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Impact of ISO 9001 Standard on Firm Performance: A Review of Innovation Effects and Relationship between Standards and Innovation

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Abstract

This master's thesis investigates the intricate relationship between the implementation of standards, with a particular focus on ISO 9001, innovation capabilities, and the performances of Italian firms. It begins with an introduction to standards, focusing on ISO standards for quality management systems, notably ISO 9001, and their organizational significance. The study explores innovation capabilities and their potential correlation with standards to enhance firm performance, addressing uncertainties in the literature. A comprehensive literature review analyzes prior research methodologies and diverse perspectives on the impact of standards and their relationship with innovation on firm performance. An empirical analysis based on statistical methods investigates the specific impact of ISO 9001 implementation on Italian firms' performance, aiming to provide empirical evidence and contribute to existing literature. Conclusions drawn critically reflect on the analysis results, summarizing key findings, acknowledging limitations, and suggesting avenues for future research and practical applications.

Contents

List of Figures

List of Tables

1 Introduction

In today's fast-paced business world, achieving excellence and staying competitive are top priorities for companies.

Quality management, therefore, is crucial, defining the processes by which companies operate and ensuring the reliability of their products and services. Certifications play a vital role in this process, assuring that businesses adhere to globally recognized standards and practices. By obtaining certification, companies demonstrate their commitment to delivering high-quality outcomes and establishing trust with customers and stakeholders. Among these certifications, ISO 9001 stands out as the most globally widespread tool for managing quality effectively, improving customer satisfaction, and ultimately boosting overall performance [53].

Examining the continuous expansion of the ISO landscape over the years proves the indispensable role of certifications in today's competitive business environment. Certifications not only enhance internal operational efficiency but also guarantee high-quality standards to all stakeholders engaged with the organization.

In such a competitive global environment, characterized by rapid and continuous changes and innovation, staying abreast of these advancements is pivotal not only for survival but also for seizing new opportunities and establishing a competitive advantage. In this dynamic landscape, companies must not only strive for excellence but also adapt and innovate continuously to maintain relevance and stay ahead of the competition (Sahoo, 2019 [42]).

Given these considerations, it becomes evident that over the past few decades, many students and researchers have dedicated their academic pursuits to understanding the relationship between the implementation of standards, innovation, and firm performance.

Furthermore, the relationship between quality management and the implementation of innovation is not trivial. When considering the definitions and contexts of these two concepts, quality management revolves around consistency, standardization, and control, while innovation is characterized by change, differentiation, and a willingness to accept failure (Silva et al., 2014 [47]). In light of the current global context, delving deeper into the complex interplay between quality management and innova-

tion becomes particularly intriguing. Do they complement each other effectively, or do they potentially hinder one another?
The state-of-the-art research in this area is subject to debate and will be thoroughly referenced and examined in the current study, highlighting the existing disparity and discussion regarding the examination of the influence of quality management practices on innovation capabilities, and vice versa, as well as their impacts on overall firm performance.
In particular, this work aims to give a perspective on large and extra-large companies in the Italian scenario, enriching the literature on this topic, and offering a statistical approach to analyze the findings.

With this aim in mind, the thesis explores the following research questions:
RQ1: *Does the implementation of ISO 9001 standard have a discernible impact on the financial performance of Italian XL and L firms? If so, does this impact tend to be positive or negative?*

RQ2: *To what extent do factors such as the size of the firm or the regional context in which it operates influence the relationship between standardization and firm performance?*

RQ3: *What is the nature of the correlation between standardization and innovation capabilities? Do they mutually reinforce each other or hinder one another?*

As will be elaborated later, RQ3 will be addressed through an in-depth critical analysis of the literature review on the subject.

The study begins with an introduction to standards in Chapter 2, emphasizing ISO standards on quality management systems, especially ISO 9001, and their significance in organizational processes. An overview of the global distribution and historical evolution of ISO 9001 is presented, with a particular emphasis on the Italian context. Following this, Chapter 3 introduces innovation capabilities, exploring their potential relationship with standards to enhance firm performance. The study delves into the diverse nature of these capabilities crucial for fostering innovation. It also ad-

dresses the uncertainty in the literature regarding the impact of standards on firm performance.

In Chapter 4, a comprehensive literature review explores prior research, examining methodologies employed in analogous studies. This review will uncover diverse perspectives on the impact of standards on firm performance and their relationship with innovation as drivers of performance improvement, as revealed by the studies conducted by diverse researchers, whose work will be surveyed in the literature review.

In Chapter 5, a comprehensive analysis will delve into the impact of ISO 9001 on the performance of Italian firms. Utilizing various methodologies, the study aims to isolate the specific effects attributable to ISO 9001 implementation, allowing for a more focused examination of the research objectives. This empirical investigation seeks to contribute to the existing literature by offering empirical evidence and shedding light on the dynamics between standards adoption, and firm performance.

In the subsequent section (Chapter 6), conclusions are drawn based on a critical discussion of the analysis results, reflecting on the state-of-the-art research regarding the implications of standards on firm performance. Chapter 7 provides a summary of the studies and results, while also highlighting their limitations. Using these limitations as a starting point, the discussion explores potential directions for future research, considering practical applications for further development and exploration.

2 Standards

2.1 ISO: International Standard Organization

ISO stands for the International Organization for Standardization. It is an independent international organization that develops and publishes international standards. These are designed to ensure a certain level of quality, safety, and efficiency of products, services, and systems across various industries and sectors, including technology, food safety, healthcare, agriculture, manufacturing, and more. The main goal is to create a set of criteria that are globally recognized, helping businesses to operate on an international scale, with common standards.

2.2 Quality Management system : ISO 9000 standards

A quality management system is a collection of business processes focused on consistently meeting customer requirements and enhancing their satisfaction. It is aligned with an organization's purpose and strategic direction [37], and its main purpose is to help an organization direct activities to meet customers and regulatory requirements, improving efficiency and effectiveness continuously.
Benefits of a QMS among others include:

- Being aligned with the customer's requirements, raising the confidence in the organization, in turn, hypothetically, leading to more customers, more sales, and more businesses [55].
- Being aligned with the organization's requirements, ensuring adherence to regulatory standards while delivering products and services efficiently in a cost-effective manner, allowing for scalability, development, and financial gain [55].

From these benefits, other positive effects should naturally emerge, such as the definition, improvement, and control of processes, waste reduction, error prevention, and lowering of costs.

Figure 1 is used to provide a graphical explanation of the interrelating functions and processes involved in quality management systems (in this figure ISO 9001). The

role of customers is underlined in its relevance as an input, through the definition of requirements that an organization has to meet throughout all the steps of a quality management system, and as an output, measured as customers' satisfaction. [16]. As it can be seen, other parties besides customers play a role in defining input requirements.

"When used within a quality management system, the process approach ensures:

- understanding and consistently meeting requirements;
- consideration of processes in terms of added value;
- the achievement of effective process performance;
- improvement of processes based on evaluation of data and information" [16].

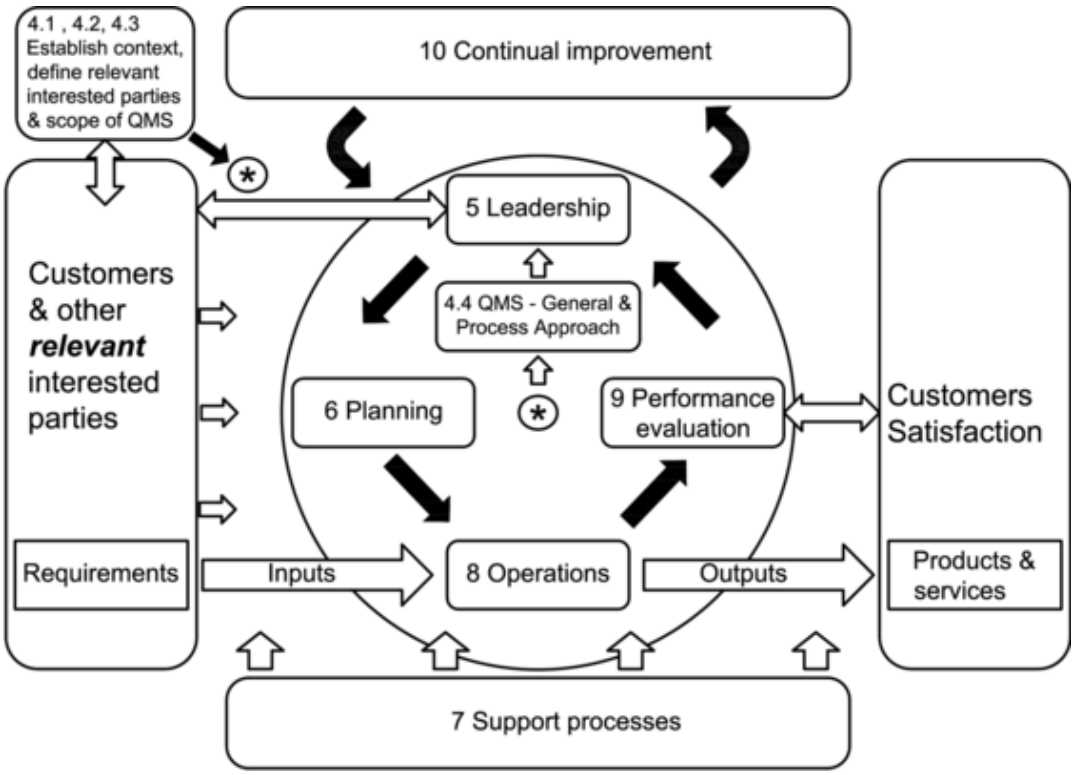

Figure 1: Model of a process-based quality management system. From ISO 9001:2015 [16]

2.2.1 The role of certification in QMS

Regarding Quality Management Systems (QMS), it is crucial for a company to obtain a certification, to indicate to customers, suppliers, competitors, and employees its

dedication to excellence and commitment to investing in enhancing processes and products.

Olkiewicz et al. [27] underline the fundamental role of standardization in addressing the topic of quality management systems. If an organization can identify the areas at greater risk, where pro-quality initiatives are crucial for process improvements, it should be always remembered that the critical nature of those activities is to be aligned and consistent with the strategic organization and mission of the company [50]. In this sense, ISO standards for Quality Management Systems (QMS) facilitate the responsible implementation of integrated management systems. Starting with the foundational ISO 9001, these standards provide precise criteria and extend the option to implement individual standards tailored for specific domains, such as ISO 14001 for Environmental Management System and ISO 27001 for Information Security Management System (Olkiewicz et al., 2023 [27]). Consequently, the standardization of quality management systems, involving the identification and interdependence of processes, parametrization using criteria and indicators, as well as risk mitigation and awareness creation, enables the company to attain the desired level of quality. This achievement is in harmony with the organization's capabilities and meets the expectations of stakeholders.

ISO 9000 is the most diffuse set of standards concerning quality management systems; in particular, ISO 9001 (Figure 2), with its latest update in 2015, is the most used globally and represents the focus of this study.

Figure 2: ISO 9001 logo

As previously pointed out, the primary goal of ISO 9001 is to enhance customer satisfaction by ensuring that company products, processes or services consistently meet or exceed customer expectations and regulatory requirements. The standard provides a framework for organizations to establish and document their processes, monitor and measure their performance, and implement corrective actions when necessary.

The key principles of ISO 9001, displayed in Figure 3 are Customer focus, Leadership, Engagement of people, Process approach, Improvement, Evidence-based decision making, and Relationship management.

Figure 3: QMS principles [55]

According to the definitions in ISO official documents [36], these principles are not prioritized in a specific order. The importance of each principle may differ among organizations and is likely to evolve over time. Once again, this statement emphasizes the broad adaptability and flexibility of ISO 9001 to address diverse organizational needs and adapt to evolving contexts. In the following paragraphs, these principles are unfolded together with the respective benefits and competitive advantages that arise from each principle [36].

Customer Focus

Quality management systems aim to meet customer requirements and try to exceed customer expectations, as the organization depends on customers, understanding current and future needs is something they should do. A company should always strive for improvement and keep its processes under control to enhance customer satisfaction. The advantages that come from this principle are to increase customer value,

satisfaction, and loyalty and also to expand the customer base and increase revenue and market share.

Leadership

Leadership establishes goals and creates a condition in which all the members of the company feel involved in achieving the organization's quality objectives, setting unity of purpose, and creating proactive participation to achieve higher quality. Advantages that are related to this principle are better coordination of the organization's process, improved communication, more effectiveness and efficiency in reaching the quality objective, and development and improvement of the capability of the organization to deliver results.

Engagement of people

Creating engagement enhances the capability of people to create and deliver value, involving employees in something that concerns them can make them feel valued. It is important to share the culture of an organization, to enhance personal development, creativity, satisfaction, and motivation.

Process approach

The process approach is the logical sequencing of activities to efficiently achieve a desired result. When activities are understood and managed as interrelated processes, consistent and predictable results are achieved more easily. Benefits related to this principle are a higher focus on improvement, predictable outcomes, and an efficient use of resources.

Continual improvement

Effective organizations continually emphasize the pursuit of improvement, which should be seen as a permanent objective. Firms need to think about long-term goals and keep improving processes. Advantages are improved process performance, capabilities, the ability to root-case investigation followed by prevention and correction, and improved use of learning for improvement.

Evidence-based decision making

When a decision is made based on an analysis and data the outcome is more likely to produce the desired results. It can be a difficult process, characterized by uncertainty, for which the crucial point is to understand the cause-effect relationship and potential consequences, to make a good decision. It is clear that the main benefit is to improve the decision-making process, but also the improved assessment of process performance, and the ability to demonstrate the effectiveness of some decisions made in the past.

Relationship management

Managing the relationships with partners, such as suppliers, is crucial for the success of an organization. All the parties that interact with the organization influence the performance, so it is important to manage the relationships with all the parties to optimize the performance. Sharing a common understanding of the goals among parties is a fundamental benefit of this principle, together with having a well-managed supply chain.

2.3 Global Diffusion and Evolution of QM Standards

The diffusion of certification, mostly ISO 9001, started in Europe. The processes began with European companies that, after gaining the certification, pressured their suppliers to get certification ISO 9001. This was the starting point of the international diffusion of this standard, when companies worldwide were afraid that not having this kind of certification could represent a barrier to international trade, thus identifying the possession of ISO 9001 as an important asset to ensure the quality of their system (Sampaio et al., 2009 [43]).

- The first ISO 9000 was first published in 1987 with many updates through the years, arriving at the current version developed in 2015. In 1987 the first version of ISO 9001 was released, and it was a model of quality assurance system. Many countries recognized these standards as crucial for conformity assessment, incorporating them into legally prescribed procedures.

- In 1994, a second version was released, with some minor adjustments, mainly of an editorial or conceptual nature.[12]
- The third version, issued in 2000, represented a turning point for quality standardization, by merging ISO 9001, ISO 9002, and ISO 9003 into a single standard. It also shifted from quality assurance to quality management, aligning with corporate management practices. The language became more accessible, benefiting all industries, especially service companies. The revision introduced a process-oriented structure, emphasizing customer satisfaction and core processes. This made ISO 9001 more adaptable and relevant across diverse sectors. [12]
- In the fourth version of 2008, changes were mainly aimed at easing the application through clarifications in the statements. The basic structure remained the same.[12]
- ISO 9001:2015 is the current version of the standard, extensively addressed in Section 2.2.

The above-presented timeline for ISO 9000 development is graphically summarized in Figure 4.

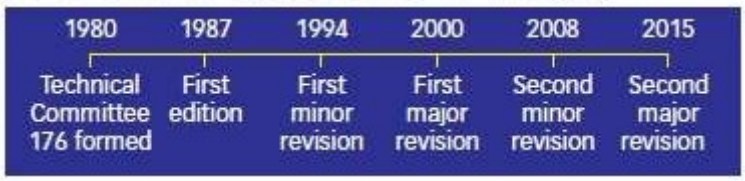

Figure 4: Evolution of ISO 9001 [56]

Global diffusion

Examining the worldwide spread of ISO 9001 since its introduction, it is intriguing to analyze and visualize the growth of the standard throughout the years, and the distribution of certifications issued among the countries of the world.
The International Organization of Standardization publishes a yearly survey in which the total number of issued certificates per country is indicated, together with the division of those certifications per sector. This is a powerful resource to observe the

growth of ISO 9001 and draw considerations on the countries with the highest number of certifications.

Year	**2000**	**2001**	**2002**	**2003**	**2004**
ISO 9001	407,674	510,349	561,766	497,919	660,132
Change (%)	-	*25.19*	*10.07*	*-11.37*	*32.58*
Year	**2005**	**2006**	**2007**	**2008**	**2009**
ISO 9001	773,843	896,905	951,486	980 322	1,063,751
Change (%)	*17.23*	*15.90*	*6.09*	*3.03*	*8.51*
Year	**2010**	**2011**	**2012**	**2013**	**2014**
ISO 9001	1,076,525	1,009,845	1,017,279	1,022,877	1,036,321
Change (%)	*1.20*	*-6.19*	*0.74*	*0.55*	*1.31*
Year	**2015**	**2016**	**2017**	**2018**	**2019**
ISO 9001	1,034,180	1,105,937	1,058,504	1,180,965	1,217,972
Change (%)	*-0.21*	*6.94*	*-4.29*	*11.57*	*3.13*

Figure 5: Evolution of globally issued ISO 9001, 2000-2019 [4]

When analyzing the total number of ISO 9001 certificates from 2000 to 2019 (Figure 5), it is evident that, despite occasional decreases in certain years, there was a general upward trend compared to previous years. However, it is noteworthy that the rate of increase experienced a decline. Specifically, there were reductions of 11.37%, 6.19%, and 4.19% during the transitions from 2002 to 2003, 2010 to 2011, and 2016 to 2017, respectively. The increased rates observed in 2018 (11.57%) and 2019 (3.13%) suggest that ISO 9001 continues to be widely regarded as a crucial strategic tool for companies [4].

According to the ISO survey 2022 [53] (which estimates the number of valid certificates as of 12/31/22), the number of certifications for ISO 9001 is 1,265,216.

In table 1 the first 10 countries with the highest number of certifications in the world are listed, in descending order for number of certifications.

