CHANGES IN THE NUMBER OF VEHICLES WITH MASS LESS THAN OR EQUAL TO 3.5T 43
TABLE 3. 5: OUTPUT TEST OF KRUSKALL-WALLIS ON THE BUSINESS POSITION OF THE COMPANY 44
TABLE 3. 6: PERCENTAGE CHANGE IN DISTANCES COVERED BY VEHICLES 44
TABLE 3. 7: OUTPUT KRUSKALL-WALLIS TEST COMPANY POSITION OCCUPIED BY RESPONDENT 45

Chart Index

CHART 3. 1: COMPANY ROLES PERCENTAGE OF SAMPLE RESPONSES 25
CHART 3. 2: PERCENTAGE REPRESENTATION OF RESPONDING COMPANY TYPES BY SIZE 25
CHART 3. 3: PERCENTAGE REPRESENTATION OF RESPONDING BUSINESS TYPES 26
CHART 3. 4: PERCENTAGE REPRESENTATION OF THE TOTAL NUMBER OF DELIVERIES PER MONTH 27
CHART 3. 5: PERCENTAGE REPRESENTATION OF CHANGE IN WEIGHT/VOLUME TRANSPORTED PER MONTH FROM 2019 TO 2020 27
CHART 3. 6: PERCENTAGE REPRESENTATION OF THE CHANGE IN AVERAGE DISTANCES TRAVELED PER MONTH FROM 2019 TO 2020 28
CHART 3. 7: PERCENTAGE REPRESENTATION OF CHANGE IN AVERAGE TIME TO DELIVERY FROM 2019 TO 2020 29
CHART 3. 8: PERCENTAGE REPRESENTATION OF THE CHANGE IN ORDER SIZE, UNDERSTOOD AS THE AVERAGE NUMBER OF UNITS FROM 2019 TO 2020 30
CHART 3. 9: PERCENTAGE REPRESENTATION OF CORRECTNESS OF DELIVERIES IN 2020 31
CHART 3. 10: PERCENTAGE REPRESENTATION OF THE CHANGE IN THE FAIRNESS INDICATOR FROM 2020 TO 2019 32
CHART 3. 11: REPRESENTATION OF THE CHANGE IN THE FAIRNESS INDICATOR FROM 2019 TO 2020 FOR THE VARIOUS RANGE CATEGORIES 32
CHART 3. 12: PERCENTAGE REPRESENTATION OF THE ORDER PUNCTUALITY INDICATOR IN 2020 33
CHART 3. 13: PERCENTAGE REPRESENTATION OF THE CHANGE IN THE PUNCTUALITY INDICATOR FROM 2020 TO 2019 33
CHART 3. 14: PERCENTAGE REPRESENTATION OF THE CHANGE IN THE PUNCTUALITY INDICATOR FROM 2020 TO 2019 34
CHART 3. 15: PERCENTAGE REPRESENTATION OF THE CHANGE IN INVESTMENTS MADE FROM 2019 TO 2020 AIMED AT INCREASING STOCK ACREAGE 35
CHART 3. 16: PERCENTAGE REPRESENTATION OF THE CHANGE IN ASSET DELIVERY COSTS FROM 2019 TO 2020 36
CHART 3. 17: PERCENTAGE REPRESENTATION OF TECHNOLOGIES IMPLEMENTED IN 202 36
CHART 3. 18: PERCENTAGE REPRESENTATION OF THE CORRECTNESS INDICATOR FOLLOWING THE USE OF TECHNOLOGIES IMPLEMENTED IN 2020 37
CHART 3. 19: PERCENTAGE REPRESENTATION OF THE ON-TIME INDICATOR FOLLOWING THE USE OF TECHNOLOGIES IMPLEMENTED IN 2020 38
CHART 3. 20: PERCENTAGE REPRESENTATION OF THE ON-TIME INDICATOR FOLLOWING THE USE OF TECHNOLOGIES IMPLEMENTED IN 2020 38
CHART 3. 21: PERCENTAGE REPRESENTATION OF CHANGES IN VEHICLES WITH MASS LESS THAN OR EQUAL TO 3.5 TONS 39

CHART 3. 22: PERCENTAGE REPRESENTATION OF CHANGES IN VEHICLES WITH MASS GREATER THAN 3.5 TONS 40
GRAFICO 3. 23: PERCENTAGE REPRESENTATION OF CHANGES IN STAFFING LEVELS 40

Appendix

Appendix 1: Questionnaire administered to companies

Empirical investigation: the impacts of Covid-19 on logistics operators in Piedmont

Dear Sir,

we are Benedetta La Rosa and Erica Zuccarelli, two Master's students of Management Engineering at the Polytechnic of Turin.
We would like to ask for your precious collaboration in writing our thesis project on the impacts of the COVID-19 pandemic on logistics operators, carried out in collaboration with Prof. Mangano and Prof. Cagliano of the Department of Management and Production Engineering.
The objective of this thesis project is to understand how the pandemic has affected the logistics industry.
Therefore, we are asking for your opinion as a representative of a company with established experience and reputation in the logistics services sector.
The questionnaire consists of 22 questions, divided into 2 sections, with multiple choice answers. Filling it in takes about 10 minutes. The data collected from the survey will be treated with the strictest confidence, in total anonymity and in compliance with the legislation on the protection of statistical confidentiality and protection of personal data.
Please do not hesitate to contact us if you have any inquiries about completing the questionnaire or the objectives of the study.
We trust that your answers will allow us to have a more complete and conscious vision of the changes created by the pandemic; for this reason, we thank you in advance.

