POLITECNICO DI TORINO

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Identifying Critical Quality Management Content on Undergraduate Courses Through Industry Feedback

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Abstract

In a world of increasingly competitive industries, any advantage that companies can reach is important for their permanence in the market. Quality management is an area that allows companies to achieve certain economic benefits in the long term, which is why companies are willing to invest in the development of these practices. In turn, universities have been updating the contents of their courses with the intention of preparing better professionals who can meet the demands of knowledge that companies need from them, this is also the case of quality management, an area that today plays a key role in the performance of organizations.

The following research presents the development of improvement proposals to the engineering courses of the Politecnico di Torino and the Universidad Adolfo Ibañez dedicated to the teaching of quality management concepts and techniques. Through the Politecnico di Torino web site for survey development, two surveys were designed. The first questionnaire was distributed to all companies that have educational agreements in force with these universities in order to measure their level of development in terms of quality management, while the second questionnaire was distributed to students who have recently finished their studies and to those in their last academic year in order to measure the level of knowledge about this subject. Once the responses were obtained, a comparative percentage analysis and a statistical analysis were carried out in order to distinguish the techniques that could be included in the engineering courses, as well as certain actions that could be recommended to increase the level of awareness of students in both countries. Additionally, hypotheses about the concern and level of development of quality management were studied in relation to the country, type of product, size and geographic scope of the companies, as well as an analysis of the critical success factors that companies identified as important when developing continuous improvement projects.

The results of the research indicate that, as a proposal, one methodology and one quality management tool could be included in the engineering courses of the Politecnico di Torino, while the recommendations to the Universidad Adolfo Ibáñez are composed of two methodologies and seven tools. Regarding the hypotheses, the study concludes that: Italian, manufacturing and large companies have higher level of development in terms of quality

management compared to Chilean, service/hybrid and small organizations, respectively. On the other hand, the geographical scope of the companies is not influential in the level of development about quality management. Finally, the critical success factors were analyzed by the number of times they were selected as critical, among which "Cultural Change and Leadership" and "Employee Training and Education" stood out, factors that occupied positions within the top three in both countries.

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Chapter 1: Introduction

During the last two decades, business paradigms have been changing seeking to increase efficiency and effectiveness during production processes. As a result, companies are facing increased pressure from their clients and competitors to deliver high-quality products at low cost in the shortest possible period of time (Prasanna and Vinoth, 2013). Since organizations can only achieve long-term survival through continual improvement (CI) in performance (Daft, 2009; Hartley, 2007; Martin, 2009), any competitive advantage that companies can obtain is very valuable, and they are always looking for ways to reach them (Koraus et al., 2015; Soltes and Gavurova, 2015; Batchimeg, 2017; Belas et al., 2017). This business environment made organizations understand the importance of quality, so they started adopting quality excellence programs like ISO 9000, Total Quality Management (TQM), Six Sigma, Lean Manufacturing, among others (Palo and Padhi, 2003; Talib et al., 2011; Gupta et al., 2016). Since the seminal works of Edward Deming, Joseph Juran, Philip Crosby and Kauro Ishikawa, generally considered to be the founders of Quality Management (QM), the field has developed to the point where it is now considered a mature and accepted field of study (Sousa and Voss, 2001), having a general agreement about what QM is and what can be considered under its umbrella (Dahlgaard et al., 1998; Dean and Bowen, 1994). A conceptual definition that highlights the essence of QM states that it is a 'philosophy or an approach to management that can be characterized by its principles, practices and techniques' (Dean and Bowen, 1994).

Different quality management programs have different objectives and impacts on business performance. One of the possible ways to increase productivity, change a corporate culture, reduce cycle time and increase value for customers is to implement Lean Manufacturing techniques. On the other hand, if the goals are to reduce waste and rework, Six Sigma projects could help to achieve them (Naslund, 2008). Among the other methodologies mentioned before, Lean Manufacturing and Six Sigma are considered as high-performance methodologies for continuous improvement (Azadegan et al., 2013; Hilton and Sohal, 2012; Swink and Jacob, 2012; Holweg, 2007; Shah and Ward, 2003; Antony and Banuelas, 2002; Anderson and Sohal, 1999).

Lean Manufacturing is a collection of tools and instruments for reducing cost and improving businesses processes by eliminating seven types of wastes: Motion, Inventory, Waiting, Defects, Overproduction, Transportation and Over-processing. This is accomplished through total involvement and the application of instruments such as Continuous Flow, Value Stream Mapping (VSM), Root Cause Analysis, Just-in-Time (JIT), Total Productive Maintenance (TPM), Kanban and Bottleneck Analysis (Rose et al., 2011; Holweg, 2007; Holweg et al., 2004; Shah and Ward, 2003). For the successful implementation of Lean, each tool needs to be adapted to the specific conditions of the organization (Furlan et al., 2011). Lean thinking emerged initially with the development of the Toyota Production System, which Taiichi Ohno structured to help Toyota company survival during the post-war recovery, a period of capital and resources constraints (Kurdve et al., 2014). The investments in implementing Lean Manufacturing projects are amortized several times in the form of cost reductions, increased labor productivity, shorter delivery times or higher quality (Al Smadi, 2009; Ginevicius et al., 2015).

The Six Sigma methodology is the application of a data-driven problem-solving methodology known as DMAIC Cycle (Define, Measure, Analyze, Improve and Control). Each phase uses statistical and managerial tools and; the American Society for Quality has identified 66 of these instruments (Chakraborty and Tan, 2006). This methodology focuses on reducing process variations and meeting customer needs (Shafer and Moeller, 2012; Snee, 2004). In statistical terms, Six Sigma means 3.4 defects per million opportunities (DPMO). Sigma (σ) is the term used to represent the variation about the mean of a process. Although the Six Sigma methodology was developed for a team of engineers of Motorola in the mid-80s in order to improve the performance of the production processes, the methodology was widely extended by General Electric CEO Jack Welch (Shah et al., 2008). The Six Sigma methodology went from seeking to reduce defects in an organization's processes, products and services, to becoming a business strategy that focuses on improving the understanding of customer needs, business productivity and financial performance (Tjahjono et al., 2010). According to Carvalho et al. (2008), main benefits of Six Sigma reported in the literature can be summarized in the following issues: decrease in the organization costs, increase in quality of products, increase in the number of customers, elimination of activities without additional value to the business process, and a positive cultural change in the organization towards a culture of excellence.

Lean Six Sigma (LSS) is a powerful strategy for process management and process excellence that aims to eliminate defects and reduce variation in the process of service and product manufacturing, leading to business process excellence (Snee, 2010). LSS is the combination between Lean Manufacturing and Six Sigma (Vinodh et al., 2012; Kumar et al., 2006; Hilton and Sohal, 2012). While both Lean Manufacturing and Six Sigma have been used for many years, they were not integrated until the late 1990s and early 2000s (George, 2002, 2003). According to Salah et al., (2010), the first integration of these methodologies occurred in 1986 in the US-based George group. However, the term Lean Six Sigma was first introduced into literature around 2000 (Antony et al., 2012a; Laureani and Antony, 2012; Snee, 2010). It is considered one of the latest CI methodologies that has proven to be successful in multiple companies around the world (Wang and Chen, 2010). Pepper and Spedding (2010) define Lean Six Sigma as: 'A structured and systematic approach for results improvement that perform statistical analysis in order to reduce the incidence of defects in the final product at 3.4 defects per million and eliminate waste around all the production process'. On the other hand, it was defined by Snee (2010) as: 'A business strategy and methodology that increases process performance resulting in enhanced customer satisfaction and improved bottom line results'. Literature shows evidence that LSS improves both operational effectiveness and efficiency in organizations (George, 2003; Brett and Queen, 2005; Sunder, 2013; Sreedharan and Raju, 2016). Some benefits include cost reduction, increase in revenues, quality and productivity improvement, customer and employee satisfaction, waste reduction, increase competitiveness, enabling effective decision making and building a culture of continuous improvement (Sunder and Antony, 2018).

Total Quality Management (TQM) is a CI methodology that aims to provide quality products to achieve customer satisfaction (Gul et al., 2012). Osman and Ali, (2009) affirmed TQM is an integrated set of practices and management philosophy that emphasizes meeting customers' requirements, continuous improvement, reducing work, employees' involvement and teamwork, and process design. Even tough it is not easy to establish the exact date of birth of the methodology, it is clear that the term and the philosophy as a whole appeared around the mid 80's. Bemowski (1992) states that the term 'TQM' was initially coined in 1985 by the Naval Air Systems Command to describe its Japanese-style management approach to quality improvement,

while empirical studies about TQM started to grow in 1989 when the critical success factors (CSFs) of TQM were first introduced by Saraph et al. (1989). Total Quality Management is considered to be a source of competitive advantage that allows organizations to obtain both a high degree of differentiation and lower costs (Samson and Terziovski, 1999). Several studies that have examined the impact of TQM in obtaining a competitive advantage have shown that its presence leads to improved performance and increased competitiveness (Anderson & Sohal, 1999; Samson and Terziovski, 1999; Texeira-Quirós and Justino, 2013; Ebrahimi and Sadeghi, 2014). Multiple studies have demonstrated positive results between TQM implementation and quality levels achieved, resulting, thus, in a better organizational performance of companies (Flynn et al., 1995; Ahire et al., 1996; Samson and Terziovski, 1999; Prajogo and Sohal, 2003, 2004; Costa & Lorente, 2004; Arumugam et al., 2008; Beck & Walgenbach, 2009).

The ISO 9000 family, widely used and applied, is considered an effective technique for providing quality assurance controls in production, and for reducing waste and labor inefficiency (Casadesús and Karapetrovic, 2005a; Douglas et al., 2003; Gotzamani and Tsiotras, 2001; Han and Chen, 2007). It promotes the adoption and application of seven underlying principles including: customer focus, leadership, engagement of people, process approach, continuous improvement, evidence-based decision making and relationship management. First versions of the ISO 9000 standards was created in 1987 by International Organization for Standardization (ISO) and was based mainly on BS-5750 series standards from British Standard Institution. The studies after 2000 provided more consistent results about the benefits of ISO 9000 implementation, which seem to be constant. The literature indicates that ISO 9000 certification can deliver significant business benefits if it is implemented as part of a CI strategy (Terziovski and Power, 2007). These benefits include: decreasing nonconformities, enhanced quality, costs reduction, improves internal procedures and more effective communication, among others (Casadesús and Karapetrovic, 2005b; Chow-Chua et al., 2003; Han and Chen, 2007; Quazi et al., 2002).

A survey distributed by 'Quality Digest', a North American company, asked about which CI program delivered the best results. This survey reached 2,870 responses (Dusharme, 2006), of which 53.6% of respondents indicated Six Sigma as the most important program, followed by

Lean Manufacturing with the 26.3% of preferences, ISO 9000 with 21%, and finally Total Quality Management with 10.3% of the respondents. During 2007, 433 respondents were asked about their company's manufacturing metrics, management practices, and financial results in a manufacturing census conducted by the IndustryWeek Magazine and the Manufacturing Performance Institute (Blanchard, 2007). The results indicated over three quarters of the respondents acknowledge that their companies applied CI methodologies in their business strategy, with nearly 70 percent deciding to adopt Lean Manufacturing.

Chapter 2: State of the Art

Despite the progress over the years and according to Ringen and Holtskog (2011), in general, out of every three CI initiative projects, two fail to achieve the expected results. This tendency dates back to much earlier due to it has been reported that just one out of every three organizational change projects succeeds (Kotter 1995; Beer and Nohria 2001; Aiken and Keller 2009). The study conducted by the IndustryWeek and the Manufacturing Performance Institute noted that only one in four of respondents were satisfied with the outcome of the CI projects (Pay 2008).

Quality Management practices help SMEs to obtain greater innovation in their process and product as shown by multiple researchers (Antony et al., 2012; Box and Woodall, 2012; Kumar et al., 2012; Kim et al., 2012) in the UK (Antony et al., 2012; Soltani and Lai, 2007; Mellor and Gupta, 2002), Australia (Kumar et al., 2014; Kumar and Antony, 2008; Prajogo, 2006, 2005; Prajogo and Sohal, 2004, 2001) and other developed nations (Kumar et al., 2014; Kumar and Antony, 2008). Bhasin (2012b) found that larger corporations (in terms of turnover, aggregate gross assets, and number of employees) are leaner than small ones. According to Sambhe and Dalu (2011), in developed countries 67.5 percent of employees in SMEs were aware of the Six Sigma methodology, however Six Sigma is applied more so in large companies (Pulakanam and Voges, 2010), and taking into account that in emerging countries the proportion of SMEs is relatively high (Sreedharan et al., 2017), it could be inferred that the awareness level of CI projects in developing countries is lower than in developed ones. Ribeiro de Jesus et al (2015) point out that Six Sigma in Brazil is being deployed mainly by large manufacturing industries. The program is highly valued by those companies, but they are not implementing it as strongly as recommended in the international literature due to they have an insufficient number of Master Black Belts (MBBs), Black Belts (BBs) and Green Belts (GBs). The literature (Pulakanam and Voges, 2010) recommends having 1 BB and 5 GBs for every 100 employees, and 1 MBB for every 1,000 employees. According with Sreedharan and Raju (2016), the application of LSS is dominant in developed economies, where firms recognize its value through full deployments. In an emerging economy like Slovenian, 49% of the companies have been using LSS for less than one year, 38% of the companies for one to three years, and 13% for more than three years. This clearly shows that LSS is a relatively new methodology for Slovenian companies (Kavčič &

Gošnik, 2016). Results from a survey elucidate that Indian manufacturing firms are aware of the LSS methodology, however this awareness is limited (Sreedharan et al., 2019).

Due to its practical relevance, as well as its inherent appeal to researchers, it is not surprising that the CSF research has remained popular in many fields, such as new product development (Ernst, 2002), continual improvement (Oprime et al., 2012), quality management (Mendes et al., 2016) and sustainable product-service system (Ceschin, 2013). For sustainable benefits, it is important to understand the critical success factors and barriers in the implementation of QM methodologies (Antony et al., 2008; Yusof and Aspinwall, 2000). In a study developed (Jenster, 1987 in Griffin, 1995), it was concluded that companies using CSFs received a higher return on equity compared with companies that did not employ the CSF approach. According to Rungasamy et al. (2002), CSFs are those factors essential to the success of any program or technique. Multiple lists of the CSFs for implementing Lean Manufacturing, Six Sigma, TQM and similar CI methodologies are available (e.g., Ramarapu et al. 1995; Yusof and Aspinwall 1999; Dayton 2001; Taylor and Wright 2003; Ahuja and Khamba 2008; Schroeder et al. 2008; Brun 2011; Manville et al. 2012; Bortolotti et al. 2015).

Gadenne and Sharma (2005) investigated the influence of QM practices on the performance of Australian SMEs, concluding that supplier support, top management philosophy, efficiency improvement and increased interaction with employees and customers had a strong impact on the performance. Mendes and Lourenço (2014) investigated the barriers/factors hindering QM implementation in the Portuguese manufacturing sector. Results of that research highlighted seven different factors, namely, top management training, costs and actual performance, lack of external support, human resources' overload, aversion to change, resource shortage, and training. The results from a study carried out in India and Namibia conclude that high cost of training is the major reason by most of the respondents from the two countries for not implementing QM practices (Chakraborty et al., 2018). Education and training, team members with great motivation, good customer relationship and cultural change were recognized as the most important CSFs in Nambia, while in India the research highlights frequent feedback and measurement, good customer relationship, understanding tools and techniques, and finally education and training.

Netland (2015) summarized the existent literature about Lean Manufacturing CSFs, describing that the most common reported critical success factors are: Management commitment, training and education, employee participation and empowerment, linking the methodology to the business strategy, cultural change, linking Lean to supplier/customer, among others. The same study concluded that, in addition to the factors mentioned previously, active leadership must be sustained. Main reasons for successful implementation of lean tools and techniques in multiple industries in the USA are: Lack of top management commitment, documentation of financial impacts, and expanding the methodology into all areas (Kovach et al., 2011). Salvatierra et al. (2015) conducted interviews in 10 Chilean companies engaged in the construction industry, and according to the opinion of the managers interviewed, the main CSFs are resistance to cultural change, lack of training, and lack of leadership. Zargun and Al-Ashaab (2013) establish that companies from developing countries must consider certain factors that companies from developed economies have taken into account. The study includes 24 CSFs divided into 4 categories: Strategy and objectives, leadership and management, human resources, and external factors. At the top of each category appear respectively: Clear targets and common understanding of direction, top management commitment, provide workers with continuous lean education and training, and communication and cooperation with suppliers.

Through the past years, a number of Six Sigma surveys have been carried out in some countries such as United Kingdom (Antony and Banuelas, 2002; Antony, 2004; Kumar and Antony, 2008), USA (Van Iwaarden et al., 2008; Zu et al., 2008) and Japan (Arauz and Suzuki, 2004). Those studies identified some CSFs, which are: Top management commitment, project prioritization and selection, linking the methodology to the business strategy, education and training, adopting tools and techniques, and use of KPIs. Brun (2011) presented a list of CSFs in Six Sigma implementation in Italy, in which were highlighted top management commitment, cultural change, education and training, linking the methodology to the business strategy, linking Six Sigma to customer, project prioritization and selection, among others. Kumar and Antony (2008) conducted a comparative study about the Six Sigma implementation in UK manufacturing SMEs and found that the lack of knowledge and limited resource availability were the main reasons for not implementing the methodology in the companies. Chakrabarty and Chuan Tan (2007)

suggested that the employees must receive training and education to implement Six Sigma efficiently. According to Harry and Schroeder (2005), Six Sigma training should be delivered to at least 50 per cent of the organization's employees in order to produce real changes and increase profits. Despite the popularity of the Six Sigma methodology, the strategy has received less attention in developing countries (Albliwi et al., 2017). A survey about Six Sigma barriers in developing countries conducted by Aboelmaged (2011) in the United Arab Emirates, including the manufacturing and service sectors, showed that the most common CSFs were related to a lack of knowledge about Six Sigma and the lack of selection and prioritization of Six Sigma projects. Ribeiro de Jesus et al. (2016) carried out a study previously identifying in the literature the most recognized CSFs associated with the implementation of Six Sigma programs in Brazilian companies. Training, top management commitment, project selection and prioritization and linking Six Sigma to the business strategy were the most indicated. Consequently, additional studies could be conducted in similar countries, and then coincidences of the success of Six Sigma across multiple countries can be explored (Desai et al., 2012). Therefore, despite some recent works (Carvalho et al., 2014; Tlapa et al., 2016; Albliwi et al., 2017), there is also a lack of research to present the current status of Six Sigma in developing countries.

Although many critical success factors have been identified in the Lean Six Sigma literature, several studies have highlighted the role of leadership, which is key to the LSS success (Hoerl and Snee, 2003). The particularity of leadership in changing the organizational culture and influencing the elements of structured practice assist the company in proposing new ideas for continuous improvement (Delgado et al., 2010). Organizational culture and linking Lean Six Sigma to business strategy have also been widely identified as CSFs in the literature (Antony and Banuelas, 2002). Lack of top management commitment was mention by Albliwi et al. (2014) as one of the most important CSFs as it appeared in 20 of the papers found, more times than any other factor. This factor is followed by the lack of training and education, and poor project selection and prioritization, in second and third place respectively. The systematic literature review conducted by these authors also distinguishes between developed and developing countries, noting that the main CSFs in developed economies are the lack of resources; such as technical, human, financial, etc.; lack of top management support, and finally the lack of training and education, while in developing countries the most important CSFs are the lack of knowledge,

and the lack of selection and prioritization of projects.

Talib et al. (2010) carried out an in-depth study with the purpose to apply a Pareto analysis quality tool and sorting of the CSFs in descending order according to the frequencies of their occurrences obtained from the 39 TQM studies on CSFs used in their literature review. At the top of the Pareto analysis appears "Top Management Commitment", followed by "Customer Focus and Satisfaction", "Training and Education", "Continuous Improvement and Innovation" and "Quality Information and Performance Measurement". One of the earlier empirical studies in the QM area by Saraph et al. (1989) identified 8 CSFs on the implementation of TQM in USA: top management leadership, role of quality department, training and education, product design, supplier quality management, process management, quality data reposting, and employee relationships. Abdullah and Abidin (2012) investigated the factors for an effective implementation of TQM in Malaysian SMEs, arguing that formalized management systems, technical design and human resource integration were the main CSFs for the successful implementation of the methodology.

Sharif and Kagioglou (2008) identified CSFs in implementing ISO 9000 initiatives from the literature. The study summarizes and tabulates the factors by author, year and country in order to illustrate them. Understanding of ISO 9000, top management commitment, training and education, employee commitment, and organization culture were the most cited. Tahir (2017) describes some CSFs found in the literature such as: subscription to some common quality frameworks such as ISO9000 or BS5750, top management commitment, training and education, availability of the ISO published material, service and support from the certification body, employee involvement, among others. Ab Wahid and Corner (2009) investigated critical success factors and problems in ISO 9000 maintenance. The results showed that top management commitment, team work, continuous improvement, the understanding of the ISO 9000 by itself, the measurement of performance and communication are all CSFs for ISO 9000 maintenance and for successful results of certification.

Considering the information about critical factors explained previously, it can be stated that there are some common CSFs among methodologies, such as: Top management commitment, training

and education, cultural change, project prioritization and selection, linking the methodology to business strategy, among others.

Continuous improvement processes should be led by quality managers due to they are supposedly prepared to develop them, but according to Sandholm (2005) the view of quality management as a profession is lacking, which has contributed to quality managers being selected based on their personality rather than on their knowledge. However, and according to Hesselbarth and Schaltegger (2014), sustainability awareness and the ability to provide sustainability solutions to industrial-scale problems have become must-have qualifications when recruiting new collaborators. The comparison between these two studies mentioned above shows the dynamic nature of the industry in terms of sustainability, and this forces higher education institutions to re-design their curricula to become more real-life oriented across all disciplines by establishing connections with industry and other stakeholders (Tilbury, 2011). Recently, the number of higher education institutions that integrated sustainability curriculum into their curricula significantly increased (Hill and Wang, 2018; Thürer et al., 2018), however, the current proficiency level of academia in terms of delivering effective curricula for next generations to address sustainability issues at a global scale is not yet at the desired levels (Tejedor et al., 2018). According to Bhasin (2013), academia has identified the lack of training and education as a major barrier to gaining awareness in LSS. Albliwi et al (2014) believe that LSS is still in its early stages, mainly in higher education, and it will be one of the world-class quality improvement programs in the coming years, especially in western countries. According to Fliedner and Mathieson (2009), the Lean practitioners surveyed want university graduates to have a comprehensive view of organizations; an understanding of the methodology as a set of human relationships, concepts and skills; and finally to have real world business knowledge and experience.

The QS ranking, probably the most important ranking for universities worldwide, elaborates its lists taking into account different factors, including the employer opinion in the calculation. Satisfying the needs of employers, one of the most important stakeholders in the education industry, in terms of the knowledge acquired by students during their period of study would produce a higher demand for those students, which would translate into a better opinion of

employers about the university reflected in the ranking.

Eckel et al. (2001) identified four factors that shaped the successful course of change in higher education institutions. Under the current atmosphere of continuous change, the factors indicated were: institutions had propitious external and internal conditions, leaders facilitated the change, leaders helped people develop new ways of thinking, and finally leaders paid attention to the change process and adjusted their actions in response to what they learned by listening to the stakeholders in these institutions. This thesis addresses precisely a part of the last factors, searching for understand the stakeholders needs in terms of QM. Trying to obtain useful information related to what industry needs and what students actually know about QM methodologies and techniques will allow the universities involved to know how they could improve their curricula in order to reduce the knowledge gaps.

This research is original in several ways. While this research takes as its main reference Kanigolla's (2013) study in which research was conducted to compare students' level of awareness of quality management at the beginning and at the end of their quality management courses. That research only indicated that quality management courses were useful for students and allowed them to improve their level of awareness of quality management knowledge, however, the study does not have industry feedback to know what companies really need in terms of quality management, and what additionally could be taught by teachers and learned by students, therefore, this thesis goes a step further by considering the voice of companies.

The originality of this study also lies in its attempt to compare the level of implementation of quality management techniques between a developed country such as Italy and a developing country such as Chile. Existing literature has only developed comparisons between industries in emerging economies such as the study by Chakraborty et al. (2018), while in developed economies they mainly focus on a single specific country. So this is one of the first, if not the first, to make a comparison between a developed and a developing country. Additionally, some hypotheses will be studied by comparing firms by type of product, size, and geographical scope, as other studies have done before, so the originality here is based on contributing information to the international literature.

Last but not least, the academic literature regarding quality management in Chile is almost non-existent due to the fact that QM methodologies were introduced and expanded in early 2010, so this thesis research will also contribute to the international literature a study about the CSFs identified by Chilean companies when developing continuous improvement projects. Although the topic has been studied more in Italy, it is still original to contribute this type of data to the international literature.

Chapter 3: Objectives

The main objective of this thesis is to generate proposals for improvement to the engineering courses related to quality management of the two participating universities about methodologies and tools that could be included in these courses with the intention of reducing the knowledge gaps between what companies need students to know with respect to what students actually know, thus allowing students to improve their knowledge levels and meet the demands of the companies.

Additionally, as secondary objectives, the research will study the accuracy of the following hypotheses:

- *Hypothesis H1:* Companies in developed countries have a greater concern and a higher level of development regarding quality management compared to companies in emerging countries.

- *Hypothesis H2:* Manufacturing companies have a greater concern and a higher level of development about quality management compared to service or hybrid organizations.

- *Hypothesis H3:* The level of development of quality management is directly proportional to the size of the companies.

- *Hypothesis H4:* The level of development of quality management is directly proportional to the geographical scope of the companies.

In addition, also as a secondary objective, the research will study the critical success factors that affect companies when developing continuous improvement projects, contributing to the international literature and the academic world a set of critical factors identified by companies in both countries.

Chapter 4: Methodology

The first survey was created to be distributed to Italian and Chilean companies that have an educational agreement in force with either of the two universities involved in the study, while the second survey was done to obtain meaningful information from senior students and alumni from both countries about their levels of knowledge of quality management techniques.

I. Companies Survey

The Companies Survey was designed through an analysis of 20 papers and researches related to quality management methodologies, the CSFs during the period of implementation, their impacts on business, and the existing literature on the implementation of quality management techniques in developed and developing countries.

The survey was created through Politecnico di Torino's survey platform (https://survey.polito.it) and distributed via email. To this purpose, Politecnico di Torino and Universidad Adolfo Ibáñez gave authorization to contact the companies with which they have an educational agreement, also providing the e-mail contacts of each of them.

Companies Survey was divided into 2 main sections: (1) General Information and (2) Quality Management Information. In the first section, general information of the company was requested such as type of company according to its products, number of employees, if the company is public or private, among others; while in the second section, specific quality management questions were asked such as if companies have a quality management department, if companies currently implement a quality management methodology, where companies have more opportunities to improve its performance in terms of quality management, among others. The structure of the survey is represented in Figures 1, 2, 3 and 4; and its details (i.e. the alternatives of each question) can be visualized in Appendix 1.

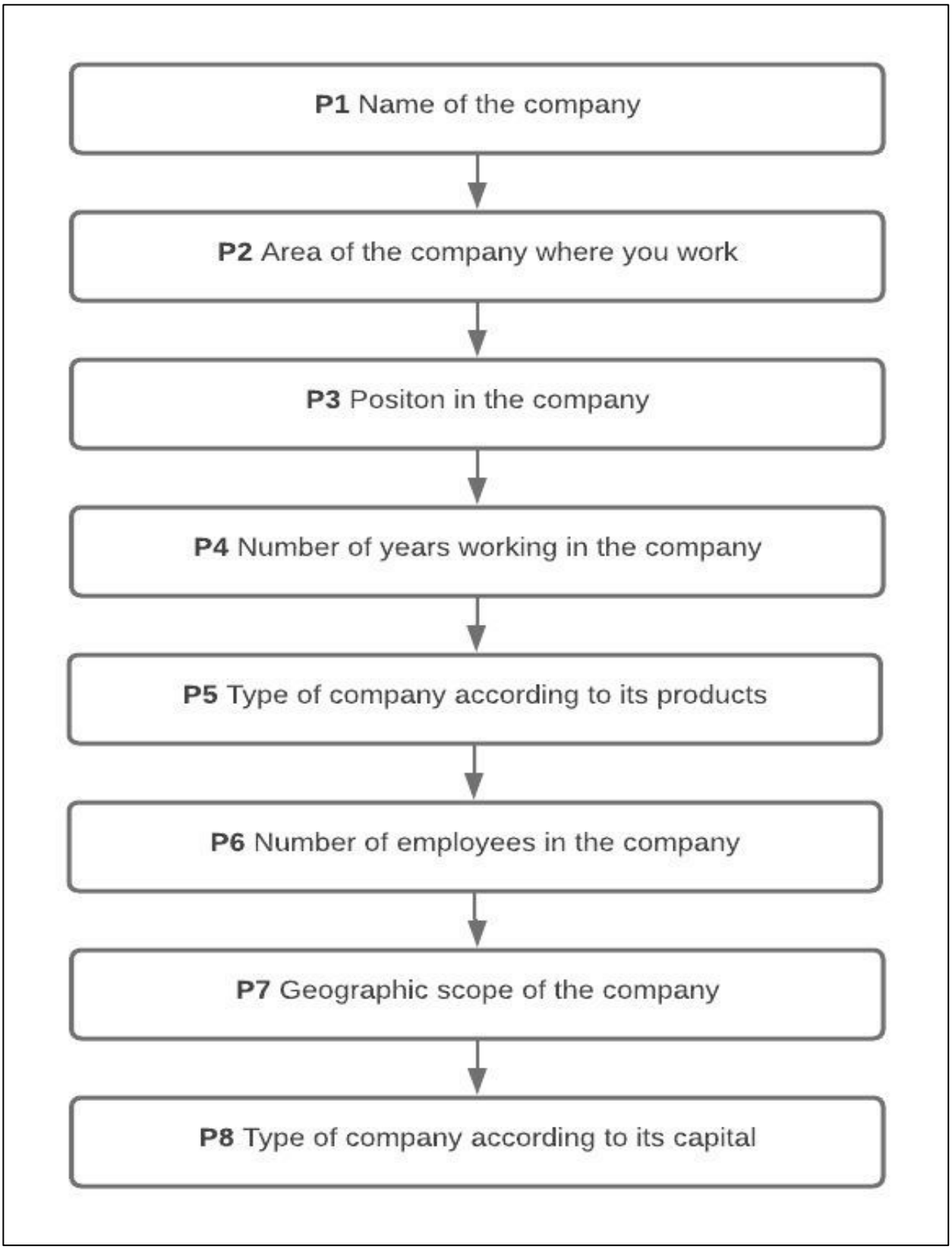

Figure 1. *Sequence of questions in the General Information section.*

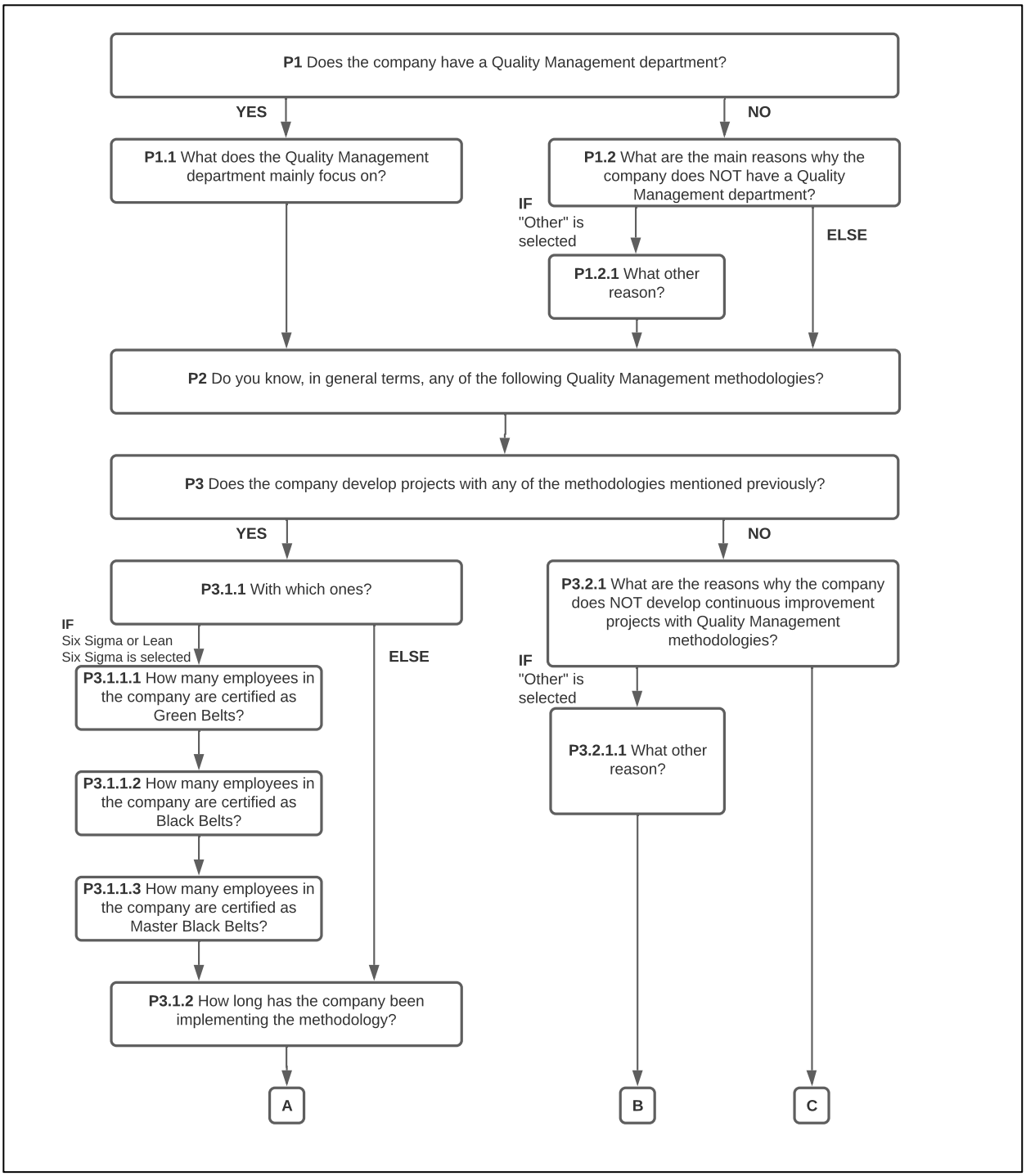

Figure 2. *Logical sequence of questions in the Quality Management Information section.*

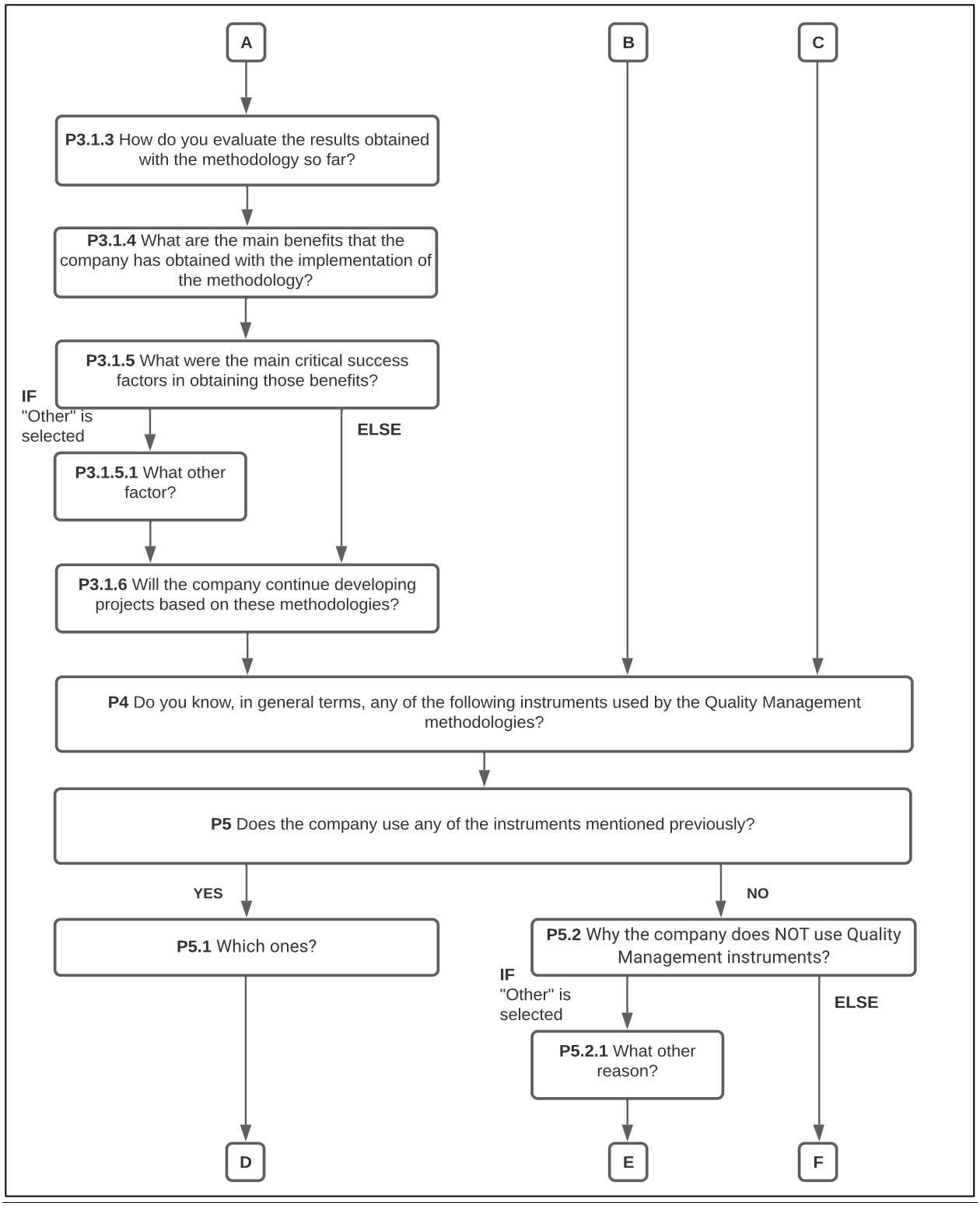

Figure 3. *Logical sequence of questions in the Quality Management Information section.*

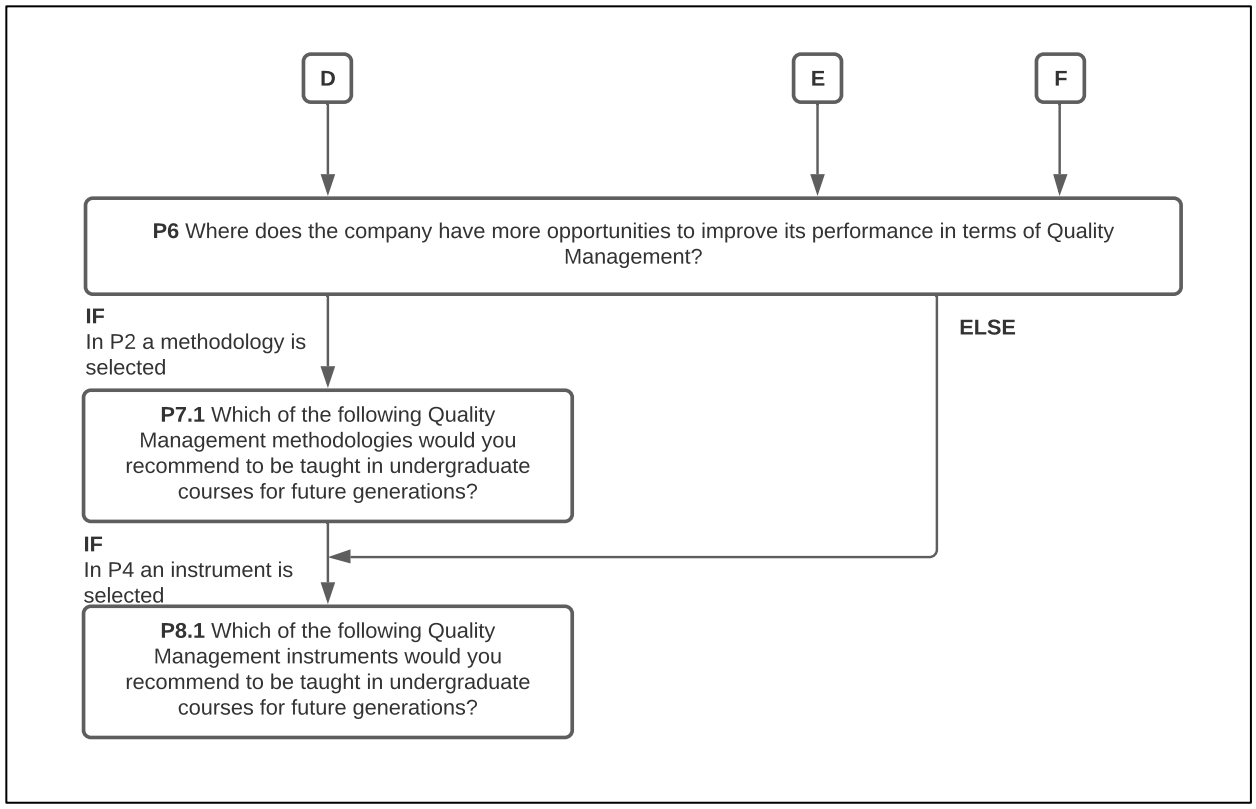

Figure 4. *Logical sequence of questions in the Quality Management Information section.*

Before the distribution of the survey, tests were conducted in order to measure the average time taken to answer the survey. Results of those tests indicated that the average time used was 7 minutes, regardless of the path.

A total of 702 companies were contacted to ask them about the possibility of cooperating with the research, of which 377 companies had an educational agreement with Politecnico di Torino and 325 companies with Universidad Adolfo Ibáñez.

Since the most likely scenario was not to obtain a 100% of response rate, the companies were classified by: Type of Product, Size, Geographic Scope and Origin of Capital. This categorization performed in order to compare the composition of the entire population with respect to the composition of the responses, and thus assess the similarity between both. LinkedIn and company websites were consulted to determine the category of companies for each classification.

II. Students Survey

The Students Survey was designed through an analysis of 4 researches related to quality management methodologies, and taking into account the 20 papers used to design the Companies Survey in order to create valuable questions for the research.

The survey was created through Politecnico di Torino's survey platform (https://survey.polito.it) and distributed by email for 2 generations. These generations of students were composed of alumni and senior students. The senior students contacted were students on their last year of studies. A total of 1,512 students were contacted to ask them about the possibility of cooperating with the research. This number is composed of 524 students from Politecnico di Torino and 988 from Universidad Adolfo Ibáñez.

Before the distribution of the survey, tests were conducted in order to measure the average time taken to answer the survey. Results of these tests indicated that the average time used was less than 2 minutes, regardless of the path.

Students Survey was divided into 2 sections as well: (1) General Information and (2) Quality Management Information. This last section was also divided in 2 sub-chapters: (a) Methodologies and (b) Instruments. In the first part, general information about the students was requested, such as if they are alumni or senior students, graduation year or if they are currently working, among others; while in the second section, specific questions about quality management were asked in order to measure the level of knowledge about the methodologies used to develop continuous improvement projects, as well as the knowledge about some of the instruments implemented in those projects. The structure of the survey is represented in Figure 5, 6 and 7; and its details (i.e. the alternatives of each question) can be visualized in Appendix 2.

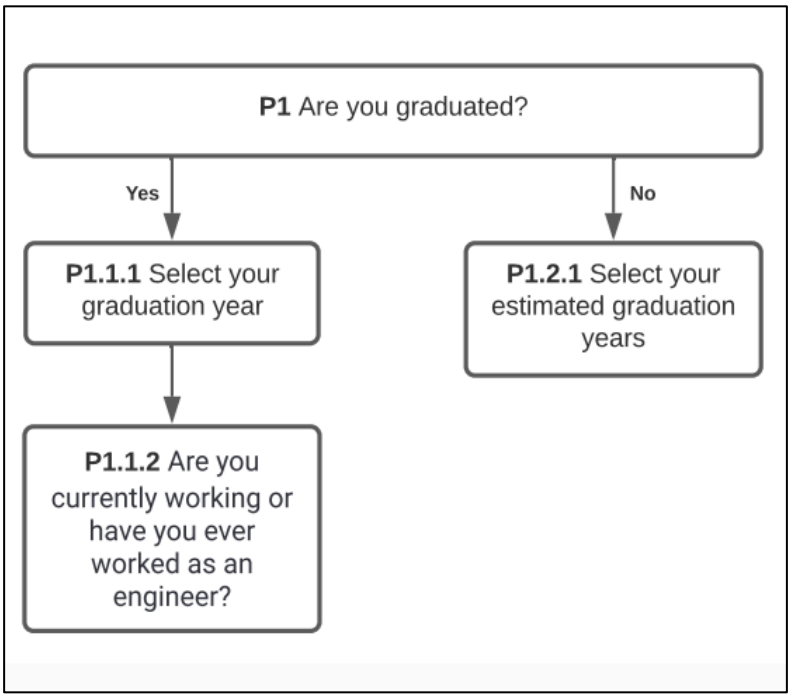

Figure 5. *Logical sequence of questions in the General Information section.*

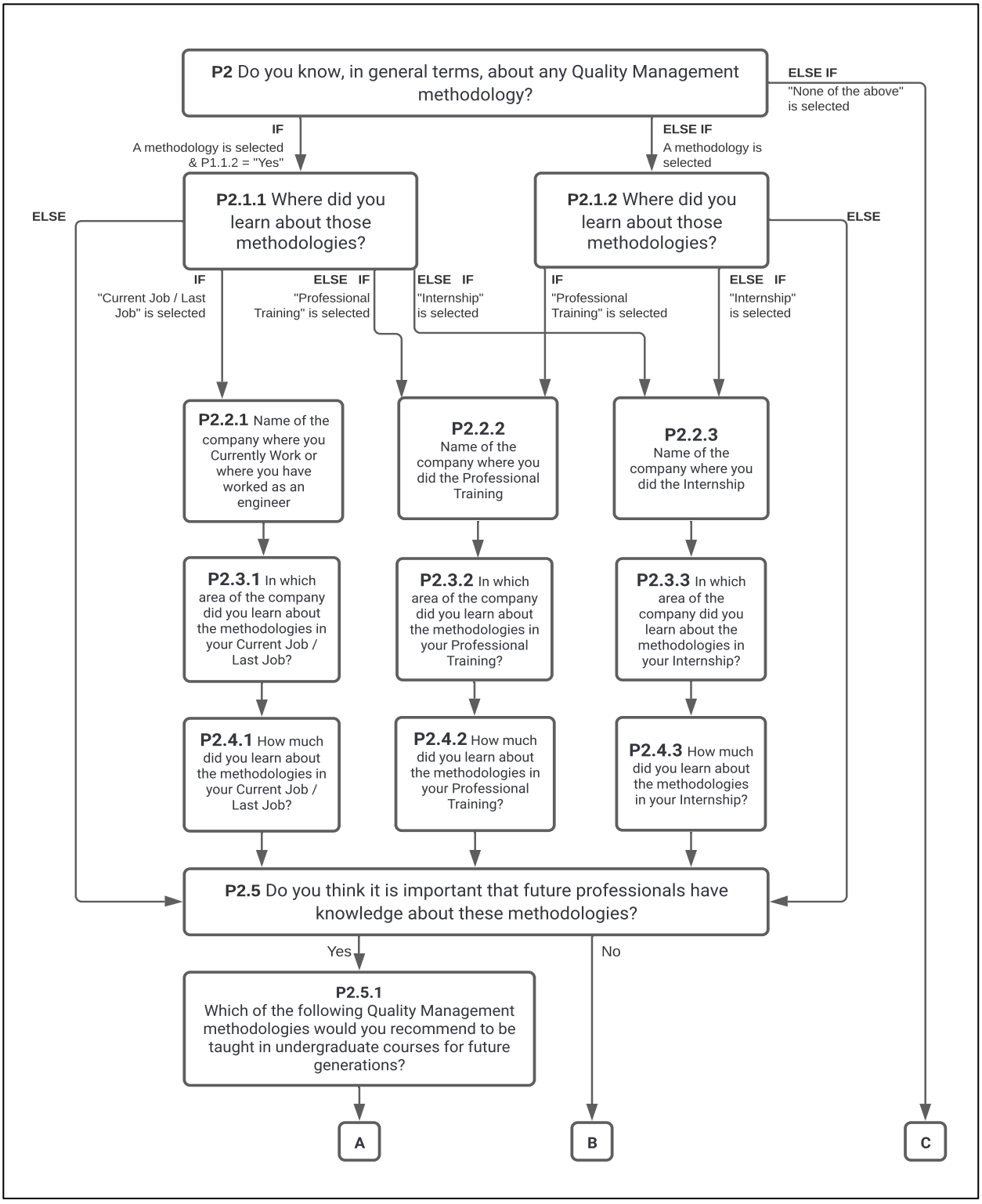

Figure 6. *Logical sequence of questions in the Quality Management Information section, Methodologies subchapter.*

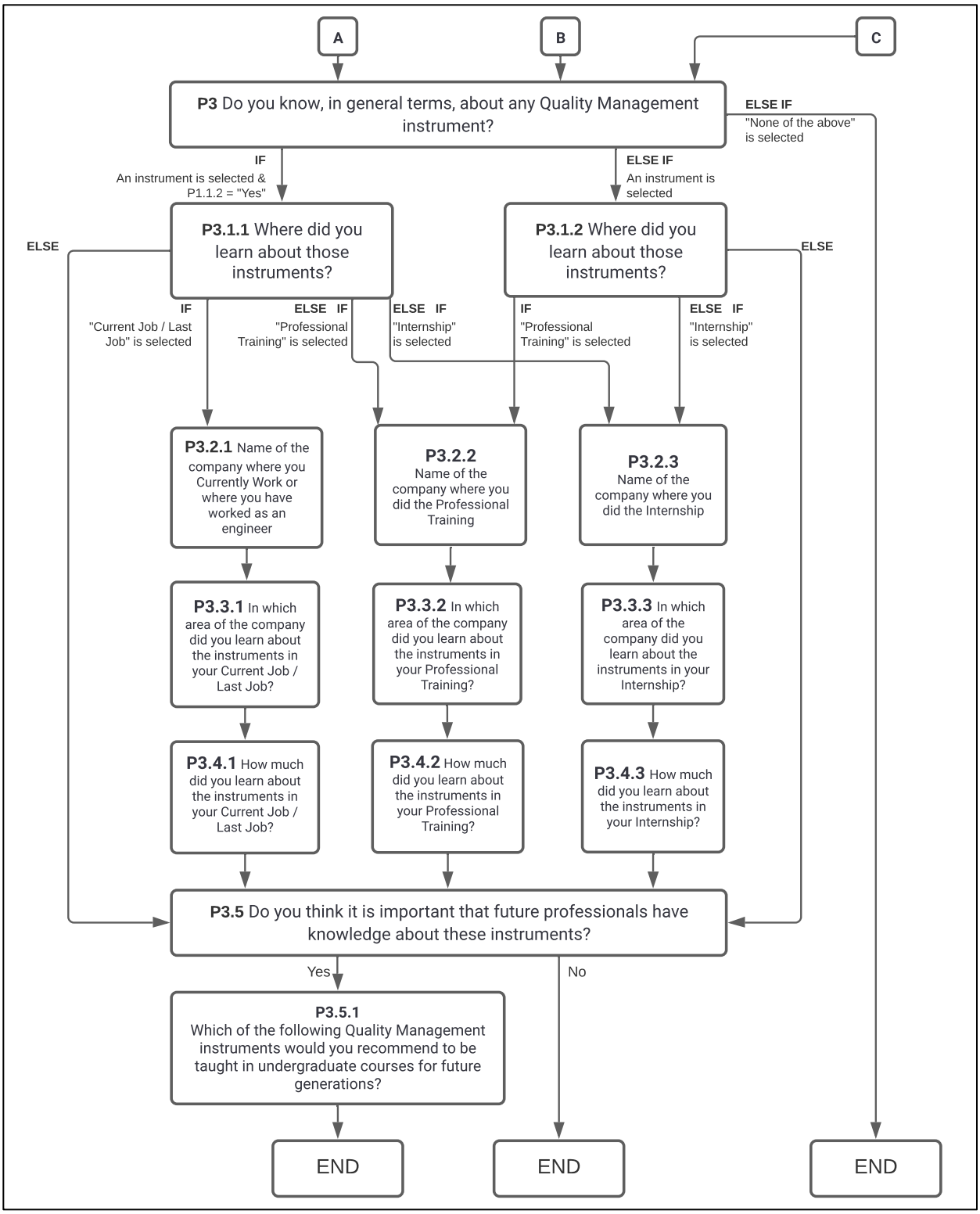

Figure 7. *Logical sequence of the questions in the Quality Management Information section, Instruments subchapter.*

III. Data Analysis

For the analysis of the results, a Kolmogorov-Smirnov (K-S) test will be performed to measure the representativeness of the responses; and a logistic regression analysis will be performed in order to inspect the relationships and behaviors between variables, and thus be able to: (1) analyze the variables that affect the techniques that will be part of the recommendations, and (2) provide further information to be able to accept or reject the hypotheses.

The K-S test is a non-parametric test that can be used to compare 2 probability distributions. The Kolmogorov-Smirnov test is one of the most useful and general nonparametric methods for comparing 2 samples, as it is sensitive to differences in both the location and shape of the cumulative distribution functions, quantifying the distance between them. The Kolmogorov-Smirnov statistic for a given cumulative distribution function *F(x)* is defined by:

$$D_n = \sup_x | S_n(x) - F(x) |$$

Where

- $S_n(x)$ is an estimator of the probability of observing values less than or equal to x.
- F(x) is the distribution function obtained in the sample.

Logistic regression analysis is one of the most widely used types of statistical analysis worldwide. The goal of logistic regression is to identify a well fitting model that describes the relationship between a binary dependent variable (categorical outcome variable) and a set of independent or explanatory variables (categorical or continuous predictor variables). It is well suited for describing and testing hypotheses about relationships between these types of variables. In other words, logistic regression analyzes the relationship between multiple independent variables and a single dependent variable, and yields a predictive equation. Although logistic regression can also be used to model dependent variables that have more than two categories, it is most often used to predict dichotomous outcomes.

Since logistic regression calculates the probability of success over the probability of failure, the

results of the analysis are in the form of an odds ratio. The odd ratio for a variable in a logistic regression represents how the odds change with the one unit increase in that variable, holding all other variable constant. Odds are calculated as the probability of an event happening divided by the probability of the event not happening. Formally, it can be written as:

$$Odds = p / (1 - p)$$

The simple logistic regression model (a single explanatory variable) is defined as:

$$\text{logit}(Y) = natural\ \log(odds) = \ln(\frac{p}{1-p}) = \alpha + \beta X$$

Applying the antilog on both sides of the previous formula, the equation for predicting or estimating the probability of the occurrence of the outcome of interest can be described as:

$$p = Probability(Y = outcome\ of\ interest \mid X = x,\ a\ specific\ value\ of\ X) = \frac{e^{\alpha+\beta x}}{1+e^{\alpha+\beta x}}$$

Where

- p is the probability of the outcome of interest
- α is the Y intercept
- β is the regression coefficient

X can be categorical or continuous, while Y can only be categorical. Extending the logic of the simple logistic regression to multiple predictors (multiple explanatory variables), a complex logistic regression model for Y can be defined as:

$$\text{logit}(Y) = natural\ \log(odds) = \ln(\frac{p}{1-p}) = \alpha + \beta_1 X_1 + \beta_2 X_2$$

Therefore,

$$p = Probability(Y = outcome\ of\ interest \mid X_1 = x_1, X_2 = x_2) = \frac{e^{\alpha+\beta_1 X_1+ \beta_2 X_2}}{1+e^{\alpha+\beta_1 X_1+ \beta_2 X_2}}$$

The null hypothesis underlying the overall model states that all β's are equal to zero. A rejection of this null hypothesis implies that at least one β is not equal to zero in the population. This means that the logistic regression model predicts the probability of the outcome better than the mean of the dependent variable Y. The interpretation of results is performed using the odds ratio for both categorical and continuous predictors.