Country	**N. of certifications**
China	551855
Italy	94216
India	61653
Germany	47576
UK	43765
Japan	38916
Spain	32059
USA	29579
Korea (Republic of)	27155
France	21880

Table 1: ISO survey 2022 top 10 countries [53]

This work is mainly focused on the effect of ISO 9001 in the Italian scenario. It is worth noting Italy's achievement of being second in ISO 9001 certifications, as indicated in table 1, underscoring its commitment to quality management systems. Moreover, aside from China, even countries with significantly larger populations and economies do not exceed Italy's certification count. This demonstrates Italy's strong emphasis on quality assurance and adherence to international standards, contributing to its competitive edge in global markets. Table 1 is just considered the ISO 9001 in fact if we consider all the types of certifications the International Standards Organization issues, the number worldwide would be much bigger, we are talking around two million and a half certifications. [15] Considering the aggregate number of certifications Italy would still maintain its record of being the second country with the most accredited companies, and the first one in Europe [15].

To provide a clearer understanding of the sectors included in the certification process, the International Accreditation Forum (IAF) categorizes organizations into 40 sectors, with the 40th sector designated as 'unknown'. Table 2 shows all the IAF codes with the relative sector. In Table 2 the total number of ISO 9001 certifications issued globally for each sector is displayed, updated to 2022, reflecting cumulative data. The data to create this table are collected from the ISO survey 2022 [53].

Code	Sector	Number
1	Agriculture, Fishing and Forestry	2800
2	Mining and quarrying	3591
3	Food products, beverage, and tobacco	22375
4	Textiles and textile products	12231
5	Leather and leather products	1917
6	Manufacture of wood and wood products	4302
7	Pulp, paper, and paper products	9242
8	Publishing companies	534
9	Printing companies	8136
10	Manufacture of coke & refined petroleum products	1321
11	Nuclear fuel	197
12	Chemicals, chemical products & fibres	30393
13	Pharmaceuticals	3403
14	Rubber and plastic products	52007
15	Non-metallic mineral products	11340
16	Concrete, cement, lime, plaster, etc.	12518
17	Basic metal & fabricated metal products	121728
18	Machinery and equipment	69326
19	Electrical and optical equipment	99558
20	Shipbuilding	3393
21	Aerospace	1218
22	Other transport equipment	11832
23	Manufacturing not elsewhere classified	14856
24	Recycling	3946
25	Electricity supply	3278
26	Gas supply	795
27	Water supply	1891
28	Construction	90735
29	Wholesale & retail trade, repairs of motor vehicles, motorcycles & personal & household goods	107975
30	Hotels and restaurants	4881
31	Transport, storage and communication	26603
32	Financial intermediation, real estate, renting	9538
33	Information technology	49559
34	Engineering services	55289
35	Other Services	60269
36	Public administration	4512
37	Education	11718
38	Health and social work	12511
39	Other social services	8384
40	Sector not known	220729

Table 2: IAF sectors with correspondent certification issued for ISO 9001 in 2022 globally. [53]

2.4 Italy

Italy is the first country in Europe for certification ISO 9001 obtained, the data come from the 2022 ISO survey, and second worldwide behind China. Italy has around 94.000 certifications for ISO 9001, and China instead has 551.000 [53].
In the business world, holding an ISO 9001 certification represents an assurance of robust structure. The certification process is rigorously evaluated and conducted by an impartial third-party authority, providing a solid assurance of quality.
Other than factors such as the value in international and national trade, what also influenced the numbers in Table 1 is the regulation in Italy that mandates construction companies to possess a certified quality management system by an accredited body to participate in public tenders. This requirement has significantly contributed to the proliferation of certifications. Additionally, within the supply chain, suppliers typically request certification to evaluate the reliability of the parties involved [18]. In addition to market dynamics, therefore, it has been the regulatory context that has influenced the use of certifications, which have also become tools for implementing the procurement policies of the Public Administration.
Figure 6 displays a graphical representation showing the annual number of ISO 9001 certifications in Italy [53]. A noteworthy observation is the substantial drop observed in 2017. This decline can be attributed to ISO's alteration in its counting methodology during its surveys, resulting in a noticeable decrease in certifications for that year. It's worth noting that, aside from the decline in 2017, the overall trend remains positive. Therefore, it can be asserted that the number of certifications in Italy is consistently increasing.

Figure 6: Total ISO 9001 certificates from 1993 to 2022 in Italy.

During the last four years, from 2019 to 2022, the total number of certifications in Italy has always grown, albeit slightly. After the decline in the years 2016-2018, due to the reasons mentioned above, the numbers have always been increasing. In 2019, the increase recorded was 0.16%, while in 2020 it was 2.41%. The same trend is repeated for 2021 and 2022, where the increases recorded are 0.16% and 2.40%, respectively. The growth of ISO 9001 certifications throughout the years is a clear indicator of how organizations in Italy show a dedication to quality.

Italy leads in the number of certifications issued in Europe also for the standard ISO 14001, the internationally recognized standard for environmental management systems (EMS), the second most issued certification behind ISO 9001 [53].

2.4.1 Sectors

In the Italian scenario, the sectors in which ISO 9001 is the most utilized standard certification are metal product manufacturing, construction, and wholesale and retail trade. Construction is the most certified sector with 3,009 certification issued in 2022. Figure 7 shows the number of certifications issued in 2022 for each sector.

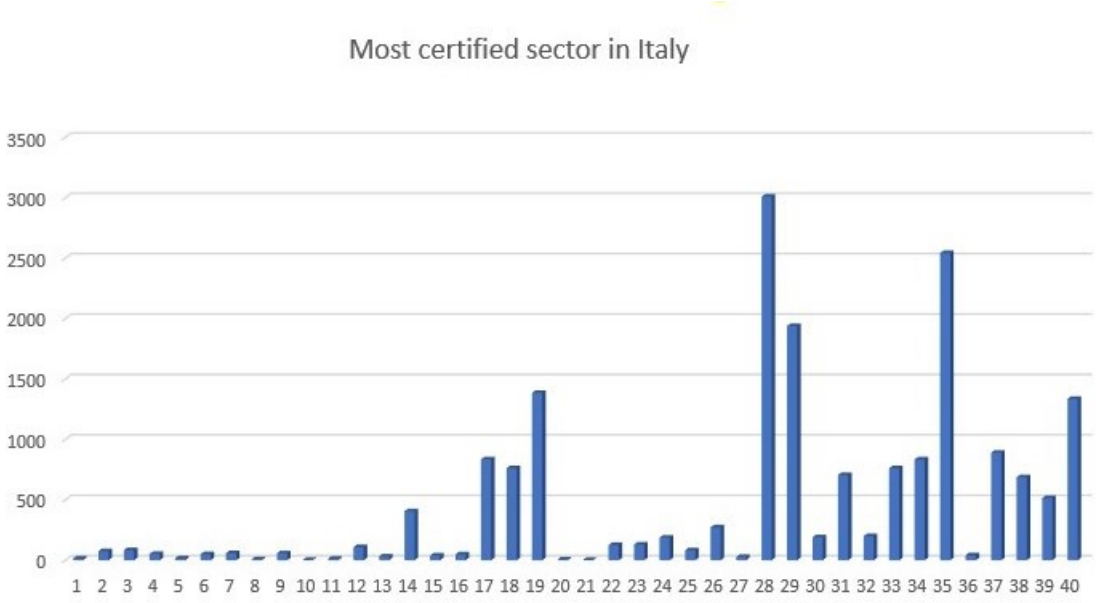

Figure 7: ISO 9001 per sector in Italy 2022.

In the x-axis of the graph in Figure 7 the IAF numbers, that correspond to a specific sector are displayed. To understand the correspondence between the IAF number and sector use Table 2. The data about this information are not updated to 2023, this is because the information relies on the ISO survey, which, at the time of writing this thesis, has not yet been published for the year 2023.

3 Innovation capabilities

In this chapter, the study delves into the research, focusing on investigating the intricate relationship between standards and innovation. The secondary scope of this work, alongside assessing if standards enable greater organizational performance, is to understand how innovation capabilities contribute to firms' performance and intersect with standards to enhance overall innovation performance within organizations.

The theme of innovation and its impact on companies has ancient roots, tracing back to the early 20th-century works of Schumpeter (Schumpeter, 1934 [44]). His writings on innovation and entrepreneurship highlight its crucial role in business development and market progress. Central to Schumpeter's ideas is the notion that innovation serves as a fundamental catalyst for competitiveness and economic evolution (Sledzik, 2013 [48]). The Austrian economist introduces the term "creative destruction" in his book "Capitalism, Socialism and Democracy" (Schumpeter, 1950 [45]) to describe the ongoing process of innovation revolutionizing the economy. He sees it as a cycle where new ideas and methods constantly replace old ones, leading to economic transformation. This concept emphasizes how innovation drives change by breaking down established structures and creating new ones.

Elaborating on these ideas, researchers have extensively focused on innovation and its ability to provide organizations with a competitive advantage, investigating the potential existing relationship between innovation capabilities and standardization (Shouyu, 2017 [46]; Śledzik, 2013 [48]; Prajogo et al., 2007 [35]; Pekovic and Galia, 2009 [31]; El Manzani et al., 2019 [9]; Manders et al., 2016[22] Abrunhosa and Moura E Sá, 2008[1] Terziovski and Guerrero, 2014 [52] Martınez-Costa and Martınez-Lorente, 2003[24] Perdomo-Ortiz et al., 2006[32] Mir et al., 2022 [26]). In Chapter 4, an in-depth literature review will be conducted, examining the findings and insights from related works on this topic.

Organizations not only leverage various quality management practices like ISO 9001 to elevate their quality standards but also anticipate a significant enhancement in their

innovation performance as a result of its implementation (Manders et al., 2016 [22]). As articulated by the chairman of Guardsmark, one of the world's largest security service companies [13], "For the last 15 years, we have been committed to the ISO standards program... It recognizes innovation and improvement. That is our goal". However, there remains a gap in research studies regarding the relationship between standards and innovation capabilities, leading to questions and doubts. For instance, it is unclear whether standards such as ISO 9001 truly enhance innovation capabilities, and the existing literature on this topic presents conflicting findings.

Pekovic and Galia (2009) [31] conducted a study in France involving a survey administered to 1146 manufacturing companies to assess the impact of ISO 9001 on product innovation. Their findings indicate a positive correlation between ISO 9001 certification and innovation. Prajogo et al. (2007) [35] argue that while innovation is regarded as an order winner, companies strive to attain both high quality and high innovation performance simultaneously to enhance productivity and/or profitability. Other studies claim the exact opposite, suggesting that ISO 9001 emphasis on process standardization and mapping might hinder innovation and creativity within organizations. El Manzani et al. (2019) [9] focus their studies on a sample of 82 Moroccan (ISO 9001) certified companies, using quantitative data collected through a survey. Their results bring to the conclusion that there is no evident relationship between the use of a Quality Management System (ISO 9001) and incremental and radical innovation, at least when referring to the technical practices associated with the implementation of certifications. Although their analysis shows that the same conclusion can be inferred for social practices of QM, El Manzani et al. (2019) [9] identify limitations of their study, underlying the difficulty in analyzing and quantitatively describe the relationship between social practices and innovation performance, and considering the multitude of researchers indicating a positive impact of those practices to the innovativeness of a firm (Abrunhosa and Moura E Sá, 2008 [1]; Feng et al., 2006 [10]).

This section of the study wants to find how ISO 9001 influences innovation, and whether it enables a greater degree of it or hinders it. It is well-known that innovation allows organizations to gain a competitive advantage against competitors (Chatzoglou

and Chatzoudes, 2018 [6]) and the quality standards ensured by ISO 9001 sometimes may not be enough.

3.1 How to define Innovation

Since there is no universally accepted definition of innovation, it is crucial to provide a clear and consistent definition within this work to ensure clarity and coherence.
The Oslo Manual [29] offers guidance on collecting and interpreting innovation data. In this research, we adhere to their definition and classifications, which state: "An innovation is the implementation of a new or significantly improved product (good or service), process, a new marketing method, or a new organizational method in business practices, workplace organization, or external relations" [29].
Moreover, this is the most common definition of innovation, although it is possible to dive more in depth exploring various facets such as types of innovation, drivers, processes, barriers, and ecosystems.
The first important distinction to make is between incremental and radical innovation. Incremental innovation involves making small improvements to existing products or services without fundamentally changing them. It's about refining what already exists. For example, think of software updates adding new features or slight design tweaks to smartphones.
Radical innovation, on the other hand, is about introducing entirely new ideas or technologies that revolutionize existing products or services. It's disruptive and can change industries. Examples include the invention of the internet or the introduction of electric vehicles.
Both types of innovation have their relevance: incremental innovation helps maintain competitiveness and improve existing offerings, while radical innovation drives significant breakthroughs and opens up new markets. Balancing both is key to long-term success [38].

While measuring innovation can be challenging, the subsequent section of the work will delve into reflective analysis, aiming to investigate the role that ISO 9001 can play in this context. "...the majority of studies that analyze innovation outcomes employ a dependent variable which is based on patents, new product development, or

financial performance. The performance of process innovation is particularly hard to measure. . . " [52].

Following the breakdown of each principle of the ISO 9001 standards in the previous paragraph, this section will now focus on how innovation is present and can interact with these principles.

Customers focus

This principle aims to better understand customers' necessities, and preferences. This understanding helps organizations develop new processes and products, and this acts as a guide to channel efforts toward innovation (Martınez-Costa and Martìnez-Lorente, 2008 [24]). Furthermore, being aware of market needs allows firms to align their strategy with their technological capabilities (Perdomo-Ortiz et al., 2006 [32]) and direct their resources toward innovative ideas that can satisfy customer demand. In summary, these arguments demonstrate that prioritizing customer focus can drive product innovation within organizations (Manders et al., 2016 [22]). Other arguments point out that, while is true that customer-focused incentive innovation, they have an effect only on incremental innovation. This would happen when organizations just focus on current customers, and in this case, the innovation is likely to be incremental. Moreover, concentrating on current customer needs has the potential to influence the mindset of the organization. In more detail, adaptive learning, which is grounded in the exploitation of previous knowledge, may overshadow generative learning. Relying solely on adaptive learning can result in organizations being shaped by a pre-established view of the firm's identity or activities, consequently leading to a focus on their existing markets. This approach may constrain radical innovation, which typically emerges from alternative responses to known demands (Manders et al., 2016 [22]).

While it is unquestionable that this principle can support innovation, it is worth noting that, according to some, a well-applied customer focus goes beyond merely satisfying the needs of current customers. It consistently strives to identify new needs and innovative solutions. This principle is grounded in the ongoing exploration of evolving markets, and such a proactive approach undoubtedly contributes to the development

of radical innovations.

Leadership

Applying this principle provides all members of an organization with a clear vision of goals. If an organization wants to pursue innovation, the goals must be toward them, communicating and setting targets. In this principle is also crucial the role of the employee who should provide ideas and contributions to the cause, a trustful environment stimulates employees to share ideas and not feel that their ideas are not appreciated. Key is also the role of training programs, that will empower employees to generate additional ideas that could bring value to the organization. As a result, the leadership principle is anticipated to enhance both incremental and radical innovation (Manders et al., 2016 [22]).

Engagement of people

This principle involves giving more responsibilities to employees and making them feel a sense of belonging to an organization. The aim is to create a sense of responsibility, share common goals and targets, and help them understand the importance of their contribution to the company. Therefore, if the objective is to be innovative, this increased degree of freedom, autonomy, and responsibility will make employees more creative and innovative in their thinking. As a result, they will generate and assess ideas more liberally, secure in the knowledge that their ideas and efforts are highly valued. Therefore, empowering individuals is anticipated to spur both incremental and radical innovation. Furthermore, the principle of involving people encourages employees to freely exchange knowledge and experiences. This facilitates the smooth flow of information and enhances technical communication (Manders et al., 2016 [22]).

Process approach

This principle states the importance of managing and controlling process that builds an organization. Applying with strictness this principle can lead to a high degree of standardization, which can inhibit innovation, especially radical innovations. The main reasons why this principle may not enable innovation are, that standardization limits the creativity of the employees, also having a precise set of activities to attend

creates compliance rules, which would result in employees being afraid of "breaking rules", and deviating from the path. Some processes might not include activities like brainstorming and improvisation because they don't fit with efforts to make things more efficient. However, getting rid of these creative activities is expected to slow down both radical and incremental innovations (Manders et al., 2016 [22]).

Continuous improvement

The continuous improvement in processes, products, and systems should be the objective of every organization. This principle is expected to increase the level of product innovation, as it encourages change and creative thinking, which should result in the development of new services, products, and processes. However, the discussion turns into which kind of innovations this principle supports, for sure incremental innovations are supported, but not radical ones, for the following reasons. First of all non-linear and unstructured thinking is needed to pursue radical innovation, instead continuous improvement, supports a more linear, analytic, and structured approach (Prajogo and S Sohal, 2001 [33]). Secondly, continuous improvement follows a carefully planned and systematic approach to enhancements, while trial and error is essential for radical innovation. When individuals focus on goals that lack ambition, they are unlikely to generate innovative solutions (Prajogo and S Sohal, 2001 [33]). To sum up, these arguments show that continuous improvement may prevent radical innovation. In conclusion, to give also some reason because this principle can improve both kinds of innovations, continuous improvement emphasizes the importance of offering employees the essential training and tools for ongoing improvement. Firstly, this enhances employees' capacity to generate innovative ideas. Secondly, possessing the necessary knowledge empowers employees to pose critical and more pertinent questions (Perdomo-Ortiz et al., 2006 [32]), which are anticipated to stimulate both incremental and radical innovations (Manders et al., 2016 [22]).

Evidence-based decision making

It is the second to last principle provided by ISO 9001 standards under consideration. This principle states that every decision should be made under analytical evidence, pursuing efficiency. By definition, an innovation needs some time to "grow", thus,

data about efficiency can reveal that some innovative practices may result in inefficiency, and following this principle should be discarded. This is the main reason why evidence-based decision-making, may prevent organizations from innovating.

Relationship management

In relationship management, especially with suppliers, the attention at managing relationships can generate innovation. Sometimes it is not just the job of R&D to find innovation, but innovations may come from the outside, for example from supplier relations. The transferability of knowledge plays a crucial role in this relationship, as the improvement in innovation from one can benefit the other, fostering cross-cutting innovation. It all relies on the ability to acquire as much knowledge as possible which is the base for innovation.

In conclusion, the principles that define ISO 9001 in most cases, tend to promote innovation, especially incremental innovation, if implemented correctly to give momentum to it, even if this does not apply to all of the aforementioned principles.

Other factors

Certainly, other factors influence the innovation performance of a firm. When combined with ISO 9001, these factors can yield positive results. In the financial analysis section of this study, which will be presented in the following paragraphs about the effect of ISO 9001, the same factors will be considered. Existing literature on this topic suggests three primary factors: the region, the sector in which the company operates, and the size of the firm.