Best regards,
Benedetta La Rosa e Erica Zuccarelli

Contacts:

Benedetta La Rosa
E-mail: s279788@studenti.polito.it
Phone: +39 3482725043

Erica Zuccarelli
E-mail: s267663@studenti.polito.it
Phone: +39 3408854928

Demographic information

1. Company position (hence your position within the Company):
   - Warehouse operator
   - Administrative employee
   - Executive

2. Business Enterprise position:
   - Business to Business, understood as the commercial transactions between enterprises
   - Business to Consumer, understood as commercial transactions between a business and a consumer/individual customer

3. Number of Employees:
   - Micro enterprise: up to 9 employees
   - Small enterprise: from 10 to 49 employees
   - Medium enterprise: 50 to 249 employees
   - Large enterprise: from 250 employees

Impacts of COVID-19

4. Has there been any change in the total number of deliveries per month from 2019 to 2020?
- Yes, they have increased a lot
- Yes, they have increased slightly
- They have remained the same
- Yes, they have decreased slightly
- Yes, they have greatly decreased

5. Has there been any change in weight to volume ratio transported per month by the vehicle fleet from 2019 to 2020? This is defined as the ratio of the weight of products to the volume they occupy.
- Yes, it has increased a lot
- Yes, it has increased slightly
- Has remained unchanged
- Yes, slightly decreased
- Yes, it has decreased a lot

6. Has there been any change in the distances traveled in a month by the vehicle fleet from 2019 to 2020?
- Yes, they have increased a lot
- Yes, they have increased slightly
- They have remained the same
- Yes, they have decreased slightly
- Yes, they have greatly decreased

7. Has there been any change in the average time elapsed from the time a shipment request is received until it is received by the client (including loading/unloading transports)? Always mean changes from 2019 to 2020
- Yes, it has increased a lot
- Yes, it has increased slightly
- Has remained unchanged
- Yes, slightly decreased
- Yes, it has decreased a lot

8. Was there a change in order size, defined as the average number of units for which customer handling is required, from 2019 to 2020?
- Yes, it has increased a lot
- Yes, it has increased slightly
- Has remained unchanged
- Yes, it has slightly decreased
- Yes, it has decreased a lot

9. If you had to assign a percentage to evaluate the correctness performance of a delivery in 2020, understood as delivery without damage and without errors in the related products, what would it be?
- 98-100% of deliveries made in a month
- 95-97% of the times a delivery occurred
- 92-94% of the times that delivery occurred
- 89-91% of times when delivery occurred
- Less than 89%

10. In reference to the previous question, has there been any change in the **delivery accuracy indicator** since 2019?
- Yes, it has increased a lot
- Yes, it has increased slightly
- It has remained unchanged
- Yes, it has decreased slightly

- Yes, it has greatly decreased

11. If you had to assign a percentage to evaluate the on-time delivery performance of an order, defined as delivery made on time with the customer in 2020, what would it be?
- 98-100% of deliveries made in a month
- 95-97% of the times a delivery occurred
- 92-94% of the times delivery occurred
- 89-91% of the times delivery occurred
- Less than 89%

12. In reference to the previous question, has there been any change in the **on-time delivery indicator** since 2019?
- Yes, it has increased a lot
- Yes, it has increased slightly
- Has remained unchanged
- Yes, it has slightly decreased
- Yes, it has decreased a lot

13. Has there been any change in the investments prepared for increased stock area, understood as the purchase or lease of new logistics branches, from 2019 to 2020?
- Yes, they have increased a lot
- Yes, they have increased slightly
- Have remained unchanged
- Yes, they have decreased slightly
- Yes, they have decreased a lot

14. Have there been any changes in the costs incurred for pickup and delivery of goods, due to an increase in business or external costs, from 2019 to 2020?
- Yes, they have increased a lot
- Yes, they have increased slightly
- They have remained the same
- Yes, they have decreased slightly
- Yes, they have greatly decreased

15. Have been implemented technology solutions to manage transportation services and any third-party inventory management from 2019-2020?
- Transportation Management System: software system for transportation planning
- Warehouse Management System: software solution that provides visibility of the entire inventory and manages order fulfillment operations
- Web portal for shipment requests, order tracking and invoicing
- Bar Coding: label systems for data collection
- Customer Relationship Management: Software system for managing all of a company's relationships and interactions with potential and existing customers
- Electronic Data Interchange (EDI): a standard electronic format that replaces paper documents such as purchase orders and invoices.
- Big Data
- Cloud-based systems
- RFID systems

16. With reference to the previous question, the technological solutions implemented have improved performance in relation to

	Much decreased	Slightly decreased	Unchanged	Slightly increased	Much increased

The correctness of the service offered	o	o	o	o	o
The punctuality of the service offered	o	o	o	o	o
The average time to process an order	o	o	o	o	o