Chapter 5: Results

The results chapter is divided into 3 subchapters. The first and second subchapters present the results of the Companies Survey and Students Survey respectively, while the third subchapter presents the results of the logistic regression models. Details of the responses and results of the Companies Survey and the Students Survey can be found in Appendix 3.

I. Companies Survey

The Companies Survey subchapter introduces the results through four different approaches: General Results, Results by Type of Company According to its Products, Results by Enterprise Size and Results by Geographic Scope.

The number of companies in an educational agreement with Politecnico di Torino reaches 377, while Universidad Adolfo Ibáñez has an agreement with 325 organizations. The results indicated that 50 Italian and 99 Chilean firms answered the Companies Survey. The representativeness of the responses was considered good due to the response rates of the Italian and Chilean companies were 13,26% (50 out of 377) and 30,46% (99 out of 325) respectively.

1. General Results

This first section analyses the results through a comparison by country. The Italian companies, those that have an educational agreement with the Politecnico di Torino, are compared with Chilean organizations, the firms in agreement with the Universidad Adolfo Ibáñez. The purpose of this comparison is to identify similarities and differences between industries in terms of quality management and thus be able to analyze the accuracy of hypothesis H1.

i. General Information

The companies were classified by: Type of Product, Enterprise Size, Geographic Scope and Origin of Capital. The classifications compare the distribution of the responses and the

distribution of the total number of companies with a current educational agreement in order to verify the representativeness of the data. The column 'Responses' represents the companies that answered the survey, while the column 'Surveyed Companies' represents the total number of companies that have an agreement with one of the universities. The distributions by category of Italian companies are shown in Figures 8, 9, 10 and 11.

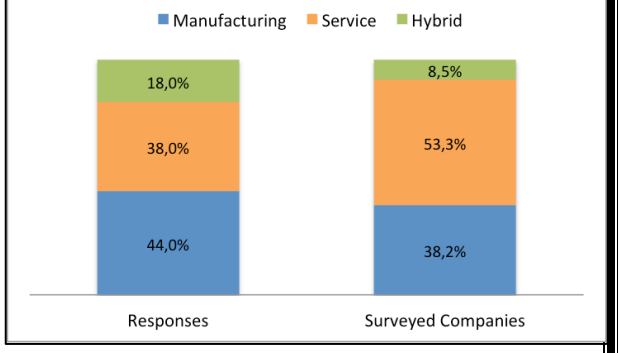

Figure 8. *Distributions of Italian companies classified by Type of Product. Comparison between surveyed companies and responses.*

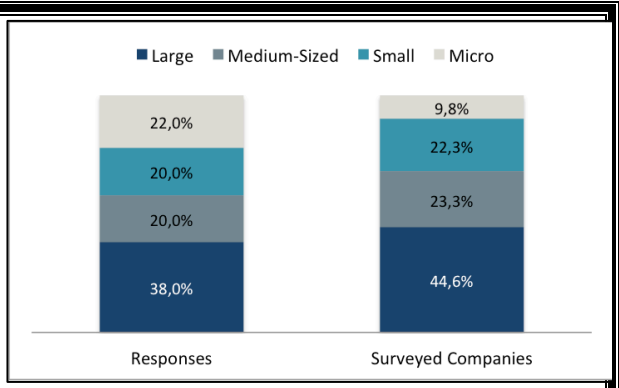

Figure 9. *Distributions of Italian companies classified by Enterprise Size. Comparison between surveyed companies and responses.*

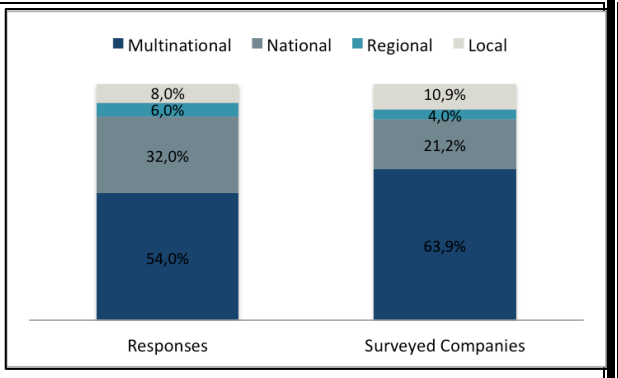

Figure 10. *Distributions of Italian companies classified by Geographic Scope. Comparison between surveyed companies and responses.*

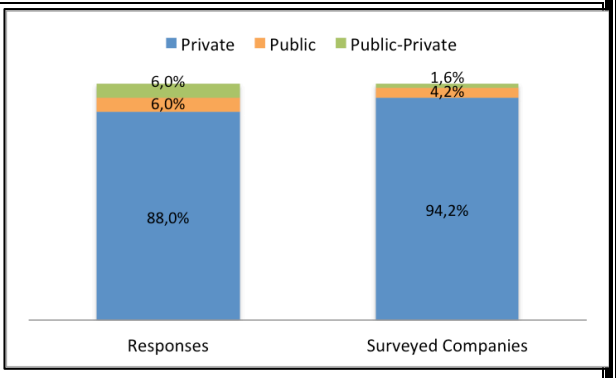

Figure 11. *Distributions of Italian companies classified by Origin of Capital. Comparison between surveyed companies and responses.*

The distributions by category of Chilean companies are shown in Figures 12, 13, 14 and 15.

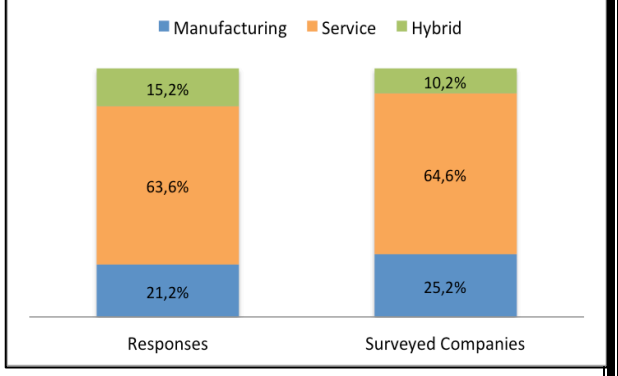

Figure 12. *Distributions of Chilean companies classified by Type of Product. Comparison between surveyed companies and responses.*

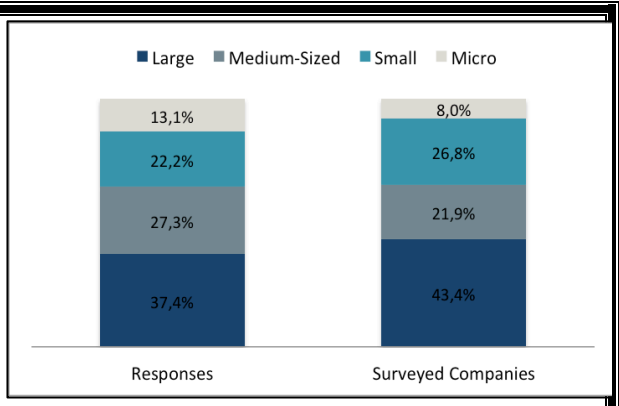

Figure 13. *Distributions of Chilean companies classified by Enterprise Size. Comparison between surveyed companies and responses.*

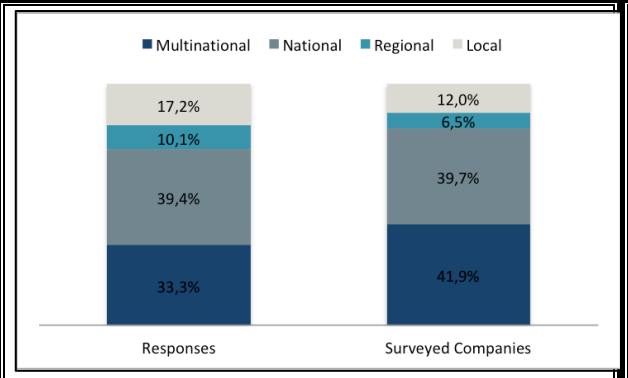

Figure 14. *Distributions of Chilean companies classified by Geographic Scope. Comparison between surveyed companies and responses.*

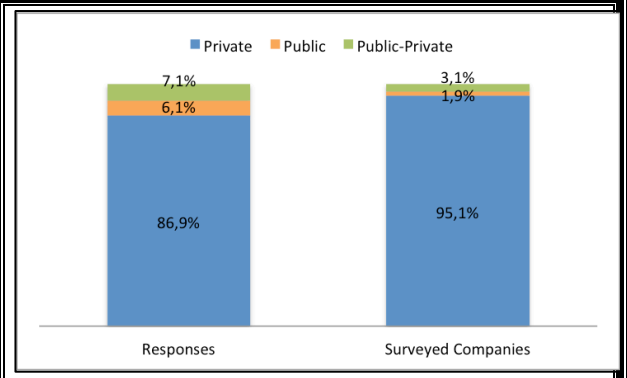

Figure 15. *Distributions of Chilean companies classified by Origin of Capital. Comparison between surveyed companies and responses.*

ii. Quality Management Information

The results of the survey about quality management information were analyzed by country in order to compare the realities, similarities and differences between a developed and an emerging country. First question of this unit is about the presence of a quality management department in the company. Responses indicate that 68% of Italian companies have a quality management department, while the value for Chilean companies reaches 53.5%.

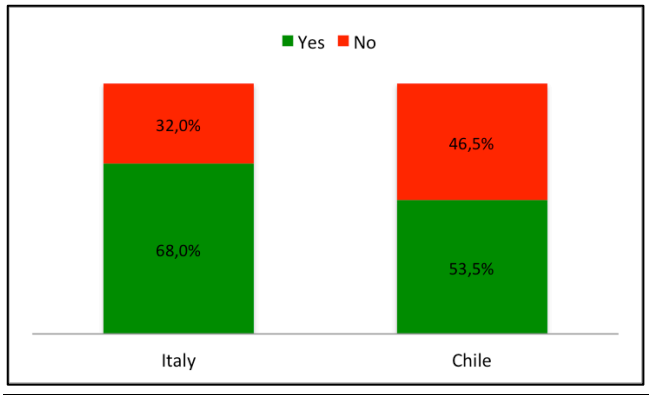

Figure 16. *Percentage of companies with a quality management department*

Regarding Italian companies with a quality management department, 94.1% indicate that this area carries out activities in order to improve the quality of its products/services. Increase Customer or Employees Satisfaction was selected as the second most developed activity by Italian quality management departments with 70.6%, followed by Reduction of the Defect Rate or Process Variability (61.8%), Cost and Waste Reduction (41.2%) and Cycle Time Reduction or Delivery Time Acceleration (23.5%). Other activities performed by Italian quality management departments are Compliance with Mandatory Regulations (5.9%).

Similar to Italian companies, 88.7% of Chilean quality management departments concentrate their efforts on improving the quality of their products/services. Chilean ranking is completed by: Reduction of Defect Rate or Process Variability with 77.4%, Increase Customer or Employees Satisfaction (73.6%), Cost and Waste Reduction (41.5%) and Cycle Time Reduction or Delivery Time Acceleration with 26.4%. Other purposes (13.2%) of Chilean quality management departments are Compliances with Mandatory Regulations, Processes Improvement, KPIs Measurement and Obtain International Certification.

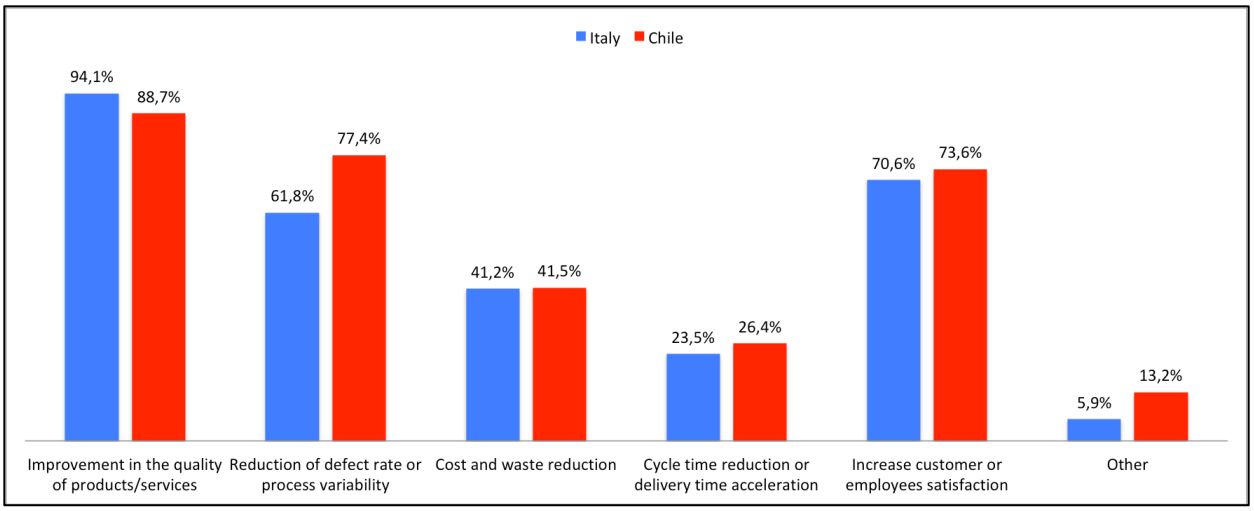

Figure 17. *Objectives of quality management departments*

Respondents were asked about their knowledge about quality management methodologies. Most of the respondents work in areas such as quality or production, or are in a senior management position. Results evidence that the awareness level of Italian respondents about quality management methodologies is higher than the level of Chilean respondents. The most familiar methodology to Italian respondents is ISO 9000, with 47 affirmative answers out of 50 (94%), followed by Lean Manufacturing (68%), Total Quality Management (54%), Six Sigma (50%) and Lean Six Sigma (36%). ISO 9000 was also selected as the most known methodology by Chilean respondents with 79.8%, but surprisingly it was seconded by Six Sigma with 40.4%, Lean Manufacturing in third (33.3%), Total Quality Management in fourth and finally Lean Six Sigma with 22.2%. Additionally, 11.1% of Chilean respondents declare do not know about any quality management methodology, while this value for Italian respondents barely reaches 2%.

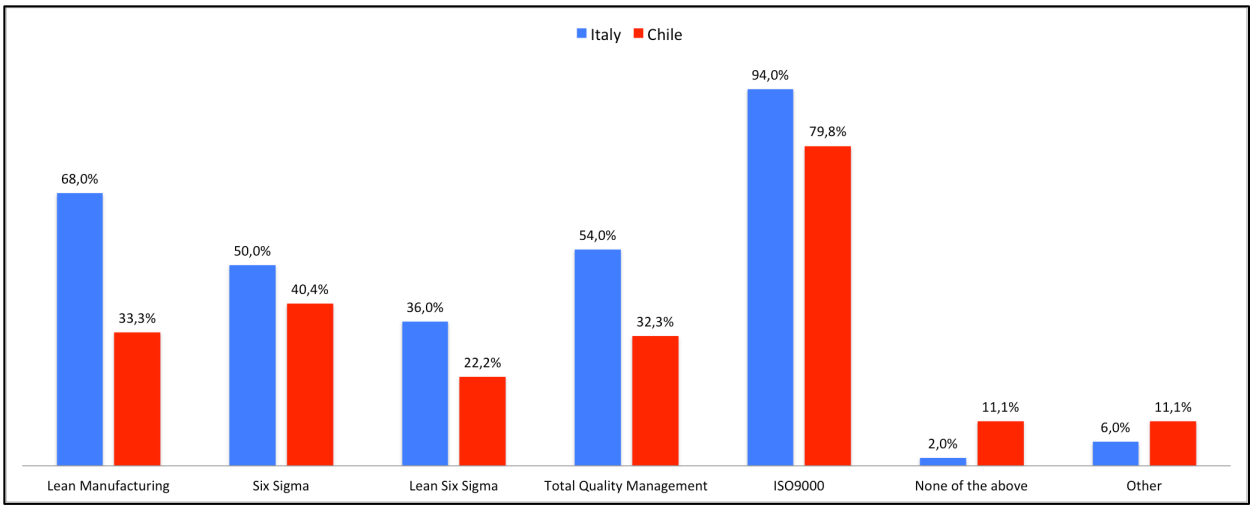

Figure 18. *Level of knowledge of respondents about quality management methodologies*

Significant differences were found between Italian and Chilean industries in terms of the percentage of companies that develop continuous improvement projects with at least one quality management methodology. A significant percentage of Italian companies (82%) stated that they develop projects with some methodology, while in the same question only 54.5% of Chilean companies indicated at least one technique.

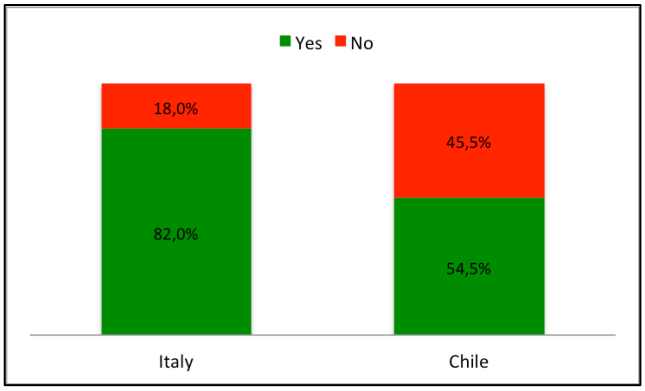

Figure 19. *Percentage of companies that develop continuous improvement projects with quality management methodologies*

Companies developing continuous improvement projects with at least one quality management methodology, 41 out of 50 in Italy and 54 out of 99 in Chile, were asked about the program implemented in these projects. The results indicated that ISO 9000 is the main methodology implemented by Italian companies with 35 companies implementing it out of 41 (85.4%). Lean

Manufacturing and Total Quality Management were selected as the second and third most implemented with 46.3% and 36.6% respectively, followed by Lean Six Sigma (17.1%) and Six Sigma (14.6%). Other portion (4.9%) is conformed by companies using ISO 17065, ISO 17020, ASME QAI-1, among others.

Similar to the Italian industry, Chilean companies selected ISO 9000 (72.2%), Lean Manufacturing (37%) and Total Quality Management (14.8%) as the three methodologies most used for continuous improvement projects. Six Sigma in fourth position with 9.3% and Lean Six Sigma in fifth position with 3.7% complete the Chilean ranking. Other methodologies mentioned by Chilean companies are some ISO standards (ISO 14000 - ISO 22000 - ISO 22300 - ISO 37000 - ISO 45000 - ISO 50000), local certifications/regulations, GRASP, HACCP and BRC.

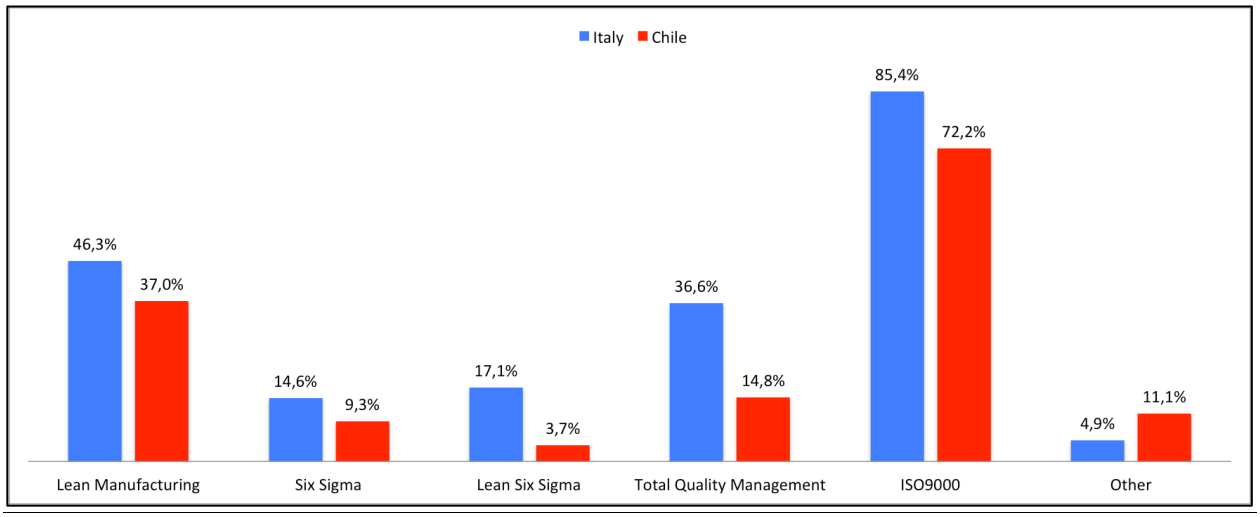

Figure 20. *Methodologies implemented by companies*

Results graphed in Figure 22 show the distribution of the length of time that companies have been applying the methodologies. 21 out of 41 (51.2%) Italian companies stated that they have been implementing quality management methodologies for 5 years o more, 9.8% between 3 and 5 years, 34.1% during 1 to 3 years, and 4.9% for less than 1 year. Chilean industry is distributed with 38.9% of companies having implemented quality management programs for 5 years or more, 20.4% for a period of 3 to 5 years, 29.6% between 1 and 3 years and 11.1% for 1 year or even less.

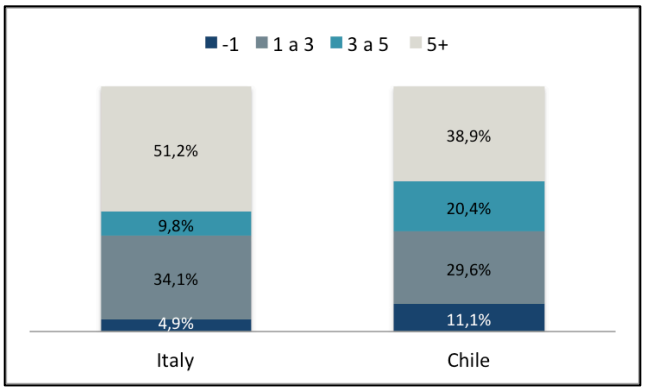

Figure 21. *Time implementing the methodology*

With regard to the evaluation of the results obtained due to the implementation of the quality management methodology, 17.1% of Italian companies classified the results as Very Good Results, and 26 of 41 organizations (63.4%) indicated them as Good Results. Likewise, 14.6% of companies affirmed to have obtained Regular Results and 4.9% rated the results as Bad Results.

Chilean companies indicated that 31.5% achieved Very Good Results due to the implementation of these programs, while 31 of 54 (57.4%) classified the results as Good Results. The classification is completed by 9.3% of companies that identified the results as Regular Results and 1.9% as Very Bad Results.

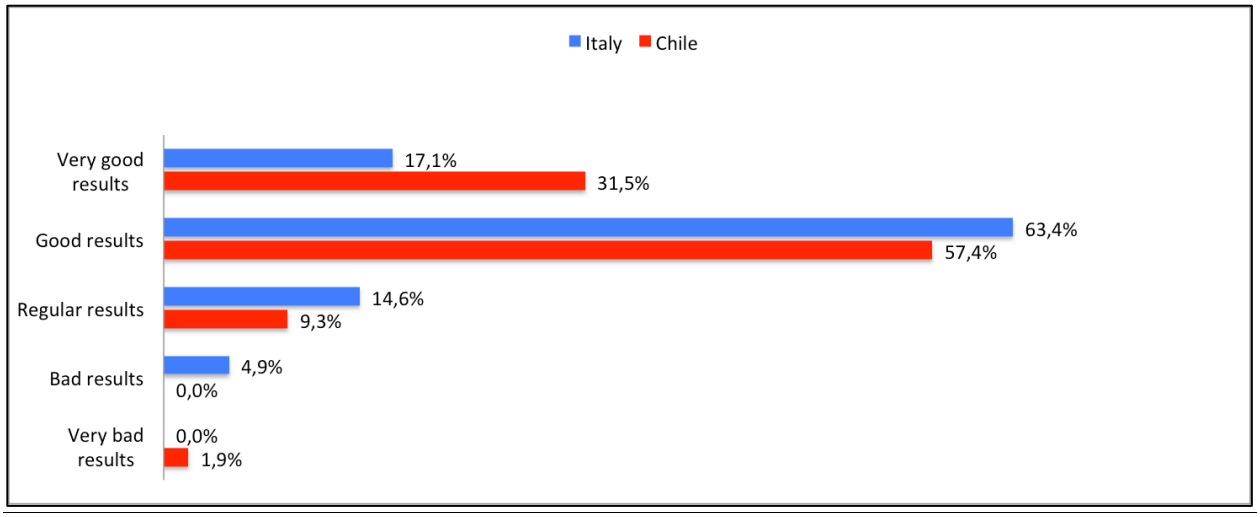

Figure 22. *Evaluation of the results obtained due to the implementation of the methodology*

Additionally, companies were asked about the benefits obtained from the development of continuous improvement projects. The responses indicated that Improvement in the Quality of Products/Services was the most obtained benefit by the Italian companies with 32 affirmative responses out of 41 (78%). Reduction of the Defect Rate or Process Variability was recognized as benefit for 58.5% of the Italian companies, followed by Increase Customer or Employees Satisfaction (43.9%), Cost and Waste Reduction (34.1%) and Cycle Time Reduction or Delivery Time Acceleration (17.1%). Additionally, 4.9% of Italian companies stated that no benefits were obtained after implementing the methodology. Other benefits recognized by Italian companies (7.3%) were Process Improvement and Being Able to Monitor Their Trends by KPI.

Improvement in the Quality of Products/Services was the most obtained benefit by Chilean companies as well. This achievement was appreciated by 40 of the 54 Chilean firms (74.1%). Increase Customer or Employees Satisfaction and Reduction of the Defect Rate or Process Variability were determined as benefits for 72.2% and 66.7% of the companies respectively. Cost and Waste Reduction was achieved by 40.7% of firms, while 37% of corporations improved their performance in terms of Cycle Time Reduction or Delivery Time Acceleration. Other benefits recognized by Chilean companies (13%) were Process Standardization, Employees Involvement, A Better Internal Control, among others.

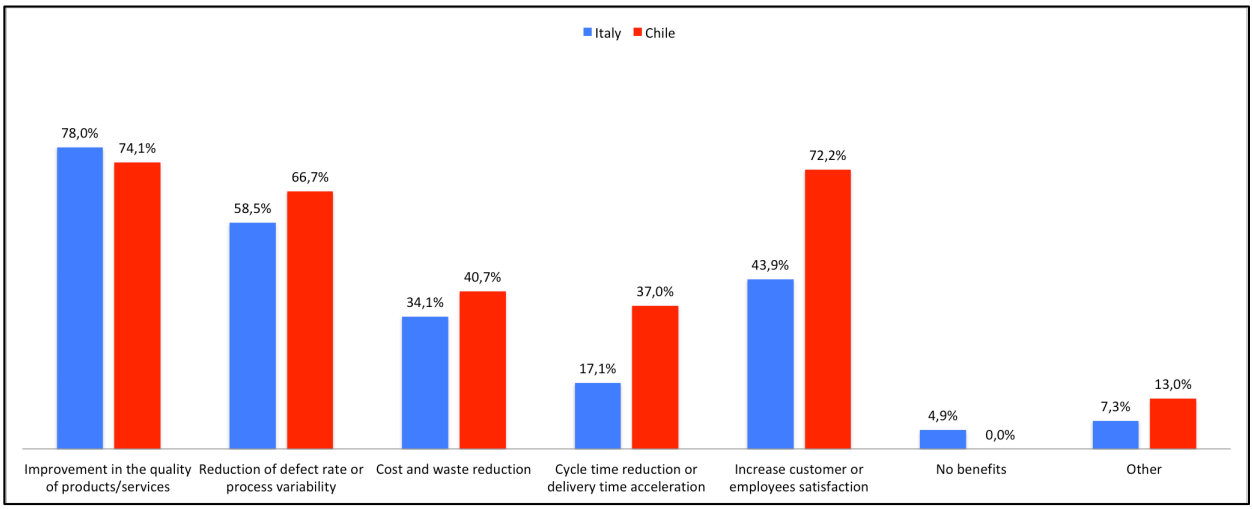

Figure 23. *Results obtained from the implementation of the methodology*

Critical success factors to obtain the benefits discussed above are shown in Figure 24. Results evidenced that "Employees Training and Education" was selected by the largest number of Italian companies as a critical factor with 33 out of 41 responses (80.5%). Being Able to Link the Quality Management Projects to the Business Strategy or the Customer Needs, Flexibility to the Cultural Change and Good Leadership were recognized as CSFs by 70.7% of all companies. The list of CSFs selected by Italian companies is completed decreasingly with: Great Top Management Involvement (65.9%), Good Data Collection and Analysis (61%), Investment of Resources (53.7%) and Good Selection and Prioritization of Projects (46.3%).

Great Involvement from the Top Management appears at the top of the Chilean ranking due to 47 firms out of 54 (87%) affirmed that it was a CSF during the development of continuous improvement projects. This factor is followed by Flexibility to the Cultural Change and Good Leadership with 85.2% and by Employees Training and Education with 81.5%. Results indicated that the percentage of other factor were: 77.8% for Being Able to Link the Quality Management Projects to the Business Strategy or the Customer Needs, 72.2% for Good Selection and Prioritization of Projects, Good Data Collection and Analysis with 68.5%, and finally Investment of Resources with 61.1%.

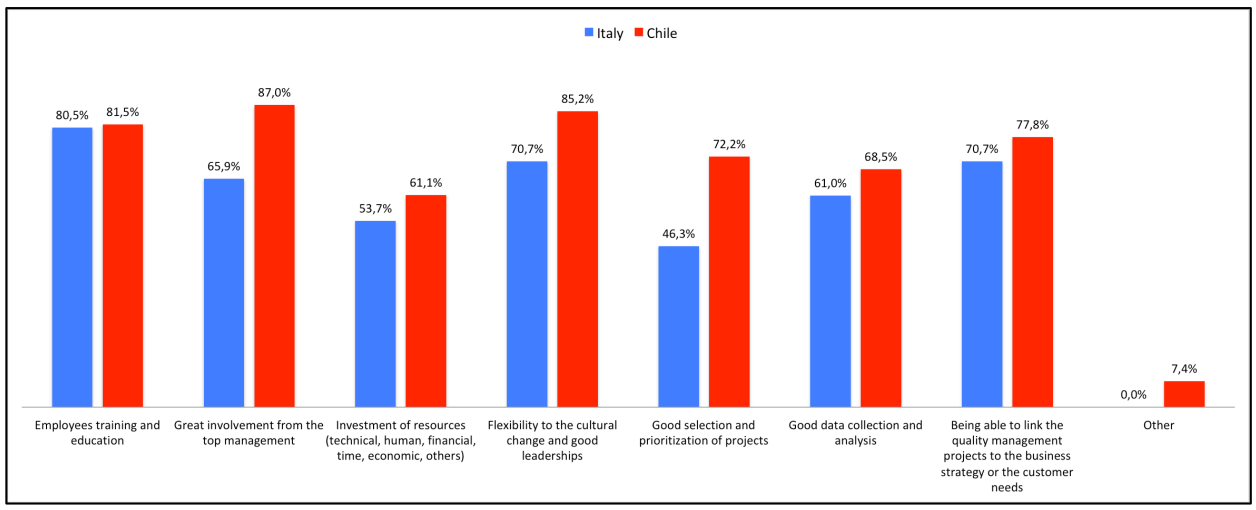

Figure 24. *Critical success factors during the implementation of the methodology*

As for the tools used by quality management methodologies, the survey listed 22 of these instruments and respondents selected those they are familiar with. The results indicated that the

instrument most selected by respondents in both countries is Gantt Chart, with 41 out of 50 (82%) in Italy and 86 out of 99 (86.9%) in Chile. Figure 25 and 26 show the results obtained from Italian and Chilean companies respectively.

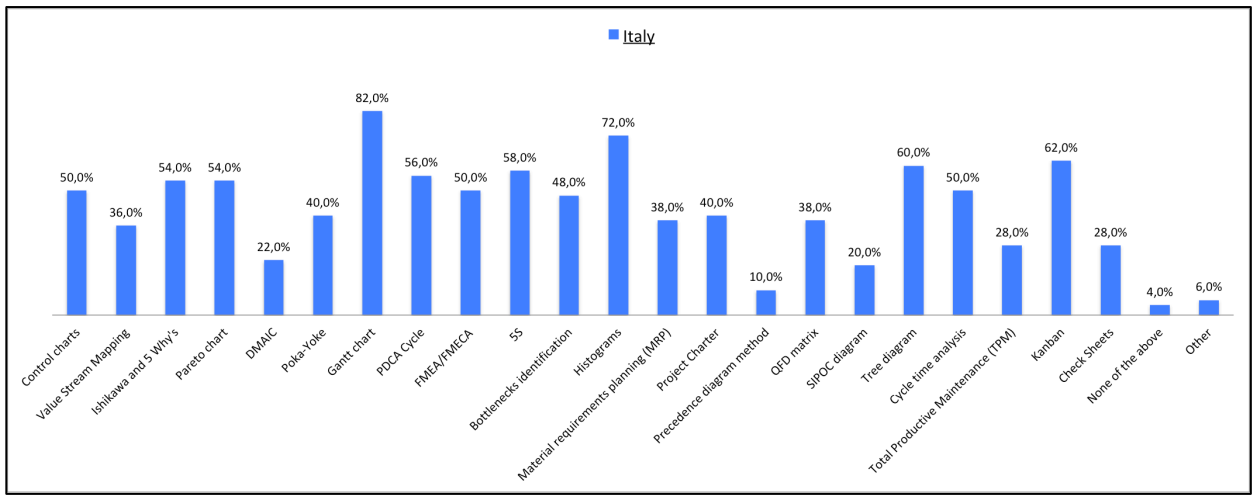

Figure 25. *Level of knowledge of Italian respondents about the instruments used by quality management methodologies*

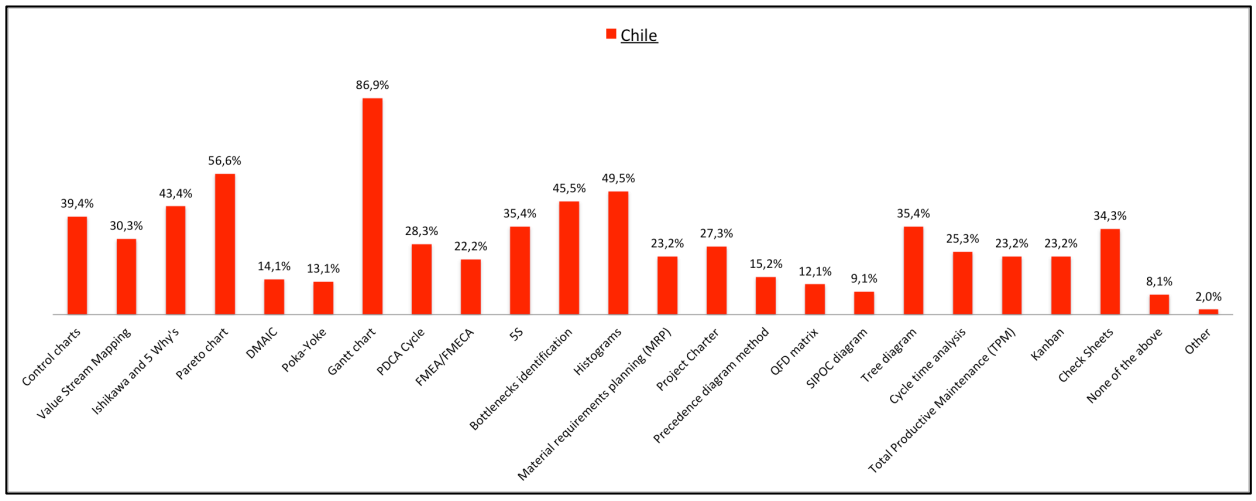

Figure 26. *Level of knowledge of Chilean respondents about the instruments used by quality management methodologies*

The comparison about the awareness level of respondents about these tools is represented in Figure 27. As can be seen, Italian respondents have a higher level of knowledge compared to Chileans, precisely, Italian respondents are more aware in 18 of the 22 tools.

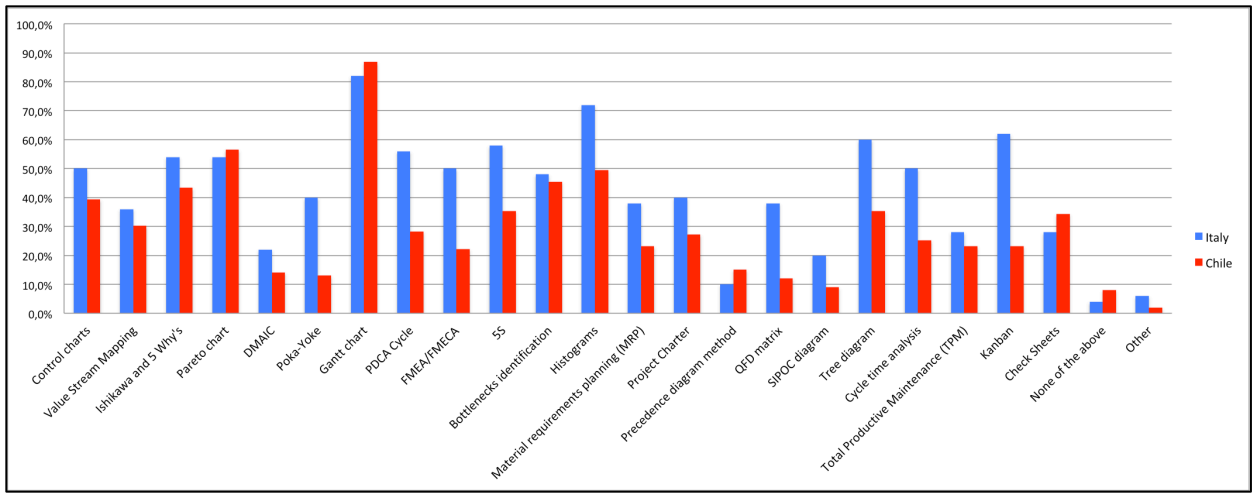

Figure 27. *Level of knowledge of the respondents about the instruments used by quality management methodologies – Comparison by country*

Table 1 shows the differences in percentage between countries for each tool. Values in blue mean that Italian companies have a higher percentage than Chilean companies, while values in red represent the opposite. The more intense the color, the greater difference between countries. As can be seen, 14 tools are very favorable (+10%) and 2 relatively favorable (5%–10%) for Italian companies, while other 2 instruments are relatively favorable for Chilean companies. Furthermore, 4 instruments do not show significant differences (0%-5%).

Control charts	Value Stream Mapping (VSM)	Ishikawa & 5 Why's	Pareto chart	DMAIC	Poka-Yoke	Gantt chart	PDCA cycle	FMEA/ FMECA	5S	Bottlenecks identification
10.6%	5.7%	10.6%	2.6%	7.9%	28.9%	4.9%	27.7%	27.8%	22.6%	2.5%
Histograms	Material requirements planning (MRP)	Project charter	Precede-nce diagram method	QFD matrix	SIPOC diagram	Tree diagram	Cycle time analysis	Total Productive Maintenance (TPM)	Kanban	Check Sheets
22.5%	14.8%	12.7%	5.2%	25.9%	10.9%	24.6%	24.7%	4.8%	38.8%	6.3%

Table 1. *Percentage differences regarding the level of knowledge of the respondents about the instruments used by quality management methodologies*

Results revealed that a higher percentage of Italian companies work with tools used by QM methodologies, as 44 out of 50 (88%) Italian companies and 77 out of 99 (77.8%) Chilean companies reported using at least 1 tool.

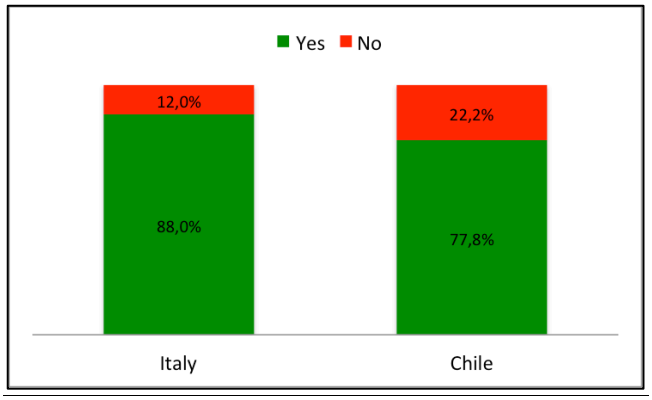

Figure 28. *Percentage of companies working with instruments used by quality management methodologies*

Companies that reported using at least 1 instrument were asked about which tools they work with. The Gantt Chart was again the most voted tool due to 32 out of 44 (72.7%) Italian companies and 62 out of 77 (80.5%) Chilean companies selected it. Figure 29 and Figure 30 show, respectively, the percentages of Italian and Chilean companies using each tool.

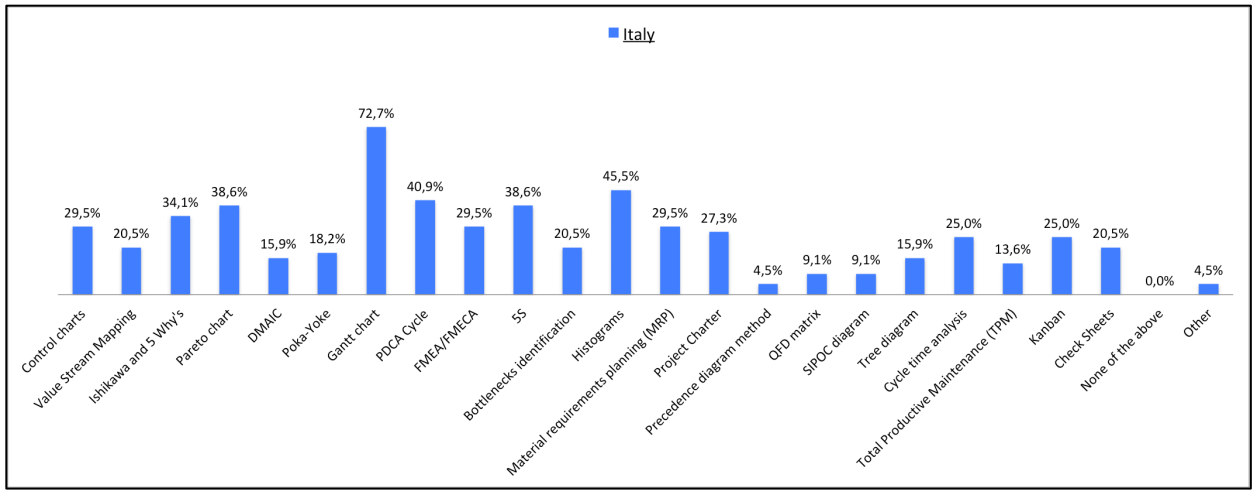

Figure 29. *Instruments used by Italian companies*

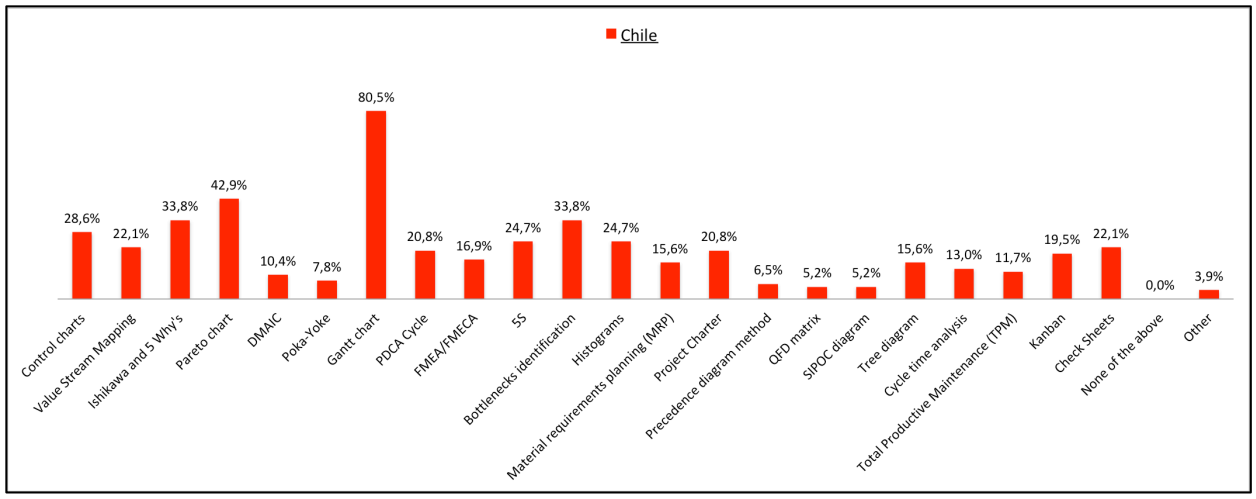

Figure 30. *Instruments used by Chilean companies*

A comparison of the percentages shown in Figures 29 and 30 is represented in Figure 31.

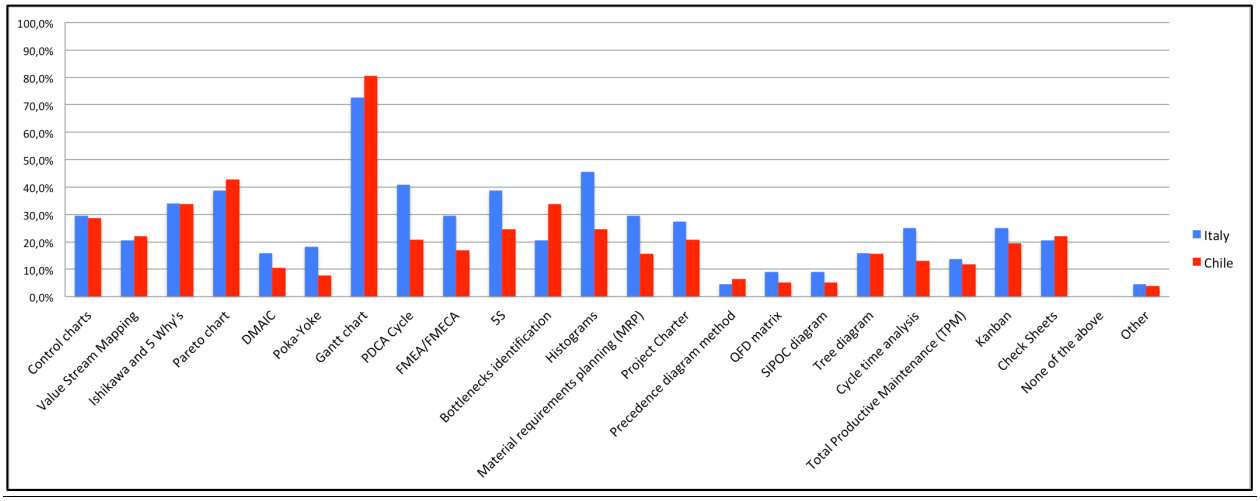

Figure 31. *Instruments used by companies – Comparison by country*

The results evidenced that Italian respondents described the Improvement in the Quality of Products/Services as the main field where companies could improve their performance due to 37/50 (74%) agreed that it is an area where the company has more opportunities to improve its operations in terms of quality management. Increase Customer or Employees Satisfaction was the second most voted with 58%, followed by Reduction of Defect Rate or Process Variability with 46%, while Cost and Waste Reduction, and Cycle Time Reduction or Delivery Time

Acceleration obtained 40%. Furthermore, 4% of Italian respondents are not able to recognize an area where their companies could increase efficiency and effectiveness.

In the case of Chilean companies, Increase Customer or Employees Satisfaction was the most indicated issue with 60 affirmative answers out of 99 (60.6%). Cost and Waste Reduction, and Improvement in the Quality of Products/Services occupy the second and third place with 49.5% and 47.5% respectively. Finally, at the bottom of the ranking are: Reduction of Defect Rate or Process Variability (46.5%) and Cycle Time Reduction or Delivery Time Acceleration (45.5%). Other answers obtained from Chilean respondents are related to Process Automation and Maintaining the Culture of Quality. Additionally, only 1% of respondents stated that they have no idea where the company could improve in terms of quality.

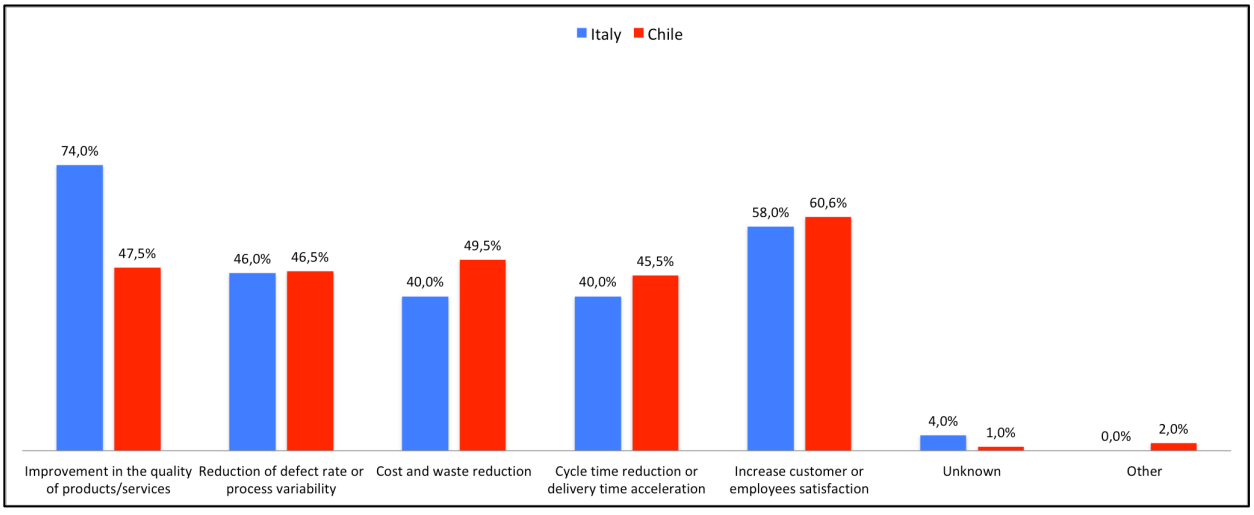

Figure 32. *Area in which companies have more opportunities to improve performance in terms of quality management*

2. Results by Type of Company According to its Products

The second subchapter analyzes the results by type of company according to their products, i.e. the companies are divided into 3 categories: Manufacturing, Services and Hybrid. This separation was done in order to analyze and compare the similarities and differences between categories in terms of quality management, and thus to be able to analyze the accuracy of hypothesis H2. In addition, the information is classified and presented by country.

i. Italy

The 50 Italian companies are divided into 22 manufacturing companies, 19 service organizations and 9 hybrid firms.

a. General Information

Manufacturing, service and hybrid companies were classified by their size, geographic scope and origin of capital. The results of these classifications are presented in Table 2 and Figures 33, 34 and 35.

		Manufacturing	Services	Hybrid
Enterprise Size	Large	54.5%	31.6%	11.1%
	Medium-Sized	31.8%	0%	33.3%
	Small	4.5%	42.1%	11.1%
	Micro	9.1%	26.3%	44.4%
Geographic Scope	Multinational	72.7%	31.6%	55.6%
	National	13.6%	52.6%	33.3%
	Regional	4.5%	10.5%	0%
	Local	9.1%	5.3%	11.1%
Origin of Capital	Private	86.4%	89.5%	88.9%
	Public	4.5%	10.5%	0%
	Public-Private	9.1%	0%	11.1%

Table 2. *Composition of Italian companies classified by Type of Product*

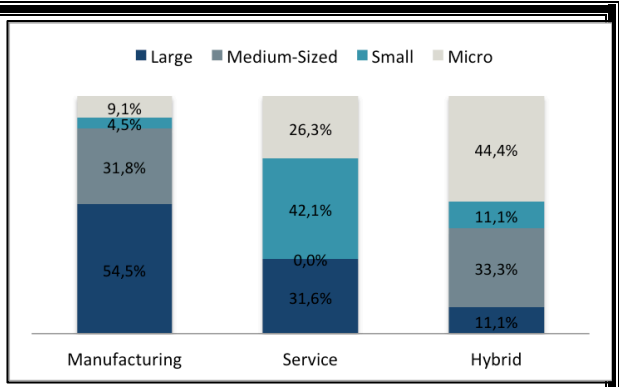

Figure 33. *Distribution of Italian companies by Type of Product – Enterprise Size*

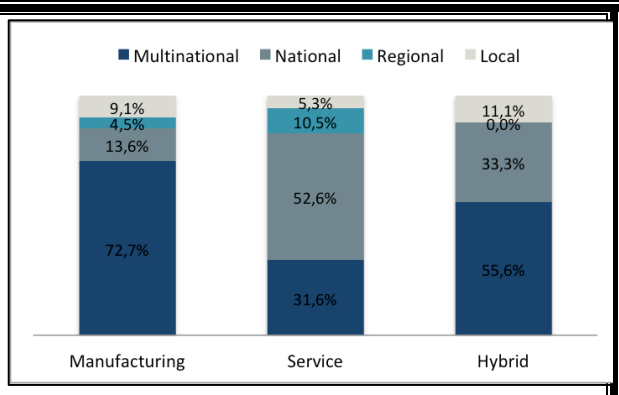

Figure 34. *Distribution of Italian companies by Type of Product – Geographic Scope*

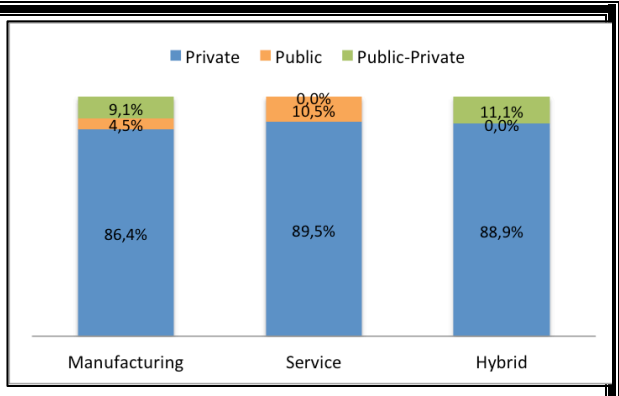

Figure 35. *Distribution of Italian companies by Type of Product – Origin of Capital*

b. Quality Management Information

Responses about quality management showed that 95.5% of Italian manufacturing companies have a quality management department, while the values for service and hybrid companies barely reach 42.1% and 55.6% respectively.

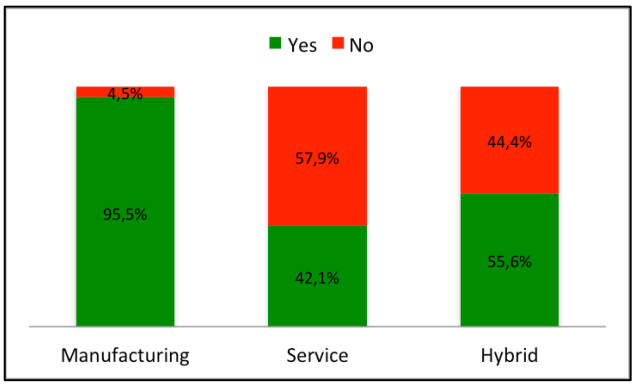

Figure 36. *Percentage of Italian companies with a quality management department – Type of Product*

The percentages of Italian respondents familiar with each methodology are shown in Figure 37. The results reveal that the most familiar methodology to respondents is ISO 9000, as it is the most voted by each category. In addition, respondents working in manufacturing organizations

are significantly more familiar with Lean Manufacturing than those working in service or hybrid companies.