The environment in which a firm operates, namely the region, are important for the development of innovation capabilities. "The presence, for example, of public research institutions, large dynamic firms, industry clusters, venture capital, and a strong entrepreneurial environment in a specific region can influence the innovative performance of region" [29].

Even if it seems that there is no link between regional development and ISO 9001, there is. Considering the relationship management principle, discussed before, it has been pointed out that external inputs and relationships with other parties can create

a mutually beneficial situation. ISO 9001 would allow managing more easily the exchange of knowledge between institutions, creating a fertile ground for innovation to grow.

Every sector may have its own dynamics, and regulations that can influence the outcome of innovation efforts. For example, in a highly technological environment innovations happen really quickly, and so do the expectations from the customer's side. This could affect the keenness of organizations to come closer to standardization (Manders et al., 2016 [22]).

Receiving a certification involves a certain economic commitment, so small-sized organizations might choose not to implement ISO 9001. Additionally, small and medium-sized enterprises (SMEs) typically lack dedicated research and development departments, focusing on their core business without a specific emphasis on innovation. Nevertheless, structuring innovation processes as outlined by ISO 9001 certification could certainly be beneficial.

Mangiarotti and Riillo (2014) [23] study the effect of ISO 9000 on innovation, in their study they asses that ISO 9001 has a greater effect on small enterprises compared to large ones, and that the use of standardization could be worth the cost for small firms that pursue innovation.

4 Literature Review

The literature review presented in this study aims to provide a deeper insight into the findings of research on standards, innovation, and their potential impacts on firm performance. This review will be articulated in two sections. The initial section gives a wide overview of the effect of ISO 9001 on firm performance, considering not only financial metrics but also insights into qualitative variables. The subsequent section, reflecting the structure of this study, covers the impact of ISO 9001 on the innovation capabilities of firms. Lastly, the literature survey will culminate in a synthesis of both perspectives. While this study focuses exclusively on the analysis of financial performance, research on the impact of ISO 9001 certification extends beyond merely assessing financial outcomes, aiming to fully comprehend the benefits derived from this standard. By utilizing other available research, a detailed and comprehensive view of all parameters influenced by ISO 9001 certification is aimed to be provided. It is important to note that not all examined studies report positive outcomes; however, even these contribute to the overall understanding of the certification's impact, offering means for critical reflection.

4.1 Standards impact on firm performance

Many researchers have focused their studies on the understanding of the relationship between the adoption of certifications in a company and its performance. Despite the numerous studies conducted in this field, the conclusions drawn still exhibit contradictory characteristics.

A very interesting and complete perspective about the majority of the literature ever done about the benefits that ISO 9001 can bring to an organization, is the paper presented by Sampaio et al. [43].

It is interesting to notice that the literature reviewed in this paper is organized explaining which method is used to study the benefits brought by certifications. To gather all the necessary information to conduct this investigation 100 papers are reviewed and these are the main approaches utilized: surveys, analysis of financial indicators, case studies, interviews, literature review, and statistical data analysis. The vast majority uses the survey to support the research, the second most used is the analysis

of financial indicators, as it is possible to see in Figure 8. The conclusions yielded by these methodologies are often subjective and contradictory, Sampaio et al. [43] seek to compile the main conclusions from existing research to describe the state of the literature on quality management systems.

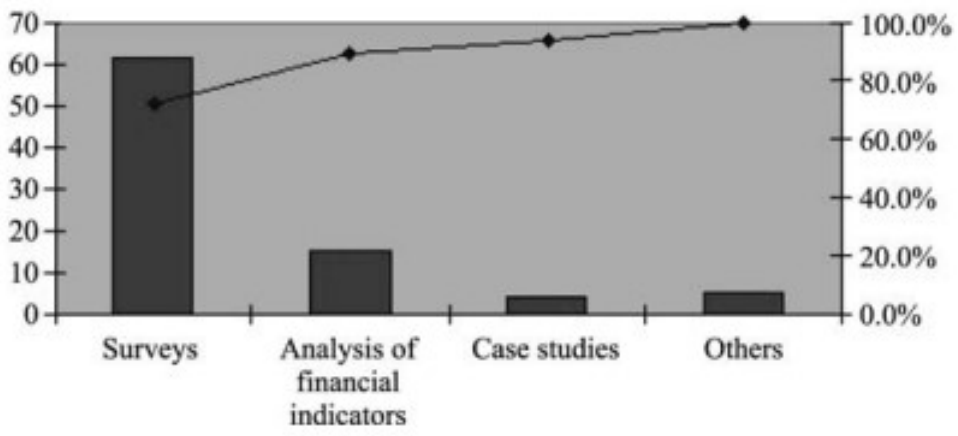

Figure 8: Pareto analysis of research techniques employed by researchers [43]

What is stated in this work of literature review is that even using different methodologies, the results remain contradictory. For the extent of this work, is important to say that there could exist a correlation between the financial performance of an organization and the implementation of a standard, a hypothesis that according to the review conducted by Sampaio et al., [43] can show some contradictions and can not always be true, but can be analyzed with relevant methods.

Heras et al. (2002) [14] argue on the value of these methods, particularly stating that case studies can document the results of 'successful stories' but cannot prove that the implementation of standards actually gives benefits to a firm in terms of performance. To cite Heras et al. [14] 'they do not provide proof that quality certification is likely to lead to improved performance, only that is possible'. Regarding descriptive statistics, they cannot justify a causal link between standards and improved performance, thus leaving statistical data analysis as the most pertinent method [14].

Another insightful literature review on the benefits of standards for organizational performance is conducted by Tarì et al. (2012) [51], who focus on finding similarities and differences between the benefits that two certifications have, namely, ISO 9001 and

ISO 14001. The review of this study will just focus on the benefits of ISO 9001, as the other standard lies beyond the scope of this dissertation. The study of Tarì et al. (2012) [51] is conducted by gathering all the studies available on the main platforms for scientific research, using specific research keywords such as 'ISO 9001' and 'performance.' The search yielded 82 articles discussing performance and ISO 9001. The study identifies 13 benefits, as they are the most frequently analyzed among the 82 articles under review. These benefits include market share, exports, sales growth, profitability, competitive advantage, systematization (e.g., improved documentation, work procedures, and clarity of roles), efficiency (e.g., productivity, cost savings, and reduced errors), product/service quality improvement, enhanced image, better employee outcomes (e.g., motivation, satisfaction, teamwork, communication, and knowledge), increased customer satisfaction (e.g., reduced complaints), improved supplier relations, and enhanced relationships with authorities and other stakeholders.

Lafuente et al (2010) [20] researched the influence of ISO certification and ownership structure on company performance. The study is done by using a sample of 163 Spanish manufacturing firms using a time span for the analysis that goes from 1996 to 2000; the analysis is performed by using a rare events logit model and a regression analysis. Their findings show that organizations that produce intermediate goods with an implemented just-in-time method are more inclined to adopt ISO certification. Empirical data substantiated the positive influence of ISO certification and ownership structure on firm performance. However, their findings suggest that the beneficial effect of ISO certification on performance decreases in companies with highly concentrated ownership.

In the framework of research conducted on the effects of ISO 9001, an interesting contribution is provided by the study of Heras et al (2002)[14], which examine the effects of ISO 9001 certification on financial performance, implementing a comparative study of the profitability of Basque (Spain) region companies. As an indicator to assess the performance, they use the metric Return on Assets (ROA). The dataset used for the analysis consists of 400 companies that have received the certification and 400 that do not possess it. The years considered are 1994, 1995, 1996, 1997, and 1998, with data

collected from national databases. By calculating the average profitability of both certified and non-certified companies, this study reveals that, on average, over the five years, profitability is higher for certified companies. To ascertain whether these differences are statistically significant, a t-test for differences in means is employed at a significance level of 0.05. The results show that there are statistically significant differences in profitability for the two samples studied, certified and non-certified companies. Their conclusion suggests that the benefits of implementing ISO 9001 are more evident over the long term rather than in the short term.

Martinez-Costa and Martinez-Lorente (2003) [25] started their research by acknowledging the fact that the ISO 9000 certified companies are increasing in number and that the possession of a certification is perceived as a prerequisite for business success. "Companies could interpret the registration as the way to obtain sustainable competitive advantages, but is it true? How is the registration interpreted by the market? Do markets assume that certified companies will get more benefits than non-certified?" [25] These are the main questions this study is trying to answer. After examining the stock price performances of Spanish companies certified by AENOR (organization in the certification of management systems), to see if the market reacts to certification as a signal of future performance improvements, the methodology employed involves conducting an event study. Unfortunately, after applying parametric and non-parametric tests, the research suggests that there is no evidence to say that the market consistently values ISO 9000 registration positively.

Beirao et al. [5] created research to empirically investigate the impact on the Portuguese stock market of achieving ISO 9000 certification. They found out, by implementing an event study methodology, that the chosen financial indicators, decreased after a year from the implementation of ISO 9001, and then started increasing again in the following years. The result of this study suggests, that even if the cost of getting a certification is high, the financial benefits that will be gained in the long run will cover the cost. In conclusion, being certified ISO 9000, according to this study, should be considered as a long-term investment.

Still in the context of how financial performance is affected by the ISO 9000 certifications, a stimulating outlook is presented by Dimara et al. (2004)[8]. This study represents a different approach to assessing financial performances, addressing the results that an ISO 9000 can bring to the strategic view or path that an organization intends to follow. The necessity of this paper comes from the contradictory and different results that the literature presents when it comes to assessing the impact of financial performance after a certification. From a first analysis, it is stated by Dimara et al. (2004) [8] that ISO certifications do not bring a decisive improvement, in a firm's financial performance, six years after being certified. Delving more in-depth into the matter, the sample of Greek-certified companies selected are divided into three categories of different strategic approaches: cost leadership, market differentiation, and focus strategy. Repeating the analysis considering these three other factors, the result shows that those firms implementing cost leadership achieve greater results, in terms of financial performance, presenting a statistically significant growth of these indicators. Moreover, those pursuing market differentiation benefit from it having a growth in turnover and market share. This paper concludes that "strategic orientation is a moderating factor influencing the relationship between registration to a quality scheme such as the ISO 9000 scheme, and the firm's financial performance" (Dimara et al., 2004 [8]).

It is evident that the various papers presented offer distinct ideas and methodologies for examining the impact of ISO certifications. The results are not consistently aligned and often lead to contradictory conclusions. For this reason, this dissertation wants to give another opinion on the discussion, presenting a study on the Italian market. As revealed in precedence, there are a lot of factors influencing performance, and there are not any clear statistics or indicators of financial performance that have a direct link with the adoption of a certification. In the reviewed literature, for each study the best indicator is chosen, according to the sample in discussion and the type of hypothesis to verify.

4.2 Standards and innovation

This section of the work tries to give a clearer vision of how ISO 9001 fosters or not innovations. To do this by means of analyses, data coming from surveys and questionnaires would be necessary. This is due to the fact that innovation capabilities have a strong impact on qualitative aspects of organizations, difficult to describe through indicators. Moreover, for the definition of these capabilities, almost the totality of researchers develop specific questions to deliver to companies, based on aspects such as project management processes, innovation culture, strategy, and structure network (Mir et al., 2022 [26]). Given these premises, this part will try to give all the necessary information that is possible to find in the literature, to help understand and have a critical perspective on the relationship between innovation and standardization, and the impact on firm performance. The literature review is done by utilizing the principal tools of academic information (Emerald, Science director, Research Gate...), to gather all the necessary information to conduct this review.

Same as for financial performance, having a clear statement about this topic is not easy, the literature is conflicting about this argument, and there is no clear evidence that can support one argument or the other. To give a clearer vision, the ISO organization decided to implement a literature review [49], confirming that there is the need for further research and an empirical method to consistently assess the impact of ISO 9001 on innovation. This study presented by ISO is written by Knut Blind Professor of Innovation Economics at the Technical University Berlin and coordinator of the Business Unit Regulation and Innovation at Fraunhofer ISI.
Five main functions of the standard are identified, namely:

- Information
- Variety reduction
- Minimum quality
- Compatibility
- Insurance

Each of these functions has both negative and positive impacts on innovation.
Information provides codified knowledge that is relevant for innovation and coordinates collaborative innovation activities, on the other side, the cost of getting a certification may generate a cost for screening that would go against innovation.
The impact of Variety reduction is difficult to determine because of the lack of meaningful data. Having variety reduction allows the organization to exploit the economy of scale, and this constitutes an advantage, but not related to innovation.

Terziovski et al. (2014) [52], contribute to this literature review in a major way, giving the idea of how difficult is to assess the innovation performance that arises from the adoption of a certification, and also that the results can be contradictory, even in the same study.
Terziovski et al. curious about the contradictory results that emerged from their literature review, decided to create a study and verify the effect and the impact that ISO 9001 has on product and process innovation.
As said before the research produced different outcomes. Product innovation presents no statistical significance with ISO 9001 and does not improve measures such as the time to market (TTM) of new products. On the other hand, this paper finds a positive effect of ISO certification on process innovation performances.
These results are reasonable in light of the considerations outlined in Chapter 3. In fact, most of the principles that constitute the ISO 9001 standard focus on information exchange and process improvement.
The preceding paragraph explores how ISO 9001 and its principles may contribute to fostering both incremental and radical innovation, while also considering additional factors that could facilitate such advancements. However, there is insufficient evidence to conclusively support the hypothesis that ISO 9001 alone can enhance innovation capabilities. Manders et al. (2016) [22] presents a comprehensive review of the existing literature on the subject, categorizing each study based on its findings. Studies are assigned a "+" if they identify a positive correlation between ISO certification and innovation, a "-" if the correlation is negative, indicating that certification may impede the innovation process, and an "N" if no significant relationship is found. The results underscore the contradictory nature of the literature; half of the studies

report a neutral effect of ISO certification on firms' innovation capabilities, while the remaining half is evenly divided between those reporting positive and negative effects.

It is interesting to cite the study of Chen [46] (2017), who recognizes the need for a new way of approaching the relationship between innovation and firm performance. In his article, the review of existing literature on the matter is conducted underlying three aspects: the direct impact of innovation on performance, the moderating effect of innovation on performance, and the mediating effect between the two.
Many are the studies that verify a positive direct impact of innovation on organizations' performance, Roberts (1999) [41] studies find that in the long run, innovation brings an improvement in terms of ROI.

Prajogo (2006) [34] conduct a comparative study between manufacturing and service firms to analyze the relationship between innovation and firm performance. His findings show that in terms of product and process innovation performance, there is no significant difference between the two sectors; nonetheless, when investigating the relation between single aspects of innovation performance and firm performance, the results prove a difference between manufacturing and service firms. In particular, Prajogo implements a t-test comparing means of aspects of business performances of the two sectors, based on a specific definition of product innovation, process innovation, and business performance.
Product innovation is articulated in aspects such as the novelty of products, the use of the latest technology, speed of product development, and early market entrants. Process innovation factors are the rate of change in processes, novelty in technology, and technological competitiveness. Business performance, finally, is defined as the interrelation of three aspects: sales growth, market share, and profitability. When he performs Pearson's correlations between each independent factor (product and process innovation) and business performance (in its three aspects) for manufacturing and service firms, the first sector shows significant correspondences for almost all the factors, whereas service firms have a weaker correlation.

Research on the moderating effects of innovation on performance emphasizes the

importance of comprehending the particular market conditions in which innovation takes place to accurately assess its effects on firm performance (Chen, 2017 [46]).
While in dynamics environment, innovation proves to be essential to get and maintain a competitive edge, when the market and firm conditions are stable, it may have a negative impact on performance; customers, suppliers, and producers might also resist to the implementation of innovation (Ram and Jung, 1991 [39]). Furthermore, for companies whose products have a significant presence in international markets, the global market dynamics play a crucial role in determining whether innovation efforts contribute positively or negatively to business performance (Chen, 2017 [46]).

In addition, research has extensively concentrated on examining the effects of innovation on firm performance, considering various mediating factors.
In their study on 449 Australian companies, Liao and Rice (2010) [21] offer a fresh perspective on the relationship between innovation and firm performance. They argue that the traditional view, which assumes a direct link between innovation and success, overlooks the risks involved in implementation and the readiness of markets for new products and processes. Instead, they develop a mediated model that considers how innovation affects firm performance through market engagement and transformation strategies. Their findings suggest that innovation drives organizational performance only when accompanied by significant changes in market positioning and offerings.
Other mediating factors that have been identified are the organization's innovativeness, IT investments, and a firm's market position.
A remarkable contribution to this field of research is given by the work of Mir et al. (2022) [26], which stands out as the first to analyze the degree of standardization, together with innovation capabilities in their effects on innovation performances.
Mir et al. [26] assess three research questions:
1. Innovation capabilities influence positively innovation performance?
2. A higher degree of standardization impact positively on the innovation performance?
3. A combination of innovation capabilities with a higher degree of standardization boosts innovation performance?
The novelty of this study lies in the third research question, which aims at analyzing

the *combined* effect of standardization and innovation capabilities. This study certainly lays the groundwork for future research frontiers in this field. After conducting a fuzzy set qualitative comparative analysis based on results from a survey delivered to 73 Spanish companies, Mir et al. [26], in line with previous research, confirm that innovation capabilities have a positive impact on the innovation performance of a firm. Particularly, this is valid for almost all of the five dimensions of innovation capabilities analyzed in the study, namely Project Management Process, Innovation Culture, Structure and Network, Market, and Strategy. Moreover, they find that in most of the configurations where innovation performance is enhanced, a high degree of standardization is present. Although this is not sufficient to state that standardization is a core driver for performance improvement, it proves the importance of management standardization to seek better performance.
Ultimately, results show that innovation performance of firms of all sizes benefit from the combined effect of standardization and innovation capabilities. This can be considered the key finding of this study, highlighting that management standardization is a valuable precursor to innovation capabilities to boost the innovation performance of a firm.

It is decided to not conduct an analysis, similar to the one in the next paragraph, of the effect of ISO 9001 on Innovation for two reasons: the literature already provides important results on how this certification impacts innovation, explaining that it depends too much on the pursuits of an organization, and on how a company wants to exploit the benefits provided by the application of ISO standards. The other reason lies in the fact that the current structure of the analysis section poses challenges for incorporating additional insights into this topic. Not only would it entail significant resource allocation, but it would also necessitate acquiring more qualitative data, possibly through surveys or in-depth interviews. Nonetheless, it remains an avenue worth exploring in future research endeavors, particularly with the aim of capturing the qualitative dimensions and complexities inherent in the subject matter.