17. Has there been any change in the number of vehicles with a capacity of less than or equal to 3.5 tons from 2019 to 2020?
- o Yes, it has increased a lot
- o Yes, it has increased slightly
- o Has remained unchanged
- o Yes, slightly decreased
- o Yes, it has decreased a lot

18. Has there been any change in the number of vehicles with a capacity greater than 3.5 tons from 2019 to 2020?
- o Yes, it has increased a lot
- o Yes, it has increased slightly
- o Has remained unchanged
- o Yes, slightly decreased
- o Yes, it has decreased a lot

19. Has there been any change in staffing levels from 2019 to 2020?
- o Yes, it has increased a lot
- o Yes, it has increased slightly
- o Has remained unchanged
- o Yes, slightly decreased
- o Yes, it has decreased a lot

Thank you for your cooperation, we wish you a good day.

Appendix 2: Test di Kruskall-Wallis

OUTPUT_ VARIATION IN THE NUMBER OF DELIVERIES_COMPANY SIZE

Descriptive Statistics

Number of employees	N	Median	Mean Rank	Z-Value
Large enterprise: from 250 employees	11	5	62,5	1,94
Medium enterprise: from 50 to 249 employees	17	4	49,9	0,41
Micro enterprise: up to 9 employees	21	4	47,0	-0,10
Small enterprise: from 10 to 49 employees	45	3	43,2	-1,48
Overall	94		47,5	

Test

Null hypothesis		H_0: All medians are equal	
Alternative hypothesis		H_1: At least one median is different	
Method	**DF**	**H-Value**	**P-Value**
Not adjusted for ties	3	4,61	0,203
Adjusted for ties	3	4,88	0,181

OUTPUT_ CHANGE IN THE NUMBER OF DELIVERIES_TYPE OF BUSINESS ENTERPRISE

Descriptive Statistics

Type of Business Enterprise	N	Median	Mean Rank	Z-Value
Business to Business	70	3	44,7	-1,72
Business to Consumer	24	4	55,8	1,72
Overall	94		47,5	

Test

Null hypothesis		H_0: All medians are equal	
Alternative hypothesis		H_1: At least one median is different	
Method	**DF**	**H-Value**	**P-Value**
Not adjusted for ties	1	2,95	0,086
Adjusted for ties	1	3,12	0,077

OUTPUT_ CHANGE IN THE NUMBER OF DELIVERIES_COMPANY ROLE

Descriptive Statistics

Corporate Role	N	Median	Mean Rank	Z-Value
Executive	62	4	48,9	0,69
Administrative employee	32	3	44,8	-0,69
Overall	94		47,5	

Test

Null hypothesis		H_0: All medians are equal	
Alternative hypothesis		H_1: At least one median is different	
Method	**DF**	**H-Value**	**P-Value**
Not adjusted for ties	1	0,48	0,488
Adjusted for ties	1	0,51	0,475

OUTPUT_ WEIGHT/VOLUME VARIATION _ COMPANY SIZE

Descriptive Statistics

Number of employees	N	Median	Mean Rank	Z-Value
Large enterprise: from 250 employees	11	3	49,7	0,29
Medium enterprise: from 50 to 249 employees	17	3	52,1	0,77
Micro enterprise: up to 9 employees	21	3	47,3	-0,04
Small enterprise: from 10 to 49 employees	45	3	45,3	-0,75
Overall	94		47,5	

Test

Null hypothesis		H_0: All medians are equal	
Alternative hypothesis		H_1: At least one median is different	
Method	**DF**	**H-Value**	**P-Value**
Not adjusted for ties	3	0,85	0,836
Adjusted for ties	3	1,00	0,800

OUTPUT_ WEIGHT/VOLUME VARIATION _ TYPE OF BUSINESS ENTERPRISE

Descriptive Statistics

Type of Business Enterprise	**N**	**Median**	**Mean Rank**	**Z-Value**
Business to Business	70	3	45,2	-1,41
Business to Consumer	24	3	54,3	1,41
Overall	94		47,5	

Test

Null hypothesis		H_0: All medians are equal	
Alternative hypothesis		H_1: At least one median is different	
Method	**DF**	**H-Value**	**P-Value**
Not adjusted for ties	1	1,99	0,159
Adjusted for ties	1	2,33	0,127

OUTPUT_ WEIGHT/VOLUME VARIATION _ CORPORATE ROLE

Descriptive Statistics

Corporate Role	**N**	**Median**	**Mean Rank**	**Z-Value**
Executive	62	3	47,7	0,10
Administrative employee	32	3	47,1	-0,10
Overall	94		47,5	

Test

Null hypothesis		H_0: All medians are equal	
Alternative hypothesis		H_1: At least one median is different	
Method	**DF**	**H-Value**	**P-Value**
Not adjusted for ties	1	0,01	0,921
Adjusted for ties	1	0,01	0,914