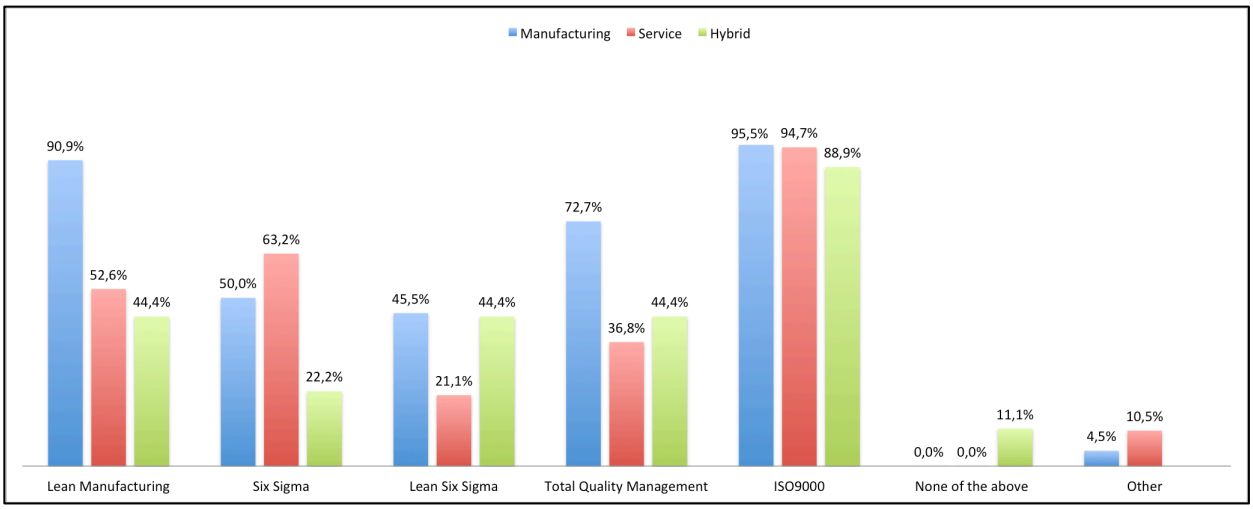

Figure 37. *Level of knowledge of the Italian respondents about quality management methodologies – Type of Product*

The results showed that quality management methodologies play a central role in the performance of Italian manufacturing companies because all of these companies develop continuous improvement projects with at least one of these techniques. Moreover, a significant difference was observed between manufacturing and service organizations in terms of the development of these projects.

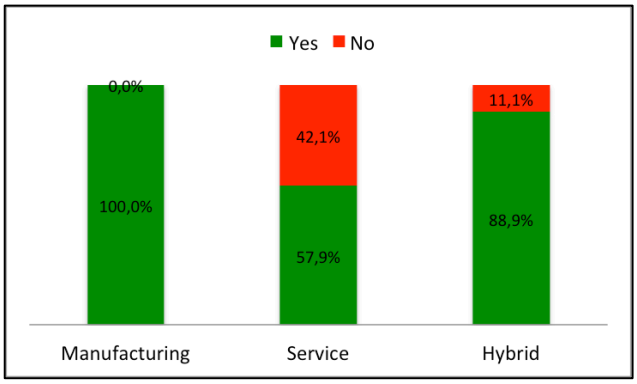

Figure 38. *Percentage of Italian companies that develop continuous improvement projects with quality management methodologies – Type of Product*

The respondents who answered affirmatively to the last question were asked about the methodology used by the company for its continuous improvement projects. In addition to the 22 Manufacturing companies, 57.9% of the Service companies correspond to 11 organizations, while 88.9% of the Hybrid corporations represent a total of 8 entities. As expected from the previous answers, ISO 9000 was selected as the most used technique by all categories: 100% of the hybrid companies developing continuous improvement projects use ISO 9000, while manufacturing and services companies share the same percentage with 81.8%. Other methodologies used by services companies (18.2%) are: ISO 17065 and 17020, ASME QAI-1 and Test Driven Development.

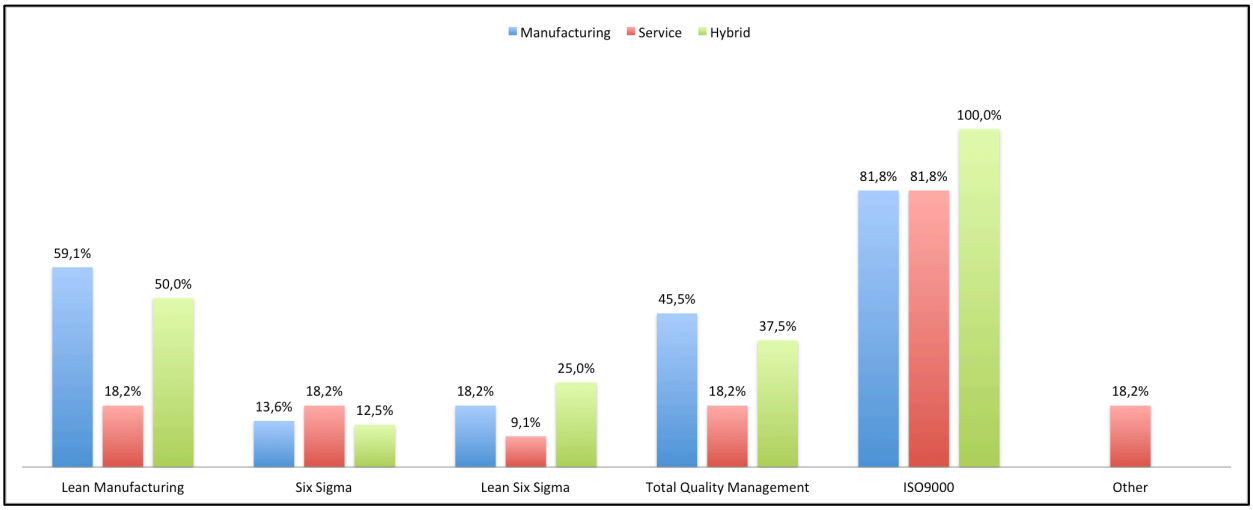

Figure 39. *Methodologies implemented by Italian companies – Type of Product*

As can be seen in Figure 40, the responses follow a pattern due to the fact that in most of the instruments the highest percentage belongs to the Manufacturing category, followed by hybrid organizations and then by service companies. This means that, in general, respondents from hybrid organizations have more knowledge about quality management tools than those working in service companies, but less than those working in manufacturing companies. In addition, a percentage of respondents working in service companies (10.5%) are not aware of any of the tools listed in the survey. Other tools known by respondents working in manufacturing companies are Kaizen, SMED and PM Analysis, while Risk Analysis was recognized by workers in service companies.

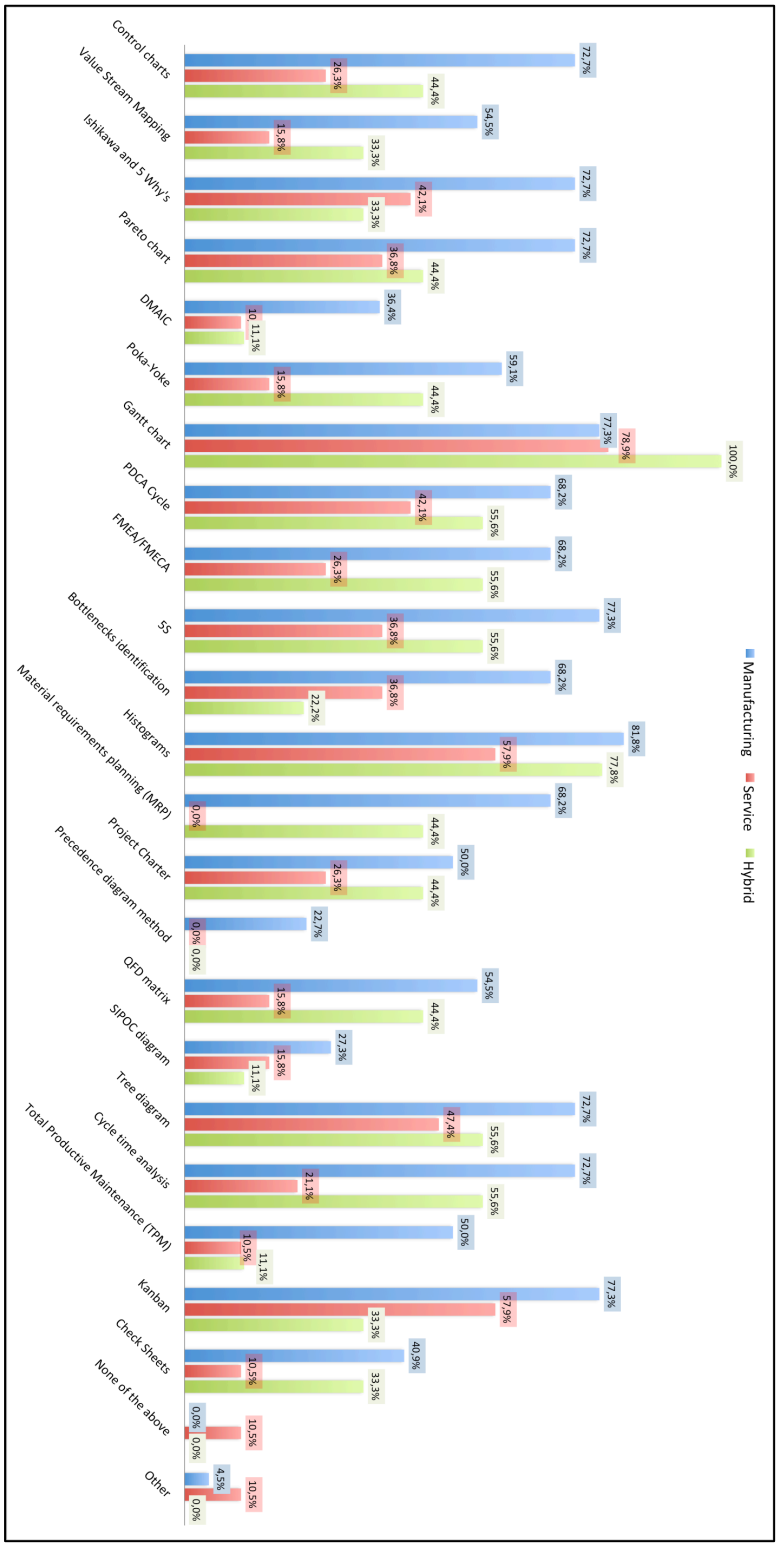

Figure 40. *Level of knowledge of the Italian respondents about the instruments used by the quality management methodologies – Type of Product*

Figure 38 and Figure 41 reveal similar results due to 100% of manufacturing companies and 88.9% of hybrid organizations work with at least 1 tool, the same percentages that develop CI projects with at least one QM methodology. Furthermore, despite the higher percentage of the Services category, the positions remain the same: Manufacturing, Hybrid and Services.

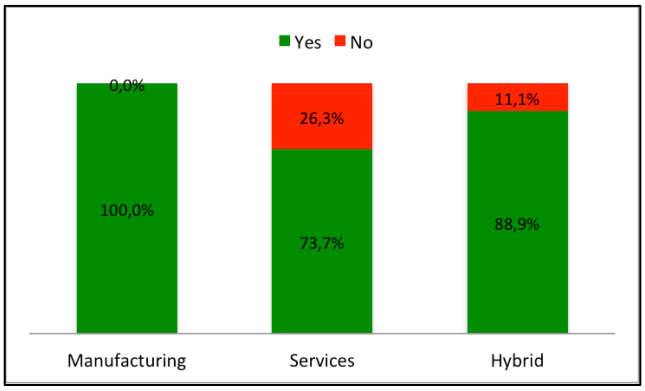

Figure 41. *Percentage of Italian companies working with instruments used by the quality management methodologies – Type of Product*

The last graph in this section is presented in Figure 42. It shows the results about the percentages of companies using a specific instrument. The percentages have been calculated from the total number of companies that answered affirmatively to the last question. Therefore, the denominators for each category are 22 for Manufacturing (100% of 22), 14 for Services (73.7% of 19) and 8 for Hybrid (88.9% of 9).

As can be seen in Figure 42, the Manufacturing category has the highest percentage in most of the instruments. Other instruments used by manufacturing and service companies are the same as those mentioned above; Kaizen, SMED and PM Analysis by manufacturing companies; and Risk Analysis by service companies.

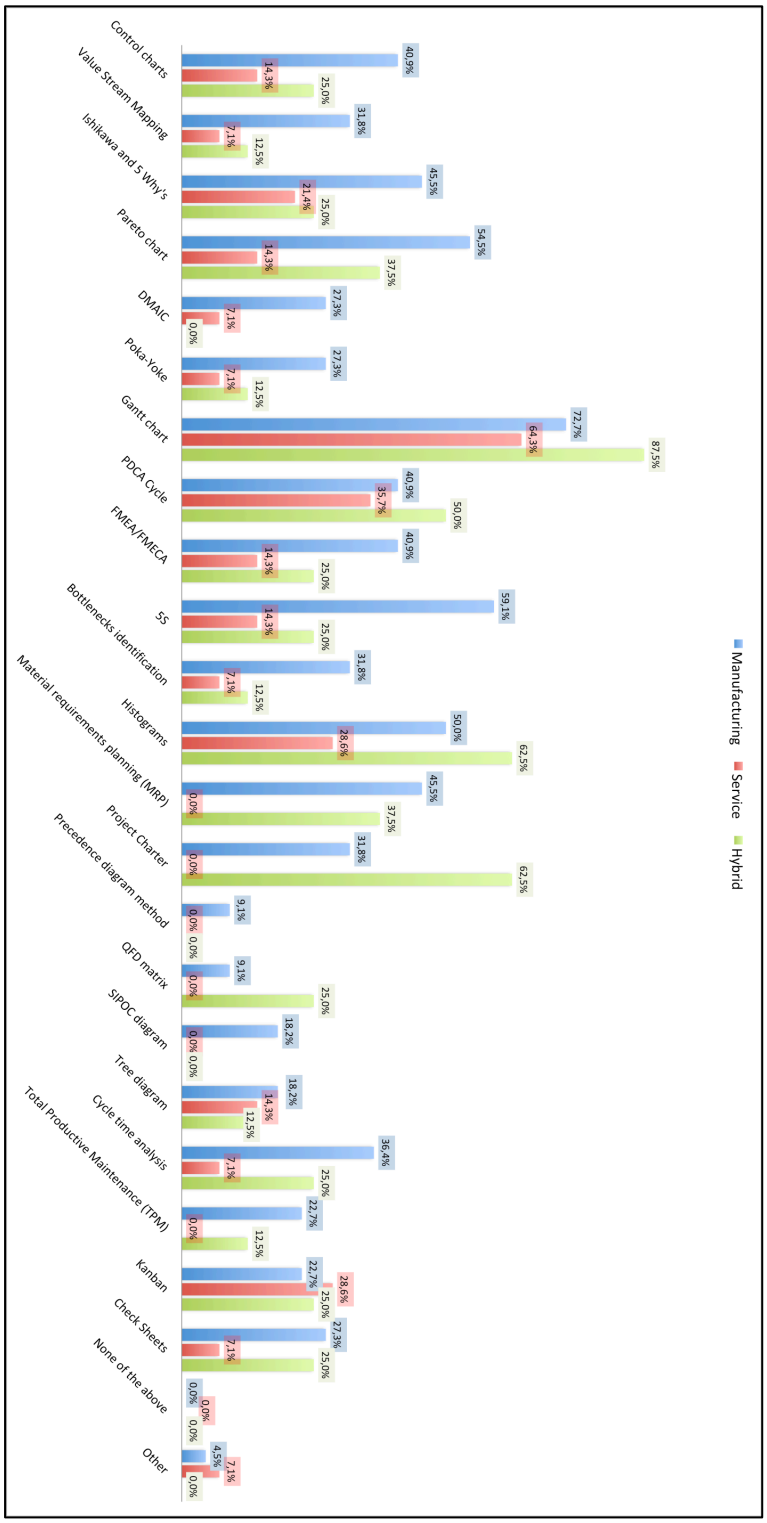

Figure 42. *Instruments used by Italian companies – Type of Product*

ii. Chile

The 99 Chilean companies are divided into 21 manufacturing firms, 63 services enterprises and 15 hybrid organizations.

a. General Information

Manufacturing, service and hybrid companies were analyzed and classified by their size, geographic scope and origin of capital. The results of this analysis are presented in Table 3 and Figures 43, 44 and 45.

		Manufacturing	Service	Hybrid
Enterprise Size	Large	38.1%	41.3%	20%
	Medium-Sized	28.6%	22.2%	46.7%
	Small	23.8%	22.2%	20%
	Micro	9.5%	14.3%	13.3%
Geographic Scope	Multinational	47.6%	33.3%	13.3%
	National	23.8%	44.4%	40%
	Regional	14.3%	7.9%	13.3%
	Local	14.3%	14.3%	33.3%
Origin of Capital	Private	90.5%	87.3%	80%
	Public	0%	7.9%	6.7%
	Public-Private	9.5%	4.8%	13.3%

Table 3. *Composition of Chilean companies classified by Type of Product*

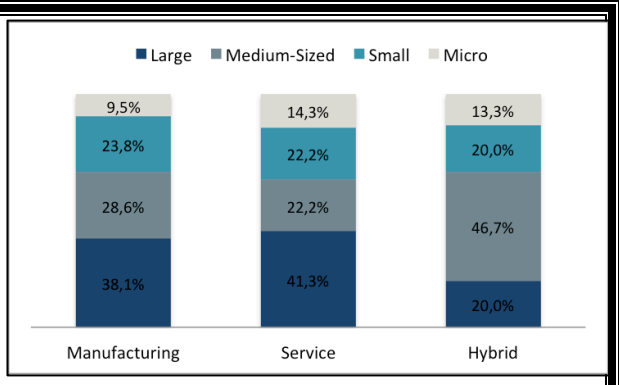

Figure 43. Distribution of Chilean companies by Type of Product – Enterprise Size

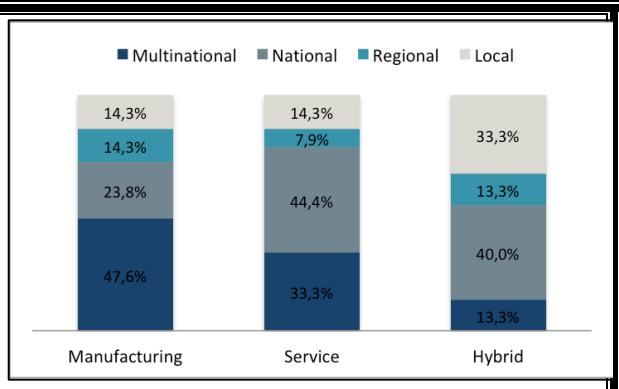

Figure 44. Distribution of Chilean companies by Type of Product – Geographic Scope

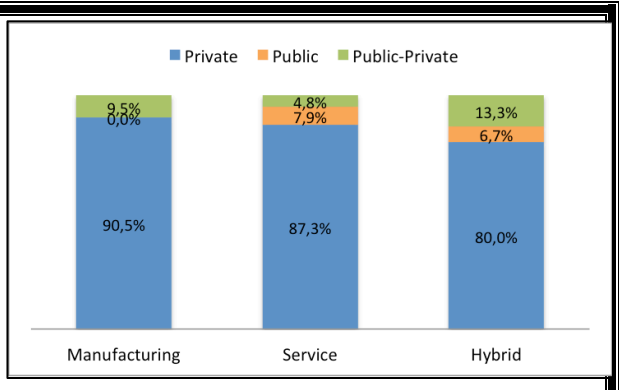

Figure 45. Distribution of Chilean companies by Type of Product – Origin of Capital

b. Quality Management Information

Chilean results do not differ from Italian results because Chilean manufacturing organizations remain as the category that proportionally has the highest number of quality management departments (66.7%), followed in second place by hybrid corporations (53.3%) and in third place by service companies (49.2%).

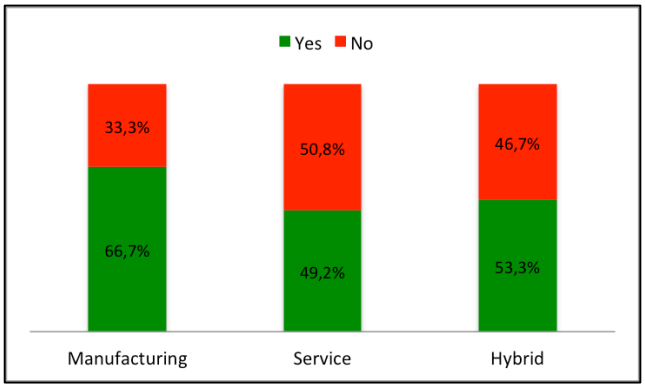

Figure 46. *Percentage of Chilean companies with a quality management department – Type of Product*

Regarding the awareness level about quality management methodologies, 4 of 5 methodologies follow the same pattern, with respondents from service enterprises knowing more about these methodologies than workers in hybrid companies, but less than respondents in manufacturing

organizations. ISO 9000 is the only methodology that does not reproduce this pattern. Furthermore, following with the trend, 14.3% of respondents from service companies stated that they do not know about any quality management methodology, while these percentages for the Hybrid and Manufacturing categories barely reach 6.7% and 4.8% respectively. Other methodologies commented by workers are: ISO 22000, OSHA, HACCP, BRC, and GMP by respondents from manufacturing companies (23.8%); local certifications/regulations, HACCP, BPM and several ISO like 14000, 22300, 37000, 45000, 50000 by employees of service firms; and CMMI by respondents working in hybrid enterprises.

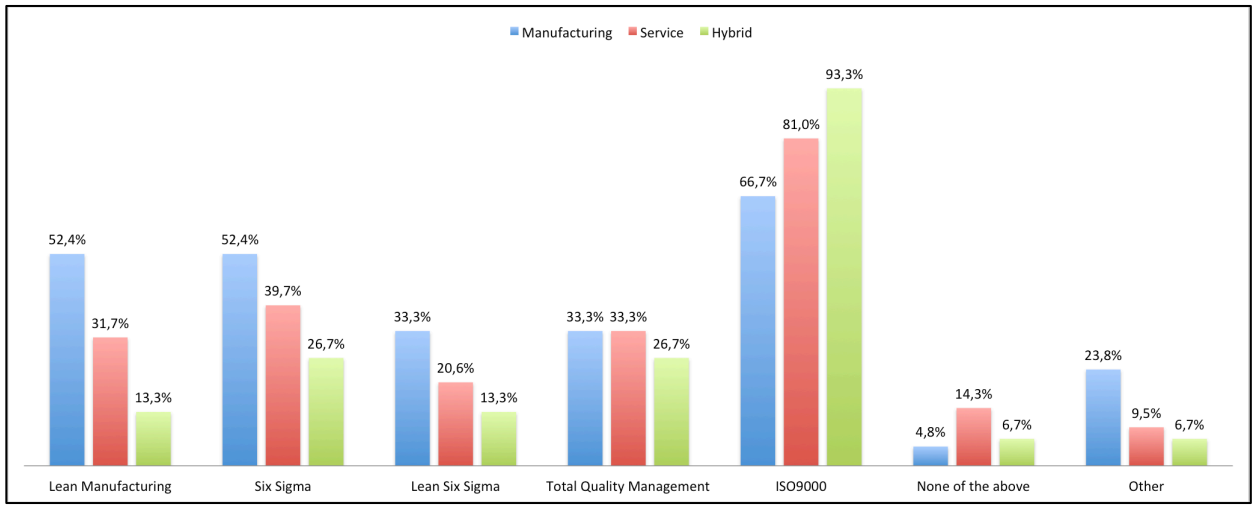

Figure 47. *Level of knowledge of the Chilean respondents about quality management methodologies – Type of Product*

Regarding the question about the percentage of Chilean companies that develop continuous improvement projects with at least one quality management methodology, 15 out of 21 (71.4%) manufacturing organizations stated that they use one or more methodologies to carry out these projects. The total number of Chilean service companies that answered affirmatively was 33 (52.4%), while for hybrid companies this value was 6 (40%).

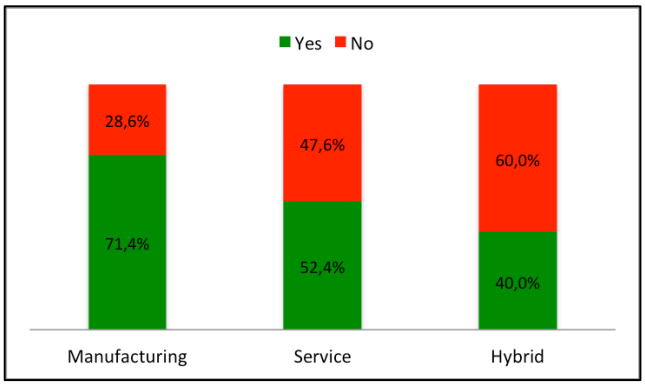

Figure 48. *Percentage of Chilean companies that develop continuous improvement projects with quality management methodologies – Type of Product*

The companies that responded affirmatively to the last question were asked about which quality management methodology they use to develop CI projects. Therefore, a total of 15 manufacturing, 33 service and 6 hybrid organizations had to answer this question.

Surprisingly, a greater number of Chilean manufacturing firms implement Lean Manufacturing rather than ISO 9000, but it is also peculiar that none of these companies use Six Sigma or Lean Six Sigma. On the other hand, service and hybrid organizations use ISO 9000 much more than any other methodology. In addition, 13.3% of manufacturing companies use ISO 22000 and BRC; 9.1% of service enterprises use HACCP, local certifications/regulations and various ISOs such as 14000, 22300, 37000, 45000 and 50000; and 16.7% of hybrids reported using GRAPS as a quality management methodology for continuous improvement projects.

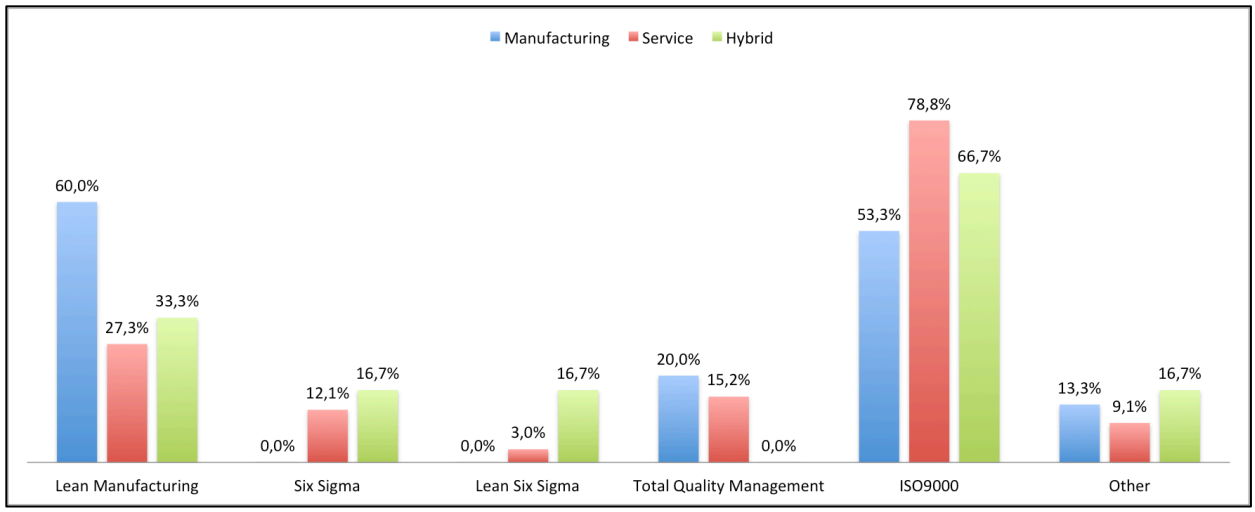

Figure 49. *Methodologies implemented by Chilean companies – Type of Product*

Regarding the level of knowledge of Chilean respondents about the tools used by quality management methodologies, a pattern can be visualized in most of the tools: proportionally, a higher number of respondents working in manufacturing companies know more about these tools than respondents from service or hybrid companies. Furthermore, in several cases, a higher percentage of respondents from service companies are more aware of the tools than respondents working in hybrid organizations. Also, supporting the trend described above, the Hybrid category has the highest percentage of respondents who do not know any tools, followed by the Services category and, in last place, the Manufacturing category. Finally, 4.8% of respondents working in Chilean manufacturing organizations are aware of the Visual Management tool, while 1.6% of respondents in the Services category responded that they are aware of the Risk and Opportunity Matrix.

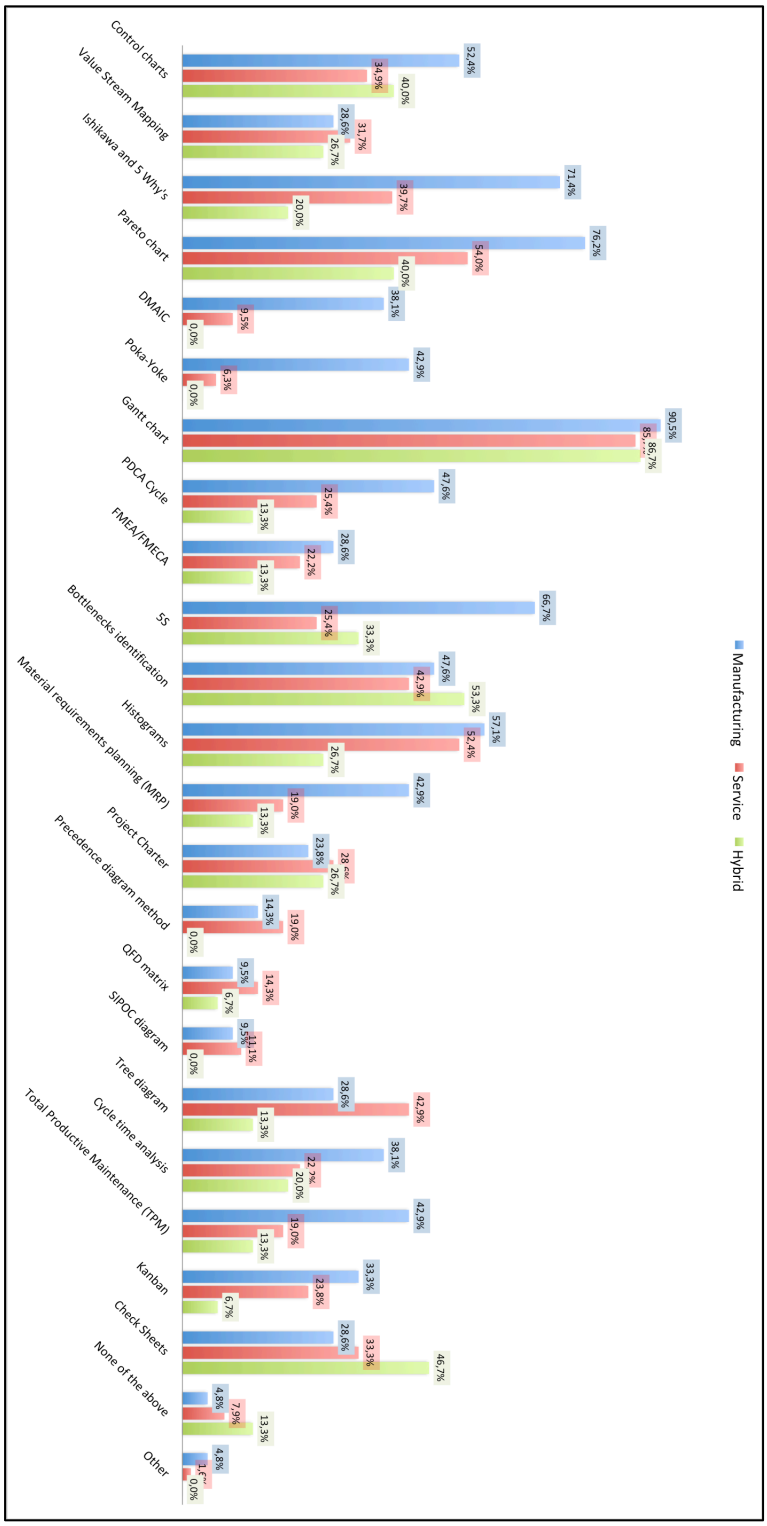

Figure 50. *Level of knowledge of the Chilean respondents about the instruments used by the quality management methodologies – Type of Product*

As can be observed in Figure 51, results indicated that manufacturing companies work with these tools in higher proportion than service or hybrid firms due to the fact that 18 of the 21 (85.7%) respondents working in manufacturing organizations stated that their companies use at least 1 of the tools listed in the alternatives, while this value for Service and Hybrid category reaches 74.6% and 80% respectively.

As can be noted, there are no significant differences between the Services categories in both countries, but there are significant differences between the Manufacturing and Hybrid categories in both countries. It is important to remember that, graphically, the percentages in Italy were 100%, 73.7% and 88.9% from left to right.

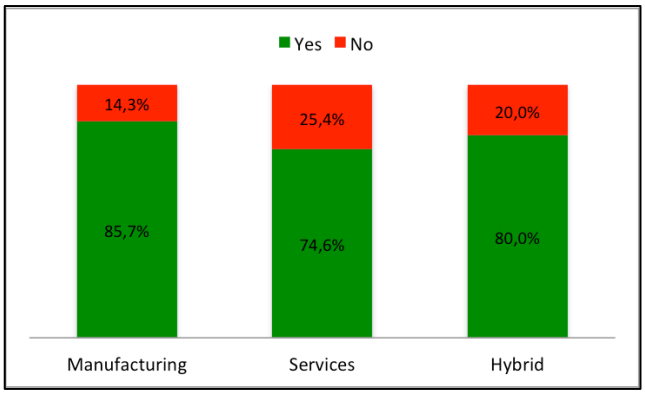

Figure 51. *Percentage of Chilean companies working with instruments used by the quality management methodologies – Type of Product*

Figure 52 represents the percentage of Chilean companies divided by category that work with a specific tool. No pattern or trend can be easily discerned by looking at the graph, but for several tools the results are in favor of the Manufacturing category. Other tools used by 11.1% of the Manufacturing companies are Visual Management and BPM, while 8.3% of the hybrid companies also use Quality Plans.

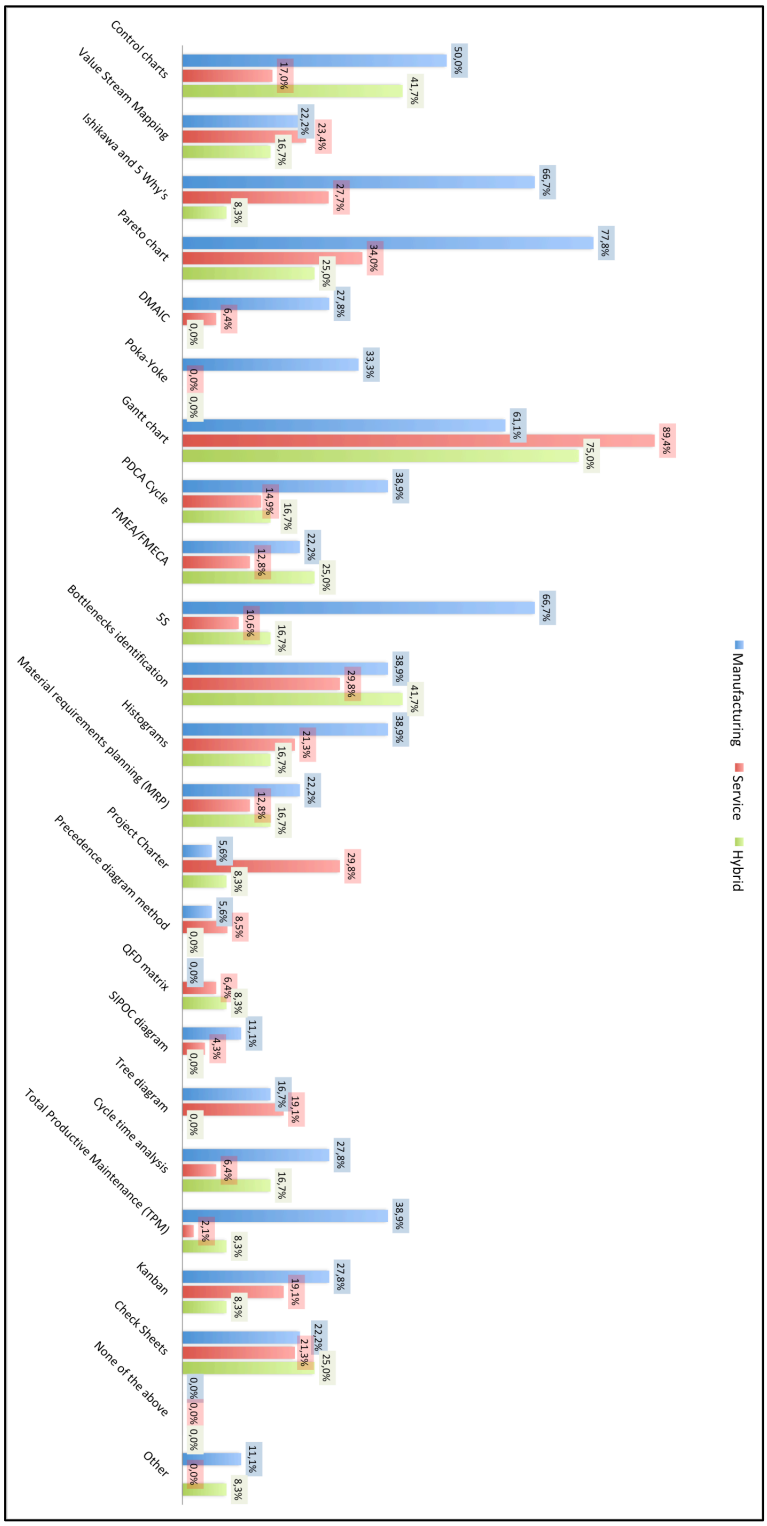

Figure 52. *Instruments used by Chilean companies – Type of Product*

3. Results by Enterprise Size

Enterprise Size subchapter classifies the results by the size of the companies according to the number of employees into 4 categories: Large companies, those with more than 250 employees; Medium-Sized organizations, between 50 and 250 employees; Small firms, those that employ more than 10 and less than 50 workers; and Micro companies, the firms with less than 10 collaborators. This separation was done in order to analyze and compare the similarities and differences between categories in terms of quality management, and thus to be able to analyze the accuracy of hypothesis H3. In addition, the information is classified and presented by country.

i. Italy

The 50 Italian firms are made up of 19 large corporations, 10 medium-sized organizations, 10 small companies and 11 micro enterprises.

a. General Information

Large, medium-sized, small and micro companies were analyzed and classified by their type of product, geographic scope and origin of capital. The results of this analysis are presented in Table 4 and Figures 53, 54 and 55.

		Large	Medium-Sized	Small	Micro
Type of Product	Manufacturing	63.2%	70%	10%	18.2%
	Service	31.6%	0%	80%	45.5%
	Hybrid	5.3%	30%	10%	36.4%
Geographic Scope	Multinational	84.2%	70%	10%	27.3%
	National	5.3%	10%	80%	54.5%
	Regional	5.3%	0%	0%	9.1%
	Local	5.3%	20%	10%	9.1%
Origin of Capital	Private	73.7%	100%	90%	100%
	Public	10.5%	0%	10%	0%
	Public-Private	15.8%	0%	0%	0%

Table 4. *Composition of Italian companies classified by*

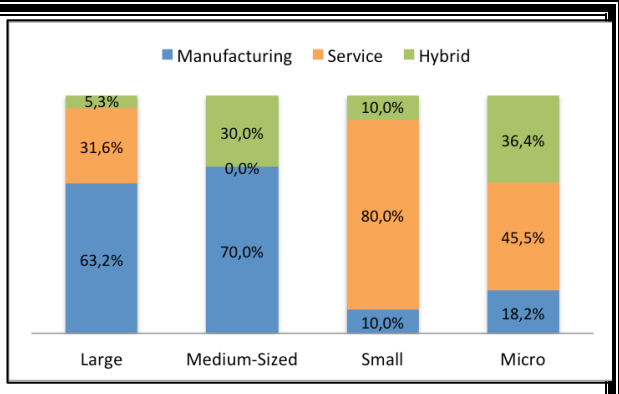

Figure 53. Distribution of Italian companies by Enterprise Size – Type of Product

Enterprise Size

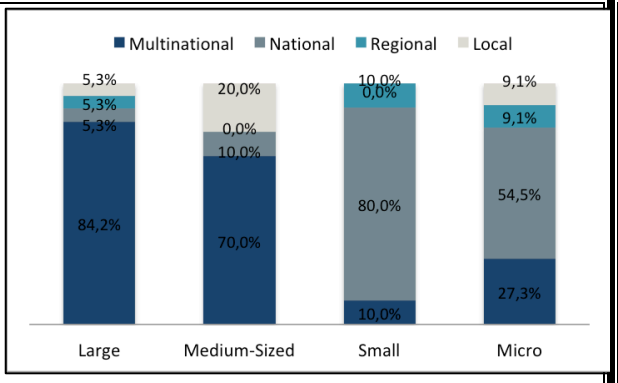

Figure 54. Distribution of Italian companies by Enterprise Size – Geographic Scope

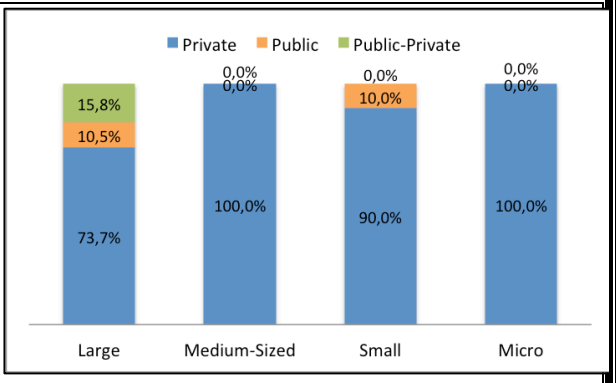

Figure 55. Distribution of Italian companies by Enterprise Size – Origin of Capital

b. Quality Management Information

As expected, 90% of large and medium-sized Italian companies have a quality management department, a significant difference compared to companies classified as small or micro. Approximately 50 percentage points separate the Large and Medium categories from the Small and Micro categories.

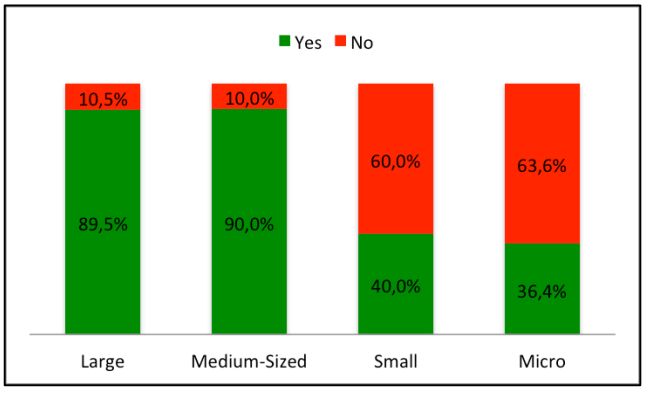

Figure 56. *Percentage of Italian companies with a quality management department – Enterprise Size*

From Figure 57, it is clear that the majority of Italian respondents are familiar with ISO 9000, even those working in companies classified as small or micro. On the other hand, and

disregarding the methodology described above, a pattern can be visualized in the other methodologies: respondents working in large or medium-sized companies are more familiar with quality management methodologies than those working in small or micro organizations. In addition, 9.1% of respondents from micro companies are not aware of any quality management methodology. Respondents from large organizations also mentioned IATF 16949 (5.3%), and those from small companies (20%) included Lean Software Development and Test Driven Development.

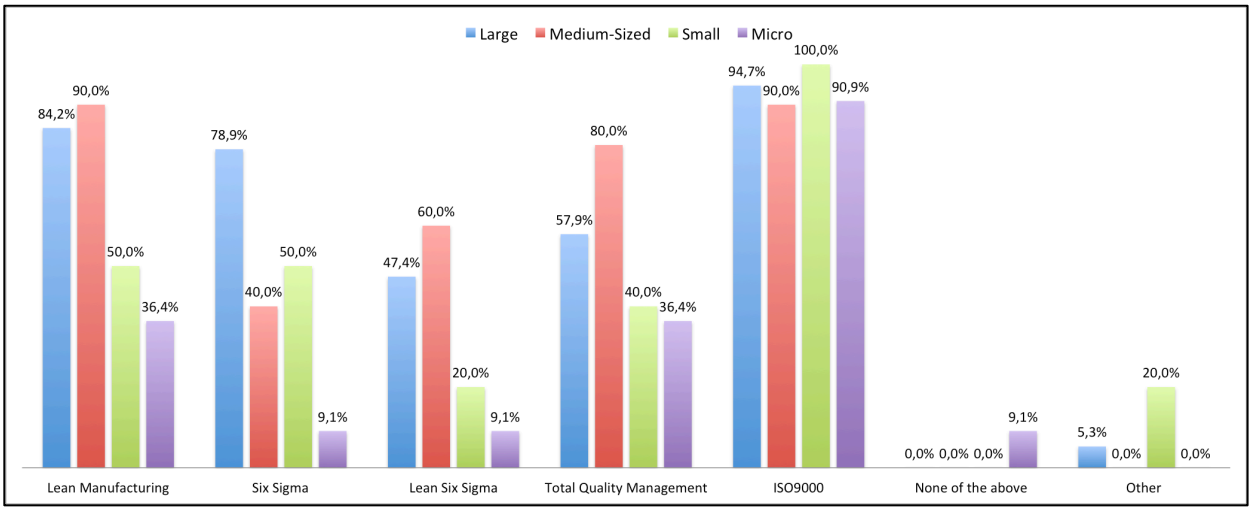

Figure 57. *Level of knowledge of the Italian respondents about quality management methodologies – Enterprise Size*

A trend can be observed in Figure 58 due to the fact that 89.5% of large companies and 100% of medium-sized companies develop continuous improvement projects with some of the methodologies included in the survey, while these percentages for small and micro companies reach only 70% and 63.6%, respectively. Therefore, the larger the category in terms of number of employees, the higher the proportion of companies that develop CI projects.

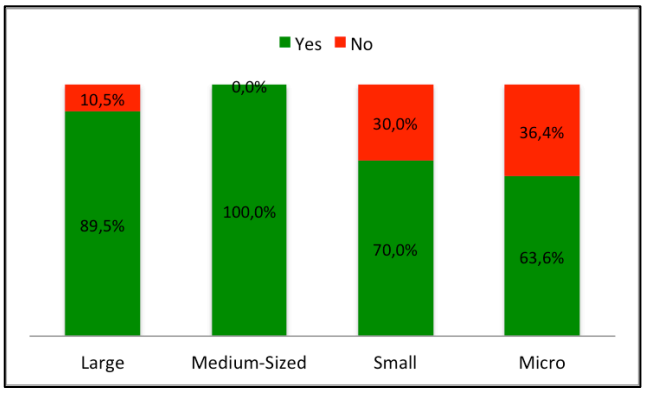

Figure 58. *Percentage of Italian companies that develop continuous improvement projects with quality management methodologies – Enterprise Size*

Respondents who answered affirmatively to the previous question were asked about which quality management methodologies their companies use to carry out continuous improvement projects. The total numbers of companies that responded affirmatively classified by size were: 17 large companies, 10 medium-sized companies, 7 small companies and 7 micro companies. As can be seen, ISO 9000 was selected as the main methodology implemented by companies in the Large, Small and Micro categories, while 8 medium-sized companies develop their projects with Lean Manufacturing, more than the 7 that do so with ISO 9000. Moreover, Italian medium-sized companies are leaner than the other categories, since only 52.9% of the large organizations implement it and this value for the Small and Micro categories is even lower (14.3% for both).

Analyzing the other methodologies (Six Sigma, Lean Six Sigma and Total Quality Management), a trend can be observed: the larger the company, the higher the proportion of companies working with the methodology. In addition, 28.6% of small companies have applied methodologies such as Test Driven Development, ASME QAI-1 and various ISOs such as ISO 17020 or 17065.

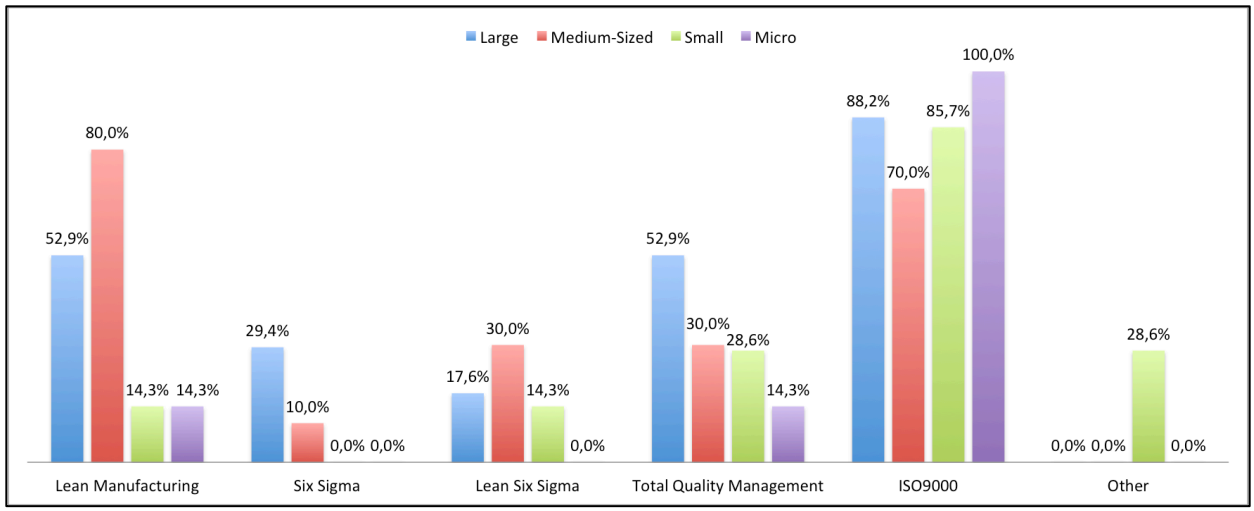

Figure 59. *Methodologies implemented by Italian companies – Enterprise Size*

As can be seen in Figure 60, in most of the instruments, respondents working in companies classified as Medium-Sized are more familiar with the tools, as a higher proportion of them are aware of these instruments compared to respondents working in companies classified in other categories. In addition, there is a significant difference in knowledge when comparing Large and Medium-Sized categories with Small and Micro categories. Furthermore, a trend similar to that observed in the question about the level of knowledge of methodologies is observed: the larger the company, the higher the proportion of respondents who are aware of a specific tool. In addition, 5.3% of the respondents from large companies and 9.1% from micro companies claim not to know any of the tools listed in the alternatives. Finally, 5.3% of respondents from large companies are familiar with Kaizen, SMED and PM Analysis, while 20% of small organizations are familiar with Risk Analysis.

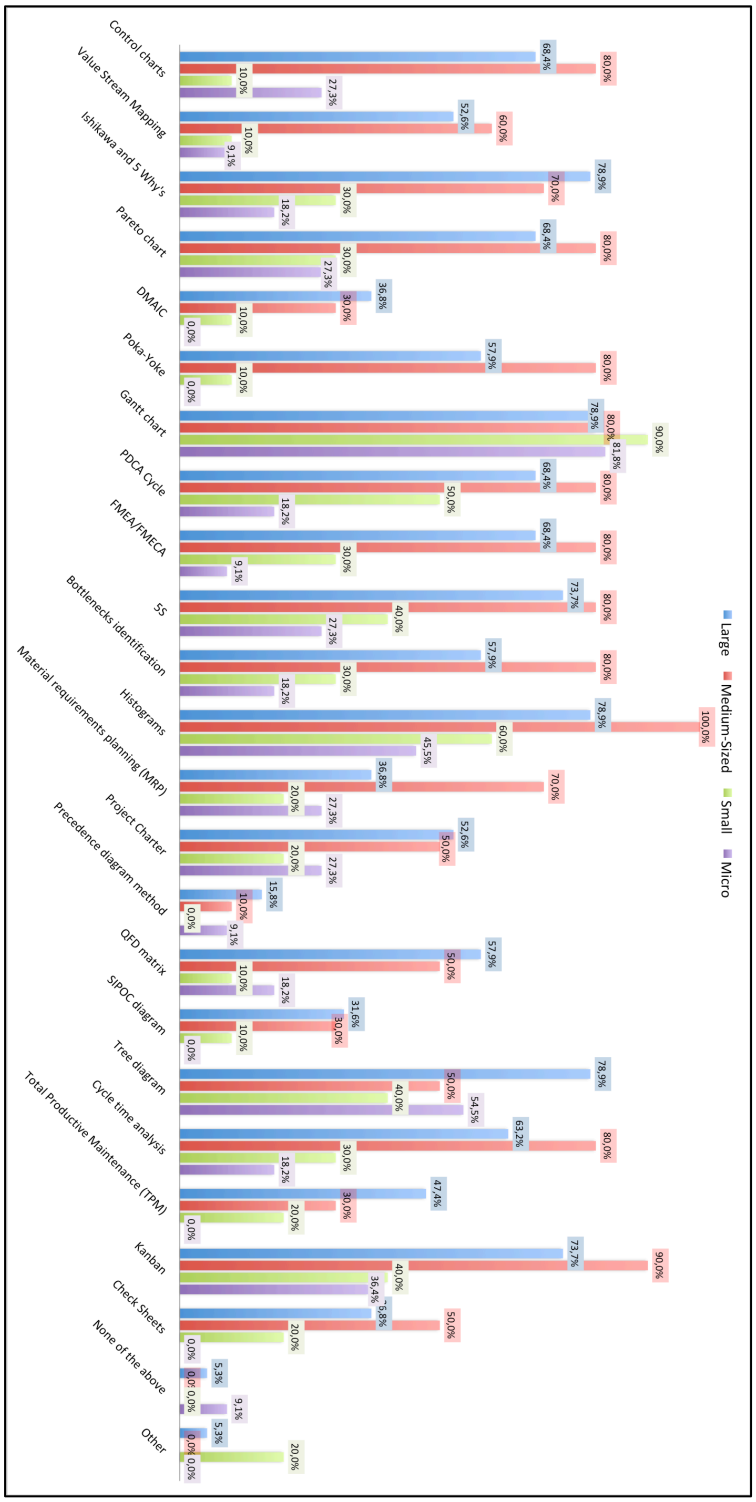

Figure 60. *Level of knowledge of the Italian respondents about the instruments used by the quality management methodologies – Enterprise Size*

Figure 61 provides information about the percentage, by category, of companies working with at least 1 of the tools mentioned in the survey. The Large and Medium-Sized categories obtained the same percentages with respect to the question about the proportion of organizations that develop CI projects with at least 1 methodology. On the other hand, companies classified as Small or Micro have higher percentages with respect to those obtained in the indicated question.

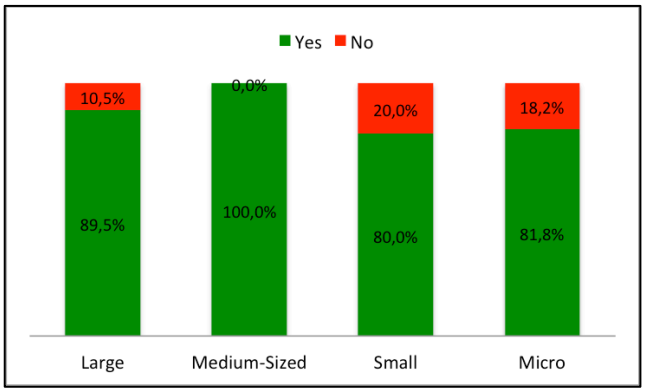

Figure 61. *Percentage of Italian companies working with instruments used by the quality management methodologies – Enterprise Size*

Respondents working in companies that use at least one tool had to select which of the tools they work with, i.e. 17 Large organizations (89.5% of the total), 10 Medium-Sized companies (100%), 8 Small firms (80%) and 9 Micro enterprises (81.8%) answered the question represented in Figure 62.