5 Analysis

The analysis conducted in this study aims to contribute to the state-of-the-art research on the effects of standards, specifically ISO 9001, on financial performance, operational results, and quality of a firm. With this purpose, the analysis is focused on comparing relevant financial indicators, in particular Return on assets (ROA), and Return on investments (ROI), of companies with a different status concerning certification. These indicators provide useful information on the impact of ISO 9001 on firm performance, particularly regarding profitability. ROA measures the capability of a firm to generate profit from its assets, ROI provides info on the capability of making investments profitable, and the implementation of ISO 9001 since it has a cost is considered an investment.

It is clear that also some other indicators would be useful to have a wider perspective. Still, the limitation imposed by the database used can not be overcome, leaving the suggestion for future research to use more financial indicators. During the analysis development, numerous indicators were initially considered; however, many inconsistencies arose, including extensive missing data and significant deviations from expected values. These challenges led to the conclusion that ROA and ROI were the only reliable indicators available for the study, calculated as indicated in Equations 1 and 2.

These profitability indicators are particularly valuable precisely because they allow for comparisons across companies of varying sizes, as they are expressed as ratios. This allows for a clearer assessment of performance, with any variations being aligned with those derived from the Aida database [3].

$$ROA = \frac{Net\ income}{Total\ Assets}\% \tag{1}$$

$$ROI = \frac{Net\ Return\ on\ Investment}{Cost\ of\ Investment}\% \tag{2}$$

There are many perspectives from which to approach the topic, thus several ways to conduct the analysis. Heras et al. (2002) [14] compare means of ROA in the years 1994-1998 of two groups of companies, divided into certified and non-certified, employing a z-test coupled with a t-test to verify the statistical significance of differences in means. Galetto et al. (2017) [11] conduct an analysis of variance (ANOVA) to study the relationship between quality management certification systems and the risk of failure of Italian companies. Mir et al. (2022) [26] follow a different approach, including in the analysis of the effects of standardization, innovation capabilities, and their combined effect on the innovation performance of firms. They implement a fuzzy set qualitative comparative analysis (fsQCA) based on input data from a delivered survey. As already pointed out in Section 4, these studies do not always demonstrate an existing cause-effect relationship between the mentioned aspects (Martinez-Costa and Martinez-Lorente, 2003 [25]). It is necessary to emphasize that the type of analysis conducted heavily depends on the available data and on the method used to obtain them (survey, online database, etc.).
Implementing a survey and asking to top management of firms which are the perceived benefits of ISO, appears to be the most precise method of discovering the real impacts of standardization. Surveys give a clearer perspective because there are some external factors, and non-observable variables, that cannot be explained by quantitative indicators that can be found in the balance sheet or income statement. Whereas, the opinion of someone involved directly in the business is more reliable, e.g. a very smart and capable manager is employed in correspondence of ISO 9001 adoption, and the greater results come from his moves on the market. Unfortunately, given the amount of time required by this method, relying on answers from a large sample of companies, a statistical approach has been used instead.

To conduct an analysis of firm performance merely based on the implementation of certification would oversimplify the issue and possibly compromise the results of the study. In fact, multiple factors play an important role in determining a business's performance, such as the region in which the organization operates, the number of employees, the overall market trend, and specific external circumstances (e.g. Covid-19 pandemic, which strongly affected the market from 2020). To analyze the inde-

pendent effects of all these factors requires a very complex analysis and specific data, which extends beyond the scope of this thesis. Building on these premises, this study aims to isolate the effect of standardization, considering a distinction among companies based on size and region, and focusing on a particular sector of interest.
In Section 5.2 the procedure to distinguish and group companies based on the aforementioned criteria will be presented.

5.1 Data collection

To collect the necessary data for the study presented in this dissertation a double-step procedure is carried out. First, the Accredia [2] database is used to identify all the companies that gained an ISO 9001 certification, providing information on the issue date of certification. Accredia is the database that officially accredits for certification Italian companies; it is used to verify which company from the sample has a valid certification.
The filters used in this step are:

- **Sector**: Only companies belonging to the sector IAF 28 (see table 2) are taken into consideration.
  RATIONALE: The construction sector is chosen because it is one of the sectors that have gained the highest number of ISO 9001 certifications through the years [18]. The practical reason for not selecting the sector with the highest number of certifications (metal products manufacturing, [18]) is due to the difficulty in retrieving the data.

- **Region**: Two distinctive inquiries are done, one related to the region Sicily and one for Piedmont. This filter is implemented when searching in the database of Accredia.
  RATIONALE: The regional development is a relevant factor to take into account when analyzing financial indicators of different companies [11]. For instance, if a regional distinction is not made when analyzing the ROA of certified and non-certified companies, the results may be biased by the company's region affiliation. The value of financial indicators is affected by the level of economic development of the respective region [11], which has a direct effect on the en-

vironment in which a company operates, its customers, and the general market 'laws'. It is more pertinent to compare companies belonging to the same region or to regions with approximately the same level of development. This is useful also to isolate the effects of certification on performance from other influencing factors, such as the region to which a company belongs. Alternatively, the effect of regional development can be included in the independent variables/factors when performing the analysis, to study its effect.
The reason why Sicily and Piedmont are chosen as regions is that they belong to two different landscapes of development in the construction sector: Sicily represents a low-developed region, whereas Piedmont is a highly developed one. This distinction is based on many factors, one of them is the total number of construction work in 2022 [17].

The results of these research studies are manually recorded in an Excel spreadsheet since the online database does not give the possibility to download a complete list of all the certified companies, to be subsequently integrated and compared with Bureau Van Dijk data.

The second phase of data collection requires using the Bureau van Dijk AIDA database [3] to gather financial and operational data of the companies of interest. The AIDA database covers all Italian companies, offering detailed financial info for each of them. It is worth mentioning that the first year with available data is 2013 and data for the year 2023 are not accessible. As a result, the most recent year taken into consideration is 2022 [11]. Filters can be applied in the database to make searching easier.
In this case, the following filters have been applied:

- **Region**: A specific region can be indicated, to narrow down the results to companies operating in that region.
  RATIONALE: The reason to implement this filter is straightforward, being the possibility to easily group these data with the ones provided by Accredia.

- **Last year with available data**: This selection allows to reduce the resulting companies to those with financial balances available until the year 2022.
  RATIONALE: Applying this filter, all the companies with incomplete data or lacking data for the year 2022 are automatically discarded.

- **Size of the company**: A distinctive research is done for different company sizes, from Very Large to Medium.
  RATIONALE: As previously pointed out for the regional development, there are many factors that could affect the performance of a firm, besides certification. It is crucial for the validity and reliability of the analysis to take into consideration those factors, among which lies the size of a company. Comparing the financial data of small companies with companies of large dimensions would mean highly compromising the results of the analysis, being unable to distinguish between the effect of certification and size in determining a certain performance. For this reason, different inquiries are made considering the various company sizes. Small companies are not considered because of the lack of financial information from the databases used. The size of the company will be further addressed in the analysis in such a way as to distinguish its effect from the one that certification could have on a firm performance.

- **Sector of operation**: The sector in which companies operate is selected as a restrictive filter in Aida.
  RATIONALE: This filter is applied to make the results consistent with the companies taken from the Accredia database. However, a clarification on the matter needs to be made. The group selected in Aida is based on the ATECO codification [7], whereas the filter applied in Accredia follows the definition of IAF sectors. Although the ATECO code selected in Aida and the IAF sector both correspond to the field of operation related to construction, there is no direct link between the two codifications. Since the IAF sector 28 comprehends a broader field of companies, being a more general reference to the sector of 'construction', some companies belonging to the IAF sector 28, resulting from the research in Accredia, will not be shown as a result in Aida. However, in this way, a specific sector is selected for the analysis, and all the companies taken into account will belong to that sector, without the possibility of misinterpretation.

Data matrices resulting from these studies, containing the financial indicators of interest for the selected companies, are downloaded as Excel spreadsheets.

5.2 Data Processing

It is necessary to elaborate and process the data from the above-mentioned databases, sorting and organizing it in a convenient way to serve as input for the analysis. With this purpose, a Matlab script is developed (fully documented in Appendix A), which takes as input the tables with companies data from Excel and gives as output an organized system of matrices, in which companies are clearly distinguished based on their certification status, size and region of operation. This step is essential to integrate and link information related to the certification status of a company (from Accredia [2]) and its financial indicators (from Aida [3]).

Reading data from Excel

The script reads the tables imported in Excel from the Accredia database and saves them as a matrix with two columns: issue date of certification, and VAT number (unique code defined for each company). The latter will allow a comparison of the data between the two databases. The same procedure is carried out for the data originating from Aida, creating matrices containing all the useful financial indicators for the years 2015-2022 and the VAT number for every company in each row.

Matching data

Subsequently, a *for* loop iterates over the elements of the column containing the VAT numbers of companies retrieved from the Aida database (`colonna_IVA`). Within each iteration, the code checks for correspondences between the current element and the elements in the column with the VAT numbers of companies from the Accredia database (`col2`). If a correspondence is found, the date associated with the corresponding element is formatted and assigned to `stringa_data`. Then, a row of data is constructed, containing various attributes such as company name, VAT number, formatted date, and other financial indicators. This row is appended to the `matriceRisultati` matrix. If no correspondence is found, a row is created with placeholders ('N/A') for the date and other financial indicators, and it is appended to a matrix representing non-certified entities.

This procedure is implemented separately for companies of different sizes, thus resulting in the following matrices: one for XL-sized certified companies, one for XL-sized

non-certified companies, one for L-sized certified companies, etc.
The matrices are then exported to Excel, creating a spreadsheet for each group of companies with the same size, operating in the same region. In Table 3 a piece of the resulting matrix, to export to Excel, is reported as an illustrative example.

VAT	Issue Date	ROA 2015	ROA 2016	ROA 2017	ROA 2018	...
05326630828	12-Jan-2022	4.99	9.58	3.84	2.64	...
02048950832	N/A	4.41	4.18	0.56	4.46	...
...	...	...	...	...	...	...

Table 3: Example of resulting matrix from Matlab script

5.3 Methodology

The method employed in this analysis is a stepwise approach, progressively delving into greater detail. Each method delineates its limitations before advancing to the next step.
Statistical techniques and visualization tools will be analyzed to enhance the understanding of the data and communicate findings effectively. The general idea is to compute the means of several financial indicators, of certified vs non-certified companies, for each of the available years (2015-2022). The obtained values will then be compared, and various methods will be employed to build results while aiming to maintain statistical coherence and ensure their reliability. The process is repeated for each group of companies sharing the same size and operating region.

The first step of the analysis consists of comparing the means of each financial indicator, for certified and non-certified companies, with a certain size and operating region, for the years with available data (2015-2022). Subsequently, if a difference in means is observed, a t-test is performed to assess whether the difference is statistically significant. When examining the effects of ISO 9001 certification on company performance, it is crucial to consider all the factors that play a role. That is why the t-test is performed comparing each time two groups having as the only varying parameter the presence or not of certification. This is the first approach to isolate the effect of standardization, dividing the companies by size and region. Certainly, the t-test can provide useful information in the comparison between the companies that

possess a certification and the ones that do not, but it does not allow yet to assess that the differences in mean are attributable solely to the attainment of certifications. Diving more in-depth into the research, it is clear that many factors could influence the performances. Here is where a pre-post comparison (event-driven analysis) becomes really helpful. By looking at how performance changes before and after certification, the impact of ISO 9001 could be isolated. This step has to be performed on a smaller data sample since a unique year needs to be identified as the transition year. Thus, all the firms composing the sample need to have the same certification issue date. This approach has the scope of filtering out the noise caused by other factors that might be affecting performance. However, as elaborated in 5.5.2, the available data samples fail to satisfy the assumptions necessary for producing reliable outcomes using this analytical approach. Consequently, an alternative methodology is pursued, involving a non-parametric test (James et al., 2014 [19]), to have insights into the varying impacts across size and region.

In the development of the methodology, various statistical analyses were considered to ensure the robustness and validity of the findings. After careful evaluation, Welch's t-test was selected for several reasons. Firstly, Welch's t-test was deemed suitable for the dataset under consideration, particularly in cases where groups may have unequal variances. This method offers flexibility and robustness, especially when dealing with differing sample sizes or violated assumptions of equal variances. By opting for Welch's t-test, the aim was to mitigate the risk of drawing incorrect conclusions. In essence, the choice of Welch's t-test ensures that the analysis maintains a high level of statistical rigor while effectively addressing the unique challenges of the dataset.

5.4 Analysis procedure

After obtaining a complete dataset with all the necessary information for the analysis, it is possible to proceed with the creation of the analytical framework. This will serve as a guide for conducting the analysis and interpreting the results. Initially, it will be explained for the first set of companies, such as XL-sized companies from Sicily. For the subsequent groups, only the results will be reported and commented upon.
Before delving into the computation of the means, some data manipulation is re-

quired. Particularly, a box plot is generated to identify outliers, which are subsequently excluded to provide a statistically more reliable sample (James et al., 2014 [19]). This procedure aims to minimize distortion, even though the outliers may convey genuine information. Additionally, some extreme values significantly skewed the dataset and unduly influenced the mean, prompting their removal to ensure accuracy and consistency.
In the context of data distribution, it is important to note that t-tests can remain robust even when the assumption of normality is not fully met, especially when dealing with large sample sizes (Rasch et al., 2007 [40]).

An important consideration is how to differentiate between certified and non-certified companies for different years. During the data collection process (Section 5.1), all certification issue dates for certified firms were meticulously recorded. Implementing a pivot table in Excel, a systematic tracking of certified companies is conducted on a yearly basis. For instance, the analysis commences in 2015, with only firms certified up to and including that year, considered as part of the certified group. Any firms not certified by that year are categorized in the non-certified section, thus including not only companies that never obtained a certification but also those who obtained it after 2015. This methodology facilitates the progressive incorporation of all certified companies up to the year 2022.

ROA Sicily XL Companies

In Figure 9 a plot displaying the means of ROA through the years for certified vs non-certified XL Sicilian companies (legend in figure) is shown. As it can be easily visualized, a difference between the two groups exists over the years, although with some fluctuations in the value (see how the graphic distance between the plot related to certified companies and that of non-certified is not constant).

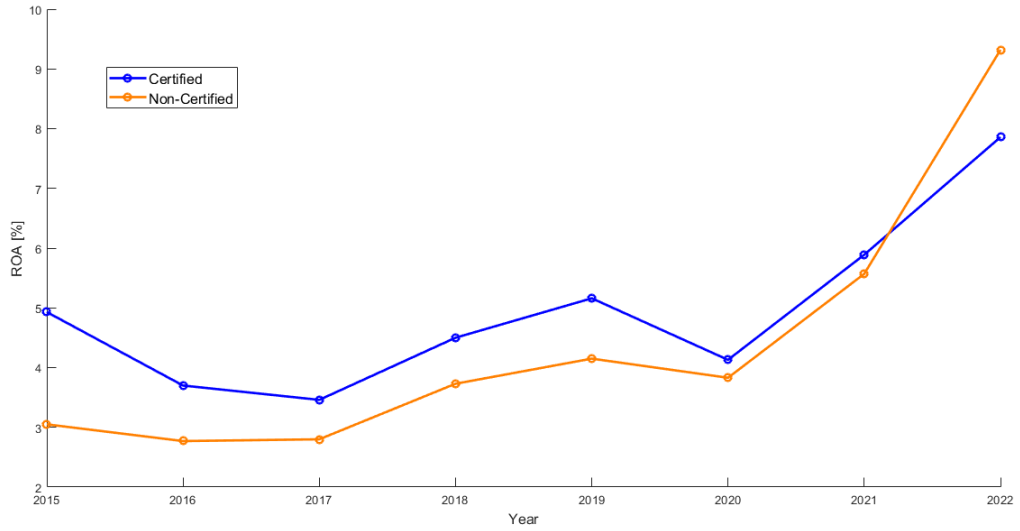

Figure 9: Graphical representation of the difference in ROA [%] between Sicilian XL firms from 2015 to 2022 (blue: certified, orange:non certified).

However, the only conclusion that can be inferred at this point, from a graphical representation, is that certified companies generally exhibit higher values of ROA, at least until 2021. Further validation is necessary to confirm the significance of these results and to examine potential differences in means statistically. In Table 4 the resulting means and variances related to ROA indicator are shown.

	Mean	**Variance**
ROA cert 2015	4.93	17.06
ROA non cert 2015	3.06	8.31
ROA cert 2016	3.70	7.50
ROA non cert 2016	2.77	10.68
ROA cert 2017	3.46	7.31
ROA non cert 2017	2.80	8.21
ROA cert 2018	4.50	15.52
ROA non cert 2018	3.73	11.02
ROA cert 2019	5.16	16.10
ROA non cert 2019	4.15	11.81
ROA cert 2020	4.13	10.45
ROA non cert 2020	3.83	11.98
ROA cert 2021	5.89	20.29
ROA non cert 2021	5.57	20.02
ROA cert 2022	7.86	48.63
ROA non cert 2022	9.32	64.16

Table 4: ROA: Mean and Variance from 2015 to 2022, Sicily XL Companies

One of the main assumptions to conduct a t-test regards homoscedasticity, i.e. homo-

geneity of variance between each population group (James et al., 2014 [19]). To test for this assumption, an F-test is performed for each year, and the results are summarized in Table 5.

Year	Stat F	p-value	Critical F
2015	2.054	<0.001	1.334
2016	1.425	0.037	1.384
2017	1.122	0.265	1.351
2018	1.407	0.013	1.290
2019	1.363	0.021	1.285
2020	1.147	0.200	1.307
2021	1.013	0.456	1.268
2022	1.319	0.035	1.286

Table 5: F-test results for ROA, Sicily XL companies

The F-test aims at validating or refusing the null hypothesis H_0 versus H_1 :
H_0 : the variances of the two groups are homogeneous $\sigma_1^2 = \sigma_2^2$
H_1 : the variance of the two groups are not equal $\sigma_1^2 \neq \sigma_2^2$

Table 5 shows the results for each year. For the null hypothesis to be confirmed, the statistical F should be significantly lower than the critical F, meaning a *p-value* lower than the significance value α, set at 0.05. Since for most of the years, the null hypothesis is rejected, asserting that there is a significant difference between the variances and the assumption of homoscedasticity is not validated, a varied version of the t-test is performed to compare the means, the Welch's t-test. This particular statistical test does not assume homogeneity of variances between the groups.
With this purpose, a one-tailed Welch's t-test is performed between the two sets of data of certified and non-certified companies. The decision to conduct a one-tailed t-test over a two-tailed t-test is associated with the hypothesis being tested, which indicates that one mean is higher or lower than the other. On the other hand, when employing a two-tailed t-test, the aim is to verify if there is a significant difference between the means of two groups, without specifying a particular direction [54]. One more specification is that the test is performed assuming different variances between the two groups. Table 6 shows the results of the t-test performed.