OUTPUT_ VARIATION OF DISTANCES _ COMPANY SIZE

Descriptive Statistics

Numero dipendenti	**N**	**Median**	**Mean Rank**	**Z-Value**
Number of employees	11	4	58,7	1,45
Large enterprise: from 250 employees	17	3	50,3	0,46
Medium enterprise: from 50 to 249 employees	21	3	43,7	-0,72
Micro enterprise: up to 9 employees	45	3	45,5	-0,69
Small enterprise: from 10 to 49 employees	94		47,5	

Test

Null hypothesis		H_0: All medians are equal	
Alternative hypothesis		H_1: At least one median is different	
Method	**DF**	**H-Value**	**P-Value**
Not adjusted for ties	3	2,67	0,445
Adjusted for ties	3	2,87	0,413

OUTPUT_ VARIATION OF DISTANCES _ TYPE OF BUSINESS ENTERPRISE

Descriptive Statistics

Type of Business Enterprise	N	Median	Mean Rank	Z-Value
Business to Business	70	3,0	44,1	-2,06
Business to Consumer	24	3,5	57,4	2,06
Overall	94		47,5	

Test

Null hypothesis		H_0: All medians are equal	
Alternative hypothesis		H_1: At least one median is different	
Method	**DF**	**H-Value**	**P-Value**
Not adjusted for ties	1	4,22	0,040
Adjusted for ties	1	4,53	0,033

OUTPUT_ VARIATION OF DISTANCES _ CORPORATE ROLE

Descriptive Statistics

Corporate Role	N	Median	Mean Rank	Z-Value
Executive	62	3	47,5	-0,02
Administrative employee	32	3	47,6	0,02
Overall	94		47,5	

Test

Null hypothesis		H_0: All medians are equal	
Alternative hypothesis		H_1: At least one median is different	
Method	**DF**	**H-Value**	**P-Value**
Not adjusted for ties	1	0,00	0,981
Adjusted for ties	1	0,00	0,980

OUTPUT_ VARIATION IN AVERAGE SHIPPING TIME _ COMPANY SIZE

Descriptive Statistics

Number of employees	N	Median	Mean Rank	Z-Value
Large enterprise: from 250 employees	11	3	41,0	-0,84
Medium enterprise: from 50 to 249 employees	17	3	49,1	0,28
Micro enterprise: up to 9 employees	21	3	40,5	-1,34
Small enterprise: from 10 to 49 employees	45	3	51,7	1,44
Overall	94		47,5	

Test

Null hypothesis		H_0: All medians are equal	
Alternative hypothesis		H_1: At least one median is different	
Method	**DF**	**H-Value**	**P-Value**
Not adjusted for ties	3	3,15	0,369
Adjusted for ties	3	3,72	0,293

OUTPUT_ VARIATION IN AVERAGE SHIPPING TIME _ TYPE OF BUSINESS ENTERPRISE

Descriptive Statistics

Type of Business Enterprise	N	Median	Mean Rank	Z-Value
Business to Business	70	3	47,1	-0,26
Business to Consumer	24	3	48,7	0,26
Overall	94		47,5	

Test

Null hypothesis		H_0: All medians are equal	
Alternative hypothesis		H_1: At least one median is different	
Method	**DF**	**H-Value**	**P-Value**
Not adjusted for ties	1	0,07	0,798
Adjusted for ties	1	0,08	0,781

OUTPUT_ VARIATION IN AVERAGE SHIPPING TIME _ CORPORATE ROLE

Descriptive Statistics

Corporate Role	N	Median	Mean Rank	Z-Value
Executive	62	3	48,5	0,49
Administrative employee	32	3	45,6	-0,49
Overall	94		47,5	

Test

Null hypothesis		H_0: All medians are equal	
Alternative hypothesis		H_1: At least one median is different	
Method	**DF**	**H-Value**	**P-Value**
Not adjusted for ties	1	0,24	0,626
Adjusted for ties	1	0,28	0,597

OUTPUT_ ORDER SIZE CHANGE _ COMPANY SIZE

Descriptive Statistics

Number of employees	N	Median	Mean Rank	Z-Value
Large enterprise: from 250 employees	11	4	63,6	2,08
Medium enterprise: from 50 to 249 employees	17	3	46,2	-0,22
Micro enterprise: up to 9 employees	21	3	49,2	0,33
Small enterprise: from 10 to 49 employees	45	3	43,3	-1,44
Overall	94		47,5	

Test

Null hypothesis		H_0: All medians are equal	
Alternative hypothesis		H_1: At least one median is different	
Method	**DF**	**H-Value**	**P-Value**
Not adjusted for ties	3	5,03	0,169
Adjusted for ties	3	5,34	0,148

OUTPUT_ ORDER SIZE CHANGE _ TYPE OF BUSINESS ENTERPRISE

Descriptive Statistics

Type of Business Enterprise	N	Median	Mean Rank	Z-Value
Business to Business	70	3	44,8	-1,65
Business to Consumer	24	4	55,4	1,65
Overall	94		47,5	

Test

Null hypothesis		H_0: All medians are equal	
Alternative hypothesis		H_1: At least one median is different	
Method	**DF**	**H-Value**	**P-Value**
Not adjusted for ties	1	2,71	0,099
Adjusted for ties	1	2,88	0,090