As can be seen, the medium-sized companies showed a proportionally higher use of the instruments than the other categories, even more than the large organizations, since in several instruments the Medium-Sized category appears in first position with the highest percentage. Furthermore, there is a significant difference between the Large and Medium-Sized categories with respect to the Small and Micro categories, since the highest percentage in all the instruments always belongs to one of the two larger categories, and because the differences in the percentage of use are significant, to the point that in several instruments no company categorized as Micro makes use of the tool. Other instruments used by 5.9% of the Large category are Kaizen, SMED and PM Analysis, while 12.5% of the Small companies use the Risk Analysis tool.

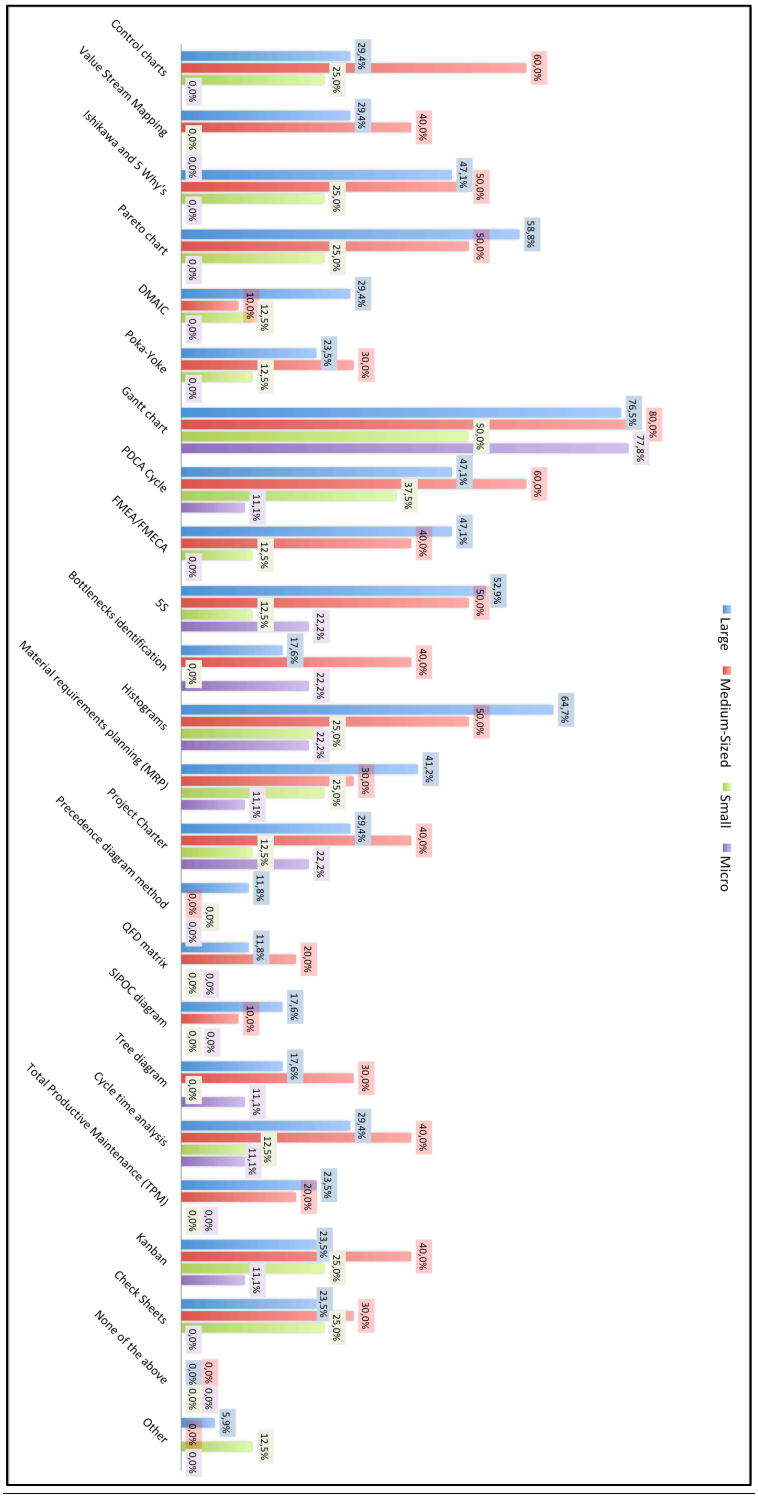

Figure 62. *Instruments used by Italian companies – Enterprise Size*

ii. Chile

The 99 Chilean companies are divided by category into: 37 Large companies, 27 Medium-sized organizations, 22 Small firms and 13 Micro enterprises.

a. General Information

Large, medium-sized, small and micro companies were analyzed and classified by type of product, geographic scope and origin of capital. The results of this analysis are presented in Table 5 and Figures 63, 64 and 65.

		Large	Medium-Sized	Small	Micro
Type of Product	Manufacturing	21.6%	22.2%	22.7%	15.4%
	Service	70.3%	51.9%	63.6%	69.2%
	Hybrid	8.1%	25.9%	13.6%	15.4%
Geographic Scope	Multinational	59.5%	14.8%	18.2%	23.1%
	National	27%	51.9%	50%	30.8%
	Regional	8.1%	14.8%	9.1%	7.7%
	Local	5.4%	18.5%	22.7%	38.5%
Origin of Capital	Private	73%	88.9%	100%	100%
	Public	16.2%	0%	0%	0%
	Public-Private	10.8%	11.1%	0%	0%

Table 5. *Composition of Chilean companies classified by Enterprise Size*

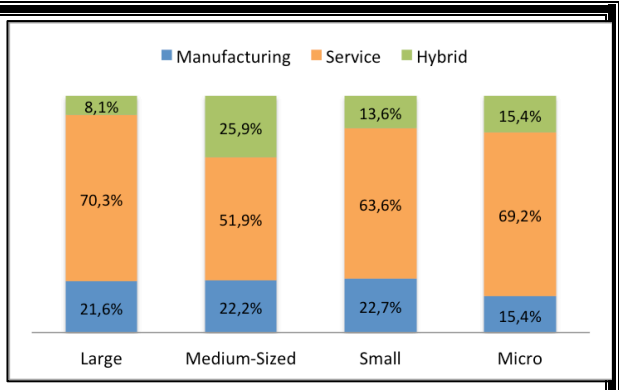

Figure 63. Distribution of Chilean companies by Enterprise Size – Type of Product

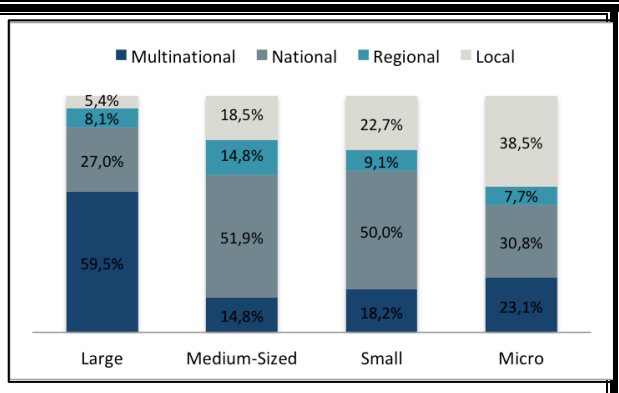

Figure 64. Distribution of Chilean companies by Enterprise Size – Geographic Scope

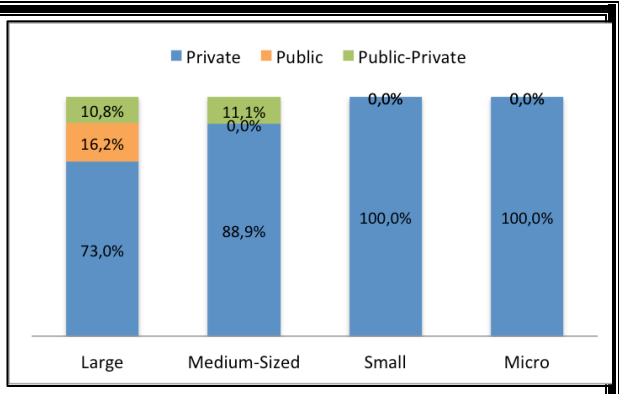

Figure 65. Distribution of Chilean companies by Enterprise Size – Origin of Capital

b. Quality Management Information

A strong relationship can be observed in Figure 66 between company size and the percentage of companies with a quality management department. The Large category obtained the highest percentage, with 32 of the 37 companies (86.5%) working with a quality management department. The Medium-Sized and Small groups obtained similar results, with 40.7% of medium-sized and 45.5% of small companies having a quality department respectively. Finally, no Chilean microenterprise has a quality management department.

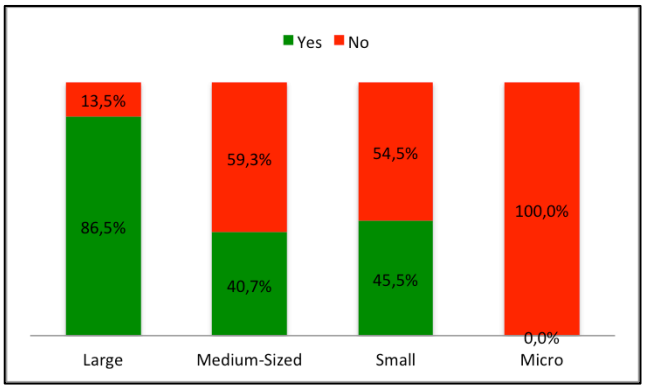

Figure 66. *Percentage of Chilean companies with a quality management department – Enterprise Size*

Proportionally, the awareness level of respondents about quality management methodologies is clearly related to the size of the company in which they work. Respondents working in large corporations are proportionally more familiar with all quality management methodologies than those working in the other categories, and for most methodologies, the larger the category in terms of number of employees, the higher the percentage of respondents who are familiar with them. In addition, ISO 9000 was selected as the methodology with which respondents are most familiar, regardless of the category to which they belong.

Following the trend explained above, the smaller the category in terms of number of employees, the higher the proportion of respondents who are not aware of any quality management methodology. In addition, 13.5% of respondents working in large companies mention that they are aware of several ISO certifications, such as: ISO 14000 - ISO 22300 - ISO 37000 - ISO 45000 - ISO 50000, in addition to local certifications/regulations, GRASP, HACCP and BRC. A proportion (18.5%) of respondents in the Medium category are familiar with ISO 22000, HACCP, GMP, GMP and CMMI, while 9.1% in the Small category are familiar with HACCP, GMP and OSHA.

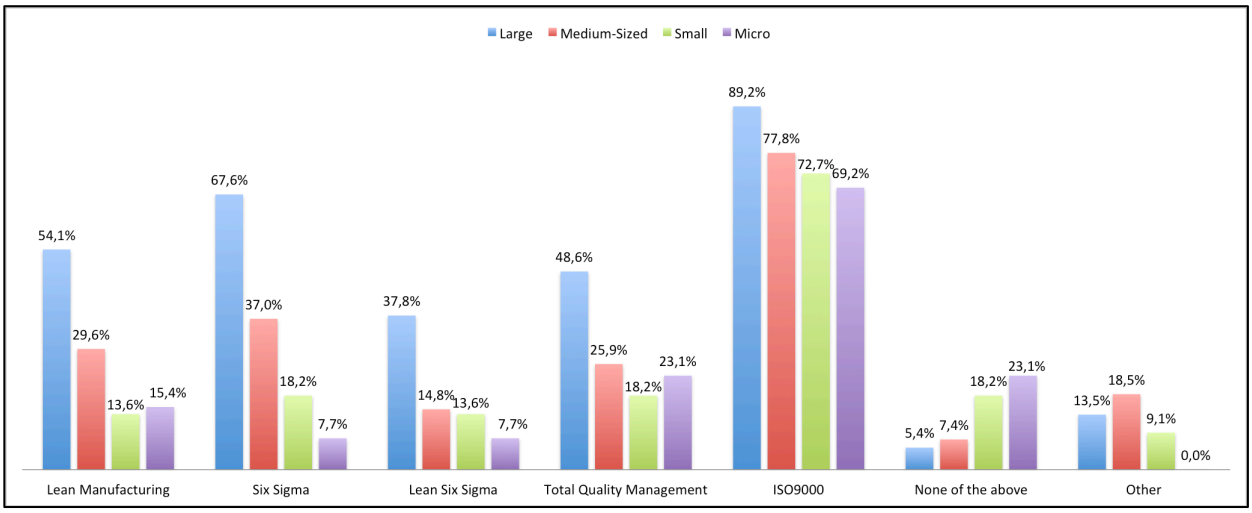

Figure 67. *Level of knowledge of the Chilean respondents about quality management methodologies – Enterprise Size*

As for the percentage of companies by category that carry out continuous improvement projects using some quality management methodology, 81.1% of large companies, 59.3% of medium-sized companies, 31.8% of small companies and 7.7% of micro-companies carry out these projects. These percentages show a clear relationship between the size of the companies and the

percentage of companies that carry out continuous improvement projects: the larger the category in terms of number of employees, the higher the percentage of companies that carry them out.

In addition, substantial differences are observed when compared with the responses of Italian companies: while the difference between the Large categories in both countries is less than 10%, the differences between the Medium-Sized, Small and Micro categories reach approximately 40%, 40% and 55% respectively.

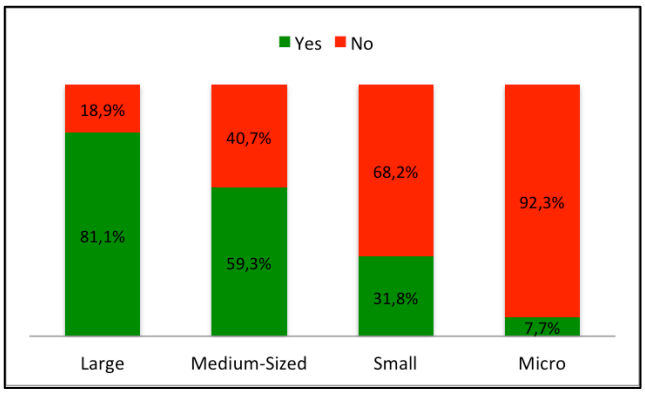

Figure 68. *Percentage of Chilean companies that develop continuous improvement projects with quality management methodologies – Enterprise Size*

The 30 companies classified as Large, 16 as Medium, 7 as Small and the only 1 as Micro that responded affirmatively to the previous question were asked about the quality management methodology used to develop their continuous improvement projects.

ISO 9000 was selected as the most used methodology by the Large, Medium-Sized and Small categories, while the only Micro company that develops continuous improvement projects declared to use Lean Manufacturing. Other methodologies implemented by 13.3% of the Large companies are ISO certifications (ISO 14000 - ISO 22300 - ISO 37000 - ISO 45000 - ISO 50000), local certifications/regulations, HACCP and BRC; while the other methodologies used by 12.5% of the Medium category are ISO 22000 and GRAPS.

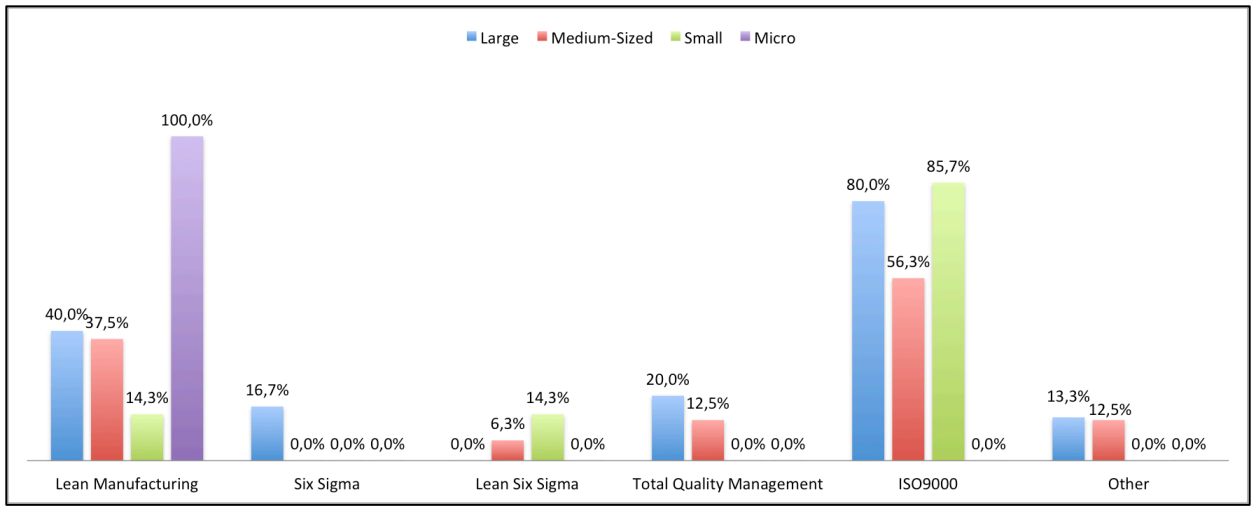

Figure 69. *Methodologies implemented by Chilean companies – Enterprise Size*

Figure 70 presents the results regarding the respondents' level of knowledge of quality management tools. For most of the tools, the Large companies category leads the ranking, followed by the Medium-Sized category. Likewise, the Small and Micro categories tend to alternate third and fourth positions. Thus, there is a difference between the Large and Medium-Sized categories with respect to the Small and Micro categories. In addition, the results indicate that 2.7% of large companies, 7.4% of medium-sized companies, 18.2% of small companies and 7.7% of micro companies are not aware of any of the tools used by quality management methodologies to carry out continuous improvement projects. Lastly, 5.4% of the large companies reported knowing the Visual Management tool, as well as the Risk and Opportunity Matrix.

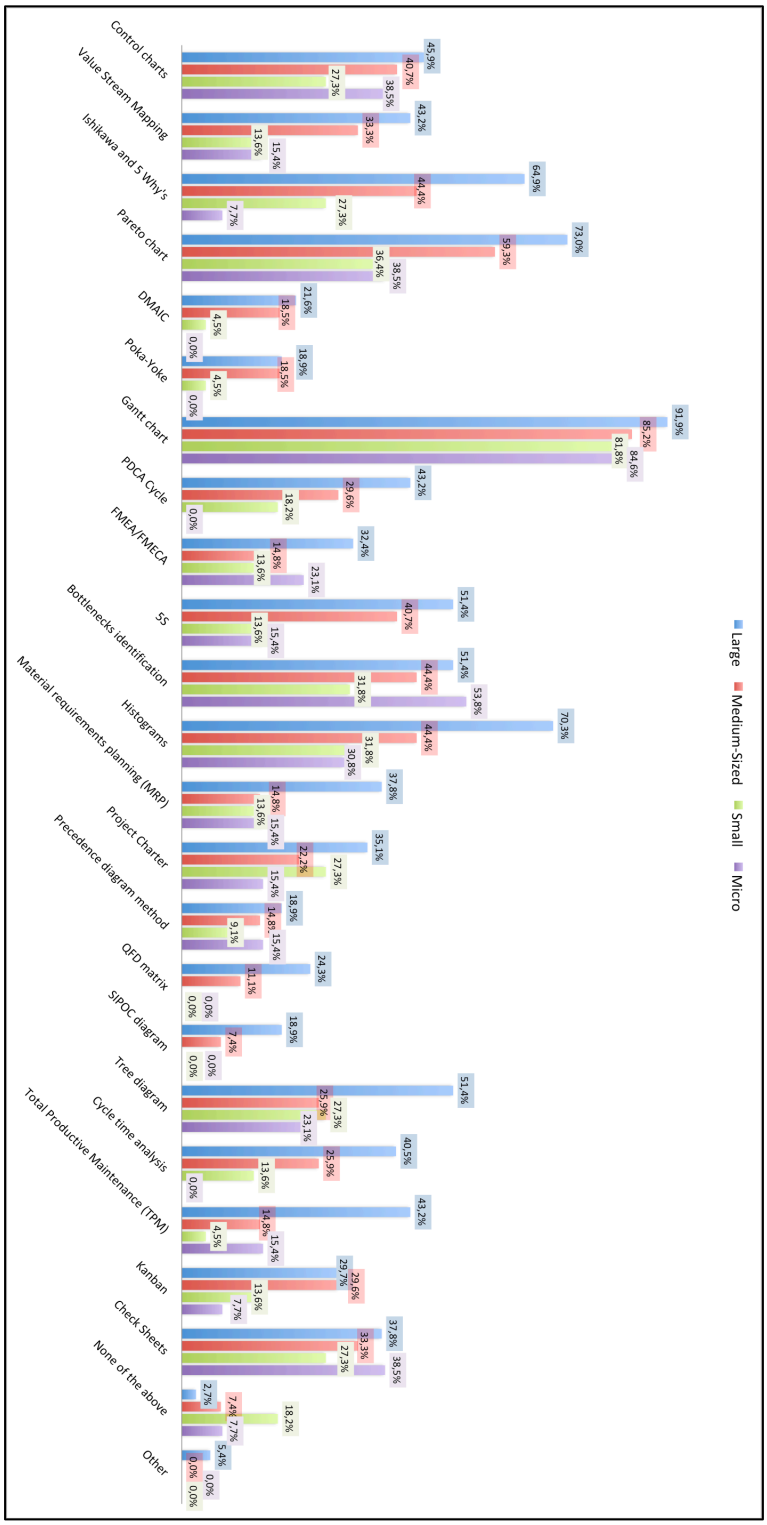

Figure 70. *Level of knowledge of the Chilean respondents about the instruments used by the quality management methodologies – Enterprise Size*

Results indicated that 34 of the 37 (91.9%) companies classified as Large work with at least one instrument listed in the survey. Following the trend previously observed in most of the charts about Chilean companies classified by size, the Large category is followed by Medium-Sized, Small and Micro, with 81.5%, 72.7% and 38.5% respectively.

Despite the non-significant differences between the Large and Small categories between the two countries, the Medium-Sized and Micro categories present the largest gaps because the percentages of Italian companies in this question were 100% and 81.8% respectively, so the gaps for both categories are 18.5% and 43.3% respectively.

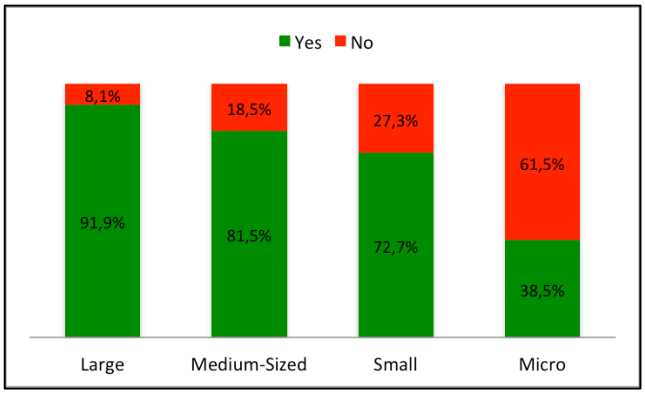

Figure 71. *Percentage of Chilean companies working with instruments used by the quality management methodologies – Enterprise Size*

Results of the question about the instruments used by the companies are represented in Figure 72. This question was only asked to respondents who answered affirmatively to the question represented in Figure 71, specifically, to respondents working in 34 large companies, 22 medium-sized firms, 16 small organizations and 5 micro enterprises. The results reproduce a clear trend in most of the instruments, since, if the Micro category is not taken into account, the larger the category in terms of number of employees, the higher the proportion of companies working with the instruments. Since the Micro category is composed of only 5 companies, each response has more percentage value compared to the responses of other categories. This could be the reason why this category does not follow the trend. Finally, other tools used by Chilean companies are: Visual Management (by 2.9% of the Large category), Quality Plans (by 4.5% of the Medium category) and BPM (by 20% of the Micro category).

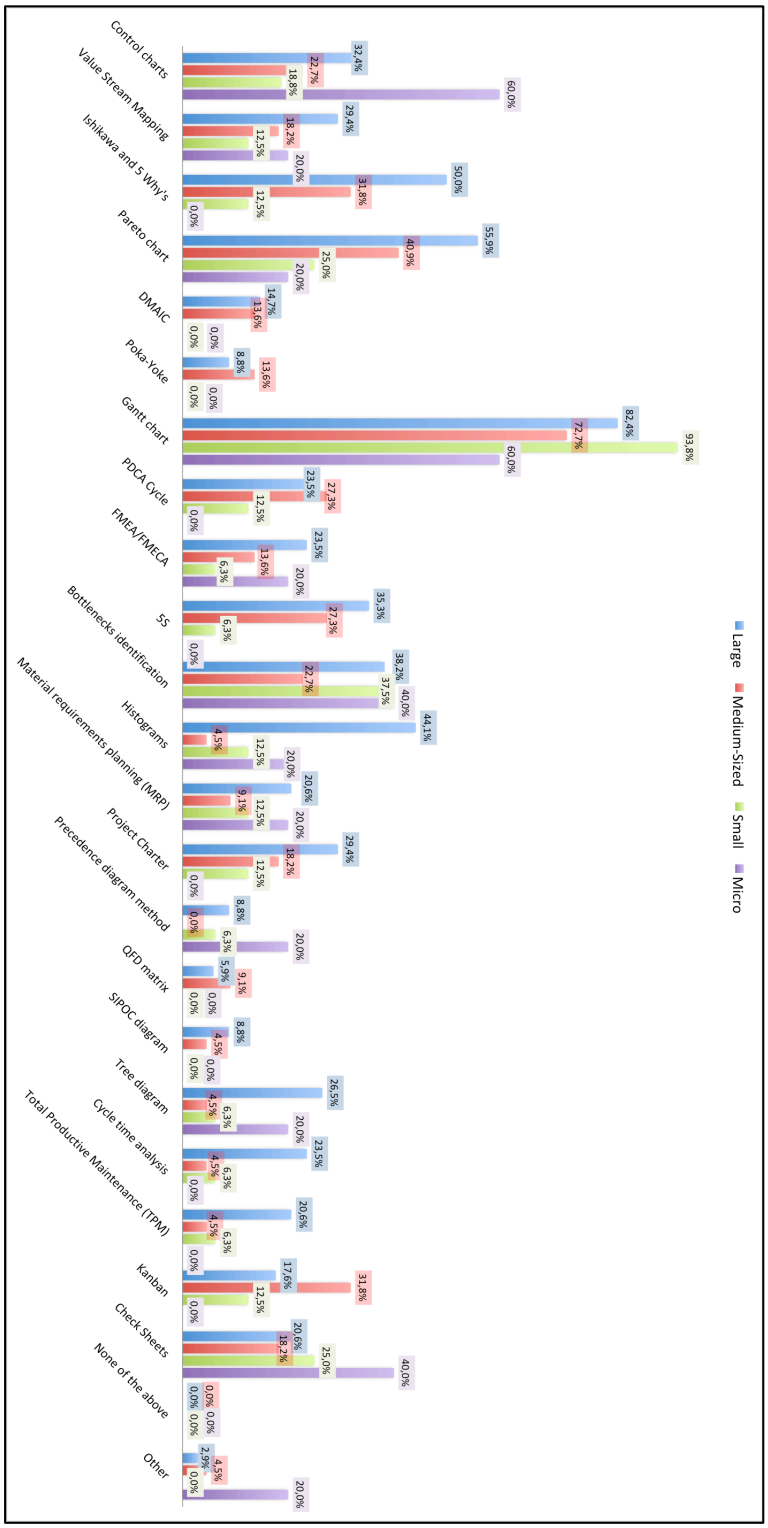

Figure 72. *Instruments used by Chilean companies – Enterprise Size*

4. Results by Geographic Scope

The last subchapter classifies the Companies Survey results by the geographic scope of companies, which means that companies were divided into 4 categories: Multinational, National, Regional and Local. This separation was done in order to analyze and compare the similarities and differences between categories in terms of quality management, and thus to be able to analyze the accuracy of hypothesis H4. In addition, the information is classified and presented by country.

i. Italy

The 50 Italian companies are composed of 27 multinational corporations, 16 national firms, 3 regional organizations and 4 micro enterprises.

a. General Information

Multinational, National, Regional and Local companies were analyzed and classified by their type of product, size and origin of capital. The results of this analysis are presented in Table 6 and Figures 73, 74 and 75.

		Multinational	National	Regional	Local
Type of Product	Manufacturing	59.3%	18.8%	33.3%	50%
	Service	22.2%	62.5%	66.7%	25%
	Hybrid	18.5%	18.8%	0%	25%
Enterprise Size	Large	59.3%	6.3%	33.3%	25%
	Medium-Sized	25.9%	6.3%	0%	50%
	Small	3.7%	50%	33.3%	0%
	Micro	11.1%	37.5%	33.3%	25%
Origin of Capital	Private	85.2%	93.8%	100%	75%
	Public	3.7%	6.3%	0%	25%
	Public-Private	11.1%	0%	0%	0%

Table 6. *Composition of Italian companies classified by*

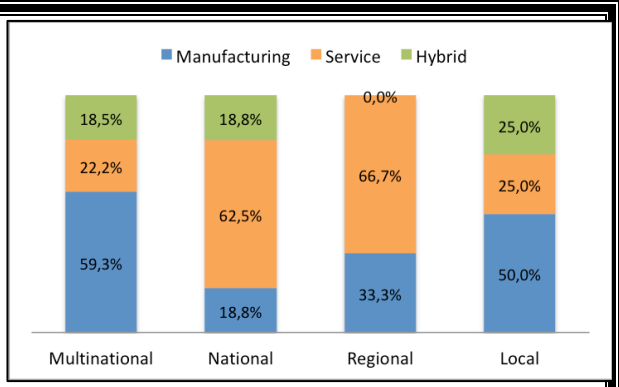

Figure 73. Distribution of Italian companies by Geographic Scope – Type of Product

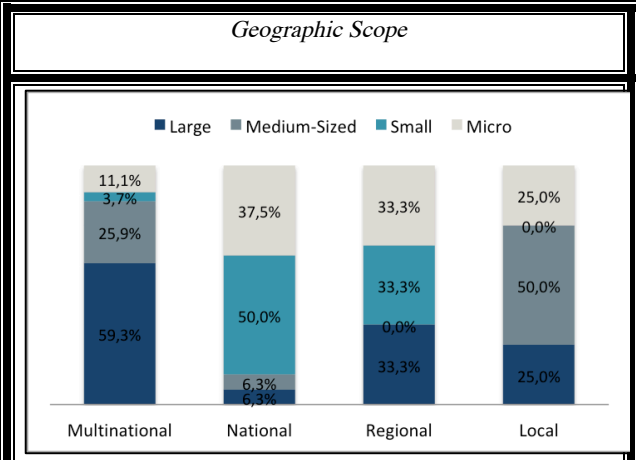

Figure 74. Distribution of Italian companies by Geographic Scope – Enterprise Size

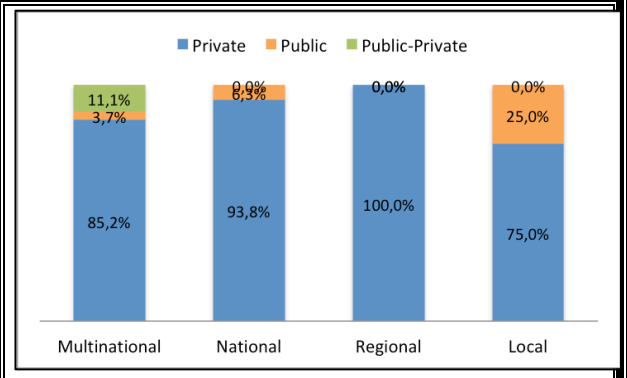

Figure 75. Distribution of Italian companies by Geographic Scope – Origin of Capital

b. Quality Management Information

As can be seen in Figure 76, companies with a quality management department are mainly concentrated in multinational organizations. The results indicate that 25 of the 27 (92.6%) multinationals have a quality management department, while these values for the National, Regional and Local categories reach 37.5%, 33.3% and 50% respectively.

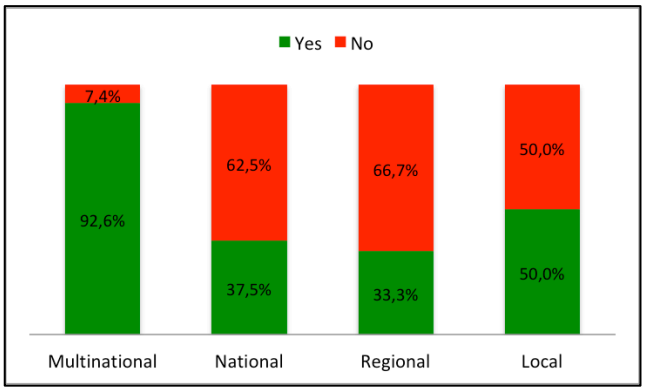

Figure 76. *Percentage of Italian companies with a quality management department – Geographic Scope*

Figure 77 presents the results about the awareness level of respondents regarding quality management methodologies. As can be seen, ISO 9000 is the methodology most known by

Italian respondents in all categories. On the contrary, Lean Six Sigma could be classified as the least known methodology. Moreover, 3 out of 4 local companies are aware of Lean Manufacturing and TQM, similar results to those obtained by the Multinational category.

Despite the ISO 9000 results, clear differences can be observed between Multinational, National and Regional categories. These differences are related to: The larger the geographic scope of a category, the higher the percentage of respondents familiar with each methodology.

As for other methodologies known by respondents, 3.7% of those working in multinational companies are familiar with IATF 16949, while 12.5% of those working in national companies are familiar with Lean Software Development and Test Driven Development. Finally, 6.3% of the companies in the National category are not aware of any quality management methodology.

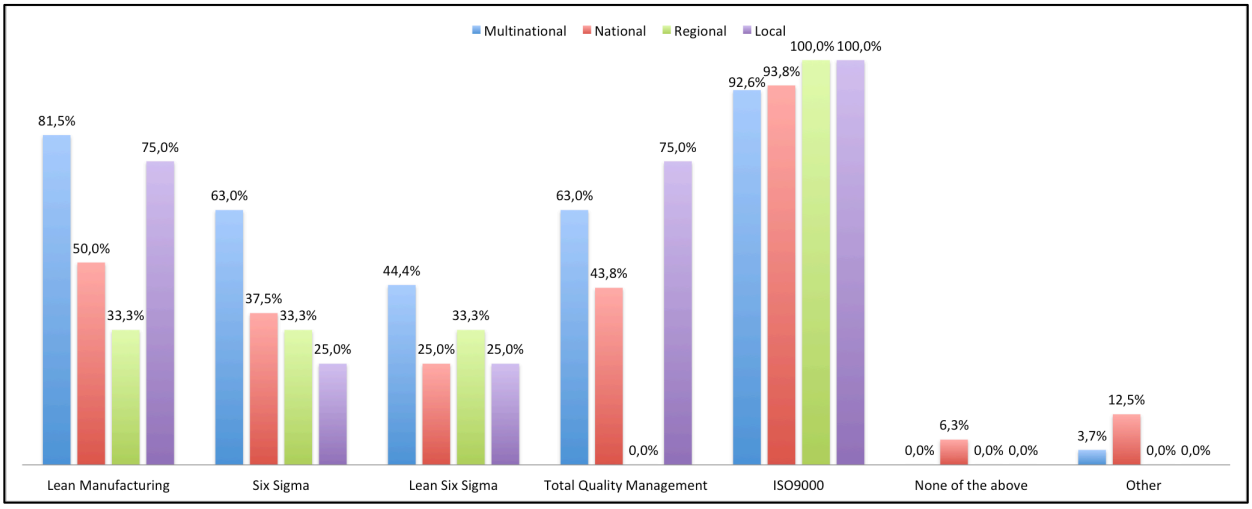

Figure 77. *Level of knowledge of the Italian respondents about quality management methodologies – Geographic Scope*

Figure 78 represents the results about the percentages of companies by category that develop CI projects with at least one quality management methodology. As can be seen, a trend similar to that explained in the previous graph (Figure 76) is repeated since, if the categories Multinational, National and Regional are taken into account, the greater the geographic scope, the greater the proportion of organizations that develop continuous improvement projects with at least one of the methodologies included in the survey. The percentages for each category are 92.6%, 68.8%

and 33.3% respectively. On the other hand, the Micro category does not follow this pattern since 100% of the companies categorized as Micro carry out this type of projects.

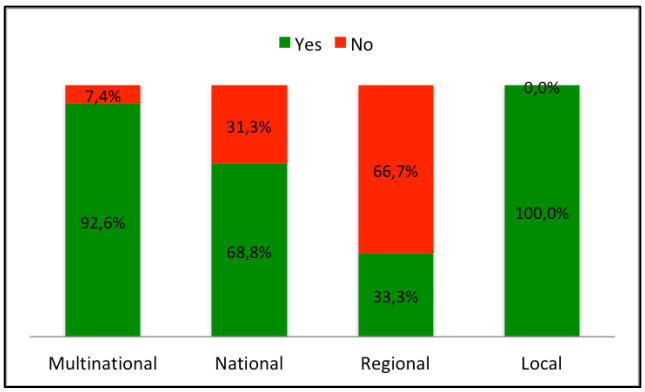

Figure 78. *Percentage of Italian companies that develop continuous improvement projects with quality management methodologies – Geographic Scope*

A total of 41 Italian companies were asked about the quality management methodology they use to develop CI projects. These 41 companies are composed of 25 multinational, 11 national, 1 regional and 4 local companies.

The results showed that the regional company works with ISO 9000 standards, while 50% and 75% of the local companies operate applying Lean Manufacturing and ISO 9000 respectively. In addition, in most of the methodologies some differences are observed between the Multinational and National categories in favor of the Multinational companies.

In addition, companies categorized as multinational and national included other methodologies in their responses. ASME QAI-1, ISO 17065 and ISO 17020 were described by 4% of the multinational companies as the other methodologies that this category uses to develop CI projects, and 9% of the organizations in the National category recognized Test Driven Development.

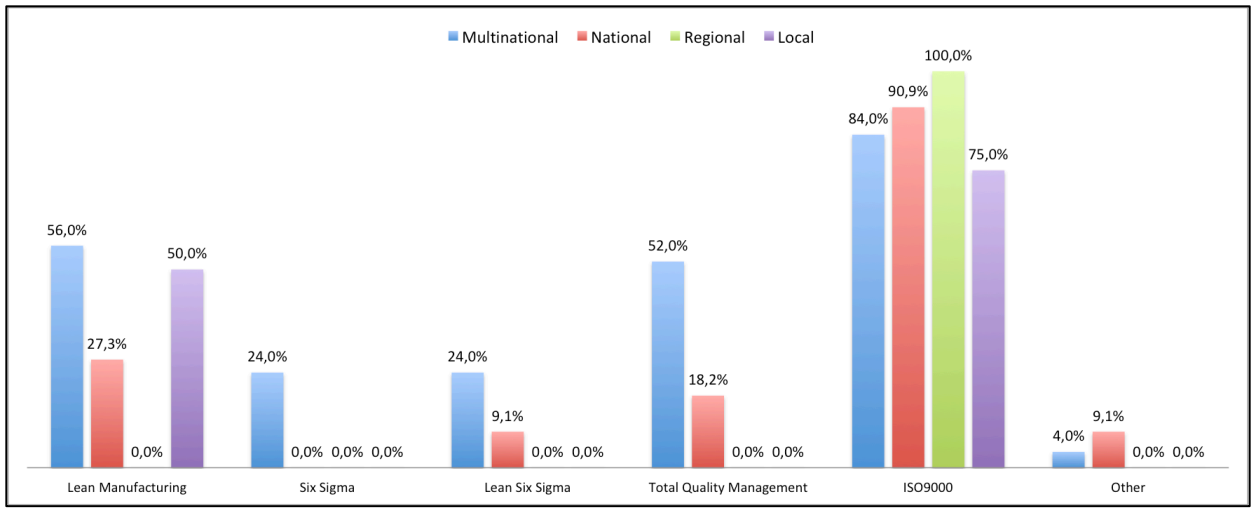

Figure 79. *Methodologies implemented by Italian companies – Geographic Scope*

Since the Multinational and National categories have the highest number of responses, their results are more representative than those of the Regional or Local categories. Precisely, through these results it can be observed that respondents working in multinational companies are more familiar with the instruments than respondents from national companies. Moreover, 7.4% of respondents from multinational companies are familiar with Kaizen, SMED and PM Analysis, while 6.3% from national companies are familiar with Risk Analysis. Finally, 1 respondent from the Multinational category and 1 from the National category acknowledged not being familiar with any of the tools listed.

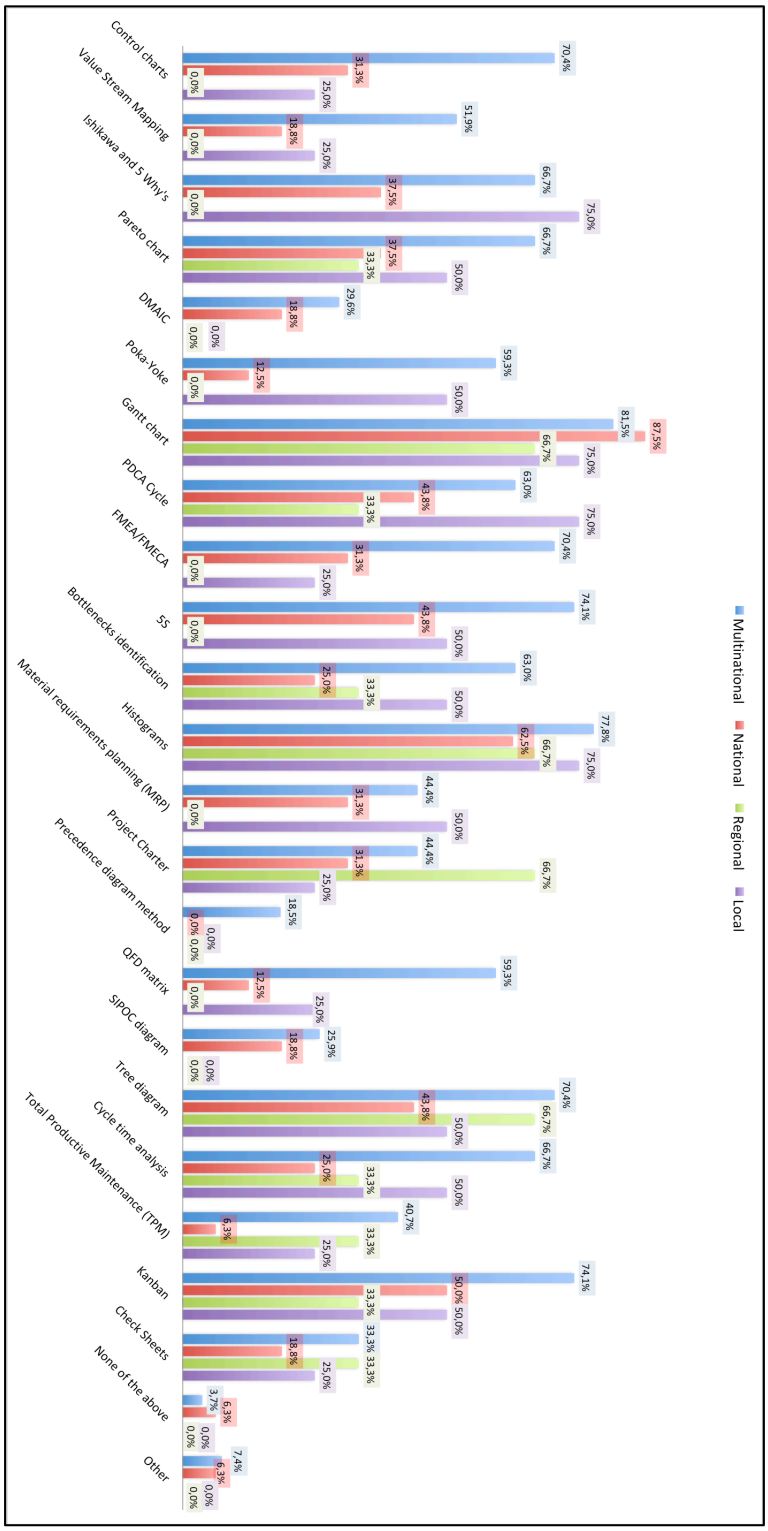

Figure 80. *Level of knowledge of the Italian respondents about the instruments used by quality management methodologies – Geographic Scope*

Figure 81 shows the results regarding the percentage of companies using the instruments mentioned in the survey. While all the companies categorized as Regional or Local operate with at least one of these instruments, the multinational and national companies reach 92.6% (25 out of 27 companies) and 75% (12 out of 16 companies) respectively.

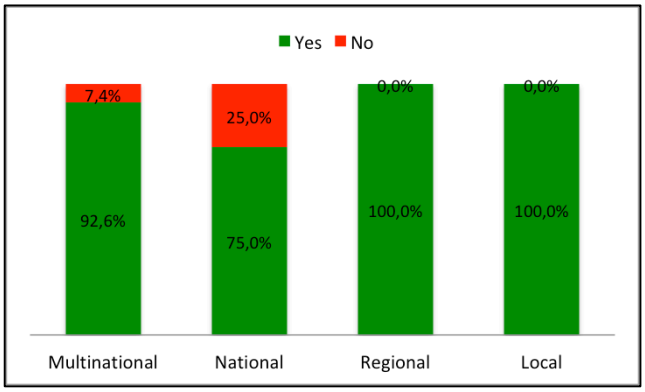

Figure 81. *Percentage of Italian companies working with instruments used by quality management methodologies – Geographic Scope*

Regional and local organizations were asked about the tools they use on a daily basis, in addition to 92.6% of multinational companies (25) and 75% of national companies (16). Since the Regional and Local categories do not have a large number of responses, it is not easy to describe the results. However, an interesting fact to mention could be that the regional companies use only 6 of the 22 instruments listed in the survey.

On the other hand, a clear pattern can be observed between the Multinational and National categories due to for most of the instruments, the Multinational category makes use of the tools in a higher proportion compared to the National category. In addition, 8% of the multinational companies use Kaizen, SMED and PM Analysis.

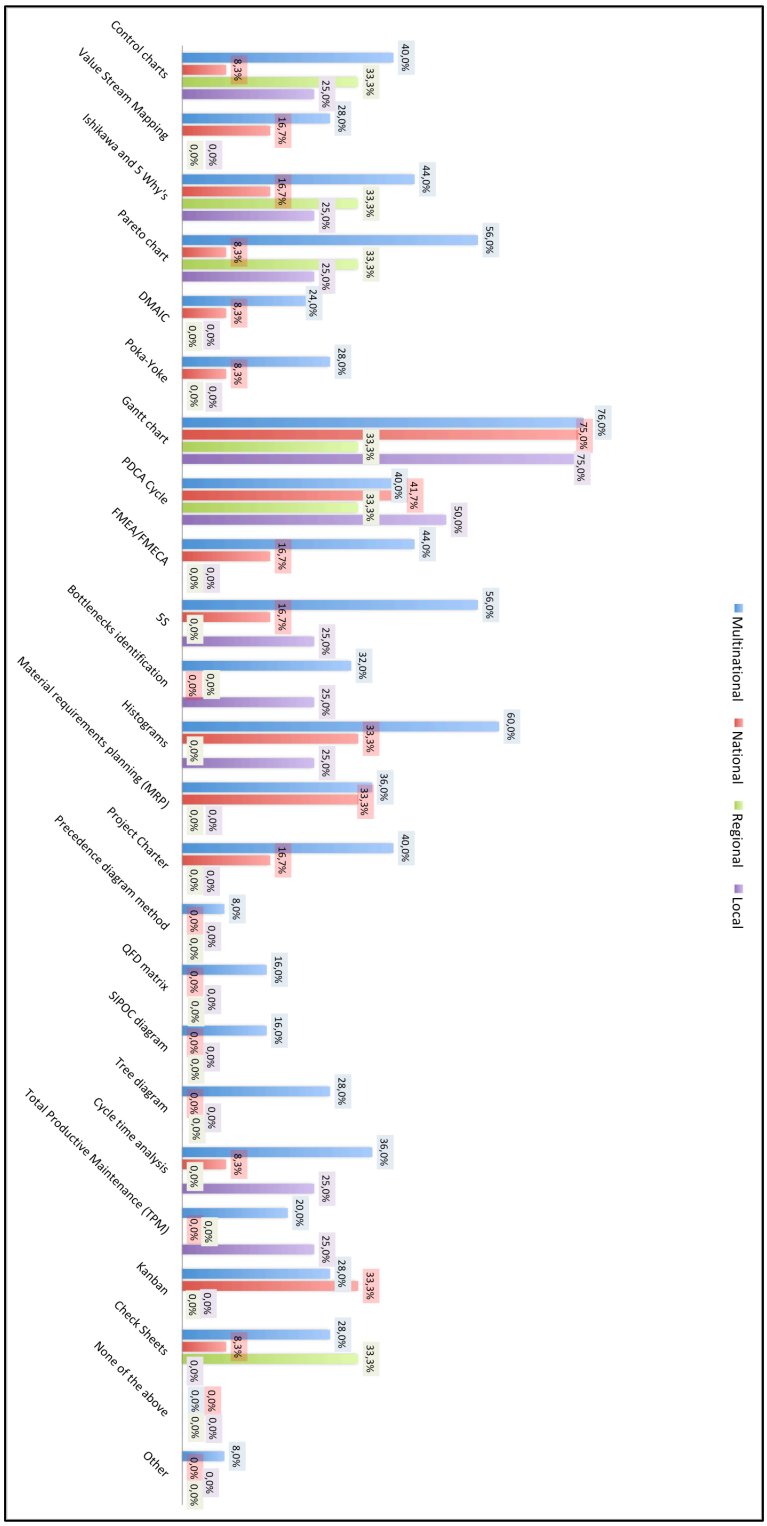

Figure 82. *Instruments used by Italian companies – Geographic Scope*

ii. Chile

The 99 Chilean companies are divided into 33 multinationals, 39 national companies, 10 regional organizations and 17 microenterprises.

a. General Information

Multinational, national, regional and local companies were analyzed and classified by their type of product, size and origin of capital. The results of this analysis are presented in Table 7 and Figures 83, 84 and 85.

		Multinational	National	Regional	Local
Type of Product	Manufacturing	30.3%	12.8%	30%	17.6%
	Service	63.6%	71.8%	50%	52.9%
	Hybrid	6.1%	15.4%	20%	29.4%
Enterprise Size	Large	66.7%	25.6%	30%	11.8%
	Medium-Sized	12.1%	35.9%	40%	29.4%
	Small	12.1%	28.2%	20%	29.4%
	Micro	9.1%	10.3%	10%	29.4%
Origin of Capital	Private	90.9%	82.1%	80%	94.1%
	Public	0%	10.3%	10%	5.9%
	Public-Private	9.1%	7.7%	10%	0%

Table 7. *Composition of Chilean companies classified by Geographic Scope*

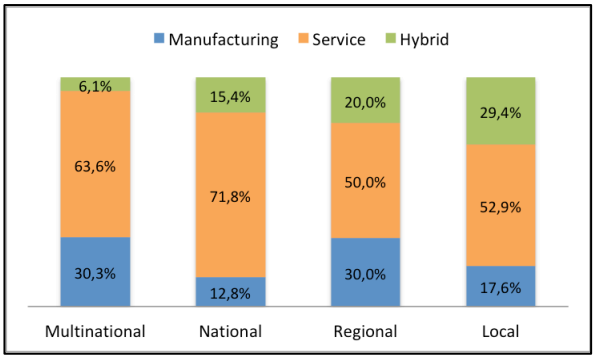

Figure 83. *Distribution of Chilean companies by Geographic Scope – Type of Product.*

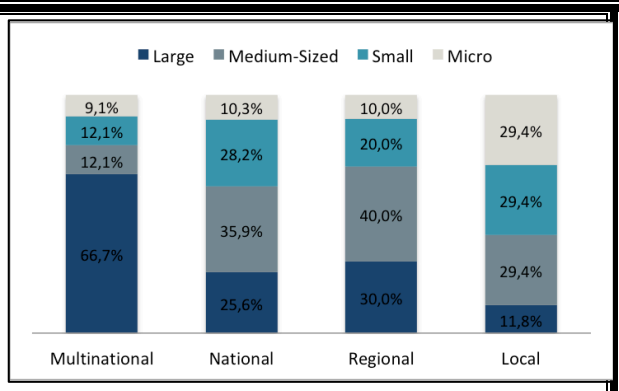

Figure 84. *Distribution of Chilean companies by Geographic Scope – Enterprise Size.*

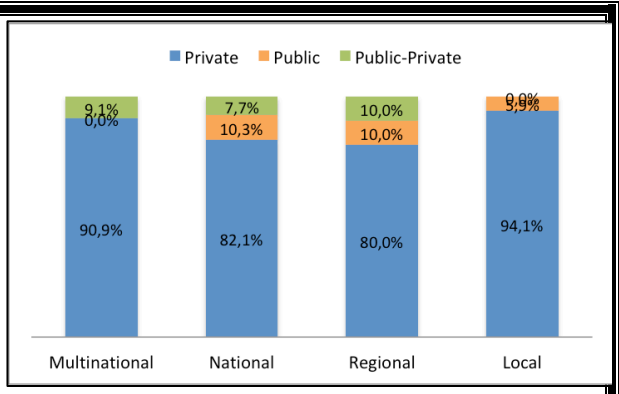

Figure 85. *Distribution of Chilean companies by Geographic Scope – Origin of Capital*

b. Quality Management Information

The percentages of Chilean companies that have a quality management department classified by geographical scope are shown in Figure 86. As can be seen, the Multinational category has the highest percentage with 69.7%, followed by Regional, National and Local categories with 60%, 48.7% and 29.4% respectively.

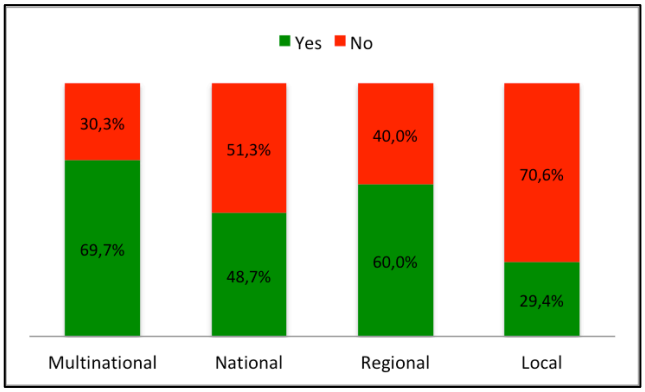

Figure 86. *Percentage of Chilean companies with a quality management department – Geographic Scope*

Respondents in all categories selected ISO 9000 as the main methodology they know. Surprisingly, Six Sigma follows ISO 9000 in second position, while the Italian companies'

results showed that this position was for Lean Manufacturing. However, the level of knowledge of Chilean respondents regarding Six Sigma is lower than the level of Italian respondents.

The number of respondents who stated that they do not know any of the quality management methodologies was 11 workers, a number distributed among 1 multinational (3%), 6 national (15.4%), 2 regional (20%) and 2 local (11.8%) organizations.

Finally, respondents recognized other quality management methodologies. For example, 15.2% of respondents working in multinational companies claimed to know some ISO standards (ISO 14000 - ISO 22000 - ISO 22300 - ISO 37000 - ISO 45000 - ISO 50000), HACCP, BRC and GMP. A portion of respondents (7%) working in national companies described ISO 22000, HACCP and GMP as the other methodologies they know, as well as 20% of respondents in regional organizations who responded ISO 22000. Local certifications/regulations and OSHA were noted by 11.8% of respondents from local companies as the other quality management methodologies they are familiar with.