Year	Stat t	p-value	Critical t
2015	3.81	<0.001	1.66
2016	2.47	0.007	1.66
2017	1.95	0.026	1.66
2018	1.82	0.035	1.66
2019	2.35	0.009	1.66
2020	0.84	0.201	1.66
2021	0.67	0.250	1.66

Table 6: Output of t-test for Sicily XL companies, ROA

These results indicate a mean of 4.93 for certified firms and 3.05 for non-certified in 2015. The significance level is set at $\alpha = 0.05$, indicating that there is a 5% risk of making erroneous conclusions by falsely asserting that the two means differ when, in fact, they do not (James et al., 2014 [19]). This requires a *p-value* lower than 0.05 to assess the statistical significance of the results. In 2015, the t-test returns a *p-value* significantly lower than 0.001, thus rejecting the null hypothesis H_0 and confirming that the difference in means in that year between certified and non-certified companies has a statistical significance. Repeating the same test for the years 2016, 2017, 2018, and 2019, will show more or less the same results, confirming that the presence of certification for a firm operating in the construction sector in Sicily and belonging to the XL size, through the years 2015-2019 brings an advantage in terms of ROA, and it is possible to affirm that with statistical proof.

The t-tests performed for the years 2020, and 2021, do not provide the same results as the previous years and suggest that the difference is not significant, so it is not possible to confirm the effect of certification stated in precedence. For the year 2022, no t-test is performed because the mean already shows that the null hypothesis for a one-tailed t-test is confirmed. An important consideration needs to be made at this point: external factors could have influenced the market from 2020 onward, such as the COVID-19 pandemic. According to Thomas Osborn (2021) [28] in the first six months of 2020, there was a year-on-year decrease of approximately 22% in the number of real estate transactions and a 7% decrease in the number of mortgages. This data suggests that the changing market conditions may have offset the impact of certification. Therefore, the results from 2020 to 2022 will not be taken into account. The comprehensive understanding of the effects of COVID and other dynamics exceeds the scope of this study, as numerous factors would have a significant influence.

ROA Sicily L Companies

The analysis performed for the same indicator (ROA), for companies classified as size L operating in Sicily, does not show the same results. The same steps are carried out to assess whether the difference is significant. As it is possible to see from Figure 10 the trend found for the XL companies does not repeat for the L-sized companies. There is a fluctuation in the value of the ROA between certified and non-certified companies that does not show any trend. Moreover, for years after 2020, the mean of non-certified companies is higher than that of certified ones. For these reasons, a t-test is not performed in this case, since the hypothesis of higher means for companies that obtained a certification is already discarded.

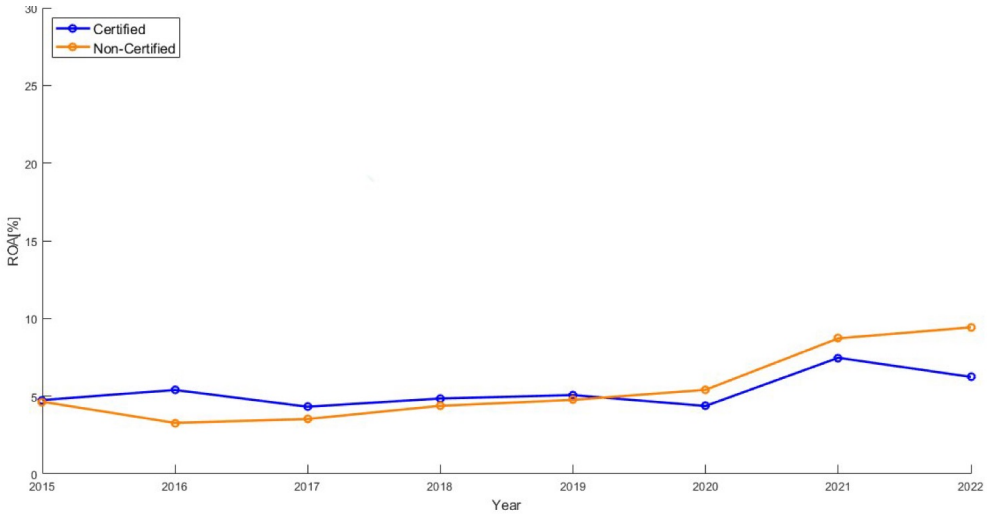

Figure 10: Graphical representation of the difference in ROA [%] between Sicilian L firms from 2015 to 2022 (blue: certified, orange: non-certified).

ROI Sicily XL Companies

The next important financial indicator that is studied is the ROI (return on investment), which measures the return generated by specific investments made by the company. These investments may include those directly related to the implementation of ISO 9001 certification, such as costs associated with staff training, process updates, or research and development of new products or services. Figure 11 displays a plot, created on Matlab, of the average value of ROI through the years of certified vs non-certified Sicilian XL firms. From this graph, it is possible to notice that, on average, certified firms perform better than non-certified. The procedure follows the same logic as the ROA analysis. It is impossible to affirm this graph's statistical relevance, so a Welch's t-test is carried out to verify it.

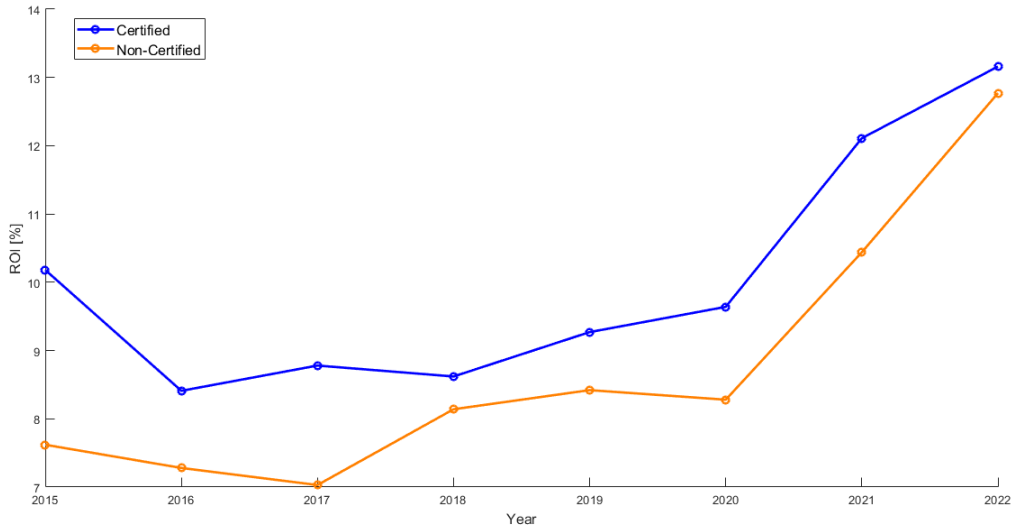

Figure 11: Graphical representation of the difference in ROI [%] between Sicilian XL firms from 2015 to 2022 (blue: certified, orange: non-certified).

The first step to compute this analysis is to create a table to have clear the difference in mean and the variance. Table 7 shows the results.

	Mean	**Variance**
ROI cert 2015	10.18	82.77
ROI non cert 2015	7,62	76.19
ROI cert 2016	8.40	48.96
ROI non cert 2016	7.28	49.88
ROI cert 2017	8.77	39.67
ROI non cert 2017	7.03	59.50
ROI cert 2018	8.62	49.20
ROI non cert 2018	8.14	68.38
ROI cert 2019	9.27	40.50
ROI non cert 2019	8.42	65.73
ROI cert 2020	9.64	40.05
ROI non cert 2020	8.28	73.25
ROI cert 2021	12.11	57.33
ROI non cert 2021	10.03	80.70
ROI cert 2022	13.16	58.03
ROI non cert 2022	12.77	73.26

Table 7: ROI: Mean and Variance from 2015 to 2022, Sicily XL companies

Even though values presented in Table 8 show that it exists the condition of homoscedasticity for some years in the analysis, it is decided to implement the Welch's t-test for all the years, to maintain coherency between the analyses.

Year	Stat F	p-value	Critical F
2015	1.08	0.331	1.38
2016	0.98	0.480	0.69
2017	0.66	0.027	0.70
2018	0.72	0.049	0.72
2019	0.61	0.006	0.73
2020	0.65	0.01	0.73
2021	0.71	0.037	0.72
2022	0.79	0.110	0.73

Table 8: F-test results for ROI, Sicily XL companies

All the assumptions made for the ROA remain valid, and a Welch's t-test is performed, to prove the thesis of a difference in mean between certified ISO 9001 companies, and noncertified companies. Table 9 shows the results.

Year	Stat t	p-value	Critical t
2015	1.94	0.028	1.66
2016	1.08	0.141	1.66
2017	1.86	0.032	1.65
2018	0.47	0.317	1.65
2019	0.95	0.171	1.65
2020	1.43	0.076	1.65
2021	1.60	0.054	1.65
2022	0.37	0.352	1.65

Table 9: Output of t-test for Sicily XL companies, ROI

The significance level of α=0.05 shows that hypothesis H_1, of a difference in mean, is verified just for the years 2015 and 2017, for all the other years the null hypothesis is true. It is possible to affirm that in this case, the effect of certification ISO 9001 does not appear determinant in bringing an advantage in ROI between the two analyzed groups. This result is "contradictory" to the one provided by ROA for XL companies in Sicily, suggesting that ISO 9001 creates an effect on the efficiency of the use of assets; another possible explanation could be that some investments need a wider recovery time, so to witness improvement the time considered should be longer. This latter consideration will be further addressed in a second analytical step, presented in Section 5.5.

ROI Sicily L Companies

The next group taken into consideration for the analysis is the group made by L-sized firms operating in Sicily. The procedure still remains the same, through a first

graphical representation of the means through the years 2015 to 2022, trends and patterns are shown. The figure shows the plot of the mean through the years.

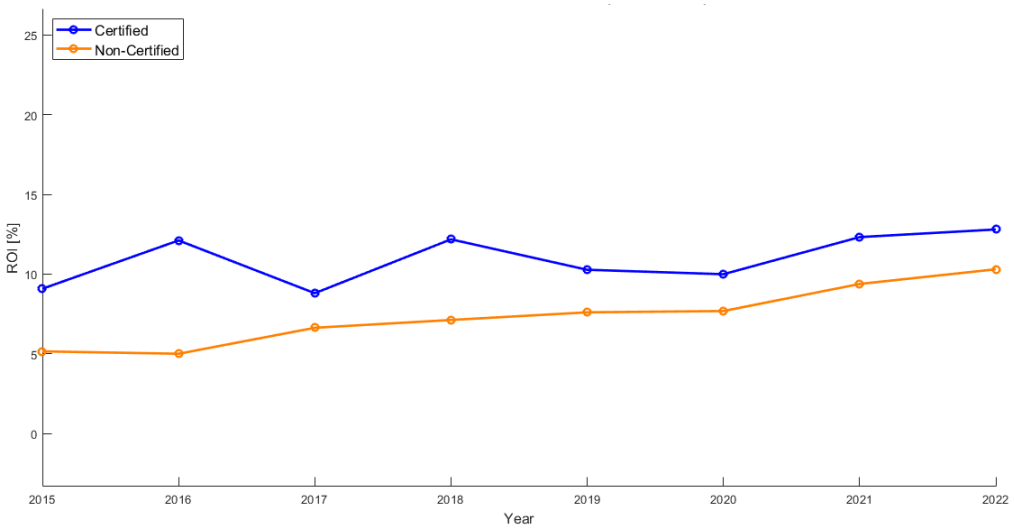

Figure 12: Graphical representation of the difference in ROI [%] between Sicilian L firms from 2015 to 2022 (blue: certified, orange: non-certified).

Here, it is clear how companies equipped with an ISO 9001 certification generally perform better with higher ROI, compared to those which did not implement any certification. As already pointed out before, this graphical representation may not show all the truth, so digging deeper into these data the next step is to run a Welch's t-test. It is important to point out that in this case an F-test is not done because the study wants to maintain coherence between the analyses.

	Mean	Variance
ROI cert 2015	9.10	82.85
ROI non cert 2015	5.16	46.14
ROI cert 2016	11.12	66.18
ROI non cert 2016	5.01	34.15
ROI cert 2017	8.80	43.48
ROI non cert 2017	6.63	46.49
ROI cert 2018	12.18	65.16
ROI non cert 2018	7.13	58.63
ROI cert 2019	10.27	84.22
ROI non cert 2019	7.60	72.64
ROI cert 2020	10.00	80,20
ROI non cert 2020	7.69	78.52
ROI cert 2021	12.32	93.87
ROI non cert 2021	9.37	82.59
ROI cert 2022	12.80	67.36
ROI non cert 2022	10.30	83.61

Table 10: ROI: Mean and Variance from 2015 to 2022, Sicily L companies

Table 10 shows the mean and variance of the companies, to provide a more clear view. The following Table 11 displays the results of the performed t-test and the results will be commentated in the following lines.

Year	Stat t	p-value	Critical t
2015	2.39	0.011	1.69
2016	4.27	<0.001	1.69
2017	1.91	0.032	1.68
2018	4.01	<0.001	1.67
2019	2.12	0.018	1.66
2020	1.88	0.031	1.66
2021	2.28	0.012	1.66
2022	2.32	0.011	1.66

Table 11: Output of t-test for Sicily L companies, ROI

As it is possible to see from the table, all the p-values are below the significance level of 0.05, confirming what the initial thought derived from the graph was. Moreover, most of the p-values are way below the significance level, suggesting a strong difference for the two groups considered. These results prove the exact opposite of the one provided by XL firms.

A possible explanation for these contradictory results can be the investment capac-

ity of the two considered groups; L-sized companies might have limited financial resources compared to XL companies, which could affect the quantity and type of investments they can make, giving the possibility to ISO 9001 to show a higher effect also in the short term. Moreover, XL companies may face unique challenges related to their size, such as complexity in implementing standardized quality management systems across multiple divisions or geographic locations. These challenges could dilute the impact of ISO 9001 certification on performance metrics, making it less discernible than smaller companies.

The next step is to repeat the analysis that has been done for Sicilian companies, for companies operating in Piedmont. The process to collect the data is the same, and also the analysis is carried out in the same way. It is expected to produce the same outcome, in this way what is affirmed in the previous part would be confirmed.
The percentage of certified firms over the totality provided by Aida is the same as Sicily having approximately 20% of certified firms over the total of firms operating in the sector.

The first step, as before, is to plot a graph showing the evolution of the mean, comparing certified and noncertified firms. The first indicator considered is the ROA, the same as the Sicilian companies, and companies classified by Aida database [3] as size XL.
Figure 13 is the graphical representation of the difference in ROA between Piedmont XL firms from 2015 to 2022. The trend is very similar to the one assessed in Sicily for the same size. Certified firms tend to perform better from 2015 to 2019, then in the COVID year and after, the trend is inverted. The consideration remains the same as before; the impact of the pandemic could have changed too many factors, so values from 2020 onward are not totally reliable.

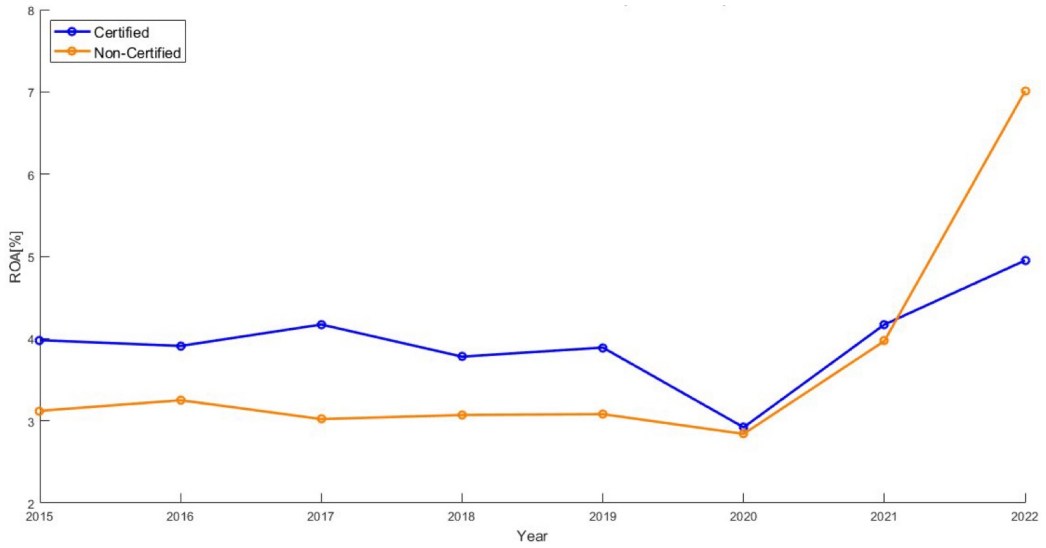

Figure 13: Graphical representation of the difference in ROA[%] between Piedmont XL firms from 2015 to 2022 (blue: certified, orange: non-certified).

The results indicate that what was observed for companies in Sicily is further corroborated by those in Piedmont. The reported values are similar and exhibit the same trend. As previously observed, a difference in means and a graphical confirmation alone are insufficient to assert the existence of a statistical difference. Therefore, a Welch's t-test is performed to enhance the analysis's validity. Table 13 shows the results.

	Mean	Variance
ROA cert 2015	3.98	8.54
ROA non cert 2015	3.12	14.42
ROA cert 2016	3.91	8.30
ROA non cert 2016	3.25	12.56
ROA cert 2017	4.16	11.59
ROA non cert 2017	3.02	12.10
ROA cert 2018	3.78	9.25
ROA non cert 2018	3.07	13.05
ROA cert 2019	3.88	8.84
ROA non cert 2019	3.08	13.36
ROA cert 2020	2.92	6.67
ROA non cert 2020	2.84	11.30
ROA cert 2021	4.17	8.66
ROA non cert 2021	3.97	14.59
ROA cert 2022	4.94	12.22
ROA non cert 2022	7.01	28.88

Table 12: ROA: Mean and Variance from 2015 to 2022, Piedmont XL companies

Year	Stat t	p-value	Critical t
2015	2.30	0.011	1.65
2016	1.81	0.036	1.65
2017	2.74	0.003	1.65
2018	1.91	0.028	1.65
2019	2.17	0.015	1.65
2020	0.23	0.40	1.65
2021	0.56	0.28	1.65

Table 13: Output of t-test for Piedmont XL companies, ROA

The numbers once again confirm the previous findings, showing a significant difference, between certified and noncertified ISO 9001 firms. The p-values from 2015 to 2019 never reached the significance level, remaining below it, and confirming the hypothesis of an advantage provided by the certification ISO 9001. In 2020 COVID shows its effects shrinking the mean together. It is noteworthy that the test for 2022 is not in the table because the mean value for noncertified firms overcomes the certified one.