OUTPUT_ ORDER SIZE CHANGE _ CORPORATE RATE

Descriptive Statistics

Corporate Role	N	Median	Mean Rank	Z-Value
Executive	62	3,0	44,8	-1,34
Administrative employee	32	3,5	52,7	1,34
Overall	94		47,5	

Test

Null hypothesis		H_0: All medians are equal	
Alternative hypothesis		H_1: At least one median is different	
Method	**DF**	**H-Value**	**P-Value**
Not adjusted for ties	1	1,79	0,181
Adjusted for ties	1	1,90	0,168

OUTPUT_ CORRECTNESS PERFORMANCE _ COMPANY SIZE

Descriptive Statistics

Number of employees	N	Median	Mean Rank	Z-Value
Large enterprise: from 250 employees	11	3	47,0	-0,06
Medium enterprise: from 50 to 249 employees	17	3	49,4	0,32
Micro enterprise: up to 9 employees	21	3	43,0	-0,85
Small enterprise: from 10 to 49 employees	45	3	49,0	0,50
Overall	94		47,5	

Test

Null hypothesis		H_0: All medians are equal	
Alternative hypothesis		H_1: At least one median is different	
Method	**DF**	**H-Value**	**P-Value**
Not adjusted for ties	3	0,79	0,853
Adjusted for ties	3	1,60	0,659

OUTPUT_ CORRECTNESS PERFORMANCE _ TYPE OF BUSINESS ENTERPRISE

Descriptive Statistics

Type of Business Enterprise	**N**	**Median**	**Mean Rank**	**Z-Value**
Business to Business	70	3	46,4	-0,68
Business to Consumer	24	3	50,8	0,68
Overall	94		47,5	

Test

Null hypothesis		H_0: All medians are equal	
Alternative hypothesis		H_1: At least one median is different	
Method	**DF**	**H-Value**	**P-Value**
Not adjusted for ties	1	0,46	0,496
Adjusted for ties	1	0,94	0,331

OUTPUT_ CORRECTNESS PERFORMANCE_ CORPORATE ROLE

Descriptive Statistics

Corporate Role	**N**	**Median**	**Mean Rank**	**Z-Value**
Executive	62	3	47,0	-0,26
Administrative employee	32	3	48,5	0,26
Overall	94		47,5	

Test

Null hypothesis		H_0: All medians are equal	
Alternative hypothesis		H_1: At least one median is different	
Method	**DF**	**H-Value**	**P-Value**
Not adjusted for ties	1	0,07	0,795
Adjusted for ties	1	0,14	0,711

OUTPUT_ ON TIME PERFORMANCE _ COMPANY SIZE

Descriptive Statistics

Number of employees	**N**	**Median**	**Mean Rank**	**Z-Value**
Large enterprise: from 250 employees	11	3	43,3	-0,54
Medium enterprise: from 50 to 249 employees	17	3	49,6	0,35
Micro enterprise: up to 9 employees	21	3	46,8	-0,14
Small enterprise: from 10 to 49 employees	45	3	48,1	0,19
Overall	94		47,5	

Test

Null hypothesis		H_0: All medians are equal	
Alternative hypothesis		H_1: At least one median is different	
Method	**DF**	**H-Value**	**P-Value**
Not adjusted for ties	3	0,39	0,942
Adjusted for ties	3	0,49	0,921

OUTPUT_ ON TIME PERFORMANCE _ POSIZIONE BUSINESS IMPRESA

Descriptive Statistics

Type of Business Enterprise	**N**	**Median**	**Mean Rank**	**Z-Value**
Business to Business	70	3	46,8	-0,41
Business to Consumer	24	3	49,5	0,41
Overall	94		47,5	

Test

Null hypothesis		H_0: All medians are equal	
Alternative hypothesis		H_1: At least one median is different	
Method	**DF**	**H-Value**	**P-Value**
Not adjusted for ties	1	0,17	0,684
Adjusted for ties	1	0,21	0,649

OUTPUT_ ON TIME PERFORMANCE _ CORPORATE ROLE

Descriptive Statistics

Corporate Role	**N**	**Median**	**Mean Rank**	**Z-Value**
Executive	62	3	46,7	-0,40
Administrative employee	32	3	49,1	0,40
Overall	94		47,5	

Test

Null hypothesis		H_0: All medians are equal	
Alternative hypothesis		H_1: At least one median is different	
Method	**DF**	**H-Value**	**P-Value**
Not adjusted for ties	1	0,16	0,690
Adjusted for ties	1	0,20	0,656

OUTPUT_ CHANGE IN STOCK AREA_ COMPANY SIZE

Descriptive Statistics

Number of employees	**N**	**Median**	**Mean Rank**	**Z-Value**
Large enterprise: from 250 employees	11	4	59,2	1,51
Medium enterprise: from 50 to 249 employees	17	3	43,1	-0,74
Micro enterprise: up to 9 employees	21	3	41,8	-1,08
Small enterprise: from 10 to 49 employees	45	3	49,0	0,50
Overall	94		47,5	

Test

Null hypothesis		H_0: All medians are equal	
Alternative hypothesis		H_1: At least one median is different	
Method	**DF**	**H-Value**	**P-Value**
Not adjusted for ties	3	3,50	0,320
Adjusted for ties	3	3,87	0,276