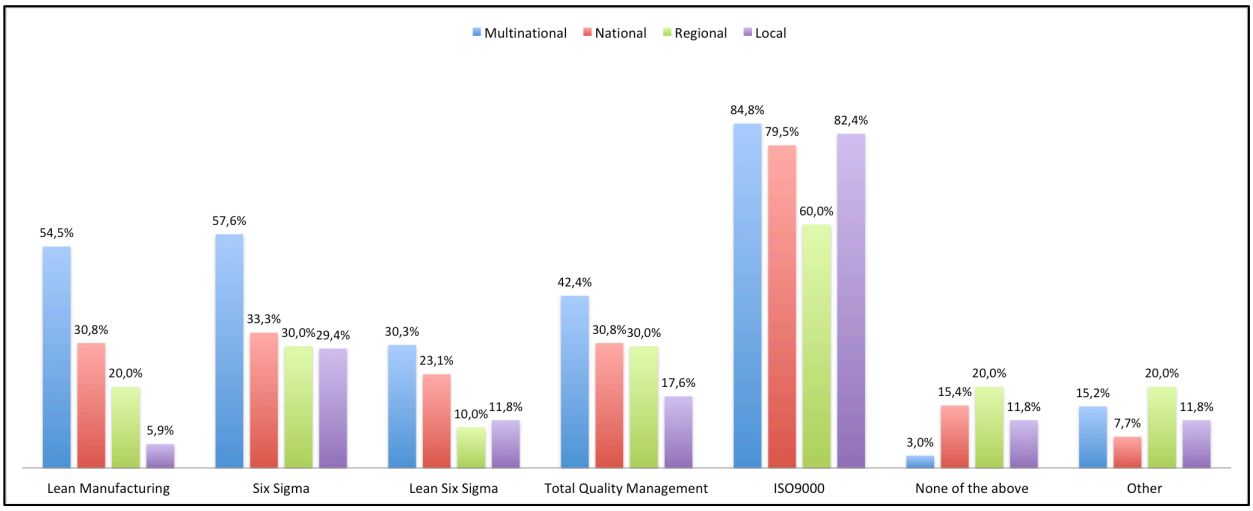

Figure 87. *Level of knowledge of the Chilean respondents about quality management methodologies – Geographic Scope*

Results about the percentages of companies, classified by geographic scope, that develop CI projects with at least one quality management methodology are represented in Figure 88. The percentages of affirmative responses by category, from left to right, are 72.7%, 51.3%, 50% and 29.4%.

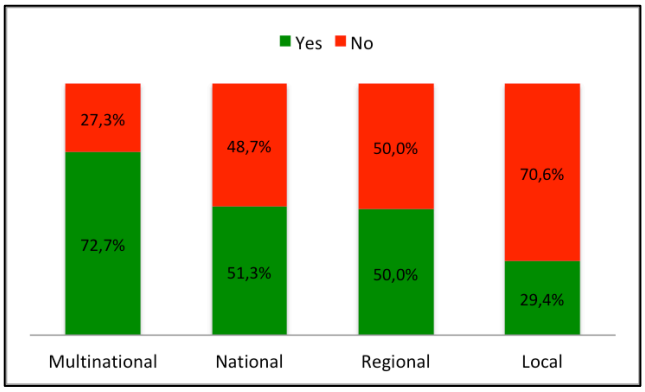

Figure 88. *Percentage of Chilean companies that develop continuous improvement projects with quality management methodologies – Geographic Scope*

The total number of multinational companies that responded affirmatively to the previous question was 24, as well as 20 national, 5 regional and 5 local companies. These 54 companies were asked about the methodologies they use to develop continuous improvement projects. The results are shown in Figure 89.

As can be seen, ISO 9000 obtained the highest percentage in each category, so this methodology was selected as the most used by Chilean companies regardless of their geographic scope. Lean Manufacturing appears in second position for the Multinational and National categories with 50% and 30% respectively, while Total Quality Management and Lean Manufacturing were chosen by the same number of respondents working in regional companies.

Other methodologies adopted by 40% of the local companies to develop CI projects were some local certifications/regulations and GRAPS. ISO 22000 was also implemented by 5% of national companies, while 12.5% of multinationals added to the list several ISO standards (ISO 14000 - ISO 22300 - ISO 37000 - ISO 45000 - ISO 50000), BRC and HACCP.

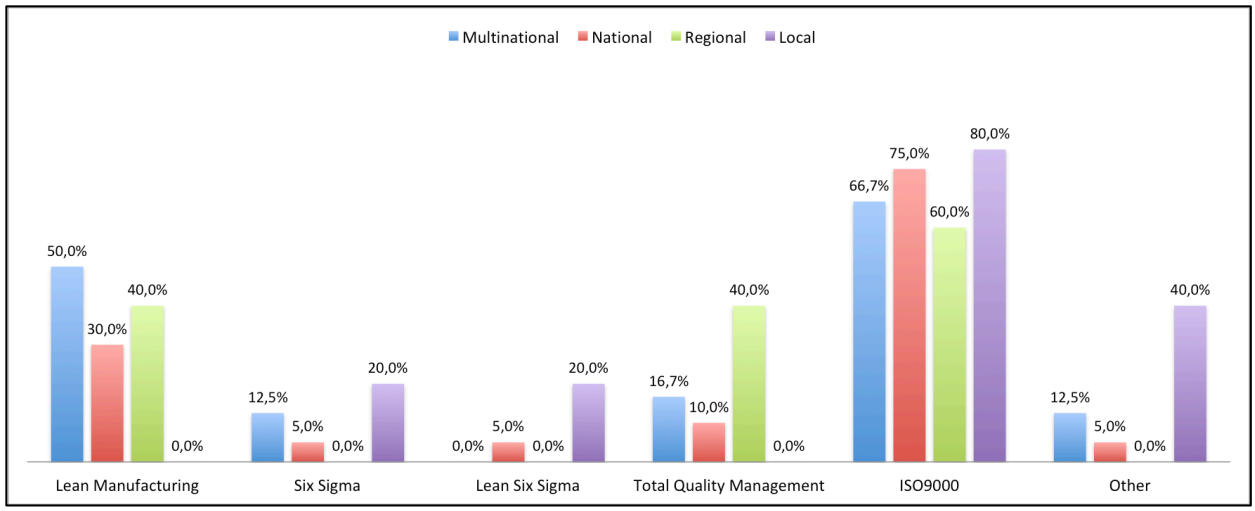

Figure 89. *Methodologies implemented by Chilean companies – Geographic Scope*

Figure 90 represents the results regarding the level of knowledge of Chilean respondents about the tools used by quality management methodologies to carry out CI projects. As can be seen, in most of the instruments, the Multinational and Local categories have the highest and lowest percentages respectively, while the National and Regional categories alternate the second and third position in almost similar proportions.

Moreover, the results indicate that the Local category has the highest percentage of respondents who indicated not to know any of the instruments listed in the survey, with 17.6%. This value for the Multinational and National categories is 6.1% and 7.7% respectively. Finally, 3% of respondents working in multinational companies claim to be familiar with Visual Management, while 5.9% of respondents working in local organizations add the Risk and Opportunity Matrix.

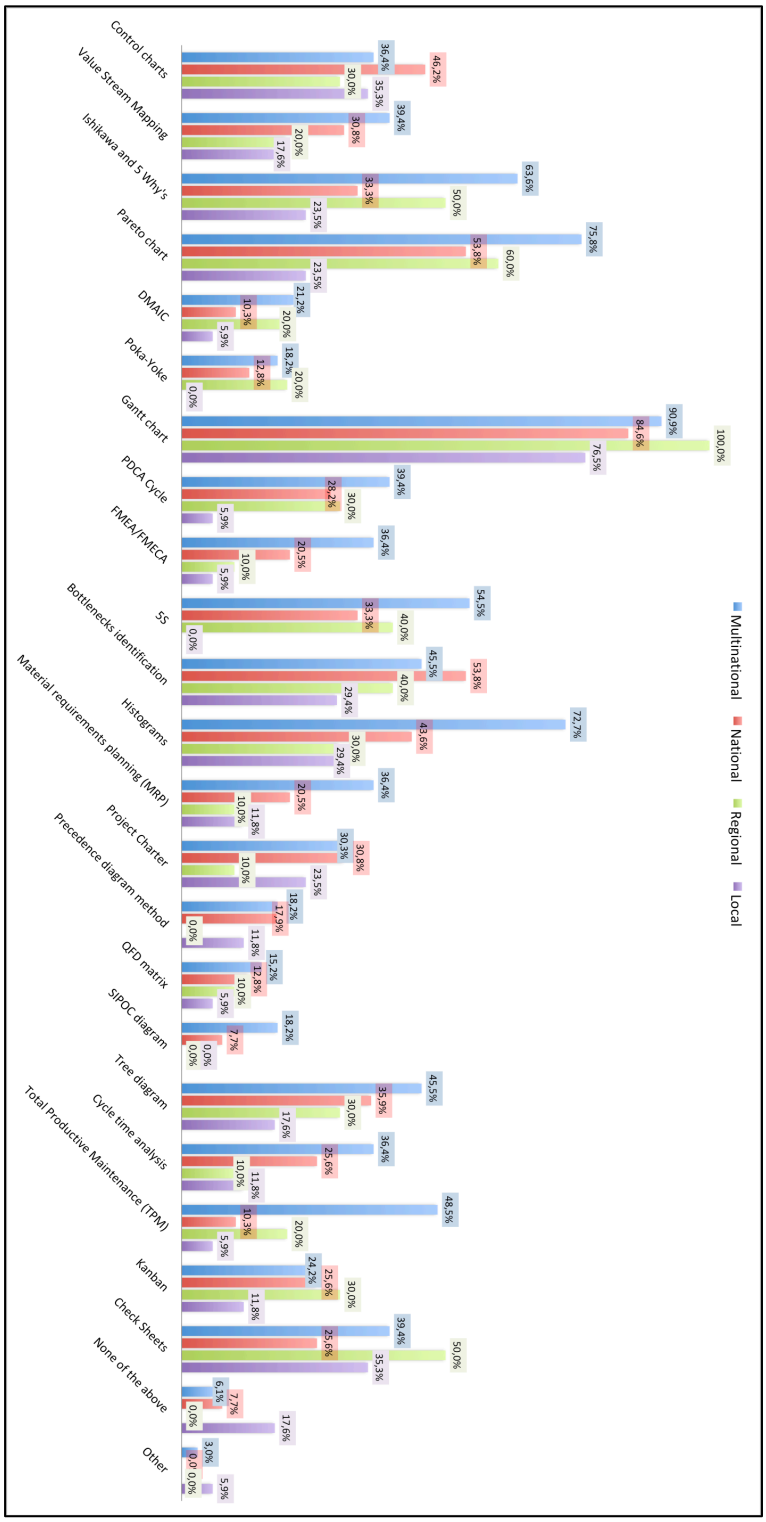

Figure 90. *Level of knowledge of the Chilean respondents about the instruments used by quality management methodologies – Geographic Scope*

Figure 91 shows non-significant differences between the Multinational, National and Regional categories in terms of the percentage of companies that work daily with at least one quality management tool, since the percentages of companies that use them are 81.8%, 79.5% and 80% respectively, while only 64.7% of local companies make use of these tools.

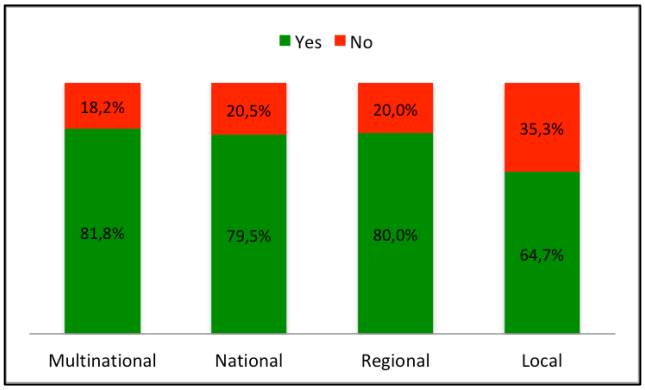

Figure 91. *Percentage of Chilean companies working with instruments used by quality management methodologies – Geographic Scope*

The last figure in this subchapter, Figure 92, shows the percentage of companies working with each instrument. This question was asked to 27 respondents working in multinationals, 31 in national companies, 8 in regional and 11 in local organizations. The only result that can be easily described from Figure 92 is the fact that, in most of the instruments, Chilean multinational companies use the tool in greater proportion than companies classified in other categories.

Additionally, some respondents described other tools used by their companies: 3.7% of multinational corporations use Visual Management, 12.5% of regional firms operate with Quality Plans and 9.1% of local organizations work with BPM.

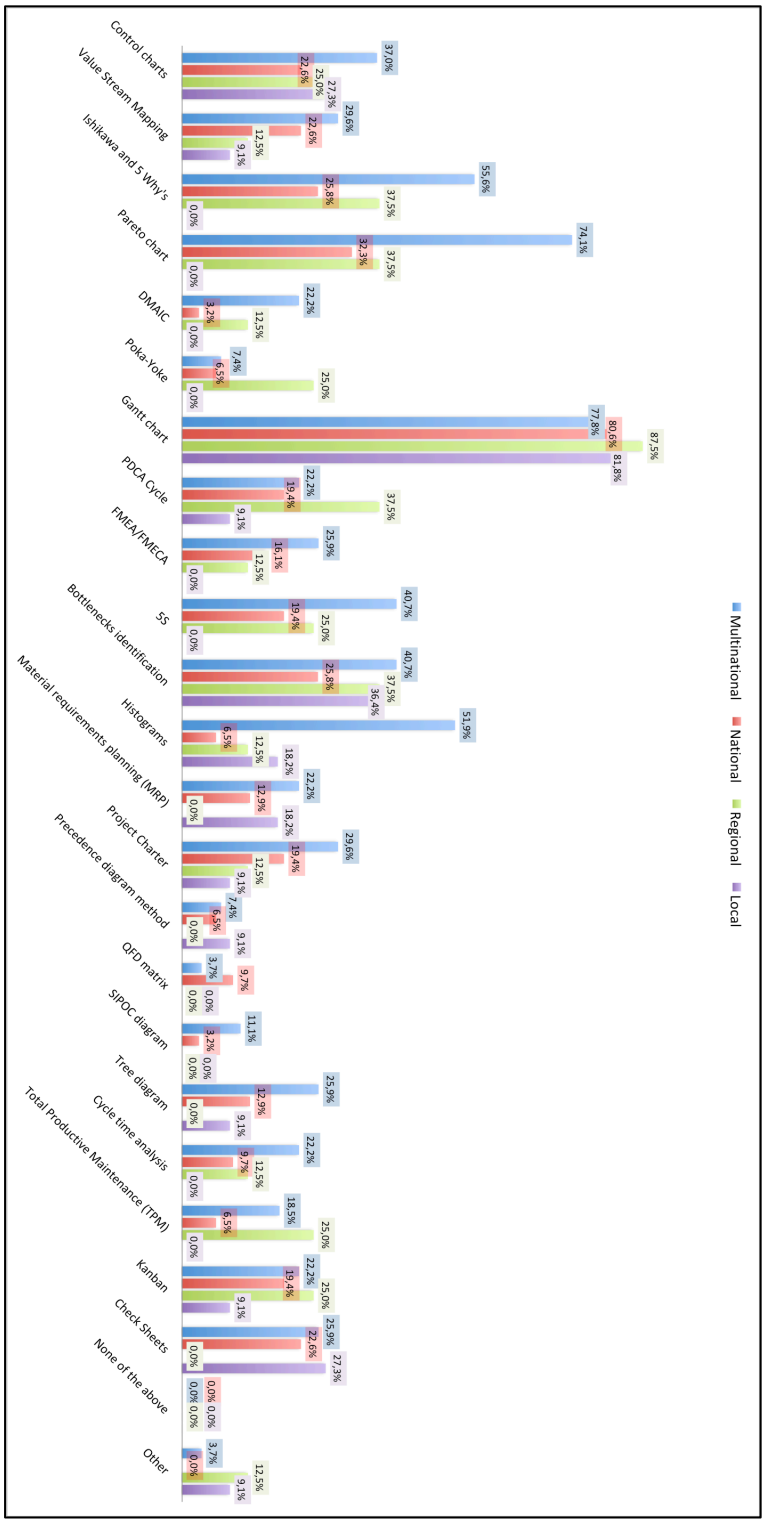

Figure 92. *Instruments used by Chilean companies – Geographic Scope*

II. Students Survey

The Students Survey subchapter presents the results in 3 different approaches: General Results, Alumni and Senior Students.

A total of 524 alumni or final year students of the Politecnico di Torino were contacted, while this number was 988 for the Universidad Adolfo Ibáñez. These numbers correspond to 2 generations of students from both educational entities. The results indicated that 124 Italian and 287 Chilean students responded to the survey. The representativeness of the responses was considered good since the response rates were 23,66% (124 out of 524) and 29,04% (287 out of 988) respectively.

1. General Results

In this first section, the responses are presented through a comparison by country. The responses of Italian students are compared with those of Chilean students in order to identify similarities and differences between them related to quality management.

i. General Information

The first section of the survey was composed of general information questions to know the academic situation of each student. As can be seen in Figure 93, 39.5% of the Italian responses belong to alumni, while the complement stated that they are final year students. The percentages of the Chilean responses are composed of 47% alumni and 53% senior students.

Figure 94 represents the distribution of alumni (39.5% of Italians and 47% of Chileans) according to the year in which they completed their studies. In addition, respondents in this category were asked about their professional status as engineers, as can be seen in Figure 95.

Finally, senior students were asked about their expected year of graduation. The results are represented in Figure 96 and, as can be seen, the majority of students in both countries will graduate in 2021 and 2022.

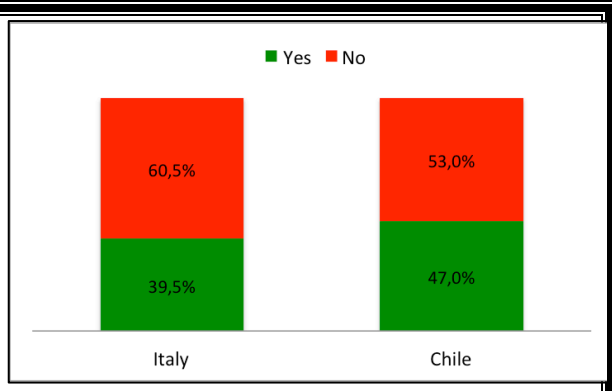

Figure 93. *Percentage of Alumni*

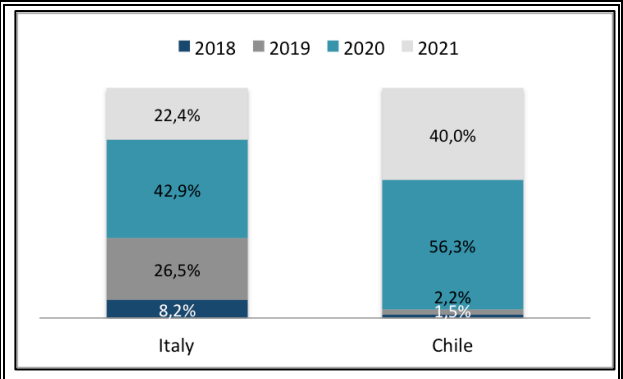

Figure 94. *Alumni graduation year*

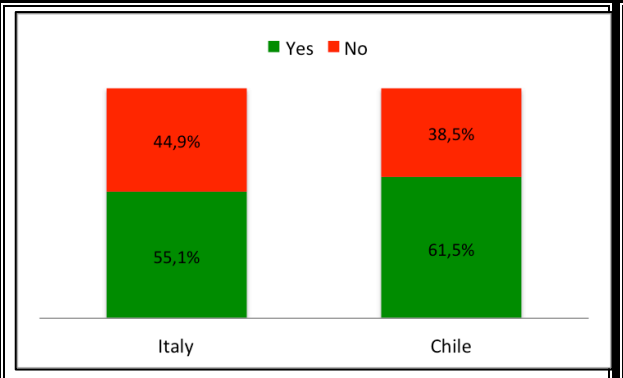

Figure 95. *Percentage of Alumni working as engineers*

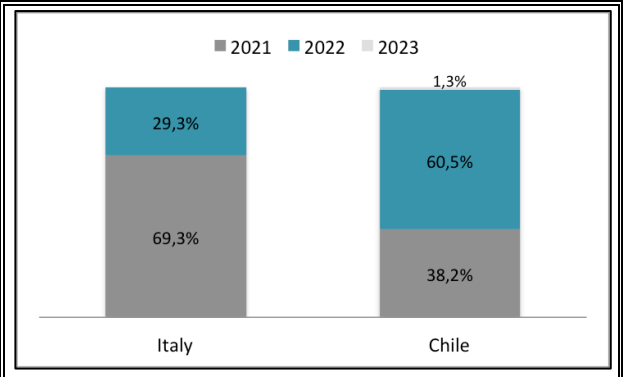

Figure 96. *Estimated year of graduation of Senior students*

ii. Quality Management Information

The Quality Management Information section was composed, as its name suggests, of questions about quality management in order to comprehend the respondents' level of knowledge about this subject.

Figure 97 represents the percentage of students who claimed to know each quality management methodology. The results clearly show that Italian students are more familiar with the methodologies than Chilean students.

Lean Manufacturing was indicated as the methodology most known by Italian respondents as 81.5% of them declared to know it, while ISO 9000 reached the highest percentage in the category of Chilean respondents with 34.8%. In addition, it is important to note that the percentage of Chilean respondents who do not know any quality management methodology (43.2%) exceeds the percentage obtained by ISO 9000, which means that the level of knowledge of Chilean students about QM methodologies is relatively limited. In the Italian case, only 0.8% of respondents stated that they do not know any quality management methodology. "Other methodologies" described by 0.8% of Italian respondents is IATF 16949, while IFS and ISO 22000 were added by 0.3% of Chileans.

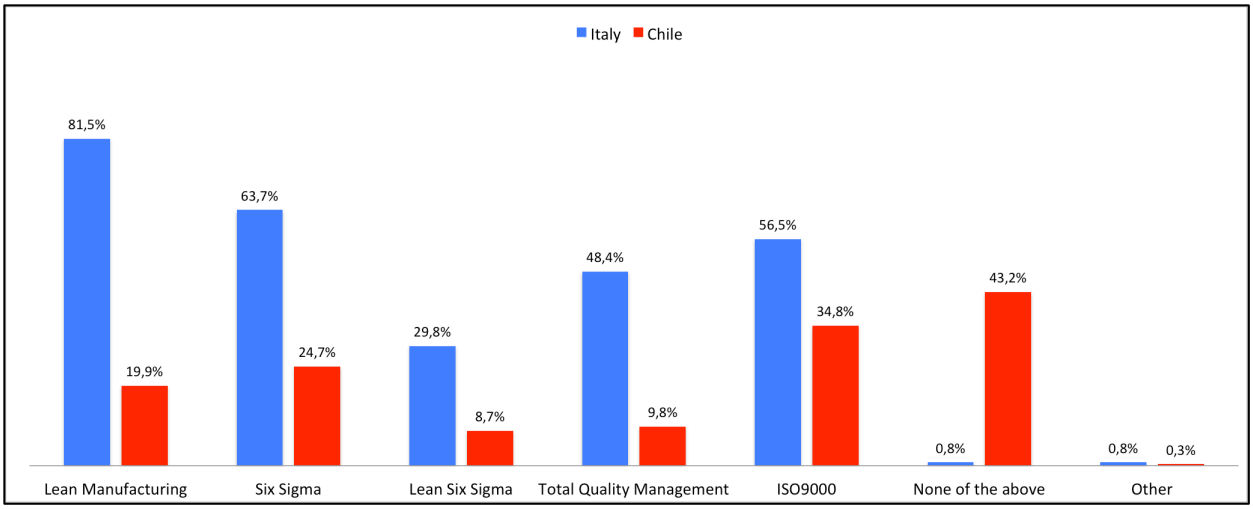

Figure 97. *Level of knowledge of the students about quality management methodologies*

Respondents who selected at least one methodology in the previous question were asked about where they had learned it. "University" was the alternative with the highest percentages in both countries, as it obtained 117 votes from Italian students out of a possible 123 (95.1%), and 102 from Chileans out of a possible 106 (62.6%). These results imply that Politecnico di Torino has been teaching its students adequately about this specific area of knowledge, as 19 out of 20 students are familiar with at least 1 quality management methodology. In contrast, a major

challenge that Universidad Adolfo Ibáñez could face is to increase this percentage, since only 62.6% of Chilean respondents know 1 or more methodologies.

The alternatives that obtained the second highest percentages were "Current Job/Last Job" and "By Myself" by Italians and Chileans respectively. Finally, comparing the alternatives involving working in companies, a higher proportion of respondents have learned at least 1 methodology when working professionally as an engineer, regardless of the country. "Other" places or activities recognized by Chilean respondents were "Family businesses".

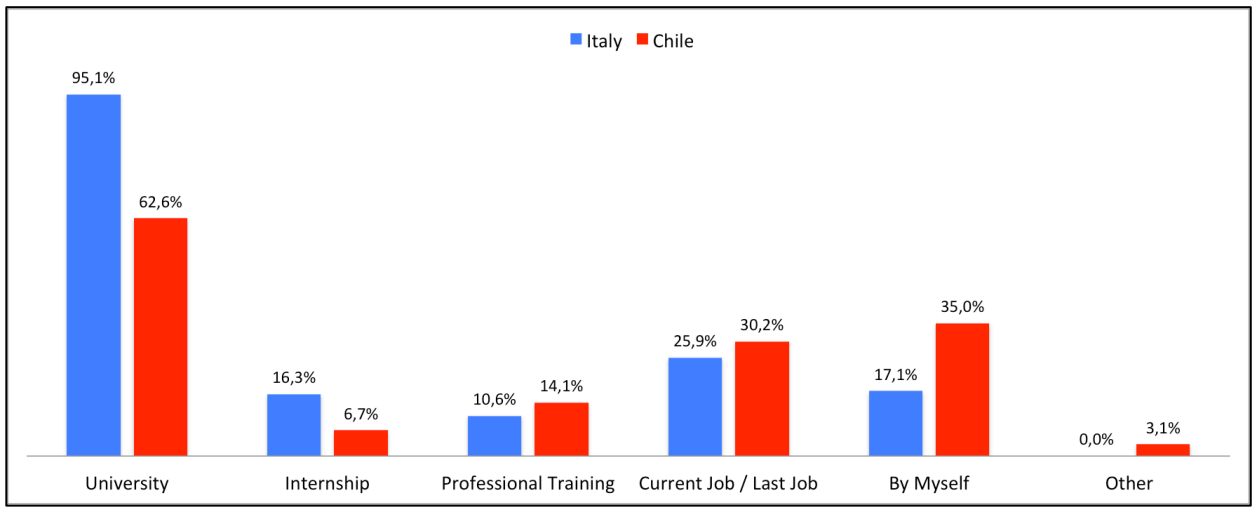

Figure 98. *Where students learned about quality management methodologies*

Respondents who selected an alternative that involved cooperating or working in a company were asked about how much they learned about the methodologies when working in the organizations, through a scale from 1 to 5 in which the higher the number, the greater the amount of knowledge acquired. As can be seen in Figure 99, Professional Training was selected by respondents from both countries as the activity that provided them with the most knowledge, with a mean value of 3.62 in Italy and 3.70 in Chile. In addition, Figures 100, 101 and 102 show the distribution of the areas in which respondents worked and learned about quality management methodologies in their current/last jobs, professional trainings and internships, respectively. As expected and as can be seen, the areas of quality, production and logistics were the most voted alternatives.

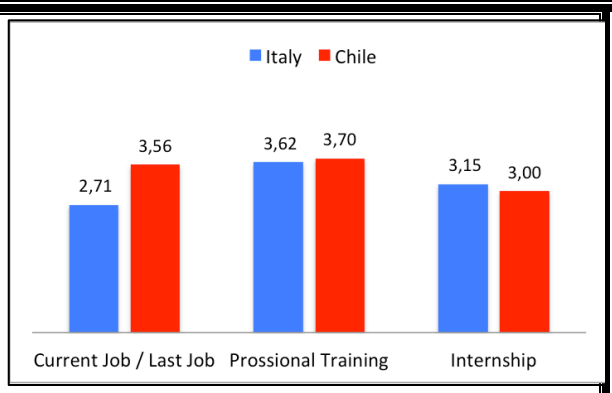

Figure 99. *Amount of knowledge acquired by students about quality management methodologies*

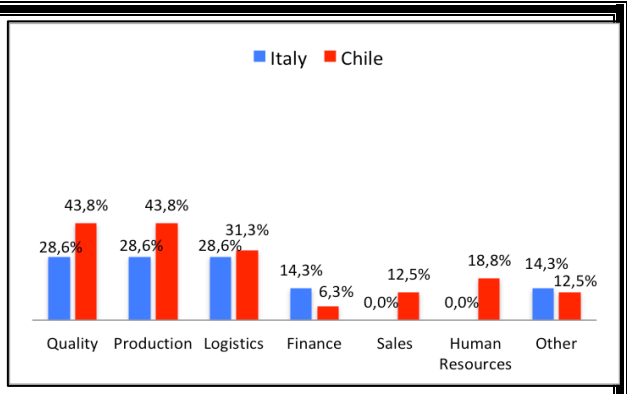

Figure 100. *Area in which respondents have learned about quality management methodologies in their current or last job as engineers*

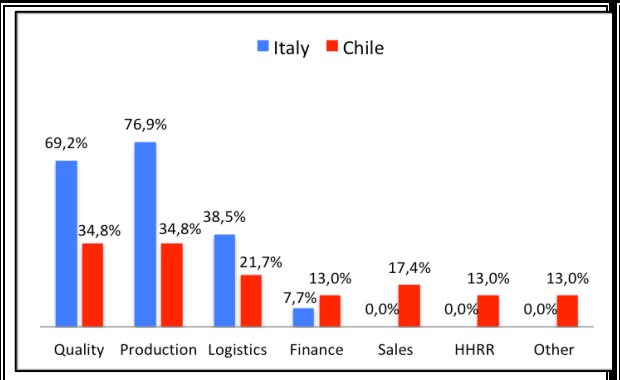

Figure 101. *Area in which respondents have learned about quality management methodologies in their professional training*

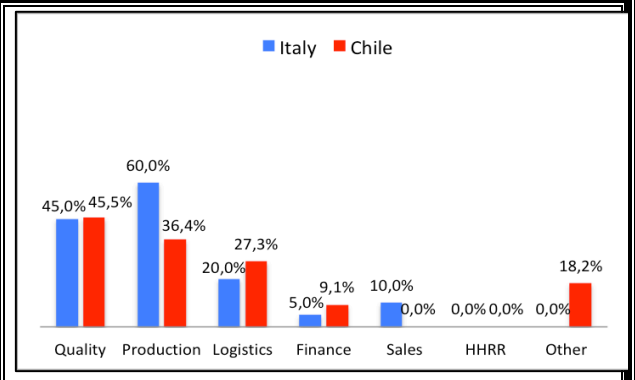

Figure 102. *Area in which respondents have learned about quality management methodologies in their internship*

Following the same structure as the questions about quality management methodologies, respondents were asked about some of the tools that apply these methodologies. The first question in this regard consisted in selecting the instruments they know or are familiar with. As can be seen, in some instruments the percentages for both countries are similar, while in others the differences are notable. Specifically, instruments such as Value Stream Map (VSM), Bottleneck Identification or Tree Diagram obtained similar percentages, while others such as Control Charts, Failure Mode and Effects Analysis (FMEA) or the Quality Function Deployment Matrix (QFD Matrix) present important gaps in favor of the Italian respondents. Moreover, while all Italian respondents claim to know at least 1 instrument, 6.3% of Chileans know none.

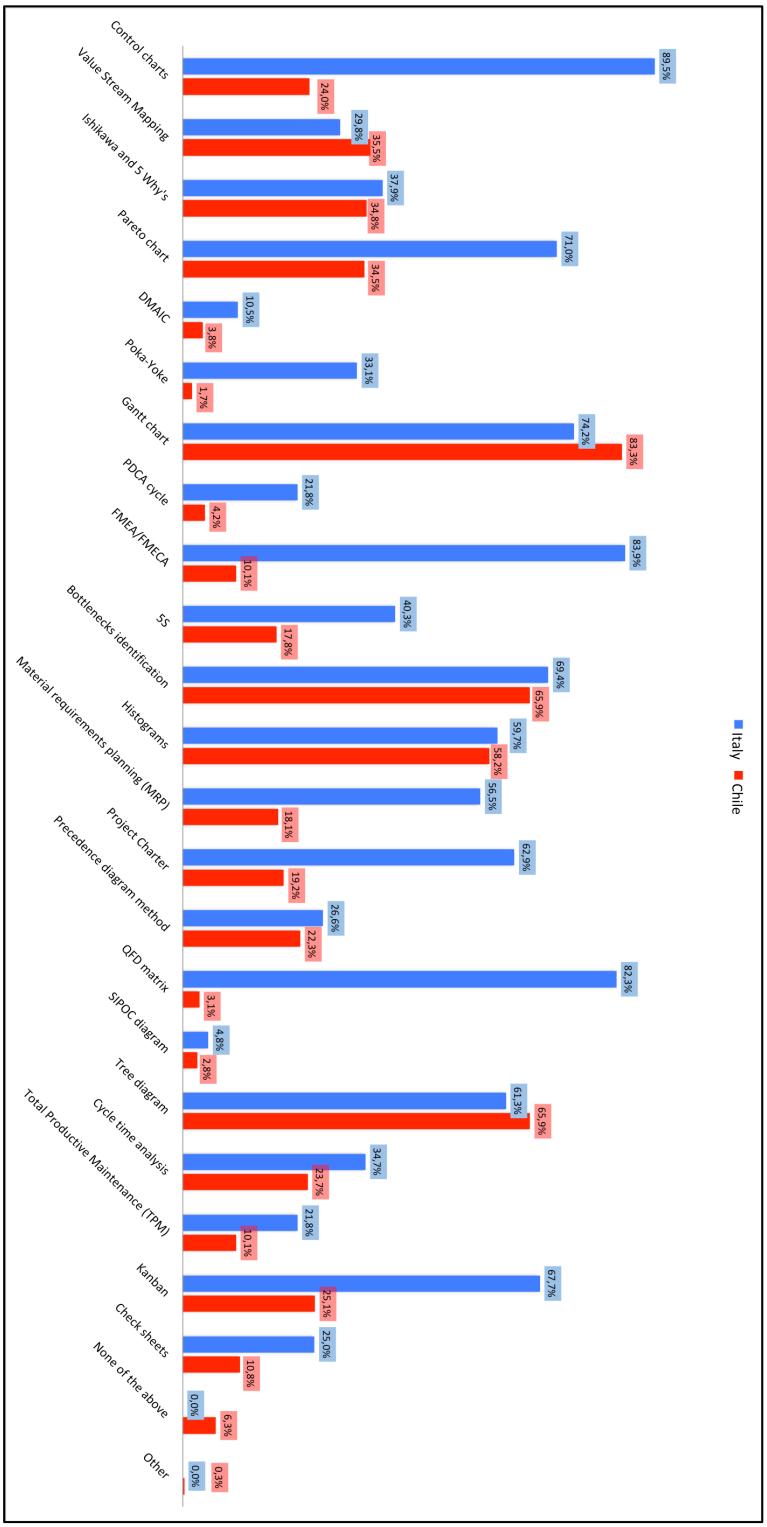

Figure 103. *Level of knowledge of the students about the instruments used by quality management methodologies*

The 124 Italians and 269 Chileans who reported knowing at least one of the instruments were asked about where they learned it. As can be seen in Figure 104, more than 90% of the respondents in each country learned at university, the place/activity par excellence for learning the instruments, taking into account that the second option in the ranking is "Current Job/Last Job" with 14.8% in Italy and 34.6% in Chile.

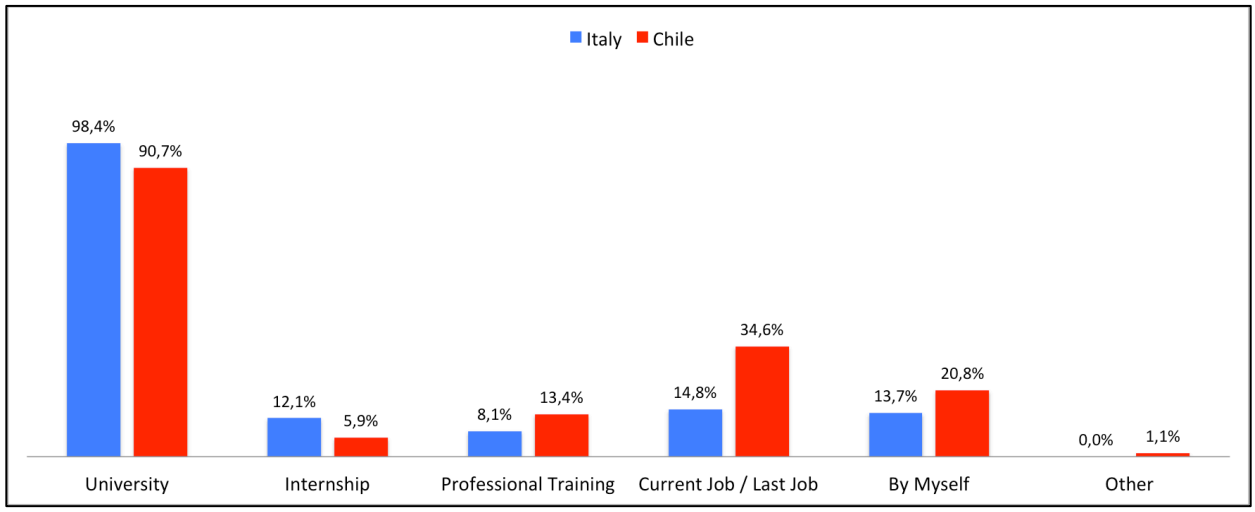

Figure 104. *Where students learned about the instruments used by the quality management methodologies*

Respondents who selected “Current Job/Last Job”, “Professional Training” or “Internship” in the previous question were asked about how much they had learned about the instruments while working in the companies where they performed those activities. The activities were rated using a scale of 1 to 5, where the higher the number, the greater the amount of knowledge acquired. Italian respondents rated Professional Training, with an average value of 4.20, as the activity in which they increased their knowledge in the highest proportion compared to the other two activities. On the other hand, Chileans placed "Current Job/Last Job" at the top of the ranking with a value of 4.04. In addition, Figures 106, 107 and 108 present the distributions of the areas in which respondents worked and learned about the tools used by QM methodologies in their Current Job/Last Job, Professional Training and Internship respectively. As expected and as can be observed, the areas of quality, production and logistics were the most voted alternatives.

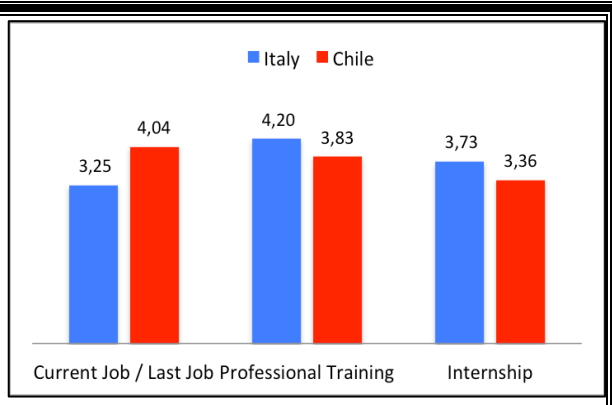

Figure 105. *Amount of knowledge acquired about the instruments used by the quality management methodologies*

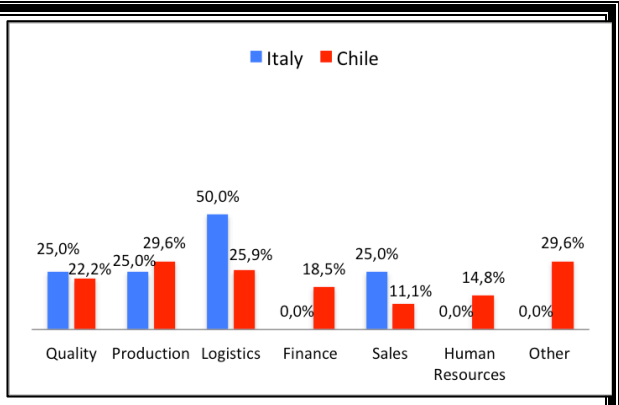

Figure 106. *Area in which respondents have learned about instruments used by quality management methodologies in their current or last job as engineers*

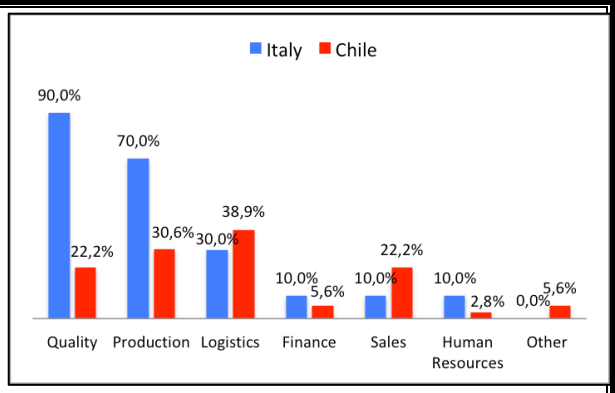

Figure 107. *Area in which respondents have learned about instruments used by quality management methodologies in their professional training*

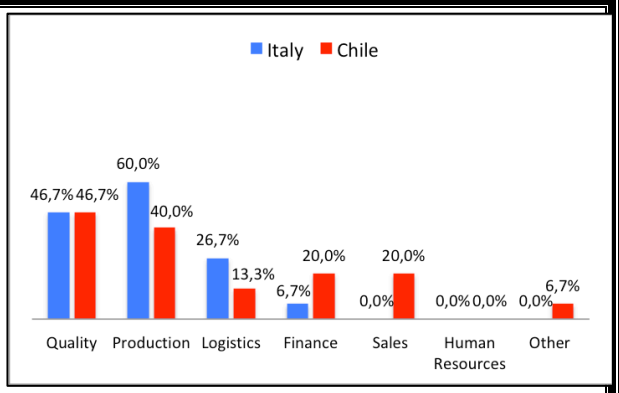

Figure 108. *Area in which respondents have learned about instruments used by quality management methodologies in their internship*

2. Alumni

This section presents only the results of Italian and Chilean respondents categorized as alumni. The responses of Italians are compared with those of Chileans in order to identify similarities and differences between them related to quality management.

i. Quality Management Information

Figure 109 represents the results about the quality management methodologies that respondents know. As can be seen, Lean Manufacturing is well known by the Italian respondents, while the level of knowledge of the Chileans is relatively limited since the option with the highest percentage is "None of the above", i.e. 40.7% of the respondents do not know any of these methodologies. The same alternative in the case of Italians is only 2%.

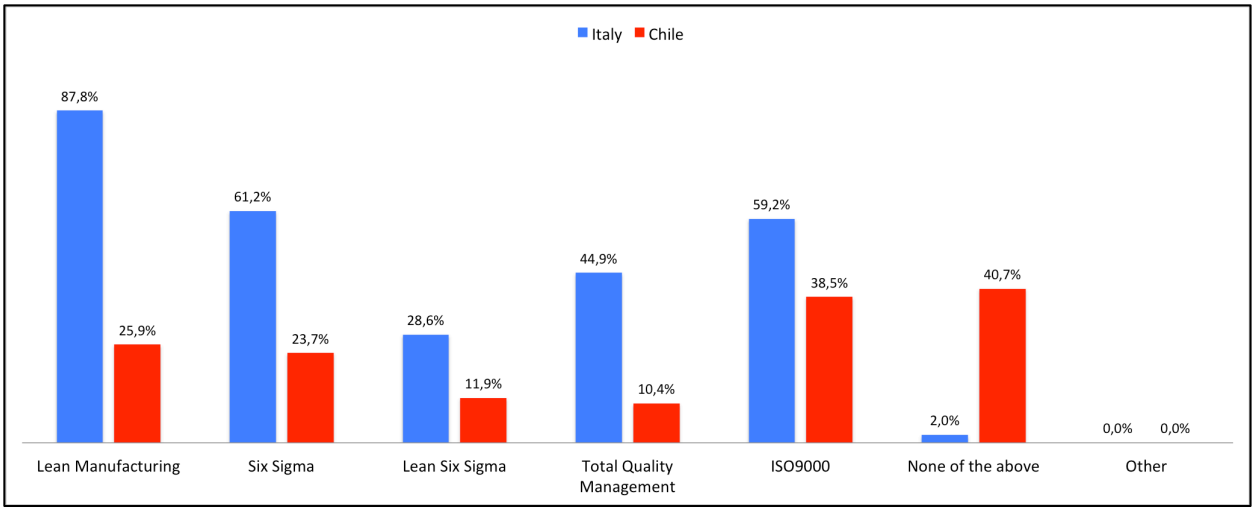

Figure 109. *Level of knowledge of the Alumni about quality management methodologies*

Respondents who selected some methodology in the previous question had to answer about where they learned that technique. Figure 110 shows the results and, as can be seen, the university plays a key role in the knowledge of Italians.

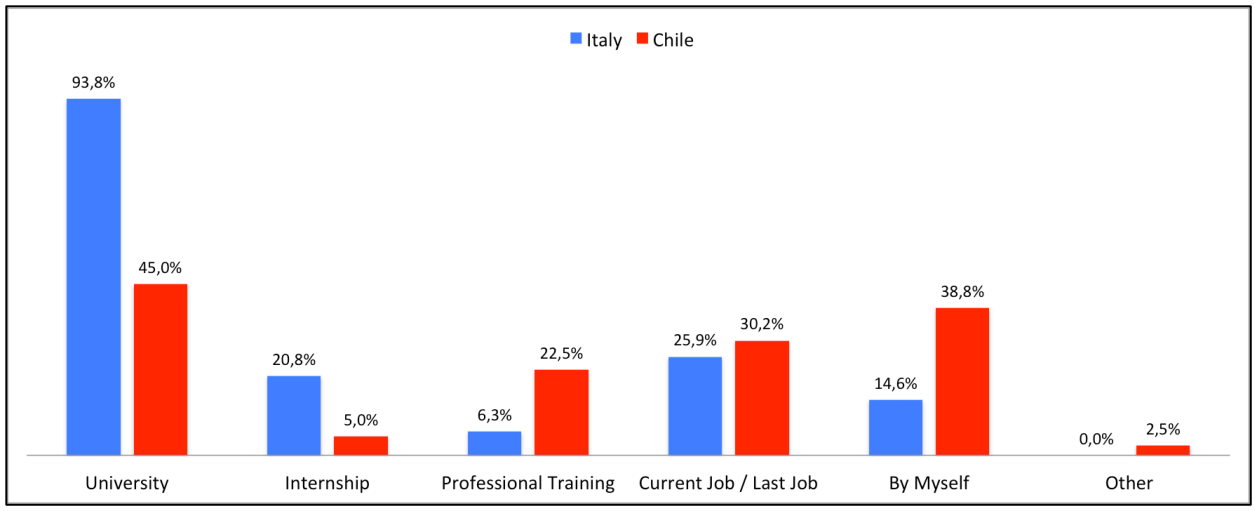

Figure 110. *Where Alumni learned about quality management methodologies*

Professional Training is the activity in which the respondents have most improved their level of knowledge about quality management methodologies, as can be seen in Figure 111. In addition, 93.8% of Italians and 96.2% of Chileans agree with including these subjects in university courses for future generations.

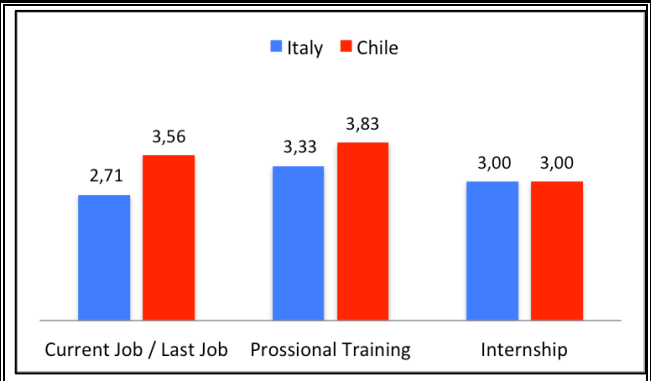

Figure 111. *Amount of knowledge acquired by Alumni about quality management methodologies*

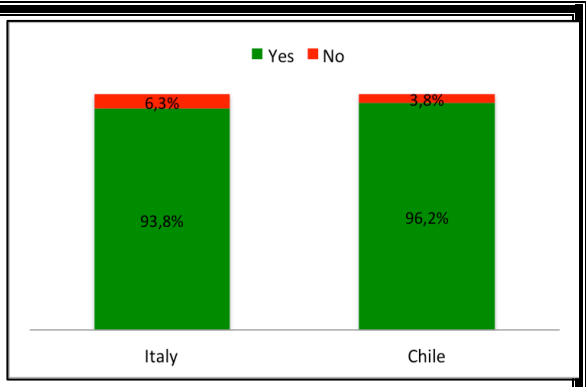

Figure 112. *Future professionals should have knowledge about quality management methodologies – Alumni*

The responses to the question about the level of knowledge of the respondents categorized as alumni regarding the instruments used by the QM methodologies are shown in Figure 113. As can be seen, in those instruments where significant differences can be appreciated, these are

always in favor of the Italians. Moreover, while all Italians know at least one instrument, 7.4% of Chileans declare that they do not know any of the instruments mentioned in the survey.

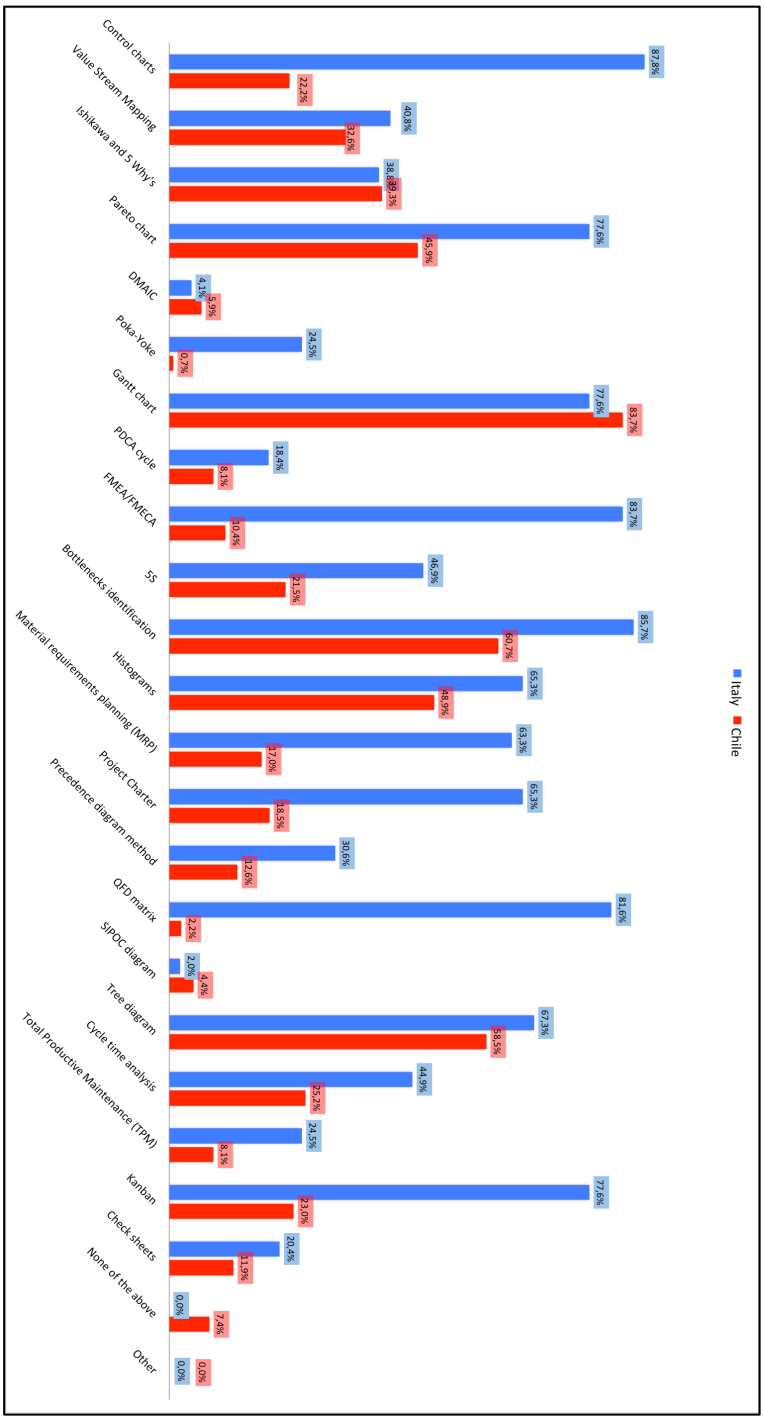

Figure 113. *Level of knowledge of the Alumni about the instruments used by the quality management methodologies*

The 49 Italians and 125 Chileans who selected at least one instrument in the previous question were asked about the place or activity where they learned that instrument. As can be seen in Figure 114, the university is the main place where most students have learned about QM tools.

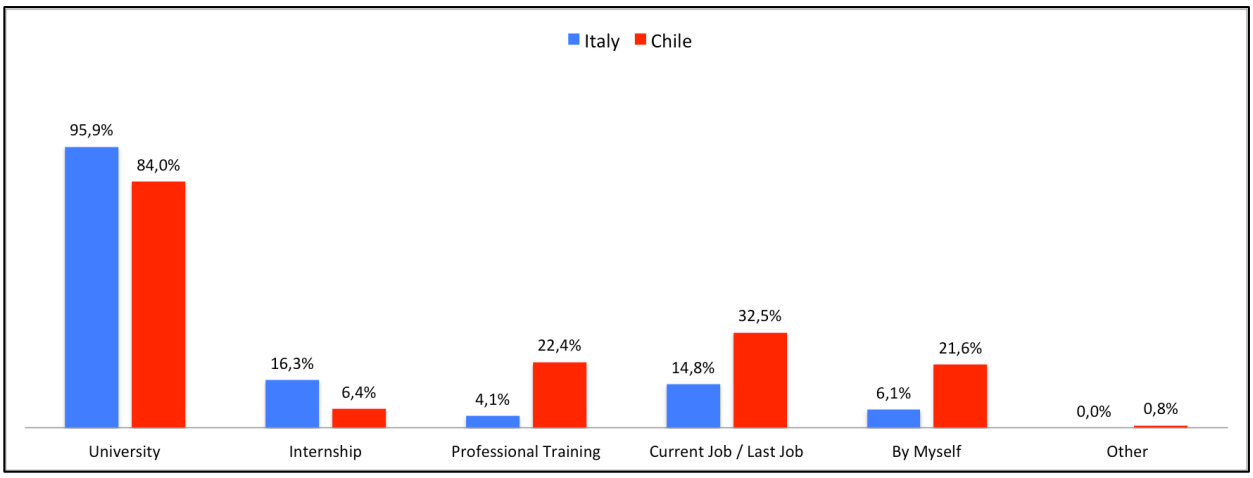

Figure 114. *Where Alumni learned about the instruments used by the quality management methodologies*

Students who selected "Internship", "Professional Training" or "Current Job/Last Job" in the last question were asked to rate how much they had learned in that activity. As can be seen, professional training is the activity in which Italians acquired the most knowledge about the instruments, while Chileans placed the alternative "Current Job/Last Lob" in first place. Moreover, 100% of the Italian respondents and 89.5% of the Chileans agree with including some of these instruments in university courses for future generations of engineers.