In the final section of this first analytical study, the ROI for XL companies in Piedmont is examined, and akin to the ROA findings, the results demonstrate a resemblance to those observed for Sicily.
Figure 14 displays the graphical representation through the years. For the first four years certified firms seemed to perform better, but for the last years, the difference is not relevant anymore.

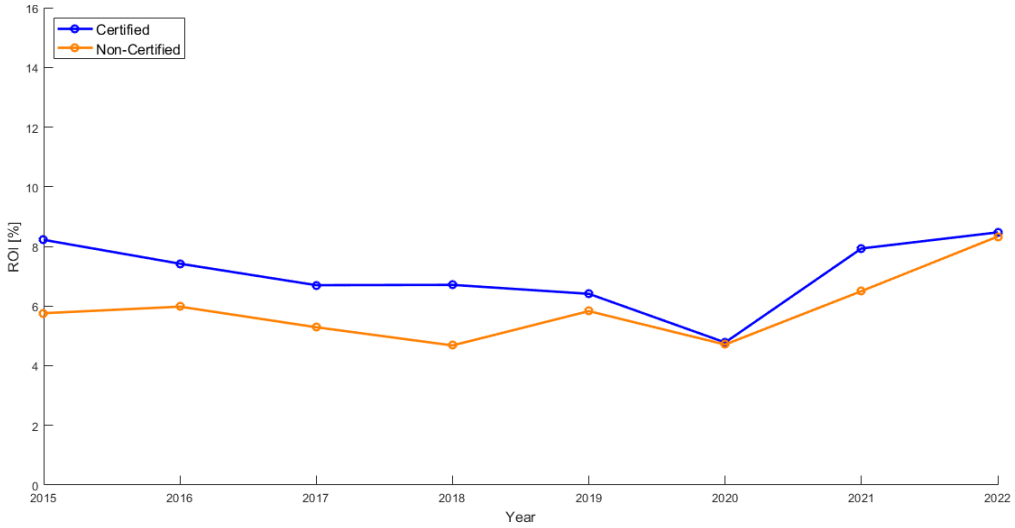

Figure 14: Graphical representation of the difference in ROI[%] between Piedmont XL firms from 2015 to 2022 (blue: certified, orange: non-certified).

Table 14 shows all the mean and the respective variance in all the years.

	Mean	Variance
ROA cert 2015	8.22	36.11
ROA non cert 2015	5.76	54.37
ROA cert 2016	7.42	31.37
ROA non cert 2016	5.98	45.63
ROA cert 2017	6.70	28.08
ROA non cert 2017	5.28	36.35
ROA cert 2018	6.71	36.22
ROA non cert 2018	4.68	35.50
ROA cert 2019	6.41	28.62
ROA non cert 2019	5.83	45.21
ROA cert 2020	4.77	16.69
ROA non cert 2020	4.71	38.24
ROA cert 2021	7.94	31.65
ROA non cert 2021	6.50	52.14
ROA cert 2022	8.47	34.32
ROA non cert 2015	8.33	44.84

Table 14: ROI: Mean and Variance from 2015 to 2022, Piedmont XL companies

Year	Stat t	p-value	Critical t
2015	3.00	0.001	1.65
2016	1.73	0.042	1.65
2017	1.78	0.038	1.66
2018	2.50	0.007	1.66
2019	0.76	0.222	1.66
2020	0.10	0.458	1.66
2021	1,71	0.044	1.66
2022	0.16	0.437	1.66

Table 15: Output of t-test for Piedmont XL companies, ROI

Table 15 shows the t-test results for the XL companies in Piedmont. The hypothesis of a significant difference is confirmed for the years: 2015, 2016, 2017, 2018, and 2021. The certification seems to slightly advantage certified companies, but this advantage is not big enough to persist in the following years.
Thus, the conclusion is that it is not possible to affirm the advantage brought by ISO 9001, considering also the results found for Sicily.
L-sized companies operating in Piedmont are excluded from the analysis due to the small sample size of certified companies, coupled with numerous missing data points, rendering the results unreliable and invalid.

It is worth noting that, contrary to expectations, the mean values of ROA and ROI are marginally better in the "underdeveloped" region of Sicily.
Possible explanations for this result include:

- Lower labor and resource costs: In regions with low development, labor and resource costs may be lower compared to more developed regions. This can contribute to higher investment profitability, as production costs are more contained.

- Local specializations and competitive advantages: Some regions with low development may have specific specializations or skills that make them competitive in certain sectors or markets. This could result in a higher ROI for investments in such regions.

- Opportunities for growth and development: Regions with low development may offer greater opportunities for growth and development, especially in sectors

where there is unmet demand or room for infrastructure expansion.

Additionally, other factors such as political stability, access to capital, and market conditions can influence these two indicators. The reasoning of these results falls beyond the scope of this work.

5.5 Non-parametric Test

The t-tests conducted on ROI and ROA over the years provide some preliminary insights into the potential impacts of standardization on these financial metrics. However, this initial analysis lacks a quantitative representation of the differences among groups of firms based on size and region. Additionally, the results are specific to a particular year, comparing certified and non-certified companies within that year.
To address these limitations and obtain a more comprehensive understanding of the effects of standardization, further analysis is needed. The objective is to conduct an in-depth analysis comparing the same financial metrics across all companies to examine the impact of certification after a certain period of its implementation within different firm scenarios.

5.5.1 Data collection

The available data will be reorganized to facilitate the analysis focusing on the effects of certification three years after its implementation. This decision aligns with previous research findings indicating that the impact of certifications becomes more pronounced over time.
To conduct this analysis, the financial data from both certified and non-certified companies will be collected and organized based on their certification status and the time elapsed since certification implementation. By focusing on the three-year mark, the study aims to capture the longer-term effects of certification on financial metrics such as ROI and ROA. The selected time frame after certification extends from 2016 to 2019. As previously noted, due to the significant economic disruptions caused by the pandemic in 2020, it is advisable to exclude data from that year onward.

The approach involves collecting ROI and ROA data from 2016 to 2019 for all types of companies (varying in size, region, and certification status). Subsequently, the yearly

difference in ROI and ROA is computed for each year (e.g., 2017 - 2016). These differences are then converted into percentages ($\Delta[\%]$) to standardize the values and provide meaningful insights, Equation 3 shows the calculations.

$$\Delta[\%] = \frac{ROI_n - ROI_{n-1}}{|ROI_{n-1}|} \times 100 \tag{3}$$

$\Delta[\%]$ is the percentage difference, n is a given year (from 2017 to 2019).

After calculating the difference rates for each year, their mean is computed. This aggregated data serves as the input for the statistical analysis. The rationale behind calculating the mean of annual change rates over multiple years is to mitigate the influence of volatile factors that could affect financial indicators within a single year. By considering the average change rate over a span of years, the aim is to smooth out potential biases arising from fluctuations in performance. For instance, focusing solely on the difference between 2019 and 2018 might be misleading if 2018 experienced poor performance while 2019 saw significant growth. Utilizing the mean helps to alleviate these potential biases and provides a more comprehensive perspective on trends over time.

The main objective is to compare the average yearly difference in ROI and ROA among different groups of companies.

With 2016 being the reference year for certification implementation, the analysis aims to test whether the yearly change in ROA/ROI significantly differs between certified and non-certified companies. Additionally, it seeks to explore whether these effects vary based on the size and operating region of the firm.

Groups division

In the statistical analysis, the regional affiliation, size, and certification status are treated as categorical input variables. This kind of variables can take on a limited number of distinct values, and each value represents a different category or group [19]. For example, size can be categorized as ”L” (small) or ”XL” (large), while region can be categorized as ”Sicily” or ”Piedmont.”

For the purpose of this analysis, companies will be divided into groups based on these categorical variables. There will be a total of six groups, each representing a combination of categories from the variables under consideration. These groups will

be reported in Table 16, providing an overview of how companies are categorized based on their regional affiliation, size, and certification status.

Group	Region	Size	Certification status
1	Piedmont	XL	Non cert.
2	Piedmont	XL	Cert. $>$ 3 years
3	Sicily	XL	Non cert.
4	Sicily	XL	Cert. $>$ 3 years
5	Sicily	L	Non cert.
6	Sicily	L	Cert. $>$ 3 years

Table 16: Groups division for Kruskal-Wallis test

5.5.2 Why not a "controlled before and after" study?

The original plan was to look at the effects of certification through an event study. In this study, the effects of certification would be evaluated by comparing an experimental group of companies that received certification to a control group of companies that did not receive certification. The difference-in-differences (DiD) test was selected as the statistical technique for this investigation.
The DiD test works by comparing changes in outcomes (e.g. ROI) over time between the treatment group and the control group, seeking a significant difference in trend after the implementation of certification, aiming to estimate the causal effect of the treatment while accounting for any other factors that may affect the outcome.
However, the DiD test requires the assumption that the trends in outcomes for the treatment and control groups are roughly parallel before the treatment occurs. This assumption was graphically tested in the present case and found to be rarely satisfied. Furthermore, an extra goal of this study is not aligned with the DiD test, which only permits a comparison between two groups.

The nature of the dataset available justifies the reason for choosing the non-parametric Kruskal-Wallis test, a robust alternative to analysis of variance (ANOVA), in case some of the assumptions of the latter are not met.
Since ROA and ROI are financial measurements that may not follow normal distributions and could be influenced by non-linear variations, the Kruskal-Wallis test better suits the nature of variables and the research hypotheses.
One of the main assumptions of ANOVA is that dependent variables of all groups

follow a normal distribution. This assumption was assessed for the groups taken into consideration in this study (see Table 16) performing a Shapiro-Wilk test in SPSS. The results, for all the groups, show a significant deviation from a normal distribution, proved by a *p-value* lower than the significance level $\alpha = 0.05$.
Although the ANOVA is robust against this assumption, the samples are too small to proceed with this analysis, also because neither the assumption of homogeneous variances among the groups is satisfied (James et al., 2014 [19]). Kruskal-Wallis non-parametric test offers a robust alternative to conduct for the case in the study [30]. This approach was adopted to consider data from multiple years simultaneously and to isolate the effect of ISO certification on the trend of financial performance rates, as well as to provide a more robust and comprehensive evaluation of the overall impact of ISO 9001 on company performance. The test is performed two times, one time for each variable studied (ROA and ROI), and as previously pointed out the independent variables composing the groups for the test are the ones presented in Table 16. Furthermore, as non-parametric tests indicate significant differences among groups without delineating specific pairwise comparisons, a post-hoc analysis is incorporated into the study to provide detailed results regarding the comparisons between each pair of groups.

5.5.3 Results

The output of the test performed on SPSS is presented here. It is important to consider that the dependent variable in the analysis is the average annual change in financial indicators (ROA or ROI).

ROA, Piedmont

The comparison between Piedmont XL certified and non-certified companies presents a p-value higher than the significance level. These results suggest that the effect of certification in Piedmont is not relevant. What this test explains is that the rate of growth between certified and certified firms does not show any significant difference.

ROA, Sicily

The results for Sicily are particularly interesting. When examining L-sized certified and non-certified firms, the p-value exceeds the significance level. This finding aligns with previous analyses, indicating no discernible effects. This test further solidifies

those conclusions, revealing that the disparity in yearly growth between certified (for more than three years) and non-certified L-sized companies from Sicily lacks statistical significance.
Conversely, different outcomes emerge for XL companies. Here, the p-value comparing certified XL versus non-certified XL groups falls below the significance level, warranting rejection of the null hypothesis of no difference between the two groups. Particularly, these results indicate a better performance for the group of certified companies, confirming earlier findings, and reaffirming the advantage brought by certification. Notably, the statistically significant difference in mean, as demonstrated by the t-test, underscores this advantage. Moreover, the subsequent test provides additional details, revealing that annual growth rates between the two groups remain significantly distinct in the years following certification.
Table 17 presents the p-value derived from the conducted tests and posthoc analyses.

Groups confrontation	Region	Size	Status	p-value
4-3	Sicily-Sicily	XL-XL	Cert-Non Cert	0.016
6-5	Sicily-Sicily	L-L	Cert-Non Cert	0.104
4-6	Sicily-Sicily	XL-L	Cert-Cert	0.004
3-5	Sicily-Sicily	XL-L	Non Cert-Non Cert	0.142

Table 17: Results of the Kruskal-Wallis Test comparing Sicilian firms, ROA

It can be therefore assessed that in Sicily, certifications have had, in the considered period, a higher effect on the ROA of XL firms than L firms.

This analysis offers an intriguing perspective by contrasting Sicily and Piedmont, specifically focusing on XL-sized certified companies. Notably, the comparison reveals a significant distinction between the two regions, evident in the comparison of non-certified groups where the p-value falls below the threshold of α=0.05.
Non certified companies operating in Piedmont show a statistically significant higher ROA than Sicilian firms.
This initial contrast underscores the presence of a more developed region, characterized by a significantly higher growth rate. On the other hand, upon examining the comparison between certified companies in Sicily vs Piedmont, the p-value fails to reach significance, indicating that certification did not yield discernible differences in annual growth rates across the two regions. The implementation of certification seems

to bridge the gap between the two regions, particularly notable for non-certified companies. It is plausible that certification has elevated Sicilian companies to a comparable level with those from more developed regions.
The numbers are presented in Table 18.

Groups confrontation	Region	Size	Status	P-value
1-3	Piedmont-Sicily	XL-XL	Non cert-Non cert	0.008
2-4	Piedmont-Sicily	XL-XL	Cert-Cert	0.163

Table 18: Results of the Kruskal-Wallis Test comparing Sicily and Piedmont, ROA

Except for the firms in Piedmont, the results of this subsequent analysis further confirm the initial findings, reaffirming the impact of ISO 9001 certification on XL firms' profitability indicator, ROA. In essence, the relationship established suggests that ISO 9001 certification has the potential to enhance ROA through streamlining operational processes, enhancing product/service quality, implementing effective human resource management strategies, and expanding market access. These collective benefits contribute to heightened business efficiency and overall profitability.
The same analysis is conducted to assess significant differences across various company sizes. The results indicate no significant disparities between XL and L Sicilian non-certified firms, with a p-value exceeding the significance level, supporting the retention of the null hypothesis of no difference between the groups (see Table 17). However, for certified ISO 9001 companies, the significance between XL and L firms suggests that the annual growth analyzed is more pronounced for XL companies, implying a greater impact of certification on the ROA of larger enterprises.

ROI

The analysis is now run for the second indicator under consideration, ROI. The consideration regarding groups and how to calculate the input of the analysis remains the same as before, the only change made is on the financial indicator considered.

ROI, Piedmont

The results of the Kruskal-Wallis test comparing groups 1 and 2 (see table ref 16), indicate that the firms that have achieved a certification and have been certified for more than three years, present a significantly higher growth from 2016 to 2019. The p-value is 0.004, and comparing the mean, the median, and the rank is possible to affirm that the certified ones perform better compared to the non-certified ISO 9001

ones.

Given the results of the previous test, this further analysis confirms that ISO 9001 brings an advantage.

ROI, Sicily

As the previous point when the analysis was run for ROA, Sicilian companies gave interesting results. Table 19 presents the results.

Groups confrontation	Region	Size	Status	P-value
4-3	Sicily-Sicily	XL-XL	Cert-Non Cert	0.013
6-5	Sicily-Sicily	L-L	Cert-Non Cert	0.015
4-6	Sicily-Sicily	XL-L	Cert-Cert	0.574
3-5	Sicily-Sicily	XL-L	Non Cert-Non Cert	0.864

Table 19: Results of the Kruskal-Wallis Test comparing Sicilian firms, ROI

The analysis highlights, through the p-value, superior performance for companies holding an ISO 9001 certification, leading to better growth in terms of ROI. This trend is consistent across both size dimensions, L and XL.

Expanding on this, ISO 9001 certification signifies adherence to international quality standards, which can instill confidence among stakeholders, including customers, investors, and partners. Companies with ISO 9001 certification often demonstrate a commitment to delivering high-quality products or services consistently. This can result in enhanced customer satisfaction, repeat business, and positive word-of-mouth referrals, ultimately driving revenue growth and improving ROI.

The analysis also offers insights into the comparison between the annual change in ROI of Sicilian L and XL firms. For both certified and non-certified companies, there is no significant difference in ROI performance between L and XL. Therefore, in this case, it appears that size is not a highly impactful parameter when assessing the annual change in ROI.

The comparison between firms operating in different regions produces consistent results, indicating a p-value exceeding the significance level. This insight suggests that the hypothesis asserting the significant influence of regional development on the annual change in ROI post-certification can be rejected.

6 Conclusions

The study aimed at finding an answer to the research questions cited in the introduction on the relationship between standardization, innovation and firm performance. With this purpose, statistical analyses have been carried out, producing some interesting results. While not all the outcomes point in the same direction, it can be generally concluded that ISO 9001 certification brings advantages to Italian firms in the construction sector. These advantages are diverse, as discussed in Chapter 2. ISO certifications facilitate significant organizational improvements, aiding decision-making, fostering operational enhancements, engaging personnel, and, notably, shifting focus towards customer needs and preferences.
This organizational enhancement positively influences the firm's financial metrics, notably improving profitability. The chosen indicators to assess this impact are ROI and ROA. Although not all outcomes demonstrate the desired impact, the majority of tests conducted confirm the initial research question.

RQ1: *Does the implementation of ISO 9001 standard have a discernible impact on the financial performance of Italian XL and L firms? If so, does this impact tend to be positive or negative?*
The answer is generally positive, yet it is crucial to interpret these findings with appropriate caution. Heras et al. (2002) [14] arrive at similar conclusions regarding the advantageous effects of ISO 9001 on profitability. However, as with this study, such conclusions require careful consideration, taking into account various factors that influence a company's performance and attempting to isolate the specific effects of ISO certification.

In this study, efforts have been made to do so, hence the multiple analyses conducted. However, limitations in the dataset sometimes impede the implementation of specific steps effectively. Nonetheless, through initial t-tests and subsequent Kruskall-Wallis tests, valid results confirming the impact of standardization on ROI and ROA within the sampled companies have been obtained.

In conclusion, upon careful examination, it is evident that companies with an ISO 9001 certification experience greater profitability. However, it is important to remember that these findings only apply to the construction sector in Italy and the two regions studied. They cannot be generalized to all sectors, but similar advantages would likely apply to most Italian regions, considering the sample includes regions at the edge of regional development classification.