OUTPUT_ CHANGE IN STOCK AREA_ TYPE OF BUSINESS ENTERPRISE

Descriptive Statistics

Type of Business Enterprise	N	Median	Mean Rank	Z-Value
Business to Business	70	3	45,6	-1,14
Business to Consumer	24	3	53,0	1,14
Overall	94		47,5	

Test

Null hypothesis		H_0: All medians are equal	
Alternative hypothesis		H_1: At least one median is different	
Method	**DF**	**H-Value**	**P-Value**
Not adjusted for ties	1	1,30	0,254
Adjusted for ties	1	1,44	0,231

OUTPUT_ CHANGE IN STOCK AREA_ CORPORATE ROLE

Descriptive Statistics

Corporate Role	N	Median	Mean Rank	Z-Value
Executive	63	3	45,9	-0,80
Administrative employee	31	4	50,7	0,80
Overall	94		47,5	

Test

Null hypothesis		H_0: All medians are equal	
Alternative hypothesis		H_1: At least one median is different	
Method	**DF**	**H-Value**	**P-Value**
Not adjusted for ties	1	0,65	0,421
Adjusted for ties	1	0,71	0,398

OUTPUT_ CHANGE IN COSTS INCURRED FOR COLLECTION AND DELIVERY OF GOODS _ COMPANY SIZE

Descriptive Statistics

Number of employees	N	Median	Mean Rank	Z-Value
Large enterprise: from 250 employees	11	4	36,9	-1,38
Medium enterprise: from 50 to 249 employees	17	4	38,9	-1,44
Micro enterprise: up to 9 employees	21	4	49,7	0,41
Small enterprise: from 10 to 49 employees	45	4	52,4	1,65
Overall	94		47,5	

Test

Null hypothesis		H_0: All medians are equal	
Alternative hypothesis		H_1: At least one median is different	
Method	**DF**	**H-Value**	**P-Value**
Not adjusted for ties	3	4,94	0,176
Adjusted for ties	3	5,56	0,135

OUTPUT_ CHANGE IN COSTS INCURRED FOR COLLECTION AND DELIVERY OF GOODS _ TYPE OF BUSINESS ENTERPRISE

Descriptive Statistics

Type of Business Enterprise	N	Median	Mean Rank	Z-Value
Business to Business	70	4	47,4	-0,03
Business to Consumer	24	4	47,7	0,03
Overall	94		47,5	

Test

Null hypothesis		H_0: All medians are equal	
Alternative hypothesis		H_1: At least one median is different	
Method	**DF**	**H-Value**	**P-Value**
Not adjusted for ties	1	0,00	0,972
Adjusted for ties	1	0,00	0,971

OUTPUT_ CHANGE IN COSTS INCURRED FOR COLLECTION AND DELIVERY OF GOODS _ CORPORATE ROLE

Descriptive Statistics

Corporate Role	N	Median	Mean Rank	Z-Value
Executive	63	4	49,1	0,83
Administrative employee	31	4	44,2	-0,83
Overall	94		47,5	

Test

Null hypothesis		H_0: All medians are equal	
Alternative hypothesis		H_1: At least one median is different	
Method	**DF**	**H-Value**	**P-Value**
Not adjusted for ties	1	0,69	0,405
Adjusted for ties	1	0,78	0,377

OUTPUT_ PERFORMANCE IMPROVEMENT FAIRNESS _ COMPANY SIZE

Descriptive Statistics

Number of employees	N	Median	Mean Rank	Z-Value
Large enterprise: from 250 employees	11	3	55,7	1,06
Medium enterprise: from 50 to 249 employees	17	3	41,4	-1,03
Micro enterprise: up to 9 employees	21	3	49,6	0,39
Small enterprise: from 10 to 49 employees	45	3	46,9	-0,22
Overall	94		47,5	

Test

Null hypothesis		H_0: All medians are equal	
Alternative hypothesis		H_1: At least one median is different	
Method	**DF**	**H-Value**	**P-Value**
Not adjusted for ties	3	2,00	0,573
Adjusted for ties	3	2,42	0,490

OUTPUT_ PERFORMANCE IMPROVEMENT FAIRNESS _ TYPE OF BUSINESS ENTERPRISE

Descriptive Statistics

Type of Business Enterprise	N	Median	Mean Rank	Z-Value
Business to Business	70	3	48,5	0,61
Business to Consumer	24	3	44,6	-0,61
Overall	94		47,5	

Test

Null hypothesis		H_0: All medians are equal	
Alternative hypothesis		H_1: At least one median is different	
Method	**DF**	**H-Value**	**P-Value**
Not adjusted for ties	1	0,37	0,541
Adjusted for ties	1	0,45	0,501

OUTPUT_ PERFORMANCE IMPROVEMENT FAIRNESS _ CORPORATE ROLE

Descriptive Statistics

Corporate Role	N	Median	Mean Rank	Z-Value
Executive	63	3	47,9	0,18
Administrative employee	31	3	46,8	-0,18
Overall	94		47,5	