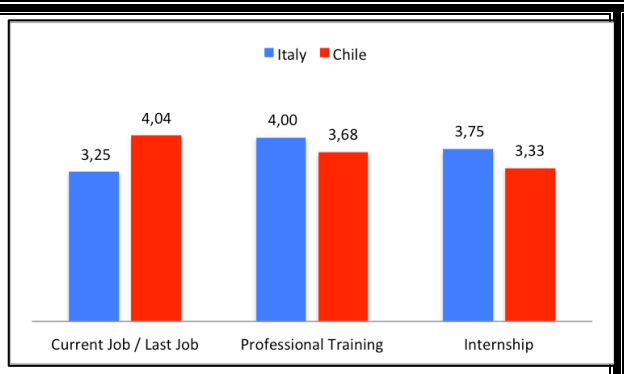

Figure 115. *Amount of knowledge acquired by Alumni about the instruments used by the quality management methodologies*

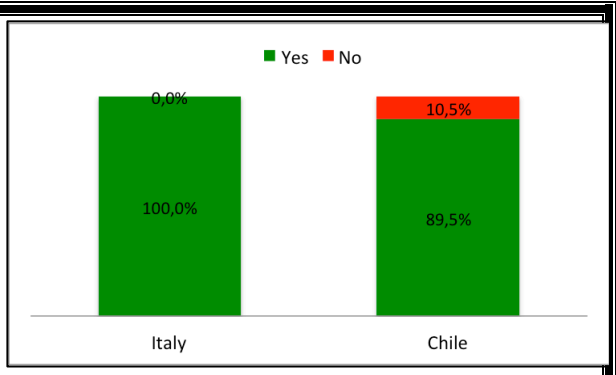

Figure 116. *Future professionals should have knowledge about the instruments used by the quality management methodologies – Alumni*

3. Senior Students

This section presents only the results of Italian and Chilean respondents categorized as senior students. The responses of Italians are compared with those of Chileans in order to identify similarities and differences between them related to quality management.

i. Quality Management Information

Figure 117 represents the results about the quality management methodologies known by respondents. As can be seen, Lean Manufacturing and Six Sigma are well known by Italian respondents, as 77.3% and 65.3% of them are familiar with these methodologies, respectively. In contrast, the level of knowledge of Chileans is relatively limited, as the option with the highest percentage is "None of the above", i.e. 45.4% of Chilean respondents do not know any of the listed methodologies.

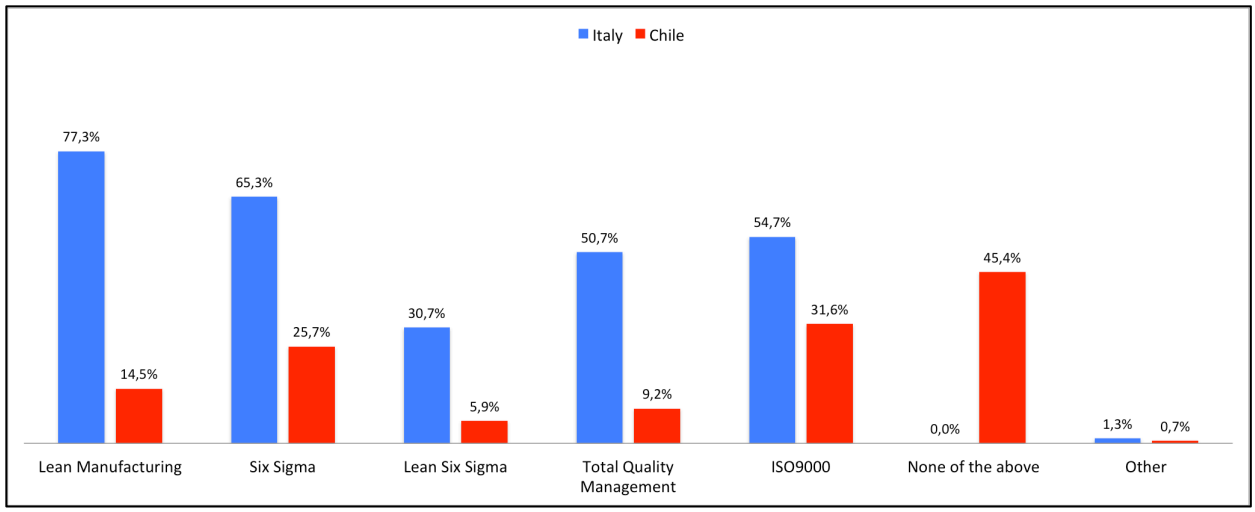

Figure 117. *Level of knowledge of the Senior students about quality management methodologies*

Respondents who selected at least one methodology in the previous question had to answer the question about where they learned that technique. Figure 118 represents the results and, as can be seen, the university plays a key role in the knowledge of Italian and Chilean respondents.

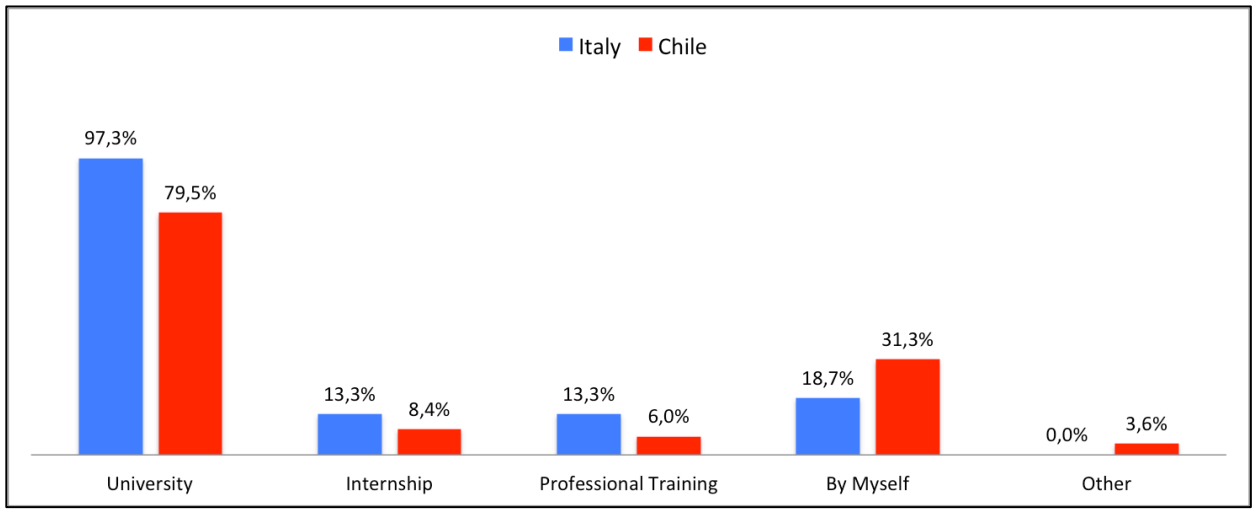

Figure 118. *Where Senior students learned about quality management methodologies*

Respondents who selected "Professional Training" or "Internship" in the previous question were asked about how much they had learned during that activity. The results are shown in Figure 119 and, as can be seen, respondents in both countries rated professional trainings higher than

internships. In addition, more than 95% of respondents in both countries agree to teach these methodologies to future generations of engineers.

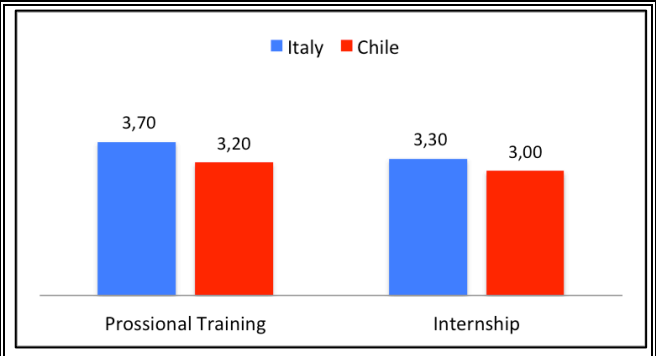

Figure 119. *Amount of knowledge acquired by Senior students about quality management methodologies*

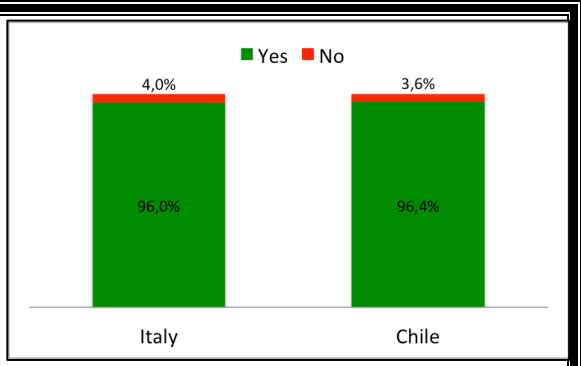

Figure 120. *Future professionals should have knowledge about quality management methodologies – Senior Students*

The answers to the question about the level of knowledge of the respondents categorized as Senior Students regarding the tools used by QM methodologies are represented in Figure 121. As can be seen, Control Charts, FMEA and QFD Matrix present the greatest differences between countries, always in favor of the Italian respondents.

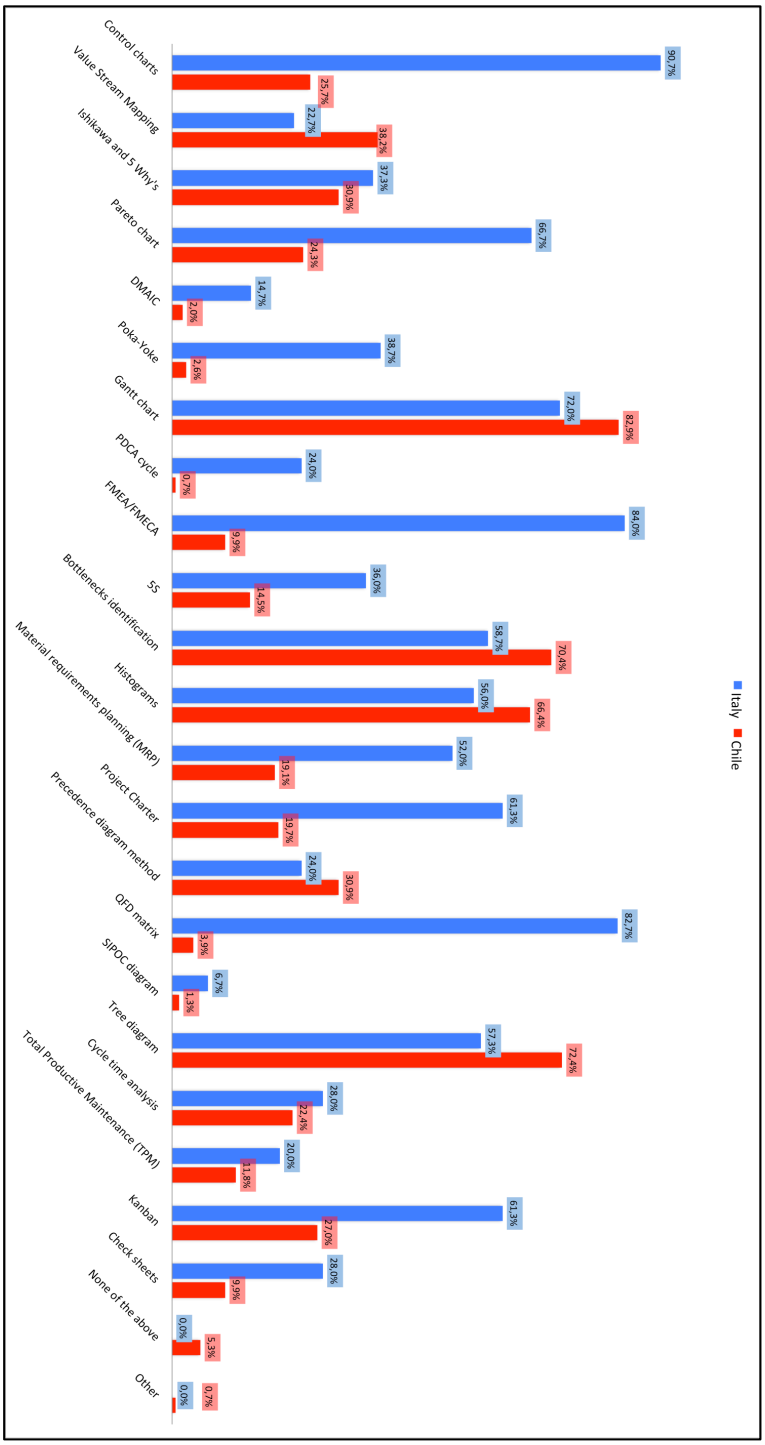

Figure 121. *Level of knowledge of senior students about the instruments used by the quality management methodologies*

The 75 Italians and 144 Chileans who selected at least one instrument in the previous question were asked about the place or activity where they learned that instrument. As can be seen in Figure 122, the university is the place par excellence where most students have learned these

instruments since 100% of the Italian respondents and 96.5% of the Chileans have learned at least 1 instrument there.

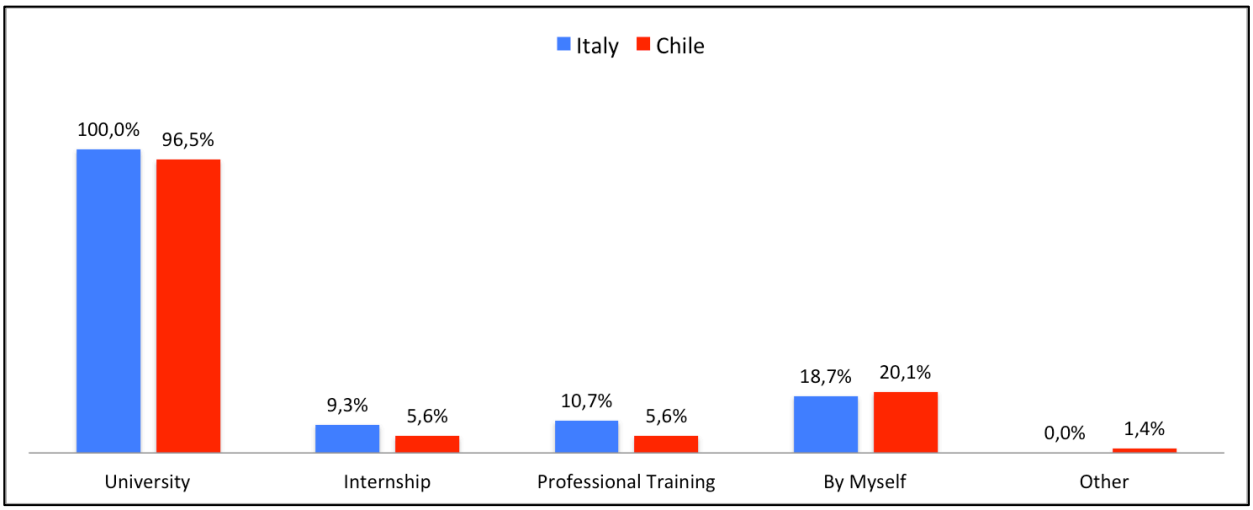

Figure 122. *Where Senior students learned about the instruments used by the quality management methodologies*

Students who selected "Internship" or "Professional Training" in the last question were asked to rate how much they had learned about the instruments in that activity. As can be seen, professional training is the activity in which Italians and Chileans acquired the most knowledge. Moreover, 94.7% of the Italian respondents and 97.2% of the Chilean respondents agree with including some of these instruments in university courses for future generations of engineers.

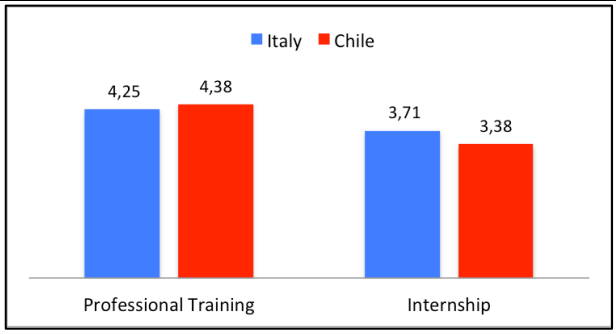

Figure 123. *Amount of knowledge acquired by Senior students about the instruments used by the quality management methodologies*

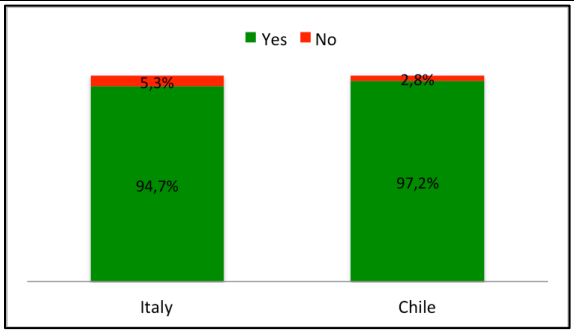

Figure 124. *Future professionals should have knowledge about the instruments used by the quality management methodologies – Senior Students*

III. Logistic Regression Models

From the results of the previous 2 subchapters, numerous logistic regressions were modeled to determine the relationships and behaviors of some variables of interest, so this subchapter aims to present and explain some of these models that will be used for the subsequent analysis of the results presented in the previous 2 subchapters. The models presented in this subchapter are those related to the level of knowledge and use of quality management methodologies and tools by companies, in which the responses of respondents from both countries were considered. In addition, logistic regression results related to the level of knowledge of Lean Manufacturing methodology will be used to explain the model.

The logistic regression described in Table 8 was modeled to investigate the significant characteristics of the companies in which the respondents are aware of Lean Manufacturing. "Know Lean Manufacturing" was defined as the dependent variable, while Country, Type of Company according to its Products, Company Size, Geographic Scope, among others, were some of the independent variables considered in the model. After some iterations, the variables Country, Product and Size were recognized as significant because their Pr(>|z|) are equal to or less than 0.05. The "Significance" column describes the level of significance that each independent variables has, therefore, the more "*" symbols, the higher the significance.

Dependent Variable	Independent Variable	Alternative	Pr(>|z|)	Significance	Estimate	Coefficient
Knowing Lean Manufacturing	Country	Italy	0.00016	***	1.784	5.950
	Product	Manufacturing	0.004147	**	1.894	6.640
	Size	Micro	0.001793	**	-2.015	0.133
	Size	Small	0.000937	***	-1.853	0.156

Table 8. *Logistic regression results: Respondents' level of knowledge about Lean Manufacturing – Companies Survey (Italian and Chilean responses)*

Considering the results of Table 8 and applying them in the logistics regression formula, the logit equation results:

$$\text{Logit}\,(Y = \textit{Know Lean Manufacturing}) = 1.784 \times \text{Country} + 1.894 \times \text{Product} + (-2.015) \times \text{Size}_{\text{Micro}} + (-1.853) \times \text{Size}_{\text{Small}}$$

To explain how the model equation works: if the company is Italian, the value of "Country" will be equal to 1, while if it is Chilean the value will be 0. The value of the variable "Product" will be 1 only if the company is a manufacturing company, and it will be 0 if the company is a service or hybrid company. Therefore, and as an example to visualize how the model works, the following characteristics will be assumed:

- Country = Italy
- Product = Manufacturing
- Size = Micro

$$\text{Logit}(Y = \textit{Know Lean Manufacturing}) = 1.784 \times 1 + 1.894 \times 1 + (-2.015) \times 1 + (-1.853) \times 0$$

$$\text{Logit}(Y = \textit{Know Lean Manufacturing}) = 1.663$$

Applying antilogit to the previous equation:

$$p = \textit{Probability}(Y = \textit{outcome of interest} \mid X_1 = x_1, X_2 = x_2) = \frac{e^{\alpha + \beta 1 X 1 + \beta 2 X 2}}{1 + e^{\alpha + \beta 1 X 1 + \beta 2 X 2}}$$

$$p = \frac{e^{1.663}}{1 + e^{1.663}} = \frac{5.275}{6.275} = 0.840626 = 84.06\%$$

As a result, the model indicates that there is an 84.06% chance that a respondent working in Italy in a manufacturing company classified as a microenterprise is aware of Lean Manufacturing.

Regarding the coefficients, the odds of a Italian respondent being aware of Lean Manufacturing, than not, are 5.95 times greater than the odds for a Chilean respondent, while holding all other indicators constant. To illustrate this, the same conditions will be considered for the predictors, however, Chile will be assumed as the country instead of Italy. As a result:

$$\text{Logit}(Y = \textit{Know Lean Manufacturing}) = 1.784\times0 + 1.894\times1 + (-2.015)\times1 + (-1.853)\times0$$

$$\text{Logit}(Y = \textit{Know Lean Manufacturing}) = -0.121$$

Applying antilogit to the previous equation:

$$p = \frac{e^{-0.121}}{1+e^{-0.121}} = \frac{0.886}{1.886} = 0.469 = 46.97\%$$

As a result, the model indicates that there is a 46.97% chance that a respondent working in Chile in a manufacturing company classified as a microenterprise is aware of Lean Manufacturing. In relation to the coefficient of 5.95, if the odds of a Chilean respondent being aware of Lean Manufacturing, than not, is multiplied by 5.95, the result correspond to the odds of an Italian respondent being aware of Lean Manufacturing:

$$0.886\times5.95 = 5.271 \approx 5.275$$

The following tables detail the independent variables and their results for each dependent variable modeled. Tables 9 and 10 present the results obtained for the dependent variables related to the level of knowledge of respondents from both countries about QM methodologies and instruments, while Tables 11 and 12 present the results related to the implementation of these tools and methodologies by companies in both countries. The results shown in these 4 tables have been obtained considering only the responses of the "Companies Survey", which means that only the relationships that incubate companies, and not the students, appear in these tables. Other logistic regression results related to the level of knowledge of the Italian or Chilean respondents, the characteristics of the companies with a quality management department and the

critical success factors they face, the level of awareness of the students, among others, can be seen directly in Appendix 4.

Dependent Variable	Independent Variable	Alternative	Pr(>|z|)	Significance	Estimate	Coefficient
Know Six Sigma	Intercept	-	0.001951	**	0.916	2.500
	Size	Medium	0.001689	**	-1.412	0.243
	Size	Micro	0.000031	***	-3.314	0.036
	Size	Small	0.000164	***	-1.854	0.156
Know Lean Six Sigma	Size	Micro	0.00964	**	-2.036	0.130
	Size	Small	0.017440	*	-1.325	0.265
Know ISO 9000	Intercept	-	4.07×10^{-8}	***	1.373	3.950
	Country	Italy	0.032900	*	1.377	3.966

Table 9. *Logistic regression results: Respondents' level of knowledge about quality management methodologies – Companies Survey (Italian and Chilean responses)*

Dependent Variable	Independent Variable	Alternative	Pr(>|z|)	Significance	Estimate	Coefficient
Know Control Charts	Size	Small	0.00501	**	-1.416	0.242
Know Poka-Yoke	Intercept	-	2.16×10^{-10}	***	-1.889	0.151
	Country	Italy	0.000345	***	1.483	4.410
Know Ishikawa	Product	Manufacturing	0.003392	**	1.839	6.292
	Size	Micro	0.000166	***	-2.654	0.070
	Size	Small	0.001011	**	-1.668	0.188
Know Tree Diagram	Country	Italy	0.00415	**	1.082	2.951
	Size	Medium	0.01118	*	-1.163	0.312
	Size	Micro	0.03009	*	-1.144	0.318
	Size	Small	0.0088	**	-1.271	0.280
Know Pareto Chart	Intercept	-	0.0091	**	-1.373	0.253
	Geographic	Multinational	0.01852	*	1.394	4.032

	Quality Department	Yes	0.00164	**	1.184	3.269
Know FMEA	Intercept	-	0.000942	***	-2.526	0.079
	Country	Italy	0.008451	**	1.046	2.848
	Geographic	Multinational	0.007676	**	2.129	8.408
Know DMAIC Cycle	Intercept	-	0.00214	**	-3.135	0.043
	Product	Product	0.01453	*	2.612	13.629
Know 5s	Intercept	-	0.000154	***	-3.089	0.045
	Geographic	Multinational	0.004936	**	2.306	10.037
	Geographic	National	0.043898	*	1.665	5.286
	Quality Department	Yes	0.0000626	***	1.693	5.440
Know Histograms	Intercept	-	0.03383	*	0.681	1.975
	Country	Italy	0.00397	**	1.176	3.241
	Size	Micro	0.00133	**	-1.772	0.169
	Size	Small	0.00301	**	-1.446	0.235
Know QFD Matrix	Intercept	-	0.000409	***	-1.284	0.276
	Country	Italy	0.000133	***	1.818	6.163
	Size	Micro	0.006537	**	-2.275	0.102
	Size	Small	0.004408	**	-3.083	0.045
Know PDCA Cycle	Country	Italy	0.000188	***	1.551	4.718
	Size	Micro	0.000409	***	-2.928	0.053
	Size	Small	0.030557	*	-1.101	0.332
Know SIPOC Diagram	Intercept	-	0.0000562	***	-1.644	0.193
	Country	Italy	0.0353	*	1.107	3.025
	Size	Small	0.0343	*	-2.270	0.103
Know CTA	Country	Italy	0.000587	***	1.428	4.172
	Size	Micro	0.000962	***	-2.712	0.066
	Size	Small	0.00679	**	-1.504	0.222
Know Kanban	Intercept	-	0.0000926	***	-2.468	0.084
	Country	Italy	0.00003	***	1.687	5.406
	Product	Manufacturing	0.005	**	1.879	6.551
Know VSM	Intercept	-	0.016	*	-1.238	0.289
	Size	Small	0.0254	*	-1.387	0.249

	Quality Department	Yes	0.0102	*	1.232	3.428

Table 10. *Logistic regression results: Respondents' level of knowledge about quality management instruments – Companies Survey (Italian and Chilean responses)*

Dependent Variable	Independent Variable	Alternative	Pr(>|z|)	Significance	Estimate	Coefficient
Using Methodologies	Intercept	-	0.000002	***	-3.608	0.027
	Quality Department	Yes	2.55×10^{-8}	***	3.043	20.977
	Know Lean Manufacturing	Yes	2.99×10^{-5}	***	2.344	10.430
	Know ISO 9000	Yes	0.00115	**	2.254	9.525
Use Lean Manufacturing	Intercept	-	4.07×10^{-8}	***	-1.373	0.253
	Country	Italy	0.0213	*	0.884	2.420
Use Total Quality Management	Intercept	-	4.3×10^{-11}	***	-2.431	0.088
	Country	Italy	0.000987	***	1.584	4.875
Use ISO 9000	Intercept	-	0.000002	***	-5.322	0.004
	Quality Department	Yes	3.21×10^{-10}	***	2.864	17.537
	Know ISO 9000	Yes	0.000191	***	4.024	55.971

Table 11. *Logistic regression results: Use of quality management methodologies – Companies Survey (Italian and Chilean responses)*

Dependent Variable	Independent Variable	Alternative	Pr(>|z|)	Significance	Estimate	Coefficient
Using Instruments	Quality Department	Yes	4.67×10^{-6}	***	2.94	18.919
Use Control Charts	Intercept	-	1.99×10^{-7}	***	-2.233	0.107
	Quality Department	Yes	0.00153	**	1.54	4.666
Use VSM	Intercept	-	0.000862	***	-1.005	0.365
	Size	Micro	0.045493	*	-2.13	0.118
	Size	Small	0.031192	*	-1.702	0.182

Use Ishikawa	Intercept	-	2.97×10^{-5}	***	-6.397	0.001
	Geographic	Multinational	0.0456	*	2.364	10.635
	Know Ishikawa	Yes	0.000515	***	4.161	64.174
	Know DMAIC	Yes	0.007532	**	1.819	6.166
Use Pareto Chart	Intercept	-	0.0000346	***	-5.351	0.004
	Geographic	Multinational	0.0117	*	2.853	17.343
	Know Pareto	Yes	0.00000218	***	3.654	38.646
Use Gantt Chart	Intercept	-	0.0000558	***	-3.323	0.036
	Quality Department	Yes	0.000319	***	1.488	4.43
	Know Gantt	Yes	9.74×10^{-6}	***	3.528	34.051
Use PDCA Cycle	Intercept	-	1.81×10^{-7}	***	-2.433	0.087
	Quality Department	Yes	0.000796	***	1.740	5.7
Use FMEA	Intercept	-	4.29×10^{-8}	***	-3.912	0.02
	Know FMEA	Yes	2.95×10^{-7}	***	3.954	52.174
Use 5s	Intercept	-	0.0033	**	-1.609	0.2
	Product	Manufacturing	0.00333	**	1.843	6.315
Use Bottleneck Identification	Intercept	-	1.44×10^{-7}	***	-4.554	0.01
	Country	Italy	0.0065	**	-1.607	0.2
	Quality Department	Yes	0.00337	**	1.706	5.511
	Know Bottleneck	Yes	2.14×10^{-6}	***	3.774	43.577
Use Histograms	Intercept	-	0.00375	**	-1.898	0.15
	Size	Medium	0.04452	*	-1.096	0.333
	Size	Small	0.04897	*	-1.242	0.288
	Quality Department	Yes	0.00207	**	1.946	7.000
Use MRP	Intercept	-	4.58×10^{-11}	***	-3.015	0.05

	Know MRP	Yes	1.25×10^{-7}	***	2.92	18.545
Use Project Charter	Intercept	-	5.49×10^{-5}	***	-4.88	0.007
	Geographic	Multinational	0.0424	*	2.348	10.472
	Know Project Charter	Yes	6.12×10^{-8}	***	3.335	28.087
Use QFD Matrix	Intercept	-	2.12×10^{-6}	***	-4.762	0.008
	Know QFD	Yes	0.00123	**	3.53	34.125
Use Tree Diagram	Intercept	-	2.76×10^{-6}	***	-5.419	0.004
	Quality Department	Yes	0.01001	*	2.717	15.142
	Know Tree Diagram	Yes	0.00148	**	2.132	8.433
Use CTA	Intercept	-	5.51×10^{-8}	***	-3.881	0.02
	Know CTA	Yes	1.1×10^{-5}	***	3.392	29.725
Use TPM	Intercept	-	2.75×10^{-6}	***	-4.71	0.009
	Know TPM	Yes	7.06×10^{-5}	***	4.213	67.565
Use Check Sheets	Intercept	-	2.71×10^{-9}	***	-3.4864	0.03
	Know Check Sheets	Yes	1.91×10^{-7}	***	3.403	30.053

Table 12. *Logistic regression results: Use of quality management instruments – Companies Survey (Italian and Chilean responses)*

Chapter 6: Analysis

I. Analysis of results and graphs

Although no minimum response rate has been established, prior to the year 2000, leading journals in the field of operations management have stated that the response rate varies between 20-40% (Frohilch, 2002). Easterby-Smith et al. (2012) argued that the 20% response rate has been considered sufficient by many researchers, furthermore, searching the literature, there are Lean Manufacturing and Six Sigma researches where a response rate of 10% is even acceptable. This view was supported by Collis and Hussey (2013) who argued that researchers using questioner techniques should expect response rates of 10% or less. Therefore, the response rate of 13.26% by Italian companies (50 out of 377) and the response rate of 30.46% by Chilean organizations (99 out of 325) are considered sufficient to be representative because these values vary within the expected ranges.

To measure the representativeness of the responses, a kind of Kolmogorov-Smirnov test was conducted. The distributions of Surveyed Companies and Responses were confronted to measure the similarity between them and to determine if the responses are representative of the total number of companies contacted for the research. As can be seen in Appendix 5, there are no significant differences due to in most of the categories the K-S value does not exceed 10%, therefore, it can be argued that the responses from both countries are representative of the total number of companies.

1. Comparative analysis between a developed and a developing country

The first hypothesis of this research states that companies in developed countries have a greater concern and a higher level of development in terms of quality management compared to companies in emerging countries. Taking into account the results about the percentage of companies that have a quality management department, the level of knowledge of the respondents about quality management methodologies and tools, the percentage of companies

that develop continuous improvement projects with quality management methodologies and the percentage of companies working with QM tools, it can be stated in first instance that hypothesis H1 is true.

2. Comparative analysis between types of companies according to their products

Hypothesis H2 of this research states that manufacturing companies have a greater concern and a higher level of development about quality management compared to service or hybrid organizations. Taking into account the results in both countries about the percentage of companies that have a quality management department, the level of knowledge of the respondents about quality management methodologies and tools, the percentage of companies that develop continuous improvement projects with quality management methodologies and the percentage of companies working with quality management tools, H2 can be accepted in the first instance.

3. Comparative analysis between companies according to their size in terms of number of employees

Hypothesis number 3 of this research (H3) states that the level of development of quality management is directly proportional to the size of the companies. Taking into account the results in both countries about the percentage of companies that have a quality management department, the level of knowledge of the respondents about quality management methodologies and tools, the percentage of companies that develop continuous improvement projects with quality management methodologies and the percentage of companies working with quality management tools, it can be verified in first instance that the level of development of quality management is directly proportional to the size of the company, therefore, hypothesis H3 can be accepted.

4. Comparative analysis between companies according to their geographic scope

The fourth hypothesis of this research states that the level of development of quality management is directly proportional to the geographical scope of the companies. Taking into account the results in both countries about the percentage of companies that have a quality management department, the level of knowledge of the respondents about quality management methodologies and tools, the percentage of companies that develop continuous improvement projects with quality management methodologies and the percentage of companies working with quality management tools, it can be verified that the level of development of quality management is not directly proportional to the geographic scope of the company, so hypothesis H3 cannot be accepted in the first instance, and therefore must be rejected.

5. Critical success factors

An important objective defined for this research was to provide a set of critical success factors in the development of quality management practices identified by companies in both countries. For this analysis, only question P3.1.5 was taken into consideration because it responds to what has been studied by academia for years, i.e., respondents answered what are the critical success factors to obtain benefits when implementing quality management methodologies. Figures 125 and 126 show the percentage of Italian and Chilean respondents respectively who considered each critical success factor as "Influential" or "Very Influential".

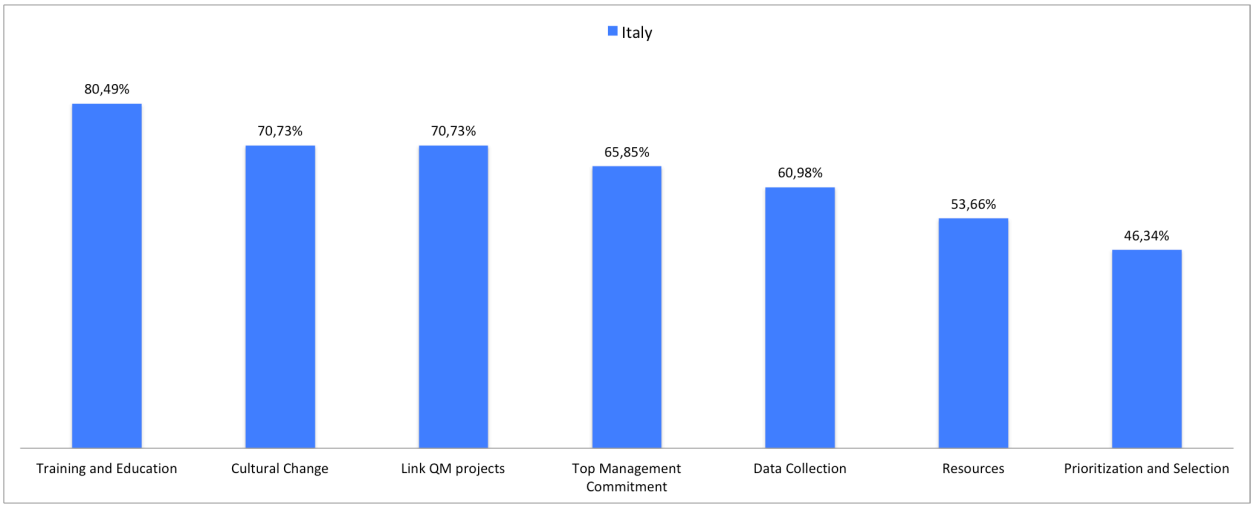

Figure 125. *Italian critical success factors*

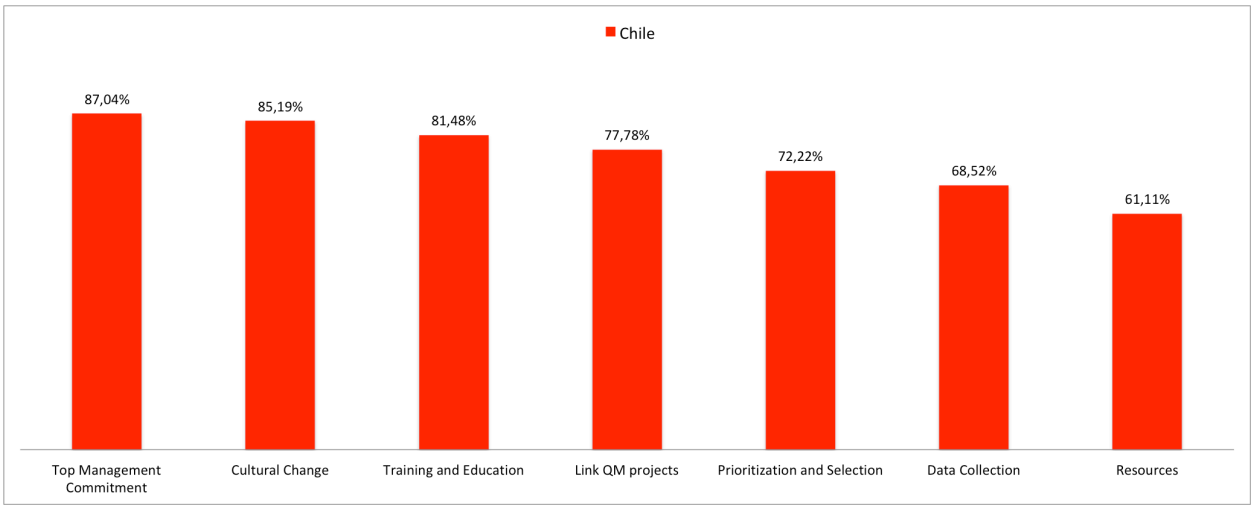

Figure 126. *Chilean critical success factors*

As can be seen from results; Data Collection, Resources Investment, and Prioritization and Selection of Projects share the last 3 positions in both countries, therefore, these factors were considered the least important and influential.

On the other hand, Cultural Change is a relatively important factor, as it received the second highest number of votes from respondents in both countries. While the critical success factor Top Management Commitment was indicated as “Influential” or “Very Influential” by the highest number of Chilean respondents, this factor ranks fourth in the Italian ranking. As a hypothesis, this could be explained by the fact that quality management might already be internalized by an

important part of Italian top management, while Chileans might not yet have understood the value of these practices. Last but not least, Training and Education of Employees was the most selected factor by Italian respondents, which means that it was considered the most important and influential factor to obtain good results when Italian organizations carry out CI projects. Although this factor does not occupy the first place in the Chilean ranking, more than 80% of Chilean respondents who responded question P3.1.5 selected it as "Influential" or "Very Influential".

6. Comparative analysis between Italian and Chilean students

From the results of the Students Survey and similar to the comparison between Italian and Chilean companies, a first general analysis of the results indicates that proportionally the students of the Politecnico di Torino know more about quality management methodologies and techniques than the students of the Universidad Adolfo Ibáñez. As can be seen in Figures 97 and 103, the level of knowledge of Italian respondents, both of quality management methodologies and tools, is higher than the level of Chileans, which means that the students of the Politecnico di Torino are better able to meet the QM requirements of companies.

In addition, and taking into account for this analysis the results of Figure 98 and Figure 104, the main place where students acquired knowledge about quality management techniques was the university, with significant differences with respect to the other places or activities. Therefore, it can be stated that, as the university is the main place where most Italian and Chilean students have learned about quality management methodologies and tools, and that the level of knowledge of these methodologies is higher in Italian students, the Politecnico di Torino has a greater capacity and effectiveness in transmitting this knowledge to its students compared to the Universidad Adolfo Ibáñez.

7. Comparative analysis between students according to their academic status

From the results of the Students Survey, a comparison can be made between the Alumni and Senior Alumni categories in order to identify similarities and differences between categories in relation to the level of knowledge about quality management techniques. The comparison of these 2 categories considering the responses of Italian students is presented in Figures 127 and 128.

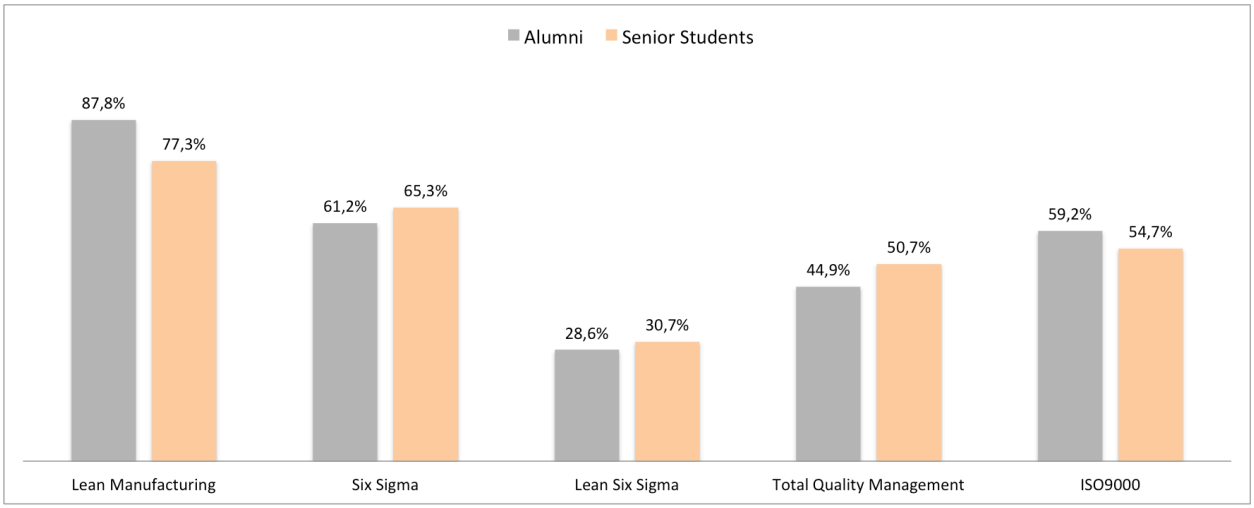

Figure 127. *Level of knowledge of Italian students about quality management methodologies – Comparison by Academic Status*

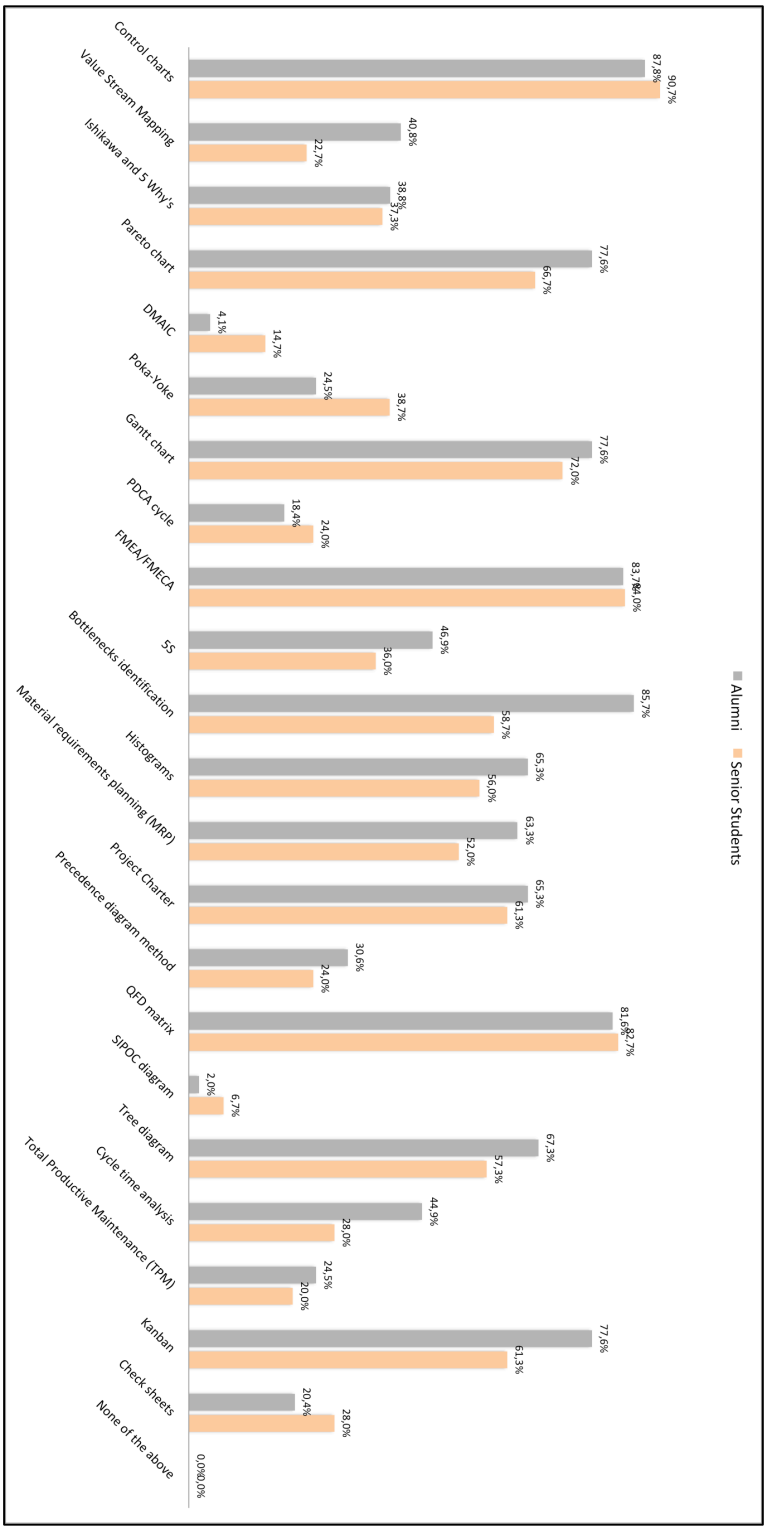

Figure 128. *Level of knowledge of Italian students about the instruments used by quality management methodologies – Comparison by Academic Status*

As can be seen from the comparison, non-significant differences can be appreciated between

Italian alumni and senior students in terms of quality management methodologies, due to the fact that the highest percentage difference between the two categories is 10% (Lean Manufacturing). On contrary, for several instruments, the Alumni category has a higher level of awareness in comparison to the Senior Students category (e.g. Value Stream Mapping, Bottleneck Identification, Kanban, etc.), and in 14 of the 22 tools listed in the survey the percentage is favorable to the Alumni category. However, it is important to take into consideration that a part of the respondents categorized as Alumni are currently working or have ever worked as engineers, therefore, this category is in an advantageous situation with respect to the Senior Students group due to the fact that the students of this first category have had another activity/opportunity to learn the methodologies and tools, so this trend described above is even normal and expected. In fact, as can be seen in Figures 129 and 130, 25.9% and 14.8% of the Italian students categorized as Alumni have learned at least 1 methodology and 1 tool in their jobs respectively.

Finally, it is important to note that, although the percentage of Italian students learning these techniques at the university is at the desired levels, the comparison between the two categories is minimally in favor of the senior category, which means that Politecnico di Torino has been improving its effectiveness in imparting quality management skills to its students.

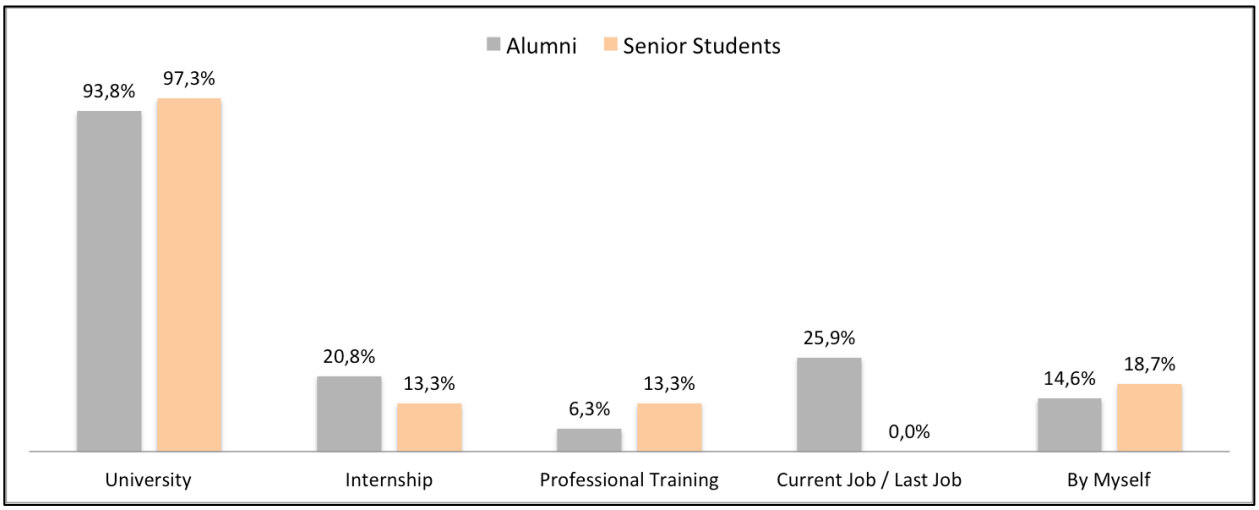

Figure 129. *Place or activity where Italian students have learned at least one quality management methodology - Comparison by Academic Status*

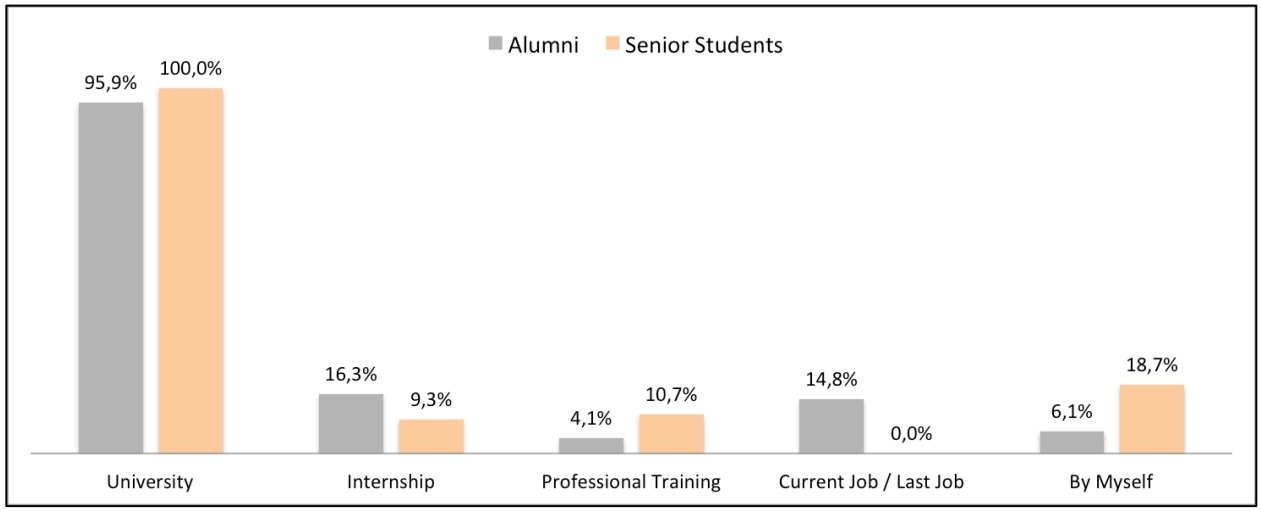

Figure 130. *Place or activity where Italian students have learned at least one instrument used by quality management methodologies - Comparison by Academic Status*

The comparison between Alumni and Senior Students categories taking into account the responses of Chilean students is presented in Figures 131 and 132.

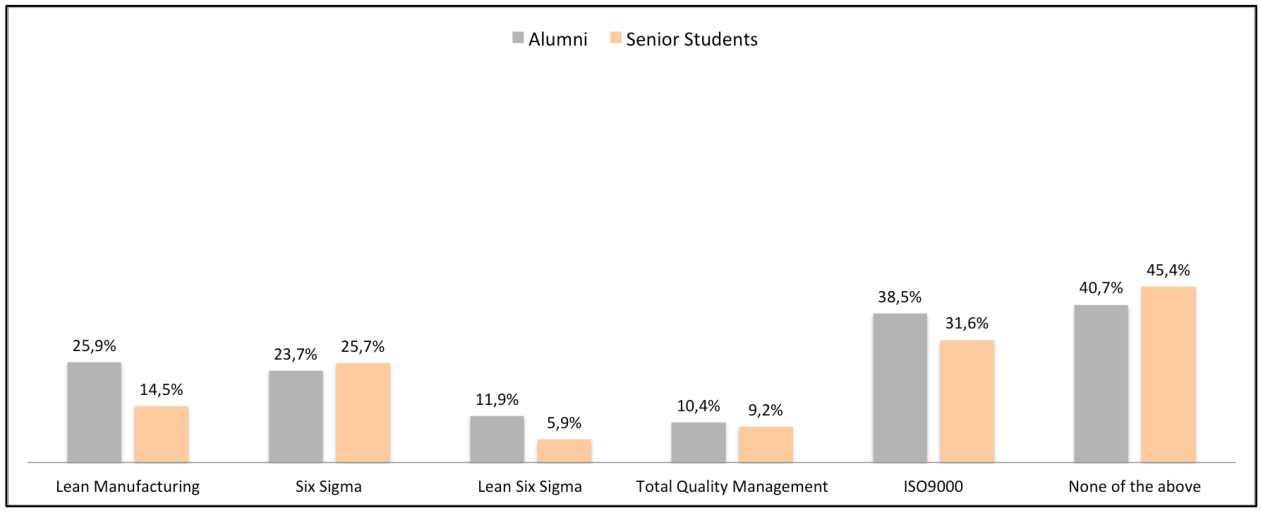

Figure 131. *Level of knowledge of Chilean students about quality management methodologies – Comparison by Academic Status*

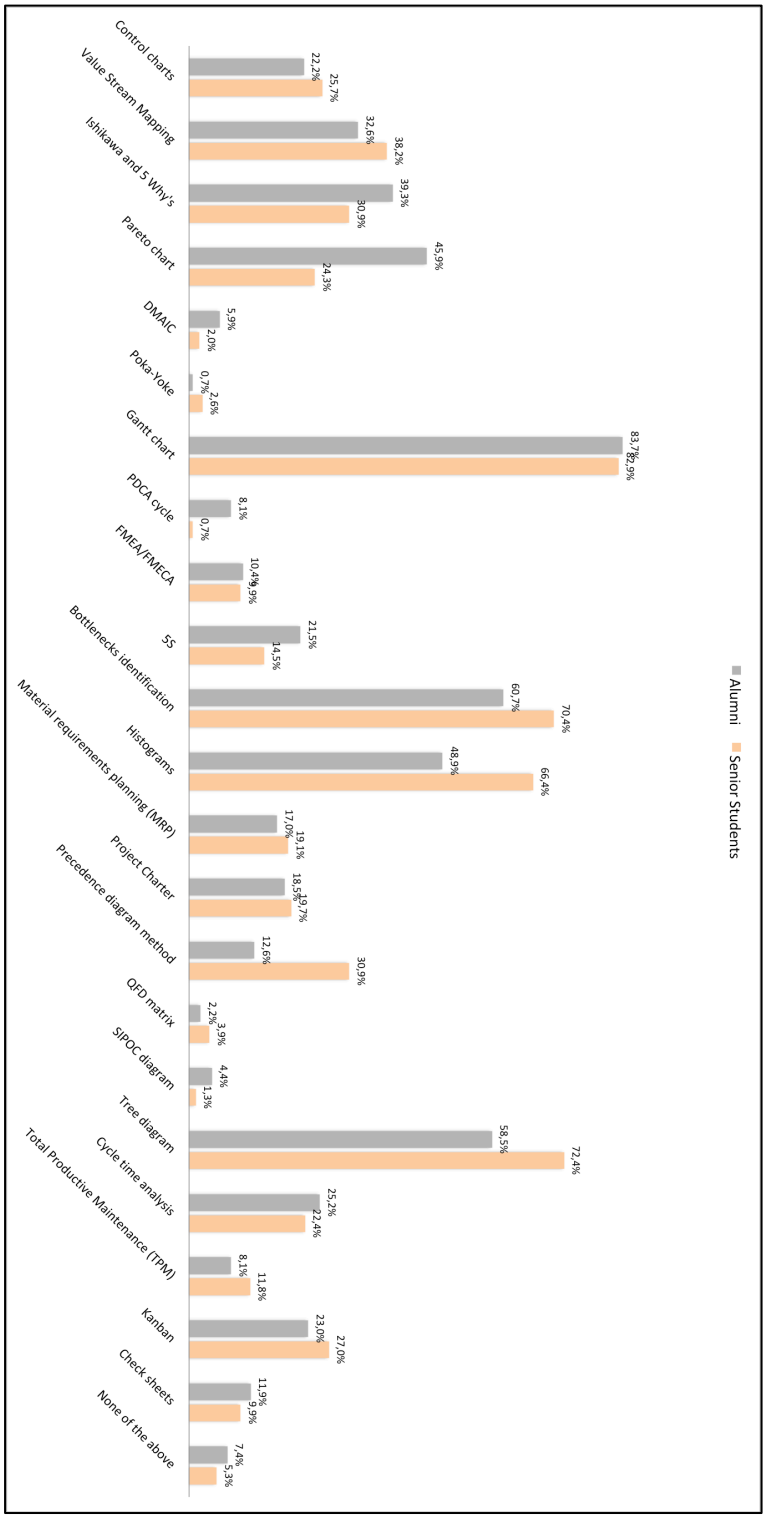

Figure 132. *Level of knowledge of Chilean students about the instruments used by quality management methodologies – Comparison by Academic Status*

As can be seen in the results and similar to the Italian case, there are non-significant differences between Chilean Alumni and Senior Alumni in terms of quality management methodologies because the highest percentage difference between the two categories is in Lean Manufacturing (11.4%). However, and unlike what was seen in the Italian results with respect to the instruments, in the Chilean case the Alumni category has a higher percentage than the Senior Students category in only 8 of the 22 tools, so that respondents belonging to the second category know more about quality management tools than those classified as Alumni. In addition, significant differences in favor of the Senior Students category are observed in some instruments such as: Histograms, Precedence Diagram Method or Tree Diagram. Only the Pareto Chart shows a significant disparity in favor of the Alumni group.