RQ2: *To what extent do factors such as the size of the firm or the regional context in which it operates influence the relationship between standardization and firm performance?*

The second analytical step provides insights to address this inquiry. As demonstrated in Section 5.5.3, when comparing the annual change rate of XL and L companies in Sicily that have been certified for at least three years, a more significant impact of certification on XL firms is evident. Hence, it can be concluded that, within the scope of this study, a variation in the impact of standardization across different company sizes is evident. However, it is important to note that these findings are confined to the data examined in this analysis; to definitively substantiate them, it would be necessary to expand the analysis to encompass all Italian regions.
The higher advantage in ROA (Return on Assets) and ROI (Return on Investment) observed in XL (extra-large) companies compared to L (large) companies following certification could be attributed to several factors:

- **Resource Allocation**: XL companies typically have larger financial resources and capabilities compared to L companies. Therefore, they may have more resources available to invest in obtaining and implementing ISO 9001 certification effectively. This can lead to a more robust implementation of quality management systems, resulting in greater improvements in efficiency, productivity, and financial performance.

- **Scale of Operations**: Larger companies (XL) typically have more extensive resources, including financial, human, and technological assets, compared to smaller enterprises (L). As a result, they may have greater capacity for investment, innovation, and operational efficiency.

The analysis also provides insights into the impact of regional development levels,

revealing that regardless of whether a region is classified as high or low in development, both demonstrate similar advantages. However, XL firms are more likely to make significant investments and implement ISO 9001 more readily.
Overall, the results suggest no discernible difference between regions. This conclusion is supported by the outcomes of the Kruskal-Wallis test, which indicates no disparity in profitability growth between the two regions under consideration.
The standardized approach promoted by ISO 9001 may lead to improvements in efficiency, quality control, and customer satisfaction that translate into enhanced performance outcomes for companies, regardless of their geographical location.
Additionally, the absence of a significant difference between regions in terms of profitability growth, as indicated by the Kruskal-Wallis test, suggests that the impact of ISO 9001 certification on financial performance is consistent across diverse regional contexts. This could imply that factors other than regional development, such as industry dynamics, company size, or management practices, may play a more influential role in determining the effectiveness of ISO 9001 certification in driving performance improvements.

RQ3: *What is the nature of the correlation between standardization and innovation capabilities? Do they mutually reinforce each other or hinder one another?*

The answer to this question is based solely on the literature study conducted in Chapter 4. As suggested by the literature, the answer to this question is intricate, and this study affirms this consideration.
However, the analysis presents a set of factors, including company size, sector, country, ISO 9001 version, and company motivation, which are likely to influence both the direction and strength of the effect that ISO 9001 certification may have on innovation. These insights are gleaned from the comprehensive literature review conducted as part of this study.
It is evident that further investigation, such as surveys, is warranted to gain a deeper understanding of this topic. The subsequent Chapter 7 will propose avenues for exploring the implications of ISO 9001 certification more effectively.
In conclusion, while ISO 9001 certification aims to standardize processes and make

them more consistent, it may unintentionally impede the creative exchange of ideas that drive innovation. Moreover, this thesis asserts that the impact of ISO 9001 certification on innovation depends on various factors, including the organization's scope and ability to align with ISO 9001 principles while pursuing innovation goals.

These reflections underscore the complexity of the relationship between standardization and innovation and highlight the need for new approaches to studying this phenomenon. By acknowledging the interplay of factors influencing this relationship, this study contributes to a more comprehensive understanding of the dynamics at play.

7 Recommendations for future works

This thesis adopts an analytical approach to the problem under investigation; however, numerous factors must be considered to robustly support the thesis. A suggestion for future studies is to conduct a dual analysis, encompassing not only the financial aspects but also the impact of certification on individuals within organizations. This recommendation stems from the literature review. Implementing a survey would be an effective means of gathering a comprehensive range of data. Integrating a survey into the analysis presented in this work would provide a holistic understanding of all the facets influenced by certification. The implementation of a survey would help understand the effect on innovation capabilities, an example can be found in the study made by Mir et al., (2022) [11].
Due to limitations in data and resources, the analysis could not be extended to all Italian regions. This limitation represents a potential avenue for future research.

A significant extension could be to incorporate other types of certifications into the analysis, such as ISO 56001, in future studies. This standard will be the first internationally certifiable for innovation management and it is currently in the development phase. Including this new standard in the analysis will provide a more comprehensive view of the effects of standards on innovation.
Furthermore, during the work on this thesis, it has become clear how many factors need to be considered to obtain robust results, such as the presence of COVID or other external events that affect the market. To address this, it may be possible to incorporate various types of analyses considering diverse indicators. Additionally, extending the analysis to an international level would be helpful, allowing for cross-national comparisons and controlling for the influence of other contextual variables.