Test

Null hypothesis		H_0: All medians are equal	
Alternative hypothesis		H_1: At least one median is different	
Method	**DF**	**H-Value**	**P-Value**
Not adjusted for ties	1	0,03	0,856
Adjusted for ties	1	0,04	0,842

OUTPUT_ ON-TIME PERFORMANCE IMPROVEMENT_ COMPANY SIZE

Descriptive Statistics

Number of employees	N	Median	Mean Rank	Z-Value
Large enterprise: from 250 employees	11	3	53,5	0,78
Medium enterprise: from 50 to 249 employees	17	3	42,5	-0,83
Micro enterprise: up to 9 employees	21	3	48,4	0,17
Small enterprise: from 10 to 49 employees	45	3	47,5	-0,00
Overall	94		47,5	

Test

Null hypothesis		H_0: All medians are equal	
Alternative hypothesis		H_1: At least one median is different	
Method	**DF**	**H-Value**	**P-Value**
Not adjusted for ties	3	1,13	0,771
Adjusted for ties	3	1,37	0,712

OUTPUT_ ON-TIME PERFORMANCE IMPROVEMENT_ TYPE OF BUSINESS ENTERPRISE

Descriptive Statistics

Type of Business Enterprise	N	Median	Mean Rank	Z-Value
Business to Business	70	3	47,7	0,12
Business to Consumer	24	3	46,9	-0,12
Overall	94		47,5	

Test

Null hypothesis		H_0: All medians are equal	
Alternative hypothesis		H_1: At least one median is different	
Method	**DF**	**H-Value**	**P-Value**
Not adjusted for ties	1	0,01	0,907
Adjusted for ties	1	0,02	0,897

OUTPUT_ ON-TIME PERFORMANCE IMPROVEMENT_ CORPORATE ROLE

Descriptive Statistics

Corporate Role	N	Median	Mean Rank	Z-Value
Executive	63	3	46,3	-0,63
Administrative employee	31	3	50,0	0,63
Overall	94		47,5	

Test

Null hypothesis		H_0: All medians are equal	
Alternative hypothesis		H_1: At least one median is different	
Method	**DF**	**H-Value**	**P-Value**
Not adjusted for ties	1	0,40	0,528
Adjusted for ties	1	0,49	0,486

OUTPUT_ IMPROVEMENT OF THE AVERAGE TIME TO PROCESS AN ORDER _ COMPANY SIZE

Descriptive Statistics

Number of employees	N	Median	Mean Rank	Z-Value
Large enterprise: from 250 employees	11	3	47,7	0,03
Medium enterprise: from 50 to 249 employees	17	3	45,0	-0,42
Micro enterprise: up to 9 employees	21	3	51,7	0,80
Small enterprise: from 10 to 49 employees	45	3	46,4	-0,36
Overall	94		47,5	

Test

Null hypothesis		H_0: All medians are equal	
Alternative hypothesis		H_1: At least one median is different	
Method	**DF**	**H-Value**	**P-Value**
Not adjusted for ties	3	0,71	0,871
Adjusted for ties	3	0,83	0,843

OUTPUT_ IMPROVEMENT OF THE AVERAGE TIME TO PROCESS AN ORDER _ TYPE OF BUSINESS ENTERPRISE

Descriptive Statistics

Type of Business Enterprise	N	Median	Mean Rank	Z-Value
Business to Business	70	3	47,1	-0,24
Business to Consumer	24	3	48,6	0,24
Overall	94		47,5	

Test

Null hypothesis		H_0: All medians are equal	
Alternative hypothesis		H_1: At least one median is different	
Method	**DF**	**H-Value**	**P-Value**
Not adjusted for ties	1	0,06	0,812
Adjusted for ties	1	0,07	0,797

OUTPUT_ IMPROVEMENT OF THE AVERAGE TIME TO PROCESS AN ORDER _ CORPORATE ROLE

Descriptive Statistics

Corporate Role	N	Median	Mean Rank	Z-Value
Executive	63	3	47,1	-0,18
Administrative employee	31	3	48,2	0,18
Overall	94		47,5	

Test

Null hypothesis		H_0: All medians are equal	
Alternative hypothesis		H_1: At least one median is different	
Method	**DF**	**H-Value**	**P-Value**
Not adjusted for ties	1	0,03	0,853
Adjusted for ties	1	0,04	0,842

OUTPUT_ CHANGE IN NUMBER OF VEHICLES <= 3,5 t_ COMPANY SIZE

Descriptive Statistics

Number of employees	N	Median	Mean Rank	Z-Value
Large enterprise: from 250 employees	11	4	61,4	1,79
Medium enterprise: from 50 to 249 employees	17	3	51,5	0,67
Micro enterprise: up to 9 employees	21	3	35,0	-2,38
Small enterprise: from 10 to 49 employees	45	3	48,4	0,31
Overall	94		47,5	

Test

Null hypothesis		H_0: All medians are equal	
Alternative hypothesis		H_1: At least one median is different	
Method	**DF**	**H-Value**	**P-Value**
Not adjusted for ties	3	7,65	0,054
Adjusted for ties	3	10,01	0,019