As mentioned in the case of the Italian results, it should be noted that a part of the Alumni category is currently working or has ever worked as an engineer and, as can be seen in Figure 133 and Figure 134, 30.2% and 32.5% of them have learned at least one QM methodology and one tool respectively. Despite this fact, there are no very relevant differences about methodologies.

Additionally, as can be seen in Figures 133 and 134, a higher percentage of Chilean senior students have learned at least one quality management methodology and one instrument when studying at the university compared to the Alumni category. The results suggest that almost 4 out of 5 Chilean respondents classified as Senior Students have learned at least 1 quality management methodology (79.5%), while this percentage for the Alumni group reaches only 45%. This trend is also repeated for the classification of tools: 96.5% of the senior students and 84% of the alumni have learned at least one tool at university.

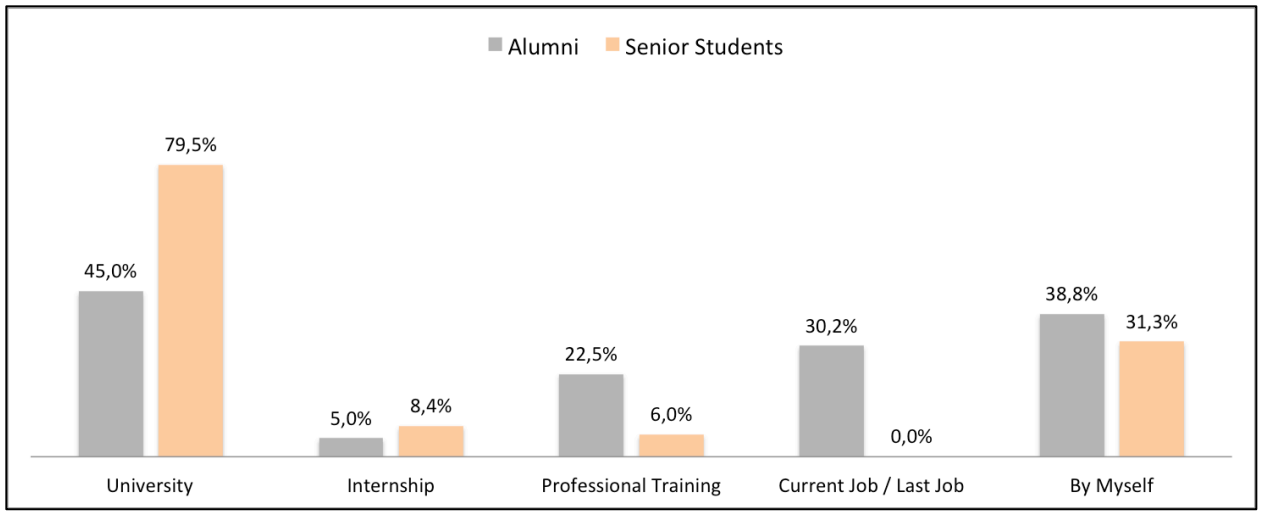

Figure 133. *Place or activity where Chilean students have learned at least one quality management methodology - Comparison by Academic Status*

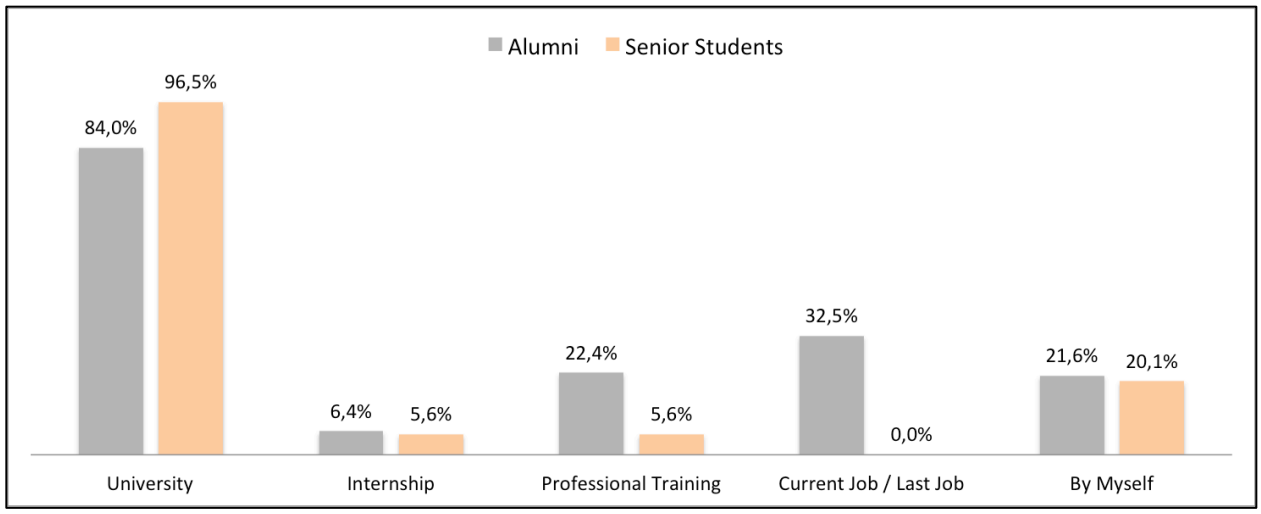

Figure 134. *Place or activity where Chilean students have learned at least one instrument used by quality management methodologies - Comparison by Academic Status*

In conclusion, taking into account both the level of knowledge of Chilean respondents and the percentage of students who have learned at least one quality management methodology and tool at the university, it can be concluded that Universidad Adolfo Ibáñez has been improving its effectiveness in delivering quality management concepts to its students, positively impacting their level of knowledge about this subject.

8. Knowledge gap analysis and recommendations

The main objective of this research is to identify critical contents related to quality management in order to indicate where is the knowledge gap between what Italian and Chilean companies do in terms of quality management, and what the students of both countries really know, and thus be able to make proposals for improvement to the engineering courses of both universities involved.

From the results, the analysis that can be performed to identify the gaps consists of comparing what methodologies or tools the companies use and what methodologies or tools the students know. Therefore, the results to be compared are those represented in questions P3.1.1 and P5.1 of the Companies Survey, and questions P2 and P3 of the Students Survey. The results of question P3.1.1 should be compared with those of P2, while the results of question P5.1 should be compared with those of P3. It is important to mention that the comparisons are made by country to determine which techniques each university should focus on in order to reduce knowledge gaps. Figures 135 and 136 present the comparisons of the Italian results, while Figures 137 and 138 present the comparisons of the Chilean results.

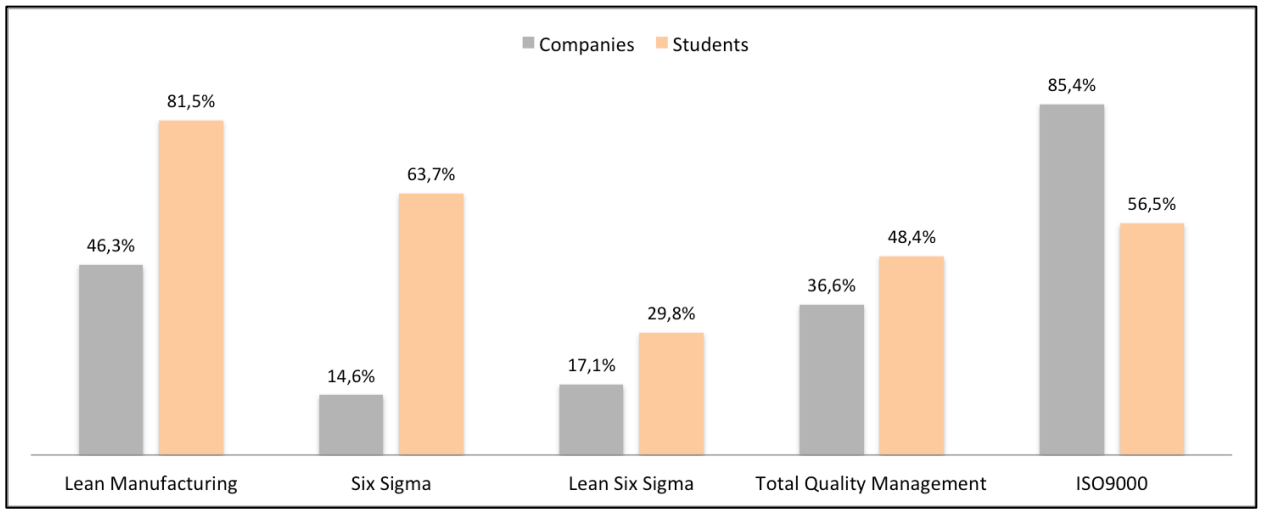

Figure 135. *Comparison between the percentage of Italian companies using each quality management methodology and the percentage of Italian students familiar with each methodology*

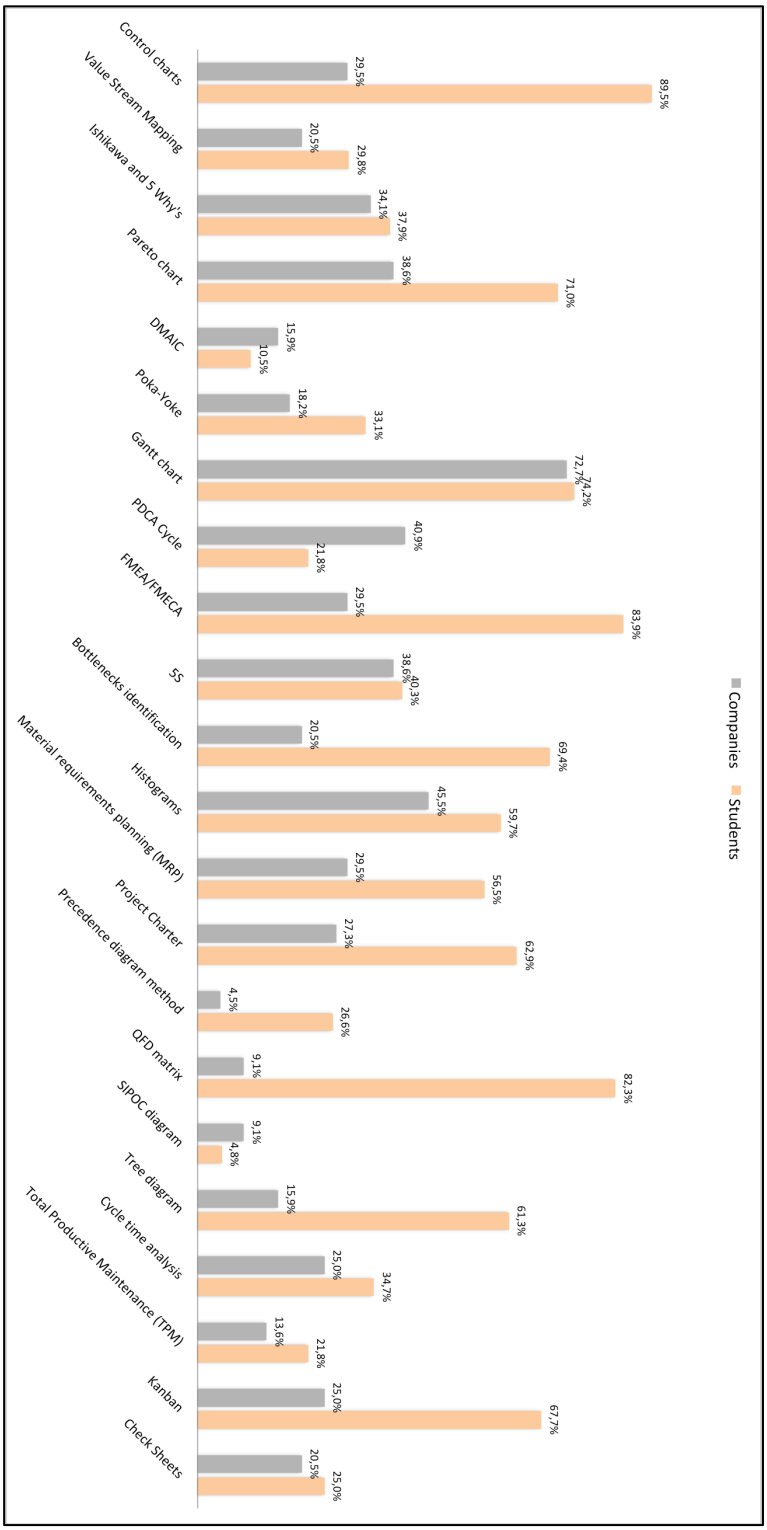

Figure 136. *Comparison between the percentage of Italian companies using each tool implemented by the quality management methodologies and the percentage of Italian students who know each tool*

As for the comparison of the Italian results, it can be seen that the level of knowledge of Italian students is at satisfactory levels, since in 4 of the 5 methodologies presented, the percentage of students who know a given methodology is higher than the percentage of companies that use it. Moreover, of these 4 methodologies mentioned, Lean Manufacturing and Six Sigma present significantly favorable differences for students. ISO 9000 is the only methodology that is favorable for the Companies category, since only 56.5% of Italian students claim to know it, while 85.4% of Italian companies that develop continuous improvement projects declare that they carry them out with ISO 9000.

Similarly, the comparison with respect to the instruments follows the same trend, as the Students category has the highest percentage in 19 of the 22 instruments that appear in the survey, and there are even 9 of those 19 that are decidedly more favorable for this category (e.g., Control Charts, FMEA, Bottleneck Identification, QFD Matrix, among others). The only 3 instruments that are not in favor of this group are: DMAIC Cycle, PDCA Cycle and SIPOC Diagram.

In relation to the above comparisons, it can be concluded that the effectiveness of Politecnico di Torino in imparting and teaching quality management knowledge to its students is at the desired levels. Although educational entities can always improve the way and the contents they teach their students, the critical contents found in this research in the case of Politecnico di Torino are few in quantity and simple to teach.

Consequently, the recommendations for Politecnico di Torino in this first instance are based on filling those small knowledge gaps about ISO 9000. Quality management courses could include general aspects about this quality certification, such as what are the objectives and results of this certification, what is and what does a Quality Management System, examples of Work Instruction templates, among others. More detailed information may not be necessary due to variations in conditions from one company to another. As for the instruments recognized as critical, 2 of them are the data-driven improvement cycles (DMAIC and PDCA), while SIPOC is a tool that summarizes process inputs and outputs. Although all these tools are easy to explain, PDCA Cycle should be the most important to be included in quality management courses, as it is one of the main methods used for control and continuous improvement when companies adopt

ISO 9000 certification, while the DMAIC Cycle and the SIPOC Diagram are used more in projects implementing Lean Manufacturing, Six Sigma, Lean Six Sigma or Total Quality Management methodologies.

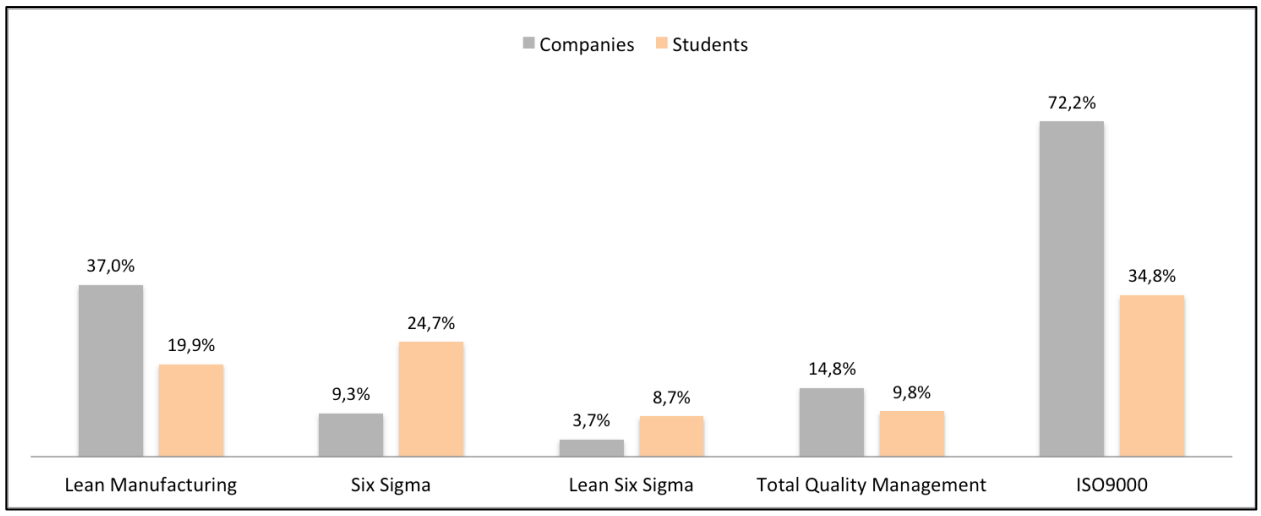

Figure 137. *Comparison between the percentage of Chilean companies using each quality management methodology and the percentage of Chilean students familiar with each methodology*

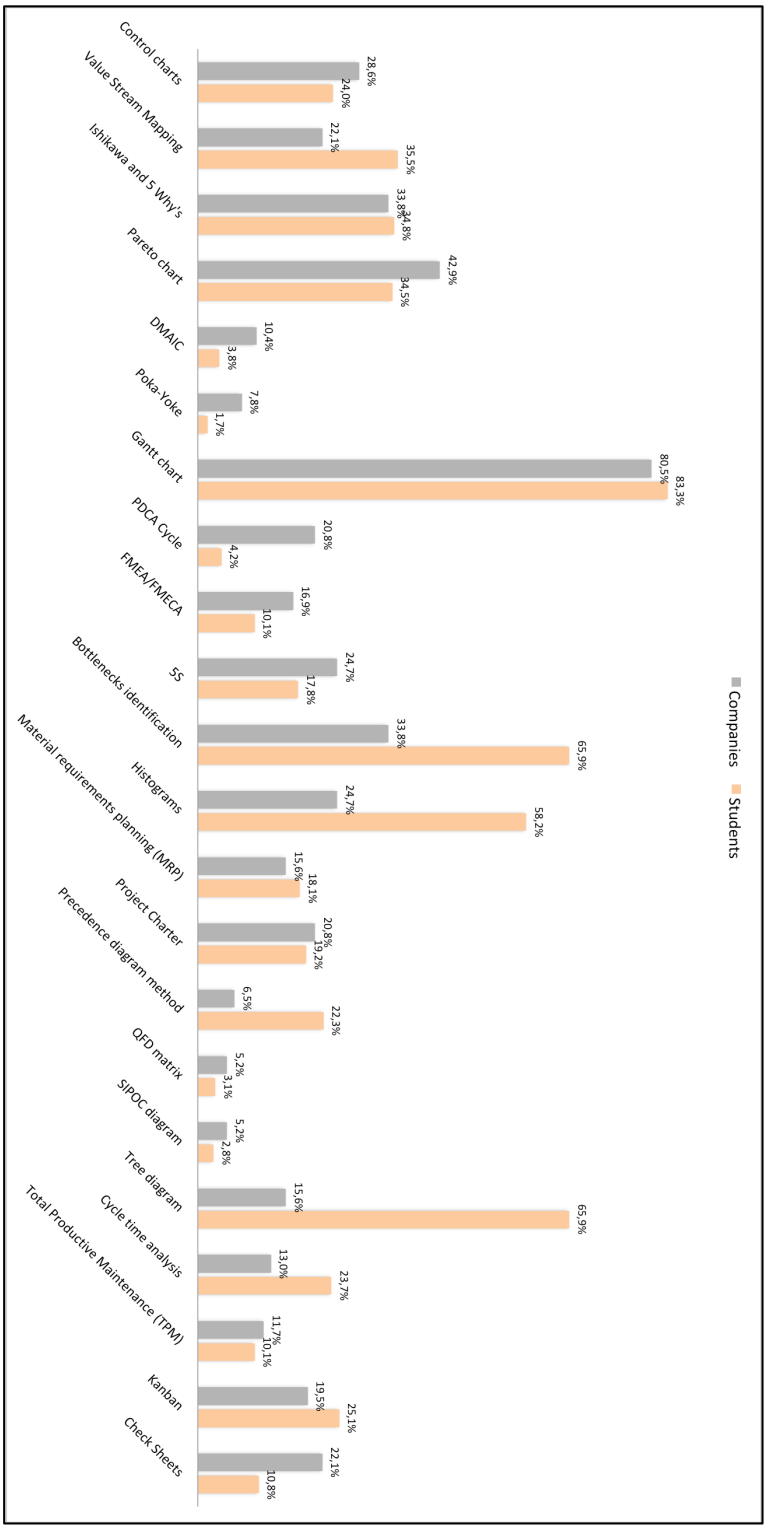

Figure 138. *Comparison between the percentage of Chilean companies using each tool implemented by the quality management methodologies and the percentage of Chilean students who know each tool*

Unlike what was seen in the comparison of the Italian results, the knowledge of Chilean students is still not at the desired levels, since in 3 of the 5 methodologies shown in Figure 137, the percentage of students who know a given methodology is lower than the percentage of companies that use it. These methodologies are Lean Manufacturing, Total Quality Management and ISO 9000. Additionally, there are no significant differences in the other 2 methodologies, which are favorable to the Students category.

In relation to the comparison of the tools seen in Figure 138, a similar trend can be recognized: a total of 10 instruments have percentages in favor of Chilean students, with 3 of them having important differences (Bottleneck Identification, Histograms and Tree Diagram); while, on the other hand, there are 12 tools that are in favor of the Companies category.

It is important to mention that, despite the fact that no clear trend can be easily identified if only the comparison of the tools is taken into account for the analysis, the fact that most of the tools present a similar percentage between both populations, means that the probability of Chilean companies hiring students with quality management skills decreases substantially compared to the Italian case, i.e., Chilean companies are more likely to have to spend resources on the education and training of their employees than Italian companies. Therefore, the effectiveness of Universidad Adolfo Ibáñez in teaching quality management knowledge to its students is not at the same level as the effectiveness of Politecnico di Torino, which means that UAI still has considerable room for improvement in this area.

Considering that educational entities cannot substantially modify their curricula in a short period of time, the recommendations for Universidad Adolfo Ibáñez should be focused on filling the largest knowledge gaps, i.e., concentrating on trying to increase the level of knowledge of students about Lean Manufacturing and ISO 9000, since the knowledge gap about Total Quality Management is only 5%, while the gaps of first 2 methodologies present 17.1% and 37.4% respectively. Following the same logic, the tools that are recommended to be included first in the quality management courses should be those that present the largest gaps between the groups, but those that are related to and used by the 2 methodologies identified above should also be prioritized. Therefore, the recommendation to the UAI is composed of the following instruments

listed in decreasing order according to the differences between categories: PDCA Cycle, Check Sheet, Pareto Chart, 5S, FMEA, DMAIC Cycle and Poka Yoke. The other "critical" tools are not taken into account in the proposal because their differences are less than 5%.

In conclusion, in this first instance, methodologies and instruments recommended for universities are summarized in the following table (Table 13).

Politecnico di Torino		Universidad Adolfo Ibáñez	
Methodologies	ISO 9000	**Methodologies**	Lean Manufacturing
			ISO 9000
Instruments	PDCA Cycle	**Instruments**	PDCA Cycle
			Check Sheets
			Pareto Chart
			5S
			FMEA
			DMAIC Cycle
			Poka-Yoke

Table 13. *Recommendations to both universities about quality management content to be included in engineering courses*

II. Logistic Regression Analysis

As a complement to the first unit, this section aims to provide numerical data to support the arguments and assertions of the previous unit. The analysis of the results of the logistic regressions is organized in the same order in which the results were analyzed in the previous unit of this chapter.

1. Comparative analysis between a developed and a developing country

This unit analyzes the logistic regression results in relation to the country in order to accept or reject the hypothesis H1, which states that companies in developed countries have a greater concern and a higher level of development regarding quality management compared to companies in emerging countries.

In addition to the percentages and results mentioned in the previous subchapter, the results of the logistic regressions support the hypothesis that the level of development of quality management by companies in developed economies is higher than the level of firms in emerging countries, as the variable "Country" proved to be significant in numerous models.

The independent variable "Country" turned out to be significant for some dependent variables such as: Know Lean Manufacturing, Know ISO 9000, Know Poka-Yoke, Know PDCA Cycle, among others. The vast majority of these relationships, which were described in the Results chapter, turned out to be favorable for Italian companies. The following table lists all the dependent variables whose logistic regression models include this predictor variable.

Dependent variables modeled by the independent variable: Italy	Dependent variables modeled by the independent variable: Chile
Know: (Positive relationship) • Lean Manufacturing, ISO 9000, Poka-	**Use:** (Positive relationship) • Bottleneck Identification

Yoke, Tree Diagram, FMEA, Histograms, QFD, PDCA Cycle, SIPOC Diagram, Cycle Time Analysis, Kanban Use: (Positive relationship) • Lean Manufacturing, Total Quality Management	

Table 14. *Lists of logistic regression models in which the independent variable "Country" is significant – Considering Italian and Chilean responses – Hypothesis H1*

By way of explanation, the table summarizes all the dependent variables whose logistic regression models determined that the independent variable "Country" was significant. The dependent variables that appear on the Italy side occupy that box because the odds of those variables when the country is Italy are significantly higher than the odds when the country is Chile, which means that, keeping the same values of the other explanatory variables, the probability of a certain event occurring is higher in the case that the country is Italy instead of Chile, as explained in the Results chapter.

In simpler words, the actions described by the dependent variables appearing on each side are more likely to occur in those countries than in the other. As an example, the results indicate that an Italian company is more likely to use Lean Manufacturing as a methodology to develop continuous improvement projects than a Chilean company (keeping the same conditions in both cases), a result that evidently supports the hypothesis that the level of development of quality management by companies in developed countries is higher than the level of companies in emerging economies.

Furthermore, as mentioned at the beginning of the unit, the following table (Table 15) summarizes the percentages about having a quality management department, developing continuous improvement projects with at least 1 quality management methodology and using at least 1 of the tools applied by the quality management methodologies, results that support the hypothesis.

	Italy	Chile
Having a QM department	68%	53.5%
Developing CI projects	82%	54.5%
Using tools	88%	77.8%

Table 15. *Percentages about the level of development of quality management by companies in both countries - Hypothesis H1*

In conclusion, due to the fact that in 14 of the 15 logistic regression models in which the independent variable "Country" was in favor of the "Italy" category, and that the percentages in Table 15 are all in favor of Italian companies, it can be concluded that the level of development and concern for quality management by the Italian companies surveyed is higher than the level of Chilean companies, confirming the hypothesis that companies from developed countries have a greater concern and a higher level of development of these activities compared to companies in emerging economies.

2. Comparative analysis between types of companies according to their products

This unit analyzes the logistic regression results in relation to the type of company according to its products in order to accept or reject the hypothesis H2, which states that manufacturing companies have a greater level of development of quality management compared to service or hybrid.

Although the percentages and results mentioned in the previous subchapter, considering only the Italian responses for the logistic regression analysis, logistic regression models do not provide enough evidence due to the only 2 relationships in which the independent variable “Type of Product” was significant were related to being aware of Bottleneck Identification and Kanban. However, for these 2 relationships, the logistic regression results, which can be seen in Appendix 4, suggest that respondents working in manufacturing companies are more likely to be aware of Bottleneck Identification and Kanban than respondents working in service or hybrid organizations, supporting the hypothesis that manufacturing companies are more aware of

quality management and provide more attention and resources for the development of its activities. Table 16 and Table 17 show, respectively, the logistic regression results and the percentages mentioned above.

Dependent variables modeled by the independent variable: Manufacturing	Dependent variables modeled by the independent variable: Service	Dependent variables modeled by the independent variable: Hybrid
Know: (Positive relationship) • Bottleneck Identification, Kanban **Have:** (Positive relationship) • Quality Management Department		

Table 16. *Lists of logistic regression models in which the independent variable "Type of Product" is significant – Considering only Italian responses - Hypothesis H2*

	Manufacturing	Service	Hybrid
Having a QM department	95.5%	42.1%	55.6%
Developing CI projects	100%	57.9%	88.9%
Using tools	100%	73.7%	88.9%

Table 17. *Percentages about the level of development of quality management by companies in Italy – Comparison by Type of Product - Hypothesis H2*

Although more favorable relationships were expected for the manufacturing category due to the significant differences outlined in Table 17, the 2 logistic regression models in which the "Type of Product" was significant indicate that an Italian respondent working in a manufacturing company is more likely to know Bottleneck Identification and Kanban than if the respondent works in a service or hybrid organization, while holding all other predictors constant. Therefore, despite the small number of relationships from the Italian results, these logistic regression models support the hypothesis, and considering the percentages in Table 17, it can be stated that Italian manufacturing firms care and do much more for the development of quality management

than service or hybrid companies.

In the case of Chilean results, 3 relationships were identified from the logistic regression models, which can be found in Appendix 4. These associations and the percentages related to the development of quality management techniques can be seen in the following tables.

Dependent variables modeled by the independent variable: Manufacturing	Dependent variables modeled by the independent variable: Service	Dependent variables modeled by the independent variable: Hybrid
Know: (Positive relationship) • Ishikawa **Use:** (Positive relationship) • At least 1 methodology, Ishikawa		

Table 18. *Lists of logistic regression models in which the independent variable "Type of Product" is significant – Considering only Chilean responses - Hypothesis H2*

	Manufacturing	Service	Hybrid
Having a QM department	66.7%	49.2%	53.3%
Developing CI projects	71.4%	52.4%	40%
Using tools	85.7%	74.6%	80%

Table 19. *Percentages about the level of development of quality management by companies in Chile – Comparison by Type of Product - Hypothesis H2*

As can be seen in both Table 18 and Table 19, quality management methodologies and techniques are more developed by Chilean manufacturing companies than Chilean service or hybrid firms, since the only 3 relationships discovered from logistic regression results are in favor of Manufacturing category, while all percentages about the development of quality management are favorable to this category as well. In conclusion, and similar to the Italian case, it can be stated that quality management techniques are more developed by Chilean

manufacturing companies than by Chilean service or hybrid organizations.

Finally, taking into account the responses of both countries to the logistic regression analysis, in 4 models the independent variable "Type of Product" was found to be significant, all of them being favorable to the Manufacturing category. As can be seen, for example, a manufacturing company is more likely to use the 5s tool than a service or hybrid company, while holding all other predictors constant. Furthermore, also taking into account all the responses obtained from respondents, the percentages shown in Table 21 dealing with quality management development are all favorable to manufacturing organizations.

Dependent variables modeled by the independent variable: Manufacturing	Dependent variables modeled by the independent variable: Service	Dependent variables modeled by the independent variable: Hybrid
Know: (Positive relationship) • Lean Manufacturing, DMAIC, Kanban Use: (Positive relationship) • 5s		

Table 20. *Lists of logistic regression models in which the independent variable "Type of Product" is significant – Considering Italian and Chilean responses - Hypothesis H2*

	Manufacturing	Service	Hybrid
Having a QM department	81.4%	47.6%	54.2%
Developing CI projects	86%	53.7%	58.3%
Using tools	93%	74.4%	83.3%

Table 21. *Percentages about the level of development of quality management by companies in both countries – Comparison by Type of Product - Hypothesis H2*

In conclusion, regardless of whether the responses from a single country or from the 2 countries are considered for the statistical and logistic regression analyses, the results of these analyses always place manufacturing companies above service or hybrid companies in terms of quality

management, therefore, it can be stated that the data obtained and the trend of the results allow confirming the hypothesis that manufacturing companies have a greater concern and a higher level of development about quality management compared to service or hybrid organizations.

3. Comparative analysis between companies according to their size in terms of number of employees

This unit analyzes the logistic regression results in relation to the size of the companies in order to accept or reject the hypothesis H3, which states that the level of development of quality management by companies is directly proportional to the size of the company.

The first table below shows the results of the logistic regression models in which the variable "Enterprise Size" was found to be significant, while the second table shows the percentages related to the level of development of quality management by Italian companies. It should be noted that the results in these two tables correspond to the results that take into account only the responses of Italian companies.

Dependent variables modeled by the independent variable: Large	Dependent variables modeled by the independent variable: Medium-Sized	Dependent variables modeled by the independent variable: Small	Dependent variables modeled by the independent variable: Micro
		Know: (Negative relationship) • Control Charts, Ishikawa	**Know:** (Positive relationship) • FMEA **Know:** (Negative relationship) • Control Charts, Ishikawa, PDCA Cycle **Use:** (Negative relationship)

			• Histograms

Table 22. Lists of logistic regression models in which the independent variable "Enterprise Size" is significant – Considering only Italian responses - *Hypothesis H3*

	Large	Medium-Sized	Small	Micro
Having a QM department	89.5%	90%	40%	36.4%
Developing CI projects	89.5%	100%	70%	63.3%
Using tools	89.5%	100%	80%	81.8%

Table 23. *Percentages about the level of development of quality management by companies in Italy – Comparison by Enterprise Size - Hypothesis H3*

As can be seen in the first table, 2 dependent variables related to the knowledge of certain tools proved to have significant relationships when the independent variable "Enterprise Size" takes the value of "Small", however, these relationships are negative relationships ("Estimate" negative and "Coefficient" < 1), which means that for those 2 dependent variables, the probability that an Italian respondent knows those tools will be lower in case the independent variable mentioned above takes the value of "Small", while keeping the other explanatory variables constant. In other words, there will be a higher probability that an Italian respondent will know these tools if he/she does not work in a company classified as "Small", while holding all other predictors constant. Additionally, logistic regression models showed that 5 dependent variables are affected when the company is a micro organization, of which 4 are negatively affected and only 1 is positively affected.

Regarding the percentages in the second table, marked differences can be observed between companies classified as Large or Medium-Sized and those classified as Small or Micro. These percentages suggest that the level of development of quality management by companies classified as Large or Medium-Sized is higher than the level of companies classified as Small or Micro. Therefore, considering both logistic regression results and the percentages about quality management development, it can be concluded that the level of development of quality management by Italian companies classified as Large or Medium-Sized is higher than the level of companies classified as Small or Micro, thus, in the Italian case, confirming the hypothesis that the larger the size of the company, the higher the level of development in terms of quality

management is confirmed.

Chilean logistic regression results divided by the size of the companies are presented in Table 24, while the Chilean results about the level of development of quality management are summarized in Table 25.

Dependent variables modeled by the independent variable: Large	Dependent variables modeled by the independent variable: Medium-Sized	Dependent variables modeled by the independent variable: Small	Dependent variables modeled by the independent variable: Micro
	Know: (Negative relationship) • Six Sigma, Lean Six Sigma, Histograms, Total Productive Maintenance **Use:** (Positive relationship) • Kanban	**Know:** (Negative relationship) • Lean Manufacturing, Six Sigma, Histograms, Total Productive Maintenance	**Know:** (Negative relationship) • Lean Manufacturing, Six Sigma, Histograms

Table 24. *Lists of logistic regression models in which the independent variable "Enterprise Size" is significant – Considering only Chilean responses - Hypothesis H3*

	Large	Medium-Sized	Small	Micro
Having a QM department	86.5%	40.7%	45.5%	0%
Developing CI projects	81.1%	59.3%	31.8%	7.7%
Using tools	91.9%	81.5%	72.7%	38.5%

Table 25. *Percentages about the level of development of quality management by companies in Chile – Comparison by Enterprise Size - Hypothesis H3*

Results of the logistic regressions when considering only Chilean companies show negative relationships between some dependent variables and the predictor "Enterprise Size" when its value is "Small" or "Micro", 4 and 3 negative relationships respectively to be more precise. Other relationships are related to this independent variable when it takes the value of "Medium-Sized". Although there is one positive relationship, there are also 4 other negative relationships, so in most of the relationships when this independent variable takes the value of "Medium size", the probabilities of a certain event happening decrease. As a result, considering that the probabilities of certain events decrease when the value of "Enterprise Size" takes the values of Micro, Small or Medium-Sized, it can be inferred that the category that presents the highest level of development in terms of quality management is the Large category, since it is the only one that does not present significant negative relationships.

Regarding the percentages in Table 25, clear differences can be observed when comparing the Large category with the group of Medium, Small and Micro categories, confirming the previous analysis in which it was stated that the Large category has a higher level of development in terms of quality management than the other 3 categories.

In conclusion, in contrast to the Italian results, which suggest that quality management is developed mainly by large and medium-sized companies, in the Chilean case the results indicate that these activities are developed at the same level only by large companies. However, the results indicate that for the Chilean case the hypothesis that the level of development of quality management is directly proportional to the size of the companies is also fulfilled.

In addition to the 2 previous analyses, the responses from both countries were taken into account for a third analysis. The results of the logistic regression models and the percentages about the level of development of quality management are presented below.

Dependent variables modeled by the independent variable: Large	Dependent variables modeled by the independent variable: Medium-Sized	Dependent variables modeled by the independent variable: Small	Dependent variables modeled by the independent variable: Micro

	Know: (Negative relationship) • Six Sigma, Tree Diagram **Use:** (Negative relationship) • Histograms **Have:** (Negative relationship) • Quality Management Department	**Know:** (Negative relationship) • Lean Manufacturing, Six Sigma, Lean Six Sigma, Control Charts, Ishikawa, Tree Diagram, Histograms, QFD Matrix, PDCA Cycle, SIPOC Diagram, Cycle Time Analysis, Value Stream Mapping **Use:** (Negative relationship) Value Stream Mapping, Histograms **Have:** (Negative relationship) • Quality Management Department	**Know:** (Negative relationship) • Lean Manufacturing, Six Sigma, Lean Six Sigma, Ishikawa, Tree Diagram, Histograms, QFD Matrix, PDCA Cycle, Cycle Time Analysis **Use:** (Negative relationship) • Value Stream Mapping **Have:** (Negative relationship) • Quality Management Department

Table 26. *Lists of logistic regression models in which the independent variable "Enterprise Size" is significant – Considering Italian and Chilean responses - Hypothesis H3*

	Large	Medium-Sized	Small	Micro
Having a QM department	87.5%	54%	43.8%	16.6%

Developing CI projects	84%	70%	43.8%	33%
Using tools	91%	86.4%	75%	58.3%

Table 27. *Percentages about the level of development of quality management by companies in both countries – Comparison by Enterprise Size - Hypothesis H3*

As can be seen, all the relationships in Table 26 are negative relationships, and there is the particularity that most of these relationships are concentrated in the Small and Micro columns, while the Medium column has only 3 of these relationships, which means that this category is in an intermediate state between the Large category and the Small and Micro categories in terms of the development of quality management. On the other hand, the percentages presented in Table 27 follow a clear trend that the larger the companies are in terms of number of employees, the higher the level of development of quality management by the category to which they belong, data that evidently support the hypothesis put forward in this unit.

In conclusion, regardless of whether responses from a single country or from both countries are considered for the statistical and logistic regression analyses, the results of these analyses always follow the trend that the larger the company in terms of number of employees, the greater the knowledge and level of development in terms of QM, thus accepting the hypothesis that the level of development of quality management is directly proportional to the size of the companies.

4. Comparative analysis between companies according to their geographic scope

This unit analyzes the logistic regression results in relation to the geographic scope of companies in order to accept or reject the hypothesis H4, which states that the level of development of quality management by companies is directly proportional to the geographic scope.

The tables below present the results of the logistic regressions and the percentages considering only the responses from the Italian companies. The first table shows the results of the logistic regression models in which the variable "Geographic Scope" was found to be significant, while the second table shows the percentages related to the level of development of quality

management by Italian companies. It should be noted that the results in these two tables correspond to the results that take into account only the responses of Italian companies.

Dependent variables modeled by the independent variable: Multinational	Dependent variables modeled by the independent variable: National	Dependent variables modeled by the independent variable: Regional	Dependent variables modeled by the independent variable: Local

Table 28. *Lists of logistic regression models in which the independent variable "Geographic Scope" is significant – Considering only Italian responses - Hypothesis H4*

	Multinational	National	Regional	Local
Having a QM department	92.6%	37.5%	33.3%	50%
Developing CI projects	92.6%	68.8%	33.3%	100%
Using tools	92.6%	75%	100%	100%

Table 29. *Percentages about the level of development of quality management by companies in Italy – Comparison by Geographic Scope - Hypothesis H4*

As can be seen, the logistic regression models did not provide significant relationships between the dependent variables and the predictor "Geographic Scope". In addition, no trend is observed in the percentages in Table 29. Consequently, no data are available to support the hypothesis, therefore, the hypothesis is rejected considering only the Italian responses.

Continuing with the analysis of the logistic regression models and the percentages related to the level of development of quality management, the following tables provide the results when considering only the responses of Chilean companies.

Dependent variables modeled by the independent variable: Multinational	Dependent variables modeled by the independent variable: National	Dependent variables modeled by the independent variable: Regional	Dependent variables modeled by the independent variable: Local

Know: (Positive relationship) • Pareto			

Table 30. *Lists of logistic regression models in which the independent variable "Geographic Scope" is significant – Considering only Chilean responses - Hypothesis H4*

	Multinational	National	Regional	Local
Having a QM department	69.7%	48.7%	60%	29.4%
Developing CI projects	72.7%	51.3%	50%	29.4%
Using tools	81.8%	79.5%	80%	64.7%

Table 31. *Percentages about the level of development of quality management by companies in Chile – Comparison by Geographic Scope - Hypothesis H4*

From the logistic regression models, only the dependent variable "Know Pareto" has a positive relationship with the predictor “Geographic Scope” when its value is "Multinational". Despite this relationship, only one relationship is not enough to be able to draw conclusions about the behavior and level of development of the companies in terms of quality management, and combined with the fact that no clear trend can be seen in the percentages shown in Table 31, the hypothesis that the level of development of quality management is directly proportional to the geographic scope of the companies cannot be accepted, therefore, the hypothesis must be rejected.

Finally, considering for the analysis all responses regardless of their country, the results of the logistic regression models and the percentages related to the level of development of quality management can be found in Tables 32 and 33 respectively.

Dependent variables modeled by the independent variable: Multinational	Dependent variables modeled by the independent variable: National	Dependent variables modeled by the independent variable: Regional	Dependent variables modeled by the independent variable: Local
Know: (Positive relationship)	**Know:** (Positive relationship)		

• Pareto, FMEA, 5s **Use:** (Positive relationship) • Ishikawa, Pareto, Project Charter **Have:** (Positive relationship) • Quality Management Department	• 5s		

Table 32. *Lists of logistic regression models in which the independent variable "Geographic Scope" is significant – Considering Italian and Chilean responses - Hypothesis H4*

	Multinational	National	Regional	Local
Having a QM department	80%	45.5%	53.8%	33.3%
Developing CI projects	81.6%	56.4%	46.2%	42.9%
Using tools	86.7%	78.2%	84.6%	71.4%

Table 33. *Percentages about the level of development of quality management by companies in both countries – Comparison by Geographic Scope - Hypothesis H4*

From the results, the Multinational category presents good percentages about the level of development of quality management and some favorable relationships, proving to be an explanatory variable of 6 dependent variables. However, analyzing the results of the other 3 categories, there is no trend or data indicating that the larger the geographical scope of a company, the higher the level of development in terms of quality management by the category to which it belongs, therefore the hypothesis is also rejected in this case.

Finally, considering that in all 3 scenarios the hypothesis was rejected, it can be concluded that the level of development of quality management by companies is not directly proportional to their geographic scope. In other words, the results reject the hypothesis that the larger the geographical scope of a company, the higher its level of development in terms of quality

management.

5. Critical success factors

Critical success factors were also analyzed through logistic regression models in order to distinguish the conditions under which these factors are most likely to be rated as critical by respondents. These logistic regression models can be found in Appendix 4.

Considering only the Italian responses, 4 critical success factors (dependent variables) turned out to be explained by some independent variables. Analyzing these factors in decreasing order in relation to the percentages obtained for each of them in the previous analysis subchapter, it can be observed that "Cultural Change", "Linking Quality Management Projects to the" and "Top Management Commitment" turned out to have in common the same explanatory variable: "Know TQM", which means that respondents who claim to know the Total Quality Management methodology are more likely to select the mentioned success factors as critical than those who do not know the methodology. While the fourth critical success factor, "Data Collection", has an inverse relationship with the variable "Enterprise Size" when this variable takes the values of "Small" or "Micro", meaning that companies classified in these 2 categories are less likely to describe this factor as critical compared to companies classified as "Large" or "Medium-Sized".

The same analysis, but considering only responses from Chilean companies, logistic regression models describing the factors "Top Management Commitment" and "Cultural Change" indicated that the independent variables "Type of Product", "Having a Quality Management Department" and "Know ISO 9000" affect the probability of these factors being classified as critical, while “Enterprise Size”, if classified as "Micro", negatively affects the probability of the respondent indicating "Training and Education" as a critical success factor.

Although the logistic regression models provided explanatory independent variables for some critical success factors, none of these predictors is repeated in both countries, a fact that would have been interesting to analyze, i.e., under which identical conditions respondents are more

likely to answer similar things.

6. Comparative analysis between Italian and Chilean students

In addition to what has already been analyzed in the previous subchapter, the results of the logistic regressions taking into account the responses of students from both countries showed that the variable "Country" was significant in explaining numerous dependent variables related to the level of knowledge of quality management tools and methodologies. These relationships are detailed below.

Dependent variables modeled by the independent variable: Italy	Dependent variables modeled by the independent variable: Chile
Know: (Positive relationship) • Lean Manufacturing, Six Sigma, Lean Six Sigma, TQM, ISO 9000, Control Charts, MRP, Project Charter, Kanban, Check Sheets, Pareto, DMAIC, Poka-Yoke, PDCA Cycle, FMEA, QFD Matrix, Cycle Time Analysis, TPM **Know:** (Negative relationship) • Gantt Chart	

Table 34. *Lists of logistic regression models in which the independent variable "Country" is significant – Considering Italian and Chilean responses – Comparison of students*

Considering the variable "Lean Manufacturing" as an example to explain the results of the logistic regressions, the table indicates that the probability of a student knowing about Lean Manufacturing will be higher if the student is Italian and not Chilean, keeping the values of the other explanatory variables constant. Therefore, from the long list in the column "Italy" it is interpreted that Italian students have a higher level of knowledge than Chilean students about quality management.

Then, analyzing student responses by country with the intention, in this unit, of analyzing the extent to which universities influence students' level of knowledge about quality management, the results in this regard can be seen in the following table.

Dependent variables modeled by the independent variable: University (Italy)	Dependent variables modeled by the independent variable: University (Chile)
Know: (Positive relationship) • Lean Manufacturing	**Know:** (Positive relationship) • Lean Manufacturing, Six Sigma, TQM, ISO 9000 **Know:** (Negative relationship) • Lean Six Sigma

Table 35. *Lists of logistic regression models in which the independent variable "University" is significant – Considering Italian and Chilean responses separately*

As can be seen in Table 35, the university plays a key role in the level of knowledge of Chilean students about, for example, the Lean Manufacturing methodology, since those who claim to know this methodology are more likely to have learned it at university than not to have learned it there, holding the other independent variables constant. The opposite occurs with the Lean Six Sigma methodology, since students are more likely not to have learned it at university than to have learned it at university.

7. Comparative analysis between students according to their academic status

The independent variable "Graduated", related to the fact of having completed university studies or not, was described as an explanatory variable of some dependent variables related to the level of knowledge of students from both countries about quality management. These relationships are presented in the following table.

Dependent variables modeled by the independent variable: Graduated (Italy)	Dependent variables modeled by the independent variable: Graduated (Chile)
Know: (Positive relationship) • Lean Six Sigma, Bottleneck Identification **Know:** (Negative relationship) • FMEA/FMECA	**Know:** (Positive relationship) • ISO 9000

Table 36. *Lists of logistic regression models in which the independent variable "Graduated" is significant – Considering Italian and Chilean responses separately*

From the table, it can be stated that, for example, the probability of an Italian respondent knowing the Lean Six Sigma methodology increases if he/she has already completed his/her university studies, provided that the other explanatory variables of this dependent variable are held constant. However, considering the data in the previous subchapter discussing the differences between Alumni and Senior Students, the relationships of the variable "Graduate" with the dependent variables "Lean Six Sigma" and "Bottleneck Identification" should not be considered significant, since the percentage difference in knowledge between the 2 categories for these 2 variables is almost non-existent. Only the relationships between the independent variable and the variables "FMEA/FMECA" and "ISO 9000" present significant percentage differences in the previous subchapter, therefore only these 2 logistic regression models can be accepted as valid.

8. Knowledge gap analysis and recommendations

Although the objective of this research was to make proposals for improvement to the engineering courses dedicated to quality management in both universities in order to reduce the knowledge gaps between students and industry with respect to certain methodologies and instruments catalogued as "critical", this unit intends to delve a little deeper into how those gaps

could be reduced. Logistic regression models describing those methodologies and instruments that are part of the recommendations made in the previous subchapter will be analyzed one by one in order to interpret how the student may be more likely to learn those techniques.

ISO 9000 and the PDCA cycle were the techniques included in the recommendations for Politecnico di Torino. The logistic regression model describing the level of knowledge of Italian students in relation to ISO 9000 indicates that the only significant variable is having completed or not an internship, i.e., the chances of a student having knowledge related to ISO 9000 increase if the student has previously completed an internship. In other words, doing an internship in a company increases the possibility that an Italian student has knowledge about ISO 9000 certification, therefore, part of the recommendations is also to encourage the practice of doing an internship. In the case of the PDCA Cycle, there are no significant relationships with any independent variable, so there are no actions or behaviors that can be encouraged with the intention of increasing the likelihood that students will improve their level of knowledge regarding this specific tool.

On the other hand, the methodologies and tools of the recommendations for Universidad Adolfo Ibáñez listed in the previous subchapter are the following: Lean Manufacturing, ISO 9000, PDCA Cycle, 5s, Control Sheets, Pareto Diagram, FMEA/FMECA, DMAIC Cycle and Poka-Yoke.

Starting with the methodologies, both Lean Manufacturing and ISO 9000 showed significant relationships with the independent variables "University", "Professional Training", "Work" and "By Myself" as places or activities where students who know the methodology have learned it. Therefore, and by way of example, a Chilean student who has developed a professional training is more likely to have knowledge about the Lean Manufacturing methodology than one who has not developed a professional training, keeping the conditions of the other explanatory variables constant. Additionally, the independent variable "Internship" also turned out to be an explanatory variable of the dependent variable ISO 9000. Finally, since the scope of the university is limited to teaching classes and promoting activities such as internship or professional training, it is recommended that students be encouraged to develop those activities to increase the likelihood

that they can learn about these methodologies. However, the third relationship under the scope of the university related to the variable "University" has a double meaning, since given that all students studied or are studying at the university, the delivery of knowledge should be the same for all, i.e. the university should not be a determining factor in the probability that a student knows or does not know a particular methodology, which implies that Chilean students are not receiving this knowledge in the same way. The cause of this could be due to changes in course contents in recent years, however, it may be necessary to pay attention to this fact in case this is not the cause.

In the case of the tools, the logistic regression models of DMAIC Cycle, Poka-Yoke and Pareto Chart did not yield significant independent variables, which means that no recommendations or comments can be made in this regard. In relation to the PDCA Cycle and the Check Sheets, the independent variable that models them is "Job", an activity that is outside the range of action of the universities, so no measures can be proposed to increase the probability that students have knowledge about these instruments. The “Professional Training” was the only predictor variable of the 5s tool, therefore, similar to the methodologies, it is an activity that should be encouraged to increase the probability of students learning this tool. Finally, the model about the FMEA tool is related to the independent variable "Know Lean", which means that knowing this methodology increases the probability of knowing FMEA, and as the Lean Manufacturing methodology is more likely to be learned by developing a professional training or an internship, the recommendation is the same as the one stated above, to promote and encourage the realization of these activities.

In conclusion, encouraging the development of internships by Italian students, and motivating Chilean students to develop professional trainings and internships are the measures and activities that can be recommended to reduce the knowledge gap of some of the methodologies and tools that are part of the list of techniques in the recommendations of the previous subchapter.

Chapter 7: Conclusions

The results of the surveys made it possible to identify the knowledge gaps between the level of development of Italian and Chilean companies in terms of quality management and the level of knowledge of students in both countries about this subject, and thus fulfill the main objective of this research related to generating proposals for improvement to the quality management courses of both participating universities about methodologies and tools that could be included in these courses with the intention of reducing those knowledge gaps, thus allowing students to improve their levels of knowledge and meet the demands of companies.

The recommendations proposed to the Politecnico di Torino are mainly based on improving the students' level of knowledge about ISO 9000 standards and the PDCA Cycle, techniques that were rated as critical since they presented the greatest differences between the percentage of companies that use them and the percentage of students that know them, differences evidently favorable to the "Companies" category. Additionally, through the analysis of the logistic regression models, it was evidenced that Italian students who did a professional internship increased their probabilities of having knowledge related to ISO 9000 standards, therefore, the recommendations to the Politecnico di Torino, besides suggesting to include somehow the mentioned techniques in the Engineering and Management courses, is also to encourage and motivate their students to do an internship, so that they can increase the probability of learning about ISO 9000 standards, which would result in a higher percentage of students who know this methodology and, therefore, the knowledge gap would be reduced.