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A Matlab script

```
%%
clear all
% Read table from Accredia database (Sicily)
tabellaDati = readtable('C:\Users\Simone\Desktop\tesi simo mag\Sicily.xlsx');

col1 = table2cell(tabellaDati(:, 'DataDiEmissione'));
col2 = table2cell(tabellaDati(:, 'IVA'));

Datamatrix = [col1, col2];

% Visualizza la matrice risultante
% disp('Matrice risultante:');
% disp(Datamatrix);
%%
tabellaM1 = readtable...
...('C:\Users\Simone\Desktop\tesi simo mag\Nuovi Sicilia M dati.xls');
tabellaCell = table2cell(tabellaM1);
nanMask = cellfun(@(x) (isnumeric(x) && any(isnan(x))), tabellaCell);
tabellaCell(nanMask) = {'n.d'};

tabellaCell = cellfun(@string, tabellaCell, 'UniformOutput', false);
tabellaM = cell2table(tabellaCell);
tabellaM.Properties.VariableNames = tabellaM1.Properties.VariableNames;

colonna_nome = table2cell(tabellaM(:,'nome'));
colonna_IVA = table2cell(tabellaM(:,'IVA'));
colonna_ROI = table2array(tabellaM(:,{'ROI2015', 'ROI2016','ROI2017',...
...'ROI2018','ROI2019','ROI2020','ROI2021','ROI2022'}));
colonna_EBITDA = table2array(tabellaM(:,{'EBITDA2015', 'EBITDA2016',...
...'EBITDA2017','EBITDA2018','EBITDA2019','EBITDA2020','EBITDA2021','EBITDA2022'}));
```

```
colonna_RD = table2array(tabellaM(:,{'RD2015', 'RD2016','RD2017',...
...'RD2018','RD2019','RD2020','RD2021','RD2022'}));
colonna_VAL= table2array(tabellaM(:,{'VAL2015', 'VAL2016','VAL2017',...
...'VAL2018','VAL2019','VAL2020','VAL2021','VAL2022'}));
colonna_DTE= table2array(tabellaM(:,{'DTE2015', 'DTE2016','DTE2017',...
...'DTE2018','DTE2019','DTE2020','DTE2021','DTE2022'}));
colonna_ROA= table2array(tabellaM(:,{'ROA2015', 'ROA2016','ROA2017',...
...'ROA2018','ROA2019','ROA2020','ROA2021','ROA2022'}));
colonna_RV= table2array(tabellaM(:,{'RV2015', 'RV2016','RV2017',...
...'RV2018','RV2019','RV2020','RV2021','RV2022'}));


matrix_M = [colonna_nome colonna_IVA colonna_ROI colonna_EBITDA...
...colonna_RD colonna_VAL colonna_DTE colonna_ROA colonna_RV] ;

matriceRisultati = [];
%stringa_data = strings(1, length(col2));
matrix_nc = [];
stringa_data = string([]);

for i = 1:length(colonna_IVA)
    % Check for correspondences
    indice_corrispondenza = find(strcmp(colonna_IVA{i}, col2));
    % If there is a corrispondence, it is saved
    %in the results matrix
    if ~isempty(indice_corrispondenza)
        stringa_data(indice_corrispondenza) =...
        ...datestr(col1{indice_corrispondenza},'dd-mmm-yyyy');
        riga_corrispondenza = {colonna_nome{i}, colonna_IVA{i}, ...
        ...stringa_data{indice_corrispondenza},colonna_ROI(i,1),...
        ...colonna_ROI(i,2),colonna_ROI(i,3),colonna_ROI(i,4),...
        ...colonna_ROI(i,5),colonna_ROI(i,6),colonna_ROI(i,7),...
```

```
    ...colonna_ROI(i,8), colonna_EBITDA(i,1),colonna_EBITDA(i,2),...
    ...colonna_EBITDA(i,3),colonna_EBITDA(i,4),colonna_EBITDA(i,5),...
    ...colonna_EBITDA(i,6),colonna_EBITDA(i,7),colonna_EBITDA(i,8), ...
    ...colonna_RD(i,1),colonna_RD(i,2),colonna_RD(i,3),colonna_RD(i,4),...
    ...colonna_RD(i,5),colonna_RD(i,6),colonna_RD(i,7),colonna_RD(i,8), ...
    ...colonna_VAL(i,1),colonna_VAL(i,2),colonna_VAL(i,3),colonna_VAL(i,4),...
    ...colonna_VAL(i,5),colonna_VAL(i,6),colonna_VAL(i,7),...
    ...colonna_VAL(i,8), colonna_DTE(i,1),colonna_DTE(i,2),colonna_DTE(i,3),...
    ...colonna_DTE(i,4),colonna_DTE(i,5),colonna_DTE(i,6),...
    ...colonna_DTE(i,7),colonna_DTE(i,8), colonna_ROA(i,1),colonna_ROA(i,2),...
    ...colonna_ROA(i,3),colonna_ROA(i,4),colonna_ROA(i,5),...
    ...colonna_ROA(i,6),colonna_ROA(i,7),colonna_ROA(i,8), ...
    ...colonna_RV(i,1),colonna_RV(i,2),colonna_RV(i,3),colonna_RV(i,4),...
    ...colonna_RV(i,5),colonna_RV(i,6),colonna_RV(i,7),colonna_RV(i,8)};
    matriceRisultati = [matriceRisultati; riga_corrispondenza];

else
    % If no correspondence, it creates rows for
    %non certified matrix
    riga_non_corrispondenza = {colonna_nome{i}, colonna_IVA{i}, 'N/A',...
    ...colonna_ROI(i,1),colonna_ROI(i,2),colonna_ROI(i,3),colonna_ROI(i,4),...
    ...colonna_ROI(i,5),colonna_ROI(i,6),colonna_ROI(i,7),...
    ...colonna_ROI(i,8), colonna_EBITDA(i,1),colonna_EBITDA(i,2),...
    ...colonna_EBITDA(i,3),colonna_EBITDA(i,4),colonna_EBITDA(i,5),...
    ...colonna_EBITDA(i,6),colonna_EBITDA(i,7),colonna_EBITDA(i,8), ...
    ...colonna_RD(i,1),colonna_RD(i,2),colonna_RD(i,3),colonna_RD(i,4),...
    ...colonna_RD(i,5),colonna_RD(i,6),colonna_RD(i,7),colonna_RD(i,8), ...
    ...colonna_VAL(i,1),colonna_VAL(i,2),colonna_VAL(i,3),colonna_VAL(i,4),...
    ...colonna_VAL(i,5),colonna_VAL(i,6),colonna_VAL(i,7),...
    ...colonna_VAL(i,8), colonna_DTE(i,1),colonna_DTE(i,2),colonna_DTE(i,3),...
    ...colonna_DTE(i,4),colonna_DTE(i,5),colonna_DTE(i,6),...
    ...colonna_DTE(i,7),colonna_DTE(i,8), colonna_ROA(i,1),colonna_ROA(i,2),...
```

```
        ...colonna_ROA(i,3),colonna_ROA(i,4),colonna_ROA(i,5),...
        ...colonna_ROA(i,6),colonna_ROA(i,7),colonna_ROA(i,8), ...
        ...colonna_RV(i,1),colonna_RV(i,2),colonna_RV(i,3),colonna_RV(i,4),...
        ...colonna_RV(i,5),colonna_RV(i,6),colonna_RV(i,7),colonna_RV(i,8)};
        matrix_nc = [matrix_nc; riga_non_corrispondenza];
    end

end

%%
tabellaL1 = readtable('C:\Users\Simone\Desktop\tesi simo mag\newdata_L.xlsx');
tabellaCell_L = table2cell(tabellaL1);
nanMask = cellfun(@(x) (isnumeric(x) && any(isnan(x))), tabellaCell_L);
tabellaCell_L(nanMask) = {'n.d'};

tabellaCell_L = cellfun(@string, tabellaCell_L, 'UniformOutput', false);
tabellaL = cell2table(tabellaCell_L);
tabellaL.Properties.VariableNames = tabellaL1.Properties.VariableNames;

colonna_nome_L = table2cell(tabellaL(:,'nome'));
colonna_IVA_L = table2cell(tabellaL(:,'IVA'));
colonna_ROI_L = table2array(tabellaL(:,{'ROI2015', 'ROI2016',...
...'ROI2017','ROI2018','ROI2019','ROI2020','ROI2021','ROI2022'}));
colonna_EBITDA_L = table2array(tabellaL(:,{'EBITDA2015', 'EBITDA2016',...
...'EBITDA2017','EBITDA2018','EBITDA2019','EBITDA2020','EBITDA2021','EBITDA2022'}));
colonna_RD_L = table2array(tabellaL(:,{'RD2015', 'RD2016','RD2017',...
...'RD2018','RD2019','RD2020','RD2021','RD2022'}));
colonna_VAL_L= table2array(tabellaL(:,{'VAL2015', 'VAL2016','VAL2017',...
...'VAL2018','VAL2019','VAL2020','VAL2021','VAL2022'}));
colonna_DTE_L= table2array(tabellaL(:,{'DTE2015', 'DTE2016','DTE2017',...
...'DTE2018','DTE2019','DTE2020','DTE2021','DTE2022'}));
colonna_ROA_L= table2array(tabellaL(:,{'ROA2015', 'ROA2016','ROA2017',...
```

```
...'ROA2018','ROA2019','ROA2020','ROA2021','ROA2022'}));
colonna_RV_L= table2array(tabellaL(:,{'RV2015', 'RV2016','RV2017',...
...'RV2018','RV2019','RV2020','RV2021','RV2022'}));



matrix_L = [colonna_nome_L colonna_IVA_L colonna_ROI_L ...
...colonna_EBITDA_L colonna_RD_L colonna_VAL_L colonna_DTE_L ...
...colonna_ROA_L colonna_RV_L] ;

matriceRisultati_L = [];
%stringa_data = strings(1, length(col2));
matrix_nc_L = [];
stringa_data_L = string([]);

for i = 1:length(colonna_IVA_L)
    % Controlla se ci sono corrispondenze
    indice_corrispondenza = find(strcmp(colonna_IVA_L{i}, col2));
    % Se ci sono corrispondenze, salva i risultati nella nuova matrice
    if ~isempty(indice_corrispondenza)
        stringa_data_L(indice_corrispondenza) = ...
        ...datestr(col1{indice_corrispondenza}, 'dd-mmm-yyyy');
        riga_corrispondenza_L = {colonna_nome_L{i}, colonna_IVA_L{i}, ...
        ...stringa_data_L{indice_corrispondenza},colonna_ROI_L(i,1),...
        ...colonna_ROI_L(i,2),colonna_ROI_L(i,3),colonna_ROI_L(i,4),...
        ...colonna_ROI_L(i,5),colonna_ROI_L(i,6),colonna_ROI_L(i,7),...
        ...colonna_ROI_L(i,8), colonna_EBITDA_L(i,1),colonna_EBITDA_L(i,2),...
        ...colonna_EBITDA_L(i,3),colonna_EBITDA_L(i,4),colonna_EBITDA_L(i,5),...
        ...colonna_EBITDA_L(i,6),colonna_EBITDA_L(i,7),colonna_EBITDA_L(i,8),...
...colonna_RD_L(i,1),colonna_RD_L(i,2),colonna_RD_L(i,3),...
...colonna_RD_L(i,4),colonna_RD_L(i,5),colonna_RD_L(i,6),...
...colonna_RD_L(i,7),colonna_RD_L(i,8), colonna_VAL_L(i,1),...
...colonna_VAL_L(i,2),colonna_VAL_L(i,3),colonna_VAL_L(i,4),...
```

```
...colonna_VAL_L(i,5),colonna_VAL_L(i,6),colonna_VAL_L(i,7),...
...colonna_VAL_L(i,8), colonna_DTE_L(i,1),colonna_DTE_L(i,2),...
...colonna_DTE_L(i,3),colonna_DTE_L(i,4),colonna_DTE_L(i,5),...
...colonna_DTE_L(i,6),colonna_DTE_L(i,7),colonna_DTE_L(i,8), ...
...colonna_ROA_L(i,1),colonna_ROA_L(i,2),colonna_ROA_L(i,3),...
...colonna_ROA_L(i,4),colonna_ROA_L(i,5),colonna_ROA_L(i,6),...
...colonna_ROA_L(i,7),colonna_ROA_L(i,8), colonna_RV_L(i,1),...
...colonna_RV_L(i,2),colonna_RV_L(i,3),colonna_RV_L(i,4),...
...colonna_RV_L(i,5),colonna_RV_L(i,6),colonna_RV_L(i,7),colonna_RV_L(i,8)};
        matriceRisultati_L = [matriceRisultati_L; riga_corrispondenza_L];


    else
        % Se non trova una corrispondenza, crea una riga per matrix_nc
        riga_non_corrispondenza_L = {colonna_nome_L{i}, colonna_IVA_L{i}, ...
        ...'N/A',colonna_ROI_L(i,1),...
        ...colonna_ROI_L(i,2),colonna_ROI_L(i,3),colonna_ROI_L(i,4),...
        ...colonna_ROI_L(i,5),colonna_ROI_L(i,6),colonna_ROI_L(i,7),...
        ...colonna_ROI_L(i,8), colonna_EBITDA_L(i,1),colonna_EBITDA_L(i,2),...
        ...colonna_EBITDA_L(i,3),colonna_EBITDA_L(i,4),colonna_EBITDA_L(i,5),...
        ...colonna_EBITDA_L(i,6),colonna_EBITDA_L(i,7),colonna_EBITDA_L(i,8),...
...colonna_RD_L(i,1),colonna_RD_L(i,2),colonna_RD_L(i,3),...
...colonna_RD_L(i,4),colonna_RD_L(i,5),colonna_RD_L(i,6),...
...colonna_RD_L(i,7),colonna_RD_L(i,8), colonna_VAL_L(i,1),...
...colonna_VAL_L(i,2),colonna_VAL_L(i,3),colonna_VAL_L(i,4),...
...colonna_VAL_L(i,5),colonna_VAL_L(i,6),colonna_VAL_L(i,7),...
...colonna_VAL_L(i,8), colonna_DTE_L(i,1),colonna_DTE_L(i,2),...
...colonna_DTE_L(i,3),colonna_DTE_L(i,4),colonna_DTE_L(i,5),...
...colonna_DTE_L(i,6),colonna_DTE_L(i,7),colonna_DTE_L(i,8), ...
...colonna_ROA_L(i,1),colonna_ROA_L(i,2),colonna_ROA_L(i,3),...
...colonna_ROA_L(i,4),colonna_ROA_L(i,5),colonna_ROA_L(i,6),...
...colonna_ROA_L(i,7),colonna_ROA_L(i,8), colonna_RV_L(i,1),...
...colonna_RV_L(i,2),colonna_RV_L(i,3),colonna_RV_L(i,4),...
```

```
...colonna_RV_L(i,5),colonna_RV_L(i,6),colonna_RV_L(i,7),colonna_RV_L(i,8)};
        matrix_nc_L = [matrix_nc_L; riga_non_corrispondenza_L];
    end

end

%%
tabellaXL1 = readtable('C:\Users\Simone\Desktop\tesi simo mag\Dati Sicilia XL...
...nuovi anni.xls');
tabellaCell_XL = table2cell(tabellaXL1);
nanMask = cellfun(@(x) (isnumeric(x) && any(isnan(x))), tabellaCell_XL);
tabellaCell_XL(nanMask) = {'n.d'};

tabellaCell_XL = cellfun(@string, tabellaCell_XL, 'UniformOutput', false);
tabellaXL = cell2table(tabellaCell_XL);
tabellaXL.Properties.VariableNames = tabellaXL1.Properties.VariableNames;

colonna_nome_XL = table2cell(tabellaXL(:,'nome'));
colonna_IVA_XL = table2cell(tabellaXL(:,'IVA'));
colonna_ROI_XL = table2array(tabellaXL(:,{'ROI2015', 'ROI2016','ROI2017',...
...'ROI2018','ROI2019','ROI2020','ROI2021','ROI2022'}));
colonna_EBITDA_XL = table2array(tabellaXL(:,{'EBITDA2015', 'EBITDA2016',...
...'EBITDA2017','EBITDA2018','EBITDA2019','EBITDA2020','EBITDA2021','EBITDA2022'}));
colonna_RD_XL = table2array(tabellaXL(:,{'RD2015', 'RD2016','RD2017',...
...'RD2018','RD2019','RD2020','RD2021','RD2022'}));
colonna_VAL_XL= table2array(tabellaXL(:,{'VAL2015', 'VAL2016','VAL2017',...
...'VAL2018','VAL2019','VAL2020','VAL2021','VAL2022'}));
colonna_DTE_XL= table2array(tabellaXL(:,{'DTE2015', 'DTE2016','DTE2017',...
...'DTE2018','DTE2019','DTE2020','DTE2021','DTE2022'}));
colonna_ROA_XL= table2array(tabellaXL(:,{'ROA2015', 'ROA2016','ROA2017',...
...'ROA2018','ROA2019','ROA2020','ROA2021','ROA2022'}));
colonna_RV_XL= table2array(tabellaXL(:,{'RV2015', 'RV2016','RV2017',...
```

```
...'RV2018','RV2019','RV2020','RV2021','RV2022'}));


matrix_XL = [colonna_nome_XL colonna_IVA_XL colonna_ROI_XL ...
...colonna_EBITDA_XL colonna_RD_XL colonna_VAL_XL colonna_DTE_XL...
...colonna_ROA_XL colonna_RV_XL] ;

matriceRisultati_XL = [];
%stringa_data = strings(1, length(col2));
matrix_nc_XL = [];
stringa_data_XL = string([]);

for i = 1:length(colonna_IVA_XL)
    % Controlla se ci sono corrispondenze
    indice_corrispondenza = find(strcmp(colonna_IVA_XL{i}, col2));
    % Se ci sono corrispondenze, salva i risultati nella nuova matrice
    if ~isempty(indice_corrispondenza)
        stringa_data_XL(indice_corrispondenza) =...
        ...datestr(col1{indice_corrispondenza}, 'dd-mmm-yyyy');
        riga_corrispondenza_XL = {colonna_nome_XL{i}, colonna_IVA_XL{i},...
        ...stringa_data_XL{indice_corrispondenza},colonna_ROI_XL(i,1),...
        ...colonna_ROI_XL(i,2),colonna_ROI_XL(i,3),colonna_ROI_XL(i,4),...
        ...colonna_ROI_XL(i,5),colonna_ROI_XL(i,6),colonna_ROI_XL(i,7),...
        ...colonna_ROI_XL(i,8), colonna_EBITDA_XL(i,1),colonna_EBITDA_XL(i,2),...
        ...colonna_EBITDA_XL(i,3),colonna_EBITDA_XL(i,4),...
        ...colonna_EBITDA_XL(i,5),colonna_EBITDA_XL(i,6),...
        ...colonna_EBITDA_XL(i,7),colonna_EBITDA_XL(i,8),...
        ...colonna_RD_XL(i,1),colonna_RD_XL(i,2),colonna_RD_XL(i,3),...
        ...colonna_RD_XL(i,4),colonna_RD_XL(i,5),colonna_RD_XL(i,6),...
        ...colonna_RD_XL(i,7),colonna_RD_XL(i,8), colonna_VAL_XL(i,1),...
        ...colonna_VAL_XL(i,2),colonna_VAL_XL(i,3),colonna_VAL_XL(i,4),...
        ...colonna_VAL_XL(i,5),colonna_VAL_XL(i,6),colonna_VAL_XL(i,7),...
```

```
        ...colonna_VAL_XL(i,8), colonna_DTE_XL(i,1),colonna_DTE_XL(i,2),...
        ...colonna_DTE_XL(i,3),colonna_DTE_XL(i,4),colonna_DTE_XL(i,5),...
        ...colonna_DTE_XL(i,6),colonna_DTE_XL(i,7),colonna_DTE_XL(i,8),...
        ...colonna_ROA_XL(i,1),colonna_ROA_XL(i,2),colonna_ROA_XL(i,3),...
        ...colonna_ROA_XL(i,4),colonna_ROA_XL(i,5),colonna_ROA_XL(i,6),...
        ...colonna_ROA_XL(i,7),colonna_ROA_XL(i,8), colonna_RV_XL(i,1),...
        ...colonna_RV_XL(i,2),colonna_RV_XL(i,3),colonna_RV_XL(i,4),...
        ...colonna_RV_XL(i,5),colonna_RV_XL(i,6),colonna_RV_XL(i,7),...
        ...colonna_RV_XL(i,8)};
        matriceRisultati_XL = [matriceRisultati_XL; riga_corrispondenza_XL];

    else
        % Se non trova una corrispondenza, crea una riga per matrix_nc
        riga_non_corrispondenza_XL = {colonna_nome_XL{i}, colonna_IVA_XL{i},...
        ...'N/A',colonna_ROI_XL(i,1),...
        ...colonna_ROI_XL(i,2),colonna_ROI_XL(i,3),colonna_ROI_XL(i,4),...
        ...colonna_ROI_XL(i,5),colonna_ROI_XL(i,6),colonna_ROI_XL(i,7),...
        ...colonna_ROI_XL(i,8), colonna_EBITDA_XL(i,1),colonna_EBITDA_XL(i,2),...
        ...colonna_EBITDA_XL(i,3),colonna_EBITDA_XL(i,4),...
        ...colonna_EBITDA_XL(i,5),colonna_EBITDA_XL(i,6),...
        ...colonna_EBITDA_XL(i,7),colonna_EBITDA_XL(i,8),...
        ...colonna_RD_XL(i,1),colonna_RD_XL(i,2),colonna_RD_XL(i,3),...
        ...colonna_RD_XL(i,4),colonna_RD_XL(i,5),colonna_RD_XL(i,6),...
        ...colonna_RD_XL(i,7),colonna_RD_XL(i,8), colonna_VAL_XL(i,1),...
        ...colonna_VAL_XL(i,2),colonna_VAL_XL(i,3),colonna_VAL_XL(i,4),...
        ...colonna_VAL_XL(i,5),colonna_VAL_XL(i,6),colonna_VAL_XL(i,7),...
        ...colonna_VAL_XL(i,8), colonna_DTE_XL(i,1),colonna_DTE_XL(i,2),...
        ...colonna_DTE_XL(i,3),colonna_DTE_XL(i,4),colonna_DTE_XL(i,5),...
        ...colonna_DTE_XL(i,6),colonna_DTE_XL(i,7),colonna_DTE_XL(i,8),...
        ...colonna_ROA_XL(i,1),colonna_ROA_XL(i,2),colonna_ROA_XL(i,3),...
        ...colonna_ROA_XL(i,4),colonna_ROA_XL(i,5),colonna_ROA_XL(i,6),...
        ...colonna_ROA_XL(i,7),colonna_ROA_XL(i,8), colonna_RV_XL(i,1),...
```

```
        ...colonna_RV_XL(i,2),colonna_RV_XL(i,3),colonna_RV_XL(i,4),...
        ...colonna_RV_XL(i,5),colonna_RV_XL(i,6),colonna_RV_XL(i,7),...
        ...colonna_RV_XL(i,8)};
        matrix_nc_XL = [matrix_nc_XL; riga_non_corrispondenza_XL];
    end

end

%% CALCOLO MOL

table_MOL_nc_L = readtable('C:\Users\Simone\Desktop\tesi simo mag\...
...RESULTS\risultati non L.xlsx');
colonna_EBITDA_MOL_nc_L = table2array(table_MOL_nc_L(1:1278,{'EBITDA2015', ...
...'EBITDA2016','EBITDA2017','EBITDA2018','EBITDA2019',...
...'EBITDA2020','EBITDA2021','EBITDA2022'}));
colonna_RV_MOL_nc_L= table2array(table_MOL_nc_L(1:1278,{'RV2015', 'RV2016',...
...'RV2017','RV2018','RV2019','RV2020','RV2021','RV2022'}));

MOL_nc_L = zeros(size(matrix_nc_L,1),8);

for j = 1: 8
    for i = 1: size(matrix_nc_L,1)
        if isnan(colonna_EBITDA_MOL_nc_L (i,j)) || ...
        ...isnan(colonna_RV_MOL_nc_L(i,j)) || colonna_RV_MOL_nc_L(i,j)==0
            MOL_nc_L(i,j)=NaN;

        else
            MOL_nc_L(i,j) = colonna_EBITDA_MOL_nc_L (i,j)/colonna_RV_MOL_nc_L(i,j);
        end

    end
end
```

```
nome_file = 'C:\Users\Simone\Desktop\tesi simo mag\RESULTS\risultati non L.xlsx';
nome_foglio = 'MOL';

% Scrivi la matrice su Excel
xlswrite(nome_file, MOL_nc_L, nome_foglio);

%%

table_MOL_nc_XL = readtable('C:\Users\Simone\Desktop\tesi simo mag\RESULTS\...
...risultati non XL.xlsx');
colonna_EBITDA_MOL_nc_XL = table2array(table_MOL_nc_XL(1:449,{'EBITDA2015', ...
...'EBITDA2016','EBITDA2017','EBITDA2018','EBITDA2019',...
...'EBITDA2020','EBITDA2021','EBITDA2022'}));
colonna_RV_MOL_nc_XL= table2array(table_MOL_nc_XL(1:449,{'RV2015', 'RV2016',...
...'RV2017','RV2018','RV2019','RV2020','RV2021','RV2022'}));

MOL_nc_XL = zeros(size(matrix_nc_XL,1),8);

for j = 1: 8
    for i = 1: size(matrix_nc_XL,1)
        if isnan(colonna_EBITDA_MOL_nc_XL (i,j)) ||...
        ...isnan(colonna_RV_MOL_nc_XL(i,j)) || colonna_RV_MOL_nc_XL(i,j)==0
            MOL_nc_XL(i,j)=NaN;

        else
            MOL_nc_XL(i,j) = colonna_EBITDA_MOL_nc_XL(i,j)/colonna_RV_MOL_nc_XL(i,j);
        end

    end
end
```

```
nome_file = 'C:\Users\Simone\Desktop\tesi simo mag\RESULTS\risultati non XL.xlsx';
nome_foglio = 'MOL';

% Scrivi la matrice su Excel
xlswrite(nome_file, MOL_nc_XL, nome_foglio);

%%

table_MOL_XL =readtable('C:\Users\Simone\Desktop\tesi simo mag\RESULTS\Res_XL.xlsx');
colonna_EBITDA_MOL_XL = table2array(table_MOL_XL(1:181,{'EBITDA2015', ...
...'EBITDA2016','EBITDA2017','EBITDA2018','EBITDA2019',...
...'EBITDA2020','EBITDA2021','EBITDA2022'}));
colonna_RV_MOL_XL= table2array(table_MOL_XL(1:181,{'RV2015', 'RV2016',...
...'RV2017','RV2018','RV2019','RV2020','RV2021','RV2022'}));

MOL_XL = zeros(size(matriceRisultati_XL,1),8);

for j = 1: 8
    for i = 1: size(matriceRisultati_XL,1)
        if isnan(colonna_EBITDA_MOL_XL (i,j)) ||...
        ...isnan(colonna_RV_MOL_XL(i,j)) || colonna_RV_MOL_XL(i,j)==0
            MOL_XL(i,j)=NaN;

        else
            MOL_XL(i,j) = colonna_EBITDA_MOL_XL(i,j)/colonna_RV_MOL_XL(i,j);
        end

    end
end

nome_file = 'C:\Users\Simone\Desktop\tesi simo mag\RESULTS\Res_XL.xlsx';
nome_foglio = 'MOL';
```

```
% Scrivi la matrice su Excel
xlswrite(nome_file, MOL_XL, nome_foglio);

%%

table_MOL_L = readtable('C:\Users\Simone\Desktop\tesi simo mag\RESULTS\Res_L.xlsx');
colonna_EBITDA_MOL_L = table2array(table_MOL_L(1:140,{'EBITDA2015', ...
...'EBITDA2016','EBITDA2017','EBITDA2018',...
...'EBITDA2019','EBITDA2020','EBITDA2021','EBITDA2022'}));
colonna_RV_MOL_L= table2array(table_MOL_L(1:140,{'RV2015', 'RV2016',...
...'RV2017','RV2018','RV2019','RV2020','RV2021','RV2022'}));

MOL_L = zeros(size(matriceRisultati_L,1),8);

for j = 1: 8
    for i = 1: size(matriceRisultati_L,1)
        if isnan(colonna_EBITDA_MOL_L (i,j)) || ...
        ...isnan(colonna_RV_MOL_L(i,j)) || colonna_RV_MOL_L(i,j)==0
            MOL_L(i,j)=NaN;

        else
            MOL_L(i,j) = colonna_EBITDA_MOL_L (i,j)/colonna_RV_MOL_L(i,j);
        end

    end
end

nome_file = 'C:\Users\Simone\Desktop\tesi simo mag\RESULTS\Res_L.xlsx';
nome_foglio = 'MOL';

% Scrivi la matrice su Excel
```

```
xlswrite(nome_file, MOL_L, nome_foglio);

%%
FILE = 'C:\Users\Simone\Desktop\tesi simo mag\RESULTS\first_M.xlsx';
sheet = 'cert_M';
table_MOL_M = readtable(FILE,'Sheet',sheet);
colonna_EBITDA_MOL_M = table2array(table_MOL_M(1:35,{'EBITDA2015', 'EBITDA2016',...
...'EBITDA2017','EBITDA2018','EBITDA2019','EBITDA2020','EBITDA2021','EBITDA2022'}));
colonna_RV_MOL_M= table2array(table_MOL_M(1:35,{'RV2015', 'RV2016','RV2017',...
...'RV2018','RV2019','RV2020','RV2021','RV2022'}));

MOL_M = zeros(size(matriceRisultati,1),8);

for j = 1: 8
    for i = 1: size(matriceRisultati,1)
        if isnan(colonna_EBITDA_MOL_M (i,j)) ||...
        ...isnan(colonna_RV_MOL_M(i,j)) || colonna_RV_MOL_M(i,j)==0
            MOL_M(i,j)=NaN;

        else
            MOL_M(i,j) = colonna_EBITDA_MOL_M (i,j)/colonna_RV_MOL_M(i,j);
        end

    end
end

nome_file = 'C:\Users\Simone\Desktop\tesi simo mag\RESULTS\first_M.xlsx';
nome_foglio = 'MOL_cert';

% Scrivi la matrice su Excel
xlswrite(nome_file, MOL_M, nome_foglio);
```

```
%%
FILE = 'C:\Users\Simone\Desktop\tesi simo mag\RESULTS\first_M.xlsx';
sheet = 'nc_M';
table_MOL_nc_M = readtable(FILE,'Sheet',sheet);
colonna_celle = table_MOL_nc_M.EBITDA2015;
colonna_numeri = str2double(colonna_celle);
colonna_numeri = colonna_numeri(1:1639);
colonna_EBITDA_MOL_nc_M = table2array(table_MOL_nc_M(1:1639,{ 'EBITDA2016',...
...'EBITDA2017','EBITDA2018','EBITDA2019','EBITDA2020','EBITDA2021','EBITDA2022'}));
colonna_EBITDA_MOL_nc_M = [colonna_numeri, colonna_EBITDA_MOL_nc_M];
colonna_celle2 = table_MOL_nc_M.RV2015;
colonna_numeri2 = str2double(colonna_celle2);
colonna_numeri2 = colonna_numeri2(1:1639);
colonna_RV_MOL_nc_M= table2array(table_MOL_nc_M(1:1639,{'RV2016','RV2017','...
...RV2018','RV2019','RV2020','RV2021','RV2022'}));
colonna_RV_MOL_nc_M=[colonna_numeri2,colonna_RV_MOL_nc_M];

MOL_nc_M = zeros(size(matrix_nc,1),8);

for j = 1: 8
    for i = 1: size(matrix_nc,1)
    if isnan(colonna_EBITDA_MOL_nc_M (i,j)) || isnan(colonna_RV_MOL_nc_M(i,j)) ...
    ...|| colonna_RV_MOL_nc_M(i,j)==0
            MOL_nc_M(i,j)=NaN;

        else
            MOL_nc_M(i,j) = colonna_EBITDA_MOL_nc_M (i,j)/colonna_RV_MOL_nc_M(i,j);
        end

    end
end
```

```
nome_file = 'C:\Users\Simone\Desktop\tesi simo mag\RESULTS\first_M.xlsx';
nome_foglio = 'MOL_nc';

% Scrivi la matrice su Excel
xlswrite(nome_file, MOL_nc_M, nome_foglio);
```