OUTPUT_ CHANGE IN NUMBER OF VEHICLES <= 3,5 t _ TYPE OF BUSINESS ENTERPRISE

Descriptive Statistics

Type of Business Enterprise	**N**	**Median**	**Mean Rank**	**Z-Value**
Business to Business	70	3	45,3	-1,32
Business to Consumer	24	3	53,8	1,32
Overall	94		47,5	

Test

Null hypothesis		H_0: All medians are equal	
Alternative hypothesis		H_1: At least one median is different	
Method	**DF**	**H-Value**	**P-Value**
Not adjusted for ties	1	1,74	0,188
Adjusted for ties	1	2,27	0,132

OUTPUT_ CHANGE IN NUMBER OF VEHICLES <= 3,5 t _ CORPORATE ROLE

Descriptive Statistics

Corporate Role	**N**	**Median**	**Mean Rank**	**Z-Value**
Executive	63	3	44,2	-1,69
Administrative employee	31	3	54,3	1,69
Overall	94		47,5	

Test

Null hypothesis		H_0: All medians are equal	
Alternative hypothesis		H_1: At least one median is different	
Method	**DF**	**H-Value**	**P-Value**
Not adjusted for ties	1	2,87	0,090
Adjusted for ties	1	3,75	0,053

OUTPUT_ CHANGE IN NUMBER OF VEHICLES > 3,5 t_ COMPANY SIZE

Descriptive Statistics

Number of employees	**N**	**Median**	**Mean Rank**	**Z-Value**
Large enterprise: from 250 employees	11	3	48,5	0,14
Medium enterprise: from 50 to 249 employees	17	4	52,5	0,83
Micro enterprise: up to 9 employees	21	3	35,5	-2,29
Small enterprise: from 10 to 49 employees	45	4	51,0	1,18
Overall	94		47,5	

Test

Null hypothesis		H_0: All medians are equal	
Alternative hypothesis		H_1: At least one median is different	
Method	**DF**	**H-Value**	**P-Value**
Not adjusted for ties	3	5,37	0,146
Adjusted for ties	3	5,96	0,113

OUTPUT_ CHANGE IN NUMBER OF VEHICLES > 3,5 t _ TYPE OF BUSINESS ENTERPRISE

Descriptive Statistics

Type of Business Enterprise	N	Median	Mean Rank	Z-Value
Business to Business	70	3	48,8	0,76
Business to Consumer	24	3	43,8	-0,76
Overall	94		47,5	

Test

Null hypothesis		H_0: All medians are equal	
Alternative hypothesis		H_1: At least one median is different	
Method	**DF**	**H-Value**	**P-Value**
Not adjusted for ties	1	0,58	0,445
Adjusted for ties	1	0,65	0,421

OUTPUT_ CHANGE IN NUMBER OF VEHICLES > 3,5 t _ CORPORATE ROLE

Descriptive Statistics

Corporate Role	N	Median	Mean Rank	Z-Value
Executive	63	3	47,2	-0,18
Administrative employee	31	3	48,2	0,18
Overall	94		47,5	

Test

Null hypothesis		H_0: All medians are equal	
Alternative hypothesis		H_1: At least one median is different	
Method	**DF**	**H-Value**	**P-Value**
Not adjusted for ties	1	0,03	0,860
Adjusted for ties	1	0,03	0,852

OUTPUT_ CHANGE IN STAFF NUMBERS _ COMPANY SIZE

Descriptive Statistics

Number of employees	N	Median	Mean Rank	Z-Value
Large enterprise: from 250 employees	11	5	62,0	1,88
Medium enterprise: from 50 to 249 employees	17	3	46,0	-0,26
Micro enterprise: up to 9 employees	21	3	36,6	-2,08
Small enterprise: from 10 to 49 employees	45	4	49,6	0,72
Overall	94		47,5	

Test

Null hypothesis		H_0: All medians are equal	
Alternative hypothesis		H_1: At least one median is different	
Method	**DF**	**H-Value**	**P-Value**
Not adjusted for ties	3	6,79	0,079
Adjusted for ties	3	7,52	0,057

OUTPUT_ CHANGE IN STAFF NUMBERS _ TYPE OF BUSINESS ENTERPRISE

Descriptive Statistics

Type of Business Enterprise	**N**	**Median**	**Mean Rank**	**Z-Value**
Business to Business	70	4,0	46,5	-0,59
Business to Consumer	24	3,5	50,3	0,59
Overall	94		47,5	

Test

Null hypothesis		H_0: All medians are equal	
Alternative hypothesis		H_1: At least one median is different	
Method	**DF**	**H-Value**	**P-Value**
Not adjusted for ties	1	0,35	0,555
Adjusted for ties	1	0,39	0,535

OUTPUT_ CHANGE IN STAFF NUMBERS _CORPORATE ROLE

Descriptive Statistics

Corporate Role	**N**	**Median**	**Mean Rank**	**Z-Value**
Executive	63	3	46,9	-0,28
Administrative employee	31	4	48,6	0,28
Overall	94		47,5	

Test

Null hypothesis		H_0: All medians are equal	
Alternative hypothesis		H_1: At least one median is different	
Method	**DF**	**H-Value**	**P-Value**
Not adjusted for ties	1	0,08	0,778
Adjusted for ties	1	0,09	0,767