In the case of the recommendations proposed to the Universidad Adolfo Ibáñez, these recommendations are composed of the following quality management methodologies and tools: Lean Manufacturing, ISO 9000, PDCA Cycle, 5s, Check Sheets, Pareto Diagram, FMEA/FMECA, DMAIC Cycle and Poka-Yoke. In addition to the comparisons by country presented in this research in relation to the level of development of quality management by companies and the level of knowledge of the students in this subject, in which it can be affirmed that in both comparisons the "Italy" category is superior, the recommendations made to the Universidad Adolfo Ibáñez are composed of a greater number of techniques than those made to

the Politecnico di Torino, a fact that is consistent with the lower level of knowledge of the Chilean students in comparison to the Italian students. Similar to the Italian case, the logistic regression models showed that professional training and internships are good activities to increase the chances that Chilean students can learn about these tools classified as critical and thus reduce the knowledge gaps. Additionally, the models indicated that the university is an influential factor in the level of knowledge of Chilean students, which should not be the case, as it means that students are not receiving knowledge in a similar way. This could be due to recent changes in course content over the last few years.

With regard to the secondary objectives of this research related to the hypotheses, it can be stated that:

Hypothesis H1 is accepted: The hypothesis that companies in developed countries have a greater concern and a higher level of development regarding quality management compared to companies in emerging countries is true, since in this research the data show that Italian companies are proportionally more developed in quality management than Chilean companies. Analyzing the percentage data about the level of implementation of these practices and taking into account the relationships that emerge from the logistic regression models, it can be affirmed that Italian companies are more advanced than Chilean companies in terms of quality management; therefore, the hypothesis is accepted.

Hypothesis H2 is accepted: The hypothesis that manufacturing firms have a greater concern and a higher level of development about quality management compared to service or hybrid companies is true, since in this research the data show that manufacturing organizations are proportionally more developed in quality management than service or hybrid firms. As previously analyzed and discussed, the results of the Companies Survey about the level of implementation of quality management techniques and the relationships of the logistic regression models clearly indicate that manufacturing companies are more advanced than service or hybrid firms in terms of quality management; therefore, the hypothesis is accepted.

Hypothesis H3 is accepted: The hypothesis that the level of development of quality management is directly proportional to the size of the companies is accepted, since in this research the data show that the categories composed of companies with a larger number of employees are proportionally more developed in terms of quality management than companies with a smaller number of employees. Analyzing the percentages about the level of implementation of these practices and taking into account the relationships that emerge from the logistic regression models, it can be concluded that the size of companies directly and proportionally affects the level of development of quality management.

Hypothesis H4 is rejected: The hypothesis that the level of development of quality management is directly proportional to the geographical scope of companies is rejected, since there is no data showing that companies with a greater geographical scope develop quality management proportionally more than companies with a smaller geographical scope. Analyzing the data about the level of implementation of these practices, as well as taking into account the lack of relationships in the logistic regression models, the hypothesis cannot be accepted and, therefore, must be rejected.

In addition to the hypotheses analyzed in this research, another secondary objective of this thesis was to investigate the critical success factors faced by Italian and Chilean companies when developing continuous improvement projects, an argument that has been widely studied in other countries, however, both in Italy and Chile the literature about this subject is scarce. The results of this research positioned the factors "Employees Training and Education", "Cultural Change and Leadership" and "Link Quality Management Projects to the Business Strategy or Customer Needs" as the 3 most important CSFs recognized by Italian companies, while "Top Management Commitment", "Cultural Change and Leadership" and "Employees Training and Education" were the 3 most indicated by Chilean respondents. In consequence, both "Cultural Change and Leadership" and "Employees Training and Education" are critical factors that are repeated in both countries, assimilating the reality of several countries that have indicated the same factors in numerous previous studies.

Other interesting data to mention is the difference in the level of knowledge of quality management methodologies and instruments between Italian and Chilean students, differences in favor of Italian students, a fact that reflects that the differences are not only at the level of companies, but also at the level of education. Both the data about the percentage of students who know a certain methodology or instrument and the results of the logistic regressions place Italian students above Chilean students in terms of their level of knowledge and understanding in this subject. In addition, the results of the Students Survey indicate that the effectiveness of the Politecnico di Torino in transferring knowledge about quality management to its students is greater than the effectiveness of the Universidad Adolfo Ibáñez, since a higher percentage of Italian students stated that they learned at least 1 methodology or tool during their university studies.

Finally, the research concludes by stating that the study achieved the main objective of the thesis: the recommendations to both universities about quality management tools and methodologies were obtained after a comparative analysis between what the companies use and what the students know, an analysis that aimed to identify those techniques that presented the greatest percentage differences, classify them as critical and indicate them as part of the list of recommendations. After the first statistical analysis, a second logistic regression analysis made it possible to analyze the factors that increased or decreased the probability of students knowing or not knowing those techniques classified as critical, i.e., the study not only made it possible to distinguish which tools or methodologies could be included in quality management courses, but also to understand which activities would allow students to learn those techniques that would facilitate closing the knowledge gaps, including them as part of the recommendations.

Chapter 8: Appendix

Appendix 1. *Structure and details of the Companies Survey*

Table 37. Questions and alternatives of the Companies Survey – General Information section

I. GENERAL INFORMATION	
P1 Name of the company	
	a) Text box
P2 Area of the company where you work	
	a) Production
	b) Quality
	c) Sales
	d) Finance
	e) Human Resources
	f) Other
P3 Position in the company	
	a) Text box
P4 Number of years working in the company	
	a) 0 – 1
	b) 1 – 3
	c) 3 – 5
	d) 5 – 10
	e) +10
P5 Type of company according to its products	
	a) Manufacturing company
	b) Service company
	c) Hybrid company (Manufacturing-Service company)
	d) Other [Text box]
P6 Number of employees in the company	
	a) 1 – 9
	b) 10 - 49

	c) 50 - 249
	d) +250
P7 Geographic scope of the company	
	a) Local company
	b) Regional company
	c) National company
	d) Multinational company
P8 Type of company according to its capital	
	a) Public company
	b) Private company
	c) Public-Private company

Table 37. *Questions and alternatives of the Companies Survey – General Information section*

Tables 38 & 39. Questions and alternatives of the Companies Survey – Quality Management Information section

II. QUALITY MANAGEMENT INFORMATION		
P1 Does the company have a Quality Management department?		
	a) Yes	
	b) No	
	P1.1 What does the Quality Management department mainly focus on?	
		a) Improvement in the quality of products/services
		b) Reduction of defect rate and process variability
		c) Cost and waste reduction
		d) Cycle time reduction or delivery time acceleration
		e) Increase customer or employees satisfaction
		f) Other [Text box]
	P1.2 What are the main reasons why the company does NOT have a Quality Management department? (Likert scale: 1 = Slightly influential; 5 = Very influential)	
		a) Lack of interest from the top management
		b) Lack of resources (technical, human, financial, time, economic, others)

	c) Resistance to cultural change and lack of leadership		
	d) Its functions are already being developed by other departments		
	e) Other		
		P1.2.1 What other reason?	
			a) Text box
P2 Do you know, in general terms, any of the following Quality Management methodologies?			
	a) Lean Manufacturing		
	b) Six Sigma		
	c) Lean Six Sigma		
	d) Total Quality Management		
	e) ISO 9000		
	f) None of the above		
	g) Other [Text box]		

Table 38. *Questions and alternatives of the Companies Survey – Quality Management Information section*

P3 Does the company develop projects with any of the methodologies mentioned previously?			
	a) Yes		
	b) No		
		P3.1.1 With which ones?	
		a) Lean Manufacturing	
		b) Six Sigma	
		c) Lean Six Sigma	
		d) Total Quality Management	
		e) ISO 9000	
		f) Other	
			P3.1.1.1 How many employees in the company are certified as Green Belts?
			a) 0
			b) 1 – 5
			c) 6 – 10
			d) 11 – 50
			e) +50

		P3.1.1.2 How many employees in the company are certified as Black Belts?	
			a) 0
			b) 1 – 5
			c) 6 – 10
			d) 11 – 50
			e) +50
		P3.1.1.3 How many employees in the company are certified as Master Black Belts?	
			a) 0
			b) 1 – 5
			c) 6 – 10
			d) 11 – 50
			e) +50
	P3.1.2 How long has the company been implementing the methodology?		
		a) Less than 1 year	
		b) Between 1 – 3 years	
		c) Between 3 – 5 years	
		d) More than 5 years	
	P3.1.3 How do you evaluate the results obtained with the methodology so far?		
		a) Very bad results	
		b) Bad results	
		c) Regular results	
		d) Good results	
		e) Very good results	
	P3.1.4 What are the main benefits that the company has obtained with the implementation of the methodology?		
		a) Improvement in the quality of products/services	
		b) Reduction of defect rate or process variability	
		c) Cost and waste reduction	
		d) Cycle time reduction or delivery time acceleration	
		e) Increase customer or employees satisfaction	
		f) No benefits	
		g) Other [Text box]	

	P3.1.5 What were the main critical success factors in obtaining those benefits? (Likert scale: 1 = Slightly influential; 5 = Very influential)			
		a) Employees training and education		
		b) Great involvement from the top management		
		c) Resources invested (technical, human, financial, time, economic, others)		
		d) Flexibility to the cultural change and good leadership		
		e) Good selection and prioritization of projects		
		f) Good data collection and analysis		
		g) Being able to link the quality management projects to the business strategy and the customer needs		
		h) Other		
			P3.1.5.1 What other factor?	
				a) Text box
	P3.1.6 Will the company continue developing Quality Management projects based on these methodologies?			
		a) Yes		
		b) No, why?		
	P3.2.1 What are the reasons why the company does NOT develop continuous improvement projects with Quality Management methodologies? (Likert scale: 1 = Slightly influential; 5 = Very influential)			
		a) Lack of employees training		
		b) Lack of interest from the top management		
		c) Lack of resources (technical, human, financial, time, economic, others)		
		d) Resistance to cultural change and lack of leadership		
		e) Poor selection and prioritization of projects		
		f) Poor data collection and analysis		
		g) NOT being able to link the Quality Management projects to the business strategy or the customer needs		
		h) Other		
			P3.2.1.1 What other reason?	
				a) Text box
P4 Do you know, in general terms, any of the following instruments used by				

the Quality Management methodologies?	
	a) Control charts
	b) Value Stream Mapping (VSM)
	c) Ishikawa and 5 Why
	d) Pareto chart
	e) DMAIC Cycle
	f) Poka-Yoke
	g) Gantt chart
	h) PDCA cycle
	i) Failure Mode and Effect Analysis (FMEA/FMECA)
	j) 5S Method
	k) Bottlenecks Identification
	l) Histograms
	m) Material Requirements Planning (MRP)
	n) Project Charter
	o) Precedence Diagram Method
	p) Quality Function Deployment (QFD matrix)
	q) SIPOC diagram
	r) Tree Diagram
	s) Cycle time analysis
	t) Total Productive Maintenance (TPM)
	u) Kanban
	v) Check Sheets
	w) None of the above
	x) Other [Text box]
P5 Does the company use any of the instruments mentioned previously?	
	a) Yes
	b) No
	P5.1 Which ones?
	a) Control charts
	b) Value Stream Mapping (VSM)
	c) Ishikawa and 5 Why
	d) Pareto chart
	e) DMAIC Cycle
	f) Poka-Yoke

			g) Gantt chart
			h) PDCA cycle
			i) Failure Mode and Effect Analysis (FMEA/FMECA)
			j) 5S Method
			k) Bottlenecks Identification
			l) Histograms
			m) Material Requirements Planning (MRP)
			n) Project Charter
			o) Precedence Diagram Method
			p) Quality Function Deployment (QFD matrix)
			q) SIPOC diagram
			r) Tree Diagram
			s) Cycle time analysis
			t) Total Productive Maintenance (TPM)
			u) Kanban
			v) Check Sheets
			w) None of the above
			x) Other [Text box]
	P5.2 Why the company does NOT use Quality Management instruments? (Likert scale: 1 = Slightly influential; 5 = Very influential)		
			a) Lack of employees training and education
			b) Lack of interest from the top management
			c) Lack of resources (technical, human, financial, time, economic, others)
			d) Resistance to cultural change and lack of leadership
			e) Poor selection and prioritization of projects
			f) Poor data collection and analysis
			g) NOT being able to link the Quality Management projects to the business strategy or the customer needs
			h) Other
		P5.2.1 What other reason?	
			a) Text box
P6 Where does the company have more opportunities to improve its performance in terms of Quality Management?			
	a) Improvement in the quality of products/services		

	b) Reduction of defect rate or process variability		
	c) Cost and waste reduction		
	d) Cycle time reduction or delivery time acceleration		
	e) Increase customer or employees satisfaction		
	f) Unknown		
	g) Other		
	P7.1 Which of the following Quality Management methodologies would you recommend to be taught in undergraduate courses for future generations?		
		a) Lean Manufacturing	
		b) Six Sigma	
		c) Lean Six Sigma	
		d) Total Quality Management	
		e) ISO 9000	
		f) Other	
	P8.1 Which of the following Quality Management instruments would you recommend to be taught in undergraduate courses for future generations?		
		a) Control charts	
		b) Value Stream Mapping (VSM)	
		c) Ishikawa and 5 Why	
		d) Pareto chart	
		e) DMAIC Cycle	
		f) Poka-Yoke	
		g) Gantt chart	
		h) PDCA cycle	
		i) Failure Mode and Effect Analysis (FMEA/FMECA)	
		j) 5S Method	
		k) Bottlenecks Identification	
		l) Histograms	
		m) Material Requirements Planning (MRP)	
		n) Project Charter	
		o) Precedence Diagram Method	
		p) Quality Function Deployment (QFD matrix)	
		q) SIPOC diagram	

	r) Tree Diagram
	s) Cycle time analysis
	t) Total Productive Maintenance (TPM)
	u) Kanban
	v) Check Sheets
	w) None of the above
	x) Other [Text box]

Table 39. *Questions and alternatives of the Companies Survey – Quality Management Information section*

Appendix 2. *Structure and details of the Students Survey*

Table 40. Questions and alternatives of the Students Survey – General Information section

I. GENERAL INFORMATION		
P1 Are you graduated?		
	a) Yes	
	b) No	
	P1.1.1 Select your graduation year	
		a) 2018
		b) 2019
		c) 2020
		d) 2021
		e) 2022
		f) 2023
	P1.1.2 Are you currently working or have you ever worked as an engineer?	
		a) Yes
		b) No
	P1.2.1 Select your estimated graduation year	
		a) 2020
		b) 2021
		c) 2022

	d) 2023
	e) 2024
	f) 2025

Table 40. *Questions and alternatives of the Students Survey – General Information section*

Table 41. Questions and alternatives of the Students Survey – Quality Management Information section

II. QUALITY MANAGEMENT INFORMATION		
P2 Do you know, in general terms, about any Quality Management methodology? (Can select more than one alternative)		
	a) Lean Manufacturing	
	b) Six Sigma	
	c) Lean Six Sigma	
	d) Total Quality Management	
	e) ISO 9000	
	f) None of the above	
	g) Other [Text box]	
	P2.1.1 Where did you learn about those methodologies?	
		a) University
		b) Internship
		c) Professional Training
		d) Current Job / Last Job
		e) By Myself
		f) Other [Text box]
	P2.1.2 Where did you learn about those methodologies?	
		a) University
		b) Internship
		c) Professional Training

	d) By Myself	
	e) Other [Text box]	
	P2.2.1 Name of the company where you Currently Work of where you have worked as an engineer	
	a) Text box	
	P2.2.2 Name of the company where you did the Professional Training	
	a) Text box	
	P2.2.3 Name of the company where you did the Internship	
	a) Text box	
	P2.3.1 In which area of the company did you learn about the methodologies in your Current Job / Last Job?	
	a) Quality	
	b) Production	
	c) Logistics	
	d) Finance	
	e) Sales	
	f) Human Resources	
	g) Other [Text box]	
	P2.3.2 In which area of the company did you learn about the methodologies in your Professional Training?	
	a) Quality	
	b) Production	
	c) Logistics	
	d) Finance	
	e) Sales	
	f) Human Resources	
	g) Other [Text box]	
	P2.3.3 In which area of the company did you learn about the methodologies in your Internship?	
	a) Quality	
	b) Production	
	c) Logistics	
	d) Finance	
	e) Sales	

		f) Human Resources
		g) Other [Text box]
	P2.4.1 How much did you learn about the Methodologies in your Current Job / Last Job? (1 = Very Little, General Concepts; 5 = A Lot, Specific Concepts)	
		a) 1
		b) 2
		c) 3
		d) 4
		e) 5
	P2.4.2 How much did you learn about the Methodologies in your Professional Training? (1 = Very Little, General Concepts; 5 = A Lot, Specific Concepts)	
		a) 1
		b) 2
		c) 3
		d) 4
		e) 5
	P2.4.3 How much did you learn about the Methodologies in your Internship? (1 = Very Little, General Concepts; 5 = A Lot, Specific Concepts)	
		a) 1
		b) 2
		c) 3
		d) 4
		e) 5
	P2.5 Do you think it is important that future professionals have knowledge about these methodologies?	
		a) Yes
		b) No
	P2.5.1 Which of the following Quality Management methodologies would you recommend to be taught in undergraduate courses for future generations?	
		a) Lean Manufacturing
		b) Six Sigma

	c) Lean Six Sigma
	d) Total Quality Management
	e) ISO 9000
	f) Other [Text box]

P3 Do you know, in general terms, about any Quality Management instrument? (Can select more than one alternative)

	a) Control charts
	b) Value Stream Mapping (VSM)
	c) Ishikawa and 5 Why
	d) Pareto chart
	e) DMAIC Cycle
	f) Poka-Yoke
	g) Gantt chart
	h) PDCA cycle
	i) Failure Mode and Effect Analysis (FMEA/FMECA)
	j) 5S Method
	k) Bottlenecks Identification
	l) Histograms
	m) Material Requirements Planning (MRP)
	n) Project Charter
	o) Precedence Diagram Method
	p) Quality Function Deployment (QFD matrix)
	q) SIPOC diagram
	r) Tree Diagram
	s) Cycle time analysis
	t) Total Productive Maintenance (TPM)
	u) Kanban
	v) Check Sheets
	w) None of the above
	x) Other [Text box]

	P3.1.1 Where did you learn about those instruments?

	a) University
	b) Internship
	c) Professional Training
	d) Current Job / Last Job

	e) By Myself
	f) Other [Text box]
	P3.1.2 Where did you learn about those instruments?
	a) University
	b) Internship
	c) Professional Training
	d) By Myself
	e) Other [Text box]
	P3.2.1 Name of the company where you Currently Work of where you have worked as an engineer
	a) Text box
	P3.2.2 Name of the company where you did the Professional Training
	a) Text box
	P3.2.3 Name of the company where you did the Internship
	a) Text box
	P3.3.1 In which area of the company did you learn about the instruments in your Current Job / Last Job?
	a) Quality
	b) Production
	c) Logistics
	d) Finance
	e) Sales
	f) Human Resources
	g) Other [Text box]
	P3.3.2 In which area of the company did you learn about the instruments in your Professional Training?
	a) Quality
	b) Production
	c) Logistics
	d) Finance
	e) Sales
	f) Human Resources
	g) Other [Text box]
	P3.3.3 In which area of the company did you learn about the

	instruments in your Internship?	
		a) Quality
		b) Production
		c) Logistics
		d) Finance
		e) Sales
		f) Human Resources
		g) Other [Text box]
	P3.4.1 How much did you learn about the instruments in your Current Job / Last Job? (1 = Very Little, General Concepts; 5 = A Lot, Specific Concepts)	
		a) 1
		b) 2
		c) 3
		d) 4
		e) 5
	P3.4.2 How much did you learn about the instruments in your Professional Training? (1 = Very Little, General Concepts; 5 = A Lot, Specific Concepts)	
		a) 1
		b) 2
		c) 3
		d) 4
		e) 5
	P3.4.3 How much did you learn about the instruments in your Internship? (1 = Very Little, General Concepts; 5 = A Lot, Specific Concepts)	
		a) 1
		b) 2
		c) 3
		d) 4
		e) 5
	P3.5 Do you think it is important that future professionals have knowledge about these instruments?	
		a) Yes

	b) No	
	P3.5.1 Which of the following Quality Management instruments would you recommend to be taught in undergraduate courses for future generations?	
		a) Control charts
		b) Value Stream Mapping (VSM)
		c) Ishikawa and 5 Why
		d) Pareto chart
		e) DMAIC Cycle
		f) Poka-Yoke
		g) Gantt chart
		h) PDCA cycle
		i) Failure Mode and Effect Analysis (FMEA/FMECA)
		j) 5S Method
		k) Bottlenecks Identification
		l) Histograms
		m) Material Requirements Planning (MRP)
		n) Project Charter
		o) Precedence Diagram Method
		p) Quality Function Deployment (QFD matrix)
		q) SIPOC diagram
		r) Tree Diagram
		s) Cycle time analysis
		t) Total Productive Maintenance (TPM)
		u) Kanban
		v) Check Sheets
		w) None of the above
		x) Other [Text box]

Table 41. *Questions and alternatives of the Students Survey – Quality Management Information section*

Appendix 3. *Responses and results of Companies Survey and Students Survey*

Table 42. Responses and results of the Companies Survey

I. GENERAL INFORMATION					
		Total Italy (50)	Percentage %	Total Chile (99)	Percentage %
P5	a) Manufacturing	22	44%	21	21.21%
	b) Service	19	38%	63	63.64%
	c) Hybrid	9	18%	15	15.15%
P6	a) 1 - 9	11	22%	13	13.13%
	b) 10 - 49	10	20%	22	22.22%
	c) 50 - 249	10	20%	27	27.27%
	d) +250	19	38%	37	37.37%
P7	a) Local	4	8%	17	17.17%
	b) Regional	3	6%	10	10.10%
	c) National	16	32%	39	39.39%
	d) Multinational	27	54%	33	33.33%
P8	a) Public	3	6%	6	6.06%
	b) Private	44	88%	86	86.87%
	c) Public-Private	3	6%	7	7.07%

II. QUALITY MANAGEMENT INFORMATION					
		Total Italy (50)	Percentage %	Total Chile (99)	Percentage %
P1	a) Yes	34	68%	53	53.54%
	b) No	16	32%	46	46.46%
		Total Italy (34)	Percentage %	Total Chile (53)	Percentage %
P1.1	a) Improvement in the quality of products/services	32	94.12%	47	88.68%
	b) Reduction of defect rate and process variability	21	61.76%	41	77.36%

		c) Cost and waste reduction	14	41.18%	22	41.51%
		d) Cycle time reduction or delivery time acceleration	8	23.53%	14	26.42%
		e) Increase customer or employees satisfaction	24	70.59%	39	73.58%
		f) Other [Text box]	2	5.88%	7	13.21%
			Total Italy (16)	Percentage %	Total Chile (46)	Percentage %
	P1.2	a) Lack of interest from the top management	1	6.25%	6	13.04%
		b) Lack of resources (technical, human, financial, time, economic, others)	7	43.75%	21	45.65%
		c) Resistance to cultural change and lack of leadership	0	0%	6	13.04%
		d) Its functions are already developed by other departments	6	37.5%	12	26.09%
		e) Other	1	6.25%	2	4.35%
			Total Italy (50)	Percentage %	Total Chile (99)	Percentage %
P2		a) Lean Manufacturing	34	68%	33	33.33%
		b) Six Sigma	25	50%	40	40.40%
		c) Lean Six Sigma	18	36%	22	22.22%
		d) Total Quality Management	27	54%	32	32.32%
		e) ISO 9000	47	94%	79	79.80%
		f) None of the above	1	2%	11	11.11%
		g) Other [Text box]	3	6%	11	11.11%
P3		a) Yes	41	82%	54	54.55%
		b) No	9	18%	45	45.45%
			Total Italy (41)	Percentage %	Total Chile (54)	Percentage %
	P3.1.1	a) Lean Manufacturing	19	46.34%	20	37.04%
		b) Six Sigma	6	14.63%	5	9.26%
		c) Lean Six Sigma	7	17.07%	2	3.70%
		d) Total Quality Management	15	36.59%	8	14.81%
		e) ISO 9000	35	85.37%	39	72.22%
		f) Other	2	4.88%	6	11.11%

			Total Italy (10)	Percentage %	Total Chile (7)	Percentage %
	P3.1.1.1	a) 0	2	20%	1	14.29%
		b) 1 – 5	3	30%	2	28.57%
		c) 6 – 10	3	30%	1	14.29%
		d) 11 – 50	0	0%	1	14.29%
		e) +50	2	20%	2	28.57%
	P3.1.1.2	a) 0	4	40%	1	14.29%
		b) 1 – 5	4	40%	3	42.86%
		c) 6 – 10	0	0%	1	14.29%
		d) 11 – 50	1	10%	1	14.29%
		e) +50	1	10%	1	14.29%
	P3.1.1.3	a) 0	7	70%	3	42.86%
		b) 1 – 5	2	20%	2	28.57%
		c) 6 – 10	0	0%	0	0%
		d) 11 – 50	1	10%	2	28.57%
		e) +50	0	0%	0	0%
			Total Italy (41)	Percentage %	Total Chile (54)	Percentage %
	P3.1.2	a) Less than 1 year	2	4.88%	6	11.11%
		b) Between 1 – 3 years	14	34.15%	16	29.63%
		c) Between 3 – 5 years	4	9.76%	11	20.37%
		d) More than 5 years	21	51.22%	21	38.89%
	P3.1.3	a) Very bad results	0	0%	1	1.85%
		b) Bad results	2	4.88%	0	0%
		c) Regular results	6	14.63%	5	9.26%
		d) Good results	26	63.41%	31	57.41%
		e) Very good results	7	17.07%	17	31.48%
	P3.1.4	a) Improvement in the quality of products / services	32	78.05%	40	74.07%
		b) Reduction of the defect rate or process variability	24	58.54%	36	66.67%
		c) Cost and waste reduction	14	34.15%	22	40.74%
		d) Cycle time reduction or delivery time acceleration	7	17.07%	20	37.04%
		e) Increase customer or employees satisfaction	18	43.90%	39	72.22%

		f) No benefits	2	4.88%	0	0%
		g) Other [Text box]	3	7.32%	7	12.96%
	P3.1.5	a) Employees training and education	33	80.49%	44	81.48%
		b) Great involvement from top management	27	65.85%	47	87.04%
		c) Resources invested (technical, human, financial, time, economic, others)	22	53.66%	33	61.11%
		d) Flexibility to the cultural change and good leadership	29	70.73%	46	85.19%
		e) Good selection and prioritization of projects	19	46.34%	39	72.22%
		f) Good data collection and analysis	25	60.98%	37	68.52%
		g) Being able to link the quality management projects to the business strategy and the customer needs	29	70.73%	42	77.78%
		h) Other	0	0%	4	7.41%
	P3.1.6	a) Yes	41	100%	51	94.44%
		b) No	0	0%	3	5.56%
			Total Italy (9)	Percentage %	Total Chile (45)	Percentage %
	P3.2.1	a) Lack of employees training and education	2	22.22%	23	51.11%
		b) Lack of interest from the top management	2	22.22%	9	20.00%
		c) Lack of resources (technical, human, financial, time, economic, others)	4	44.44%	22	48.89%
		d) Resistance to cultural change and lack of leadership	0	0%	10	22.22%
		e) Poor selection and prioritization of projects	0	0%	8	17.78%
		f) Poor data collection and analysis	0	0%	8	17.78%
		g) NOT being able to link the quality management projects to	0	0%	12	26.67%

	the business strategy or the customer needs				
	h) Other	0	0%	5	11.11%

		Total Italy (50)	Percentage %	Total Chile (99)	Percentage %		Total Italy (50)	Percentage %	Total Chile (99)	Percentage %
P4	a) Control charts	25	50%	39	39.39%	b) Value Stream Mapping (VSM)	18	36%	30	30.30%
	c) Ishikawa and 5 Whys	27	54%	43	43.43%	d) Pareto chart	27	54%	56	56.57%
	e) DMAIC cycle	11	22%	14	14.14%	f) Poka-Yoke	20	40%	13	13.13%
	g) Gantt chart	41	82%	86	86.87%	h) PDCA cycle	28	56%	28	28.28%
	i) Failure Mode and Effect Analysis (FMEA / FMECA)	25	50%	22	22.22%	j) 5S method	29	58%	35	35.35%
	k) Bottlenecks identification	24	48%	45	45.45$	l) Histograms	36	72%	49	49.49%
	m) Material Requirements Planning	19	38%	23	23.23%	n) Project charter	20	40%	27	27.27%
	o) Precedence diagram method	5	10%	15	15.15%	p) Quality Function Deployment (QFD matrix)	19	38%	12	12.12%
	q) SIPOC diagram	10	20%	9	9.09%	r) Tree diagram	30	60%	35	35.35%
	s) Cycle time analysis	25	50%	25	25.25%	t) Total Productive Maintenance (TPM)	14	28%	23	23.23%
	u) Kanban	31	62%	23	23.23%	v) Check Sheets	14	28%	34	34.34%
	w) None of the above	2	4%	8	8.08%	x) Other [Text box]	3	6%	2	2.02%

P5	a) Yes	44	88%	77	77.78%
	b) No	6	12%	22	22.22%

			Total Italy (44)	Percentage %	Total Chile (77)	Percentage %		Total Italy (44)	Percentage %	Total Chile (77)	Percentage %
	P5.1	a) Control charts	13	29.55%	22	28.57%	b) Value Stream Mapping (VSM)	9	20.45%	17	22.08%
		c) Ishikawa and 5 Whys	15	34.09%	26	33.77%	d) Pareto chart	17	38.64%	33	42.86%
		e) DMAIC cycle	7	15.91%	8	10.39%	f) Poka-Yoke	8	18.18%	6	7.79%
		g) Gantt chart	32	72.73%	62	80.52%	h) PDCA cycle	18	40.91%	16	20.78%
		i) Failure Mode and Effect Analysis (FMEA / FMECA)	13	29.55%	13	16.88%	j) 5S method	17	38.64%	19	24.68%
		k) Bottlenecks identification	9	20.45%	26	33.77%	l) Histograms	20	45.45%	19	24.68%
		m) Material Requirements Planning	13	29.55%	12	15.58%	n) Project charter	12	27.27%	16	20.78%
		o) Precedence diagram method	2	4.55%	5	6.49%	p) Quality Function	4	9.09%	4	5.19%

						Deployment (QFD matrix)				
	q) SIPOC diagram	4	9.09%	4	5.19%	r) Tree diagram	7	15.91%	12	15.58%
	s) Cycle time analysis	11	25.00%	10	12.99%	t) Total Productive Maintenance (TPM)	6	13.64%	9	11.69%
	u) Kanban	11	25.00%	15	19.48%	v) Check Sheets	9	20.45%	17	22.08%
	w) None of the above	0	0%	0	0%	x) Other [Text box]	2	4.55%	3	3.90%

			Total Italy (6)	Percentage %	Total Chile (22)	Percentage %
	P5.2	a) Lack of employees training	0	0%	8	36.36%
		b) Lack of interest from the top management	0	0%	4	18.18%
		c) Lack of resources (technical, human, financial, time, economic, others)	1	16.67%	7	31.82%
		d) Resistance to cultural change and lack of leadership	0	0%	3	13.64%
		e) Poor selection and prioritization of projects	0	0%	4	18.18%
		f) Poor data collection and analysis	0	0%	2	9.09%
		g) NOT being able to link the quality management projects to the business strategy or the customer needs	0	0%	2	9.09%
		h) Other	0	0%	5	22.73%

		Total Italy (50)	Percentage %	Total Chile (99)	Percentage %
P6	a) Improvement in the quality of products / services	37	74%	47	47.47%
	b) Reduction of the defect rate or process variability	23	46%	46	46.46%
	c) Cost and waste reduction	20	40%	49	49.49%
	d) Cycle time reduction or delivery time acceleration	20	40%	45	45.45%
	e) Increase customer or employees satisfaction	29	58%	60	60.61%
	f) No benefits	2	4%	1	1.01%
	g) Other [Text box]	0	0%	2	2.02%

		Total Italy (49)	Percentage %	Total Chile (88)	Percentage %
P7.1	a) Lean Manufacturing	15	30.61%	24	27.27%
	b) Six Sigma	3	6.12%	8	9.09%
	c) Lean Six Sigma	16	32.65%	19	21.59%
	d) Total Quality Management	14	28.57%	15	17.05%
	e) ISO 9000	19	38.78%	35	39.77%
	f) Other [Text box]	2	2.04%	3	3.41%

		Total Italy (48)	Percentage %	Total Chile (91)	Percentage %		Total Italy (48)	Percentage %	Total Chile (91)	Percentage %
P8.1	a) Control charts	20	41.67%	26	28.57%	b) Value Stream Mapping (VSM)	22	45.83%	26	28.57%
	c) Ishikawa and 5 Whys	22	45.83%	38	41.76%	d) Pareto chart	17	35.42%	38	41.76%
	e) DMAIC cycle	12	25.00%	13	14.29%	f) Poka-Yoke	14	29.17%	9	9.89%
	g) Gantt chart	28	58.33%	52	57.14%	h) PDCA cycle	18	37.50%	25	27.47%
	i) Failure Mode and Effect Analysis (FMEA / FMECA)	21	43.75%	21	23.08%	j) 5S method	18	37.50%	25	27.47%
	k) Bottlenecks identification	21	43.75%	37	40.66%	l) Histograms	13	27.08%	24	26.37%
	m) Material Requirements Planning	15	31.25%	15	16.48%	n) Project charter	13	27.08%	24	26.37%
	o) Precedence diagram method	8	16.67%	10	10.99%	p) Quality Function Deployment (QFD matrix)	14	29.17%	16	17.58%
	q) SIPOC diagram	10	20.83%	8	8.79%	r) Tree diagram	12	25.00%	32	35.16%
	s) Cycle time analysis	13	27.08%	21	23.08%	t) Total Productive Maintenance (TPM)	15	31.25%	22	24.18%
	u) Kanban	23	47.92%	23	25.27%	v) Check Sheets	9	18.75%	14	15.38%
	w) Other [Text box]	1	2.08%	2	2.20%					

Table 42. *Responses and results of the Companies Survey*

Table 43. Responses and results of the Students Survey

I. GENERAL INFORMATION					
		Total Italy (124)	Percentage %	Total Chile (287)	Percentage %
P1	a) Yes	49	39.52%	135	47.04%
	b) No	75	60.48%	152	52.96%

		Total Italy (49)	Percentage %	Total Chile (135)	Percentage %
P1.1.1	a) 2018	4	8.16%	2	1.48%
	b) 2019	13	26.53%	3	2.22%
	c) 2020	21	42.86%	76	56.30%
	d) 2021	11	22.45%	54	40%
P1.1.2	a) Yes	27	55.10%	83	61.48%
	b) No	22	44.90%	52	38.52%

		Total Italy (75)	Percentage %	Total Chile (152)	Percentage %
P1.2.1	a) 2021	52	69.33%	58	38.16%
	b) 2022	22	29.33%	92	60.53%
	c) 2023	1	1.33%	2	1.32%

II. QUALITY MANAGEMENT INFORMATION

		Total Italy (124)	Percentage %	Total Chile (287)	Percentage %
P2	a) Lean Manufacturing	101	81.45%	57	19.86%
	b) Six Sigma	79	63.71%	71	24.74%
	c) Lean Six Sigma	37	29.84%	25	8.71%
	d) Total Quality Management	60	48.39%	28	9.76%
	e) ISO 9000	70	56.45%	100	34.84%
	f) None of the above	1	0.81%	124	43.21%
	g) Other [Text box]	1	0.81%	1	0.35%

		Total Italy (27)	Percentage %	Total Chile (53)	Percentage %
P2.1.1	a) University	25	92.59%	22	41.51%
	b) Internship	7	25.93%	4	7.55%
	c) Professional Training	3	11.11%	14	26.42%
	d) Current Job / Last Job	7	25.93%	16	30.19%
	e) By Myself	3	11.11%	20	37.74%
	f) Other [Text box]	0	0%	1	1.89%

		Total Italy (96)	Percentage %	Total Chile (110)	Percentage %
P2.1.2	a) University	92	95.83%	80	72.73%
	b) Internship	13	13.54%	7	6.36%

		c) Professional Training	10	10.42%	9	8.18%
		d) By Myself	18	18.75%	37	33.64%
		e) Other [Text box]	0	0%	4	3.64%
			Total Italy (123)	Percentage %	Total Chile (163)	Percentage %
	P2.1.1 + P2.1.2	a) University	117	95.12%	102	62.58%
		b) Internship	20	16.26%	11	6.75%
		c) Professional Training	13	10.57%	23	14.11%
		d) Current Job / Last Job	7 (27)	25.93%	16 (53)	30.19%
		e) By Myself	21	17.07%	57	34.97%
		f) Other [Text box]	0	0%	5	3.07%
	P2.2.1	a) Text box				
	P2.2.2	a) Text box				
	P2.2.3	a) Text box				
			Total Italy (7)	Percentage %	Total Chile (16)	Percentage %
	P2.3.1	a) Quality	2	28.57%	7	43.75%
		b) Production	2	28.57%	7	43.75%
		c) Logistics	2	28.57%	5	31.25%
		d) Finance	1	14.29%	1	6.25%
		e) Sales	0	0%	2	12.50%
		f) Human Resources	0	0%	3	18.75%
		g) Other [Text box]	1	14.29%	2	12.50%
			Total Italy (13)	Percentage %	Total Chile (23)	Percentage %
	P2.3.2	a) Quality	9	69.23%	8	34.78%
		b) Production	10	76.92%	8	34.78%
		c) Logistics	5	38.46%	5	21.74%
		d) Finance	1	7.69%	3	13.04%
		e) Sales	0	0%	4	17.39%
		f) Human Resources	0	0%	3	13.04%
		g) Other [Text box]	0	0%	3	13.04%
			Total Italy (20)	Percentage %	Total Chile (11)	Percentage %

	P2.3.3	a) Quality	9	45%	5	45.45%
		b) Production	12	60%	4	36.36%
		c) Logistics	4	20%	3	27.27%
		d) Finance	1	5%	1	9.09%
		e) Sales	2	10%	0	0%
		f) Human Resources	0	0%	0	0%
		g) Other [Text box]	0	0%	2	18.18%
			Total Italy (7)	Percentage %	Total Chile (16)	Percentage %
	P2.4.1	a) 1	0	0%	1	6.25%
		b) 2	3	42.85%	3	18.75%
		c) 3	3	42.85%	2	12.50%
		d) 4	1	14.28%	6	37.50%
		e) 5	0	0%	4	25%
			Total Italy (13)	Percentage %	Total Chile (23)	Percentage %
	P2.4.2	a) 1	1	7.69%	0	0%
		b) 2	1	7.69%	2	8.69%
		c) 3	3	23.07%	9	39.13%
		d) 4	5	38.46%	6	26.08%
		e) 5	3	23.07%	6	26.08%
			Total Italy (20)	Percentage %	Total Chile (11)	Percentage %
	P2.4.3	a) 1	1	5%	2	18.18%
		b) 2	5	25%	3	27.27%
		c) 3	7	35%	1	9.09%
		d) 4	4	20%	3	27.27%
		e) 5	3	15%	2	18.18%
			Total Italy (123)	Percentage %	Total Chile (163)	Percentage %
	P2.5	a) Yes	117	95.12%	157	96.32%
		b) No	6	4.88%	6	3.68%
			Total Italy (117)	Percentage %	Total Chile (157)	Percentage %
	P2.5.1	a) Lean Manufacturing	85	72.65%	97	61.78%
		b) Six Sigma	70	59.83%	78	49.68%

	c) Lean Six Sigma	53	45.30%	62	39.49%
	d) Total Quality Management	62	52.99%	81	51.59%
	e) ISO 9000	47	40.17%	89	56.69%
	f) Other [Text box]	0	0%	0	0%

		Total Italy (124)	Percentage %	Total Chile (287)	Percentage %		Total Italy (124)	Percentage %	Total Chile (287)	Percentage %
P3	a) Control charts	111	89.52%	69	24.04%	b) Value Stream Mapping (VSM)	37	29.84%	102	35.54%
	c) Ishikawa and 5 Whys	47	37.90%	100	34.84%	d) Pareto chart	88	70.97%	99	34.49%
	e) DMAIC cycle	13	10.48%	11	3.83%	f) Poka-Yoke	41	33.06%	5	1.74%
	g) Gantt chart	92	74.19%	239	83.28%	h) PDCA cycle	27	21.77%	12	4.18%
	i) Failure Mode and Effect Analysis (FMEA / FMECA)	104	83.87%	29	10.10%	j) 5S method	50	40.32%	51	17.77%
	k) Bottlenecks identification	86	69.35%	189	65.85%	l) Histograms	74	59.68%	167	58.19%
	m) Material Requirements Planning	70	56.45%	52	18.12%	n) Project charter	78	62.90%	55	19.16%
	o) Precedence diagram method	33	26.61%	64	22.30%	p) Quality Function Deployment (QFD matrix)	102	82.26%	9	3.14%
	q) SIPOC diagram	6	4.84%	8	2.79%	r) Tree diagram	76	61.29%	189	65.85%
	s) Cycle time analysis	43	34.68%	68	23.69%	t) Total Productive Maintenance (TPM)	27	21.77%	29	10.10%
	u) Kanban	84	67.74%	72	25.09%	v) Check Sheets	31	25%	31	10.80%
	w) None of the above	0	0%	18	6.27%	x) Other [Text box]	0	0%	1	0.35%

		Total Italy (27)	Percentage %	Total Chile (78)	Percentage %
P3.1.1	a) University	26	96.30%	60	76.92%
	b) Internship	7	25.93%	5	6.41%
	c) Professional Training	2	7.41%	19	24.36%
	d) Current Job / Last Job	4	14.81%	27	34.62%
	e) By Myself	2	7.41%	13	16.67%
	f) Other [Text box]	0	0%	1	1.28%

		Total Italy (97)	Percentage %	Total Chile (191)	Percentage %
P3.1.2	a) University	96	98.97%	184	96.34%
	b) Internship	8	8.25%	11	5.76%
	c) Professional Training	8	8.25%	17	8.90%
	d) By Myself	15	15.46%	43	22.51%
	e) Other [Text box]	0	0%	2	1.05%

		Total Italy	Percentage	Total Chile	Percentage

			(124)	%	(269)	%
	P3.1.1 + P3.1.2	a) University	122	98.39%	244	90.71%
		b) Internship	15	12.10%	16	5.95%
		c) Professional Training	10	8.06%	36	13.38%
		d) Current Job / Last Job	4 (27)	14.81%	27 (78)	34.62%
		e) By Myself	17	13.71%	56	20.82%
		f) Other [Text box]	0	0%	3	1.12%
	P2.2.1	a) Text box				
	P2.2.2	a) Text box				
	P2.2.3	a) Text box				
			Total Italy (4)	Percentage %	Total Chile (27)	Percentage %
	P3.3.1	a) Quality	1	25%	6	22.22%
		b) Production	1	25%	8	29.63%
		c) Logistics	2	50%	7	25.93%
		d) Finance	0	0%	5	18.52%
		e) Sales	1	25%	3	11.11%
		f) Human Resources	0	0%	4	14.81%
		g) Other [Text box]	0	0%	8	29.63%
			Total Italy (10)	Percentage %	Total Chile (36)	Percentage %
	P3.3.2	a) Quality	9	90%	8	22.22%
		b) Production	7	70%	11	30.56%
		c) Logistics	3	30%	14	38.89%
		d) Finance	1	10%	2	5.56%
		e) Sales	1	10%	8	22.22%
		f) Human Resources	1	10%	1	2.78%
		g) Other [Text box]	0	0%	2	5.56%
			Total Italy (15)	Percentage %	Total Chile (15)	Percentage %
	P3.3.3	a) Quality	7	46.67%	7	46.67%
		b) Production	9	60%	6	40%
		c) Logistics	4	26.67%	2	13.33%
		d) Finance	1	6.67%	3	20%

	e) Sales	0	0%	3	20%
	f) Human Resources	0	0%	0	0%
	g) Other [Text box]	0	0%	1	6.67%
		Total Italy (4)	Percentage %	Total Chile (27)	Percentage %
P3.4.1	a) 1	0	0%	0	0%
	b) 2	1	25%	2	7.41%
	c) 3	1	25%	6	22.22%
	d) 4	2	50%	8	29.63%
	e) 5	0	0%	11	40.74%
		Total Italy (10)	Percentage %	Total Chile (36)	Percentage %
P3.4.2	a) 1	0	0%	0	0%
	b) 2	0	0%	3	8.33%
	c) 3	1	10%	11	30.56%
	d) 4	6	60%	11	30.56%
	e) 5	3	30%	11	30.56%
		Total Italy (15)	Percentage %	Total Chile (14)	Percentage %
P3.4.3	a) 1	0	0%	0	0%
	b) 2	1	6.67%	2	14.28%
	c) 3	6	40%	7	50%
	d) 4	4	26.67%	3	21.42%
	e) 5	4	26.67%	2	14.28%
		Total Italy (124)	Percentage %	Total Chile (267)	Percentage %
P3.5	a) Yes	120	96.77%	250	93.63%
	b) No	4	3.23%	17	6.37%

		Total Italy (120)	Percentage %	Total Chile (250)	Percentage %		Total Italy (120)	Percentage %	Total Chile (250)	Percentage %
P3.5.1	a) Control charts	95	79.17%	122	48.80%	b) Value Stream Mapping (VSM)	50	41.67%	139	55.60%
	c) Ishikawa and 5 Whys	37	30.83%	105	42%	d) Pareto chart	68	56.67%	92	36.80%
	e) DMAIC cycle	23	19.17%	51	20.40%	f) Poka-Yoke	36	30%	50	20%
	g) Gantt chart	80	66.67%	156	62.40%	h) PDCA cycle	28	23.33%	52	20.80%
	i) Failure Mode	83	69.17%	105	42%	j) 5S method	52	43.33%	117	46.80%

	and Effect Analysis (FMEA / FMECA)									
	k) Bottlenecks identification	76	63.33%	154	61.60%	l) Histograms	47	39.17%	120	48%
	m) Material Requirements Planning	65	54.17%	103	41.20%	n) Project charter	61	50.83%	97	38.80%
	o) Precedence diagram method	34	28.33%	84	33.60%	p) Quality Function Deployment (QFD matrix)	79	65.83%	74	29.60%
	q) SIPOC diagram	17	14.17%	59	23.60%	r) Tree diagram	55	45.83%	128	51.20%
	s) Cycle time analysis	42	35%	110	44%	t) Total Productive Maintenance (TPM)	38	31.67%	83	33.20%
	u) Kanban	70	58.33%	90	36%	v) Check Sheets	33	27.5%	75	30%
	w) None of the above	1	0.83%	8	3.2%	x) Other [Text box]	0	0%	0	0%

Table 43. *Responses and results of the Students Survey*

Appendix 4. *Results of logistic regression models*

Table 44. Knowledge and use of quality management tools – Companies Survey (Considering only Italian responses)

Dependent Variable	Independent Variable	Alternative	Pr(>|z|)	Significance	Estimate	Coefficient
Know Control Charts	Size	Micro	0.0363	*	-1.754	0.173
	Size	Small	0.0107	*	-2.97	0.051
Know Ishikawa	Intercept	-	0.0188	*	1.321	3.75
	Size	Micro	0.0034	**	-2.825	0.059
	Size	Small	0.0149	*	-2.169	0.114
Know PDCA Cycle	Size	Micro	0.013	*	-2.277	0.102
Know FMEA	Size	Micro	0.008	**	-3.075	0.046
Know Bottleneck Identification	Product	Manufacturing	0.0291	*	2.015	7.5
Know Kanban	Product	Manufacturing	0.0278	*	1.917	6.8

Use Ishikawa	Intercept	-	5.32×10^{-4}	***	-1.6864	0.185
	Know Lean Six Sigma	Yes	0.004965	**	1.9095	6.75
Use Pareto Chart	Intercept	-	0.00121	**	-1.4663	0.23
	Know Lean Six Sigma	Yes	0.00378	**	1.9183	6.81
Use Gantt Chart	Know Lean Six Sigma	Yes	0.0121	*	2.079	8
Use Histograms	Size	Micro	0.0451	*	-1.8225	0.161

Table 44. *Logistic regression results: Knowledge and use of quality management tools – Companies Survey (Considering only Italian responses)*

Table 45. Knowledge and use of quality management methodologies and tools – Companies Survey (Considering only Chilean responses)

Dependent Variable	Independent Variable	Alternative	Pr(>|z|)	Significance	Estimate	Coefficient
Know Lean Manufacturing	Size	Micro	0.0256	*	-1.867	0.155
	Size	Small	0.0043	**	-2.008	0.134
Know Six Sigma	Intercept	-	0.0366	*	0.734	2.083
	Size	Medium	0.0172	*	-1.265	0.282
	Size	Micro	0.0033	**	-3.219	0.04
	Size	Small	0.00063	***	-2.238	0.106
Know Lean Six Sigma	Size	Medium	0.05	*	-1.253	0.285
Know Ishikawa	Intercept	-	8.34×10^{-4}	***	-2.604	0.074
	Product	Manufacturing	0.004881	**	2.446	11.536
	Quality Department	Yes	0.000162	***	1.826	6.211
Know Pareto	Intercept	-	0.00803	**	-1.661	0.19

Chart						
	Geographic	Multinational	0.00723	**	1.968	7.154
	Quality Department	Yes	0.00379	**	1.326	3.767
Know PDCA Cycle	Intercept	-	0.0000089	***	-2.104	0.122
	Quality Department	Yes	0.000808	***	1.838	6.286
Know 5s	Intercept	-	0.0000285	***	-1.718	0.18
	Quality Department	Yes	0.000211	***	1.831	6.24
Know Histograms	Intercept	-	0.01678	*	0.86	2.363
	Size	Medium	0.0404	*	-1.083	0.338
	Size	Micro	0.01703	*	-1.671	0.188
	Size	Small	0.00532	**	-1.622	0.197
Know Total Productive Maintenance	Size	Medium	0.02005	*	-1.477	0.228
	Size	Small	0.00996	**	-2.773	0.062
Using Methodologies	Intercept	-	0.0000816	***	-6.596	0.001
	Product	Manufacturing	0.024367	*	2.731	15.362
	Quality Department	Yes	0.0000036	***	3.857	47.332
	Know Lean Manufacturing	Yes	0.000158	***	3.747	42.41
	Know ISO 9000	Yes	0.001141	**	3.469	32.105
Use ISO 9000	Intercept	-	0.0000039	***	-7.192	0.0007
	Quality Department	Yes	0.0000001	***	3.631	37.7762
	Know ISO 9000	Yes	0.00115	**	3.711	40.901
Using Instruments	Quality Department	Yes	0.000135	***	2.976	19.615
Use Control Charts	Intercept	-	0.000007	***	-2.351	0.095

	Quality Department	Yes	0.00482	**	1.686	5.4
Use Ishikawa	Intercept	.	0.00227	**	-3.411	0.033
	Product	Manufacturing	0.00706	**	3.190	24.292
	Know TQM	Yes	0.00151	**	1.769	5.87
Use Gantt Chart	Quality Department	Yes	0.00937	**	1.191	3.29
	Know Six Sigma	Yes	0.02534	*	1.104	3.016
Use Histograms	Intercept	-	0.000019	***	-3.091	0.045
	Quality Department	Yes	0.00271	**	2.34	10.388
Use Tree Diagram	Intercept	-	0.0000032	***	-3.345	0.035
	Know Six Sigma	Yes	0.00526	**	2.251	9.5
Use Kanban	Intercept	-	0.0000149	***	-3.76	0.023
	Size	Medium	0.049339	*	1.533	4.632
	Know Lean Manufacturing	Yes	0.000388	***	2.818	16.755

Table 45. *Logistic regression results: Knowledge and use of quality management methodologies and tools – Companies Survey (Considering only Chilean responses)*

Table 46. Critical success factors – Companies Survey (Considering Italian and Chilean responses)

Dependent Variable	Independent Variable	Alternative	Pr(>|z|)	Significance	Estimate	Coefficient
Employees Training & Education	Intercept	-	0.016342	*	-1.425	0.24
	Product	Manufacturing	0.004537	**	1.758	5.804
	Using Instruments	Yes	0.000351	***	1.671	5.32
Top Management Commitment	Geographic	Multinational	0.043	*	1.113	3.043

	Geographic	Regional	0.04377	*	1.639	5.152
	Know TQM	Yes	0.00156	**	1.229	3.418
Cultural Change & Leadership	Know TQM	Yes	0.00687	**	1.002	2.725
Project Selection and Prioritization	Intercept	-	0.0000498	***	-1.232	0.291
	Quality Department	Yes	0.0000136	***	1.628	5.093
Data Collection and Analysis	Size	Micro	0.000139	***	-2.665	0.07
	Size	Small	0.001035	**	-1.66	0.19
	Know Check Sheets	Yes	0.001716	**	1.287	3.622
Link Quality Management Projects to Business Strategy or Customer Needs	Intercept	-	0.0127	*	-0.67	0.512
	Quality Department	Yes	0.0000105	***	1.577	4.842

Table 46. *Logistic regression results: Critical success factors – Companies Survey (Considering Italian and Chilean responses)*

Table 47. Critical success factors – Companies Survey (Considering only Italian responses)

Dependent Variable	Independent Variable	Alternative	Pr(>|z|)	Significance	Estimate	Coefficient
Top Management Commitment	Know TQM	Yes	0.0149	*	1.492	4.444
Cultural Change & Leadership	Know TQM	Yes	0.0149	*	1.492	4.444
Data Collection and Analysis	Size	Micro	0.0138	*	-2.277	0.102
	Size	Small	0.0205	*	-2.160	0.115
Link QM Projects to	Know TQM	Yes	0.0032	**	1.881	6.562

Business Strategy or Customer Needs						

Table 47. *Logistic regression results: Critical success factors – Companies Survey (Considering only Italian responses)*

Table 48. Critical success factors – Companies Survey (Considering only Chilean responses)

Dependent Variable	Independent Variable	Alternative	Pr(>|z|)	Significance	Estimate	Coefficient
Employees Training & Education	Product	Manufacturing	0.0038	**	2.819	16.759
	Size	Micro	0.0145	*	-1.843	0.158
Top Management Commitment	Intercept	-	0.000813	***	-2.985	0.05
	Product	Manufacturing	0.010986	*	2.085	8.042
	Product	Service	0.039447	*	1.352	3.866
	Quality Department	Yes	0.00224	**	1.428	4.168
	Know ISO 9000	Yes	0.010652	*	1.547	4.698
Cultural Change & Leadership	Intercept	-	0.00101	**	-3.256	0.038
	Product	Manufacturing	0.01622	*	2.167	8.73
	Quality Department	Yes	0.0000017	***	2.518	12.403
	Know ISO 9000	Yes	0.03173	*	1.446	4.248
Project Selection and Prioritization	Intercept	-	0.00192	**	-1.042	0.353
	Quality Department	Yes	0.00012	***	1.706	5.51
Data Collection and Analysis	Intercept	-	0.000231	***	-1.432	0.238
	Quality Department	Yes	0.000531	***	1.62	5.052
	Know Lean Six Sigma	Yes	0.005778	**	1.597	4.937

Link Quality Management Project to Business Strategy or Customer Needs	Intercept	-	0.000429	***	-3.232	0.039
	Product	Service	0.025781	*	1.513	4.538
	Quality Department	Yes	0.00031	***	1.74	5.695
	Know ISO 9000	Yes	0.008839	**	1.593	4.92

Table 48. *Logistic regression results: Critical success factors – Companies Survey (Considering only Chilean responses)*

Table 49. Logistic regression results: Having a quality management department – Companies Survey (Considering Italian and Chilean responses)

Dependent Variable	Independent Variable	Alternative	Pr(>|z|)	Significance	Estimate	Coefficient
Have a Quality Management Department	Size	Medium	0.00941	***	-1.418	0.242
	Size	Micro	0.0000037	**	-3.229	0.039
	Size	Small	0.00278	**	-1.715	0.179
	Geographic	Multinational	0.02318	*	1.452	4.273

Table 49. *Logistic regression results: Having a quality management department – Companies Survey (Considering Italian and Chilean responses)*

Table 50. Logistic regression results: Having a quality management department – Companies Survey (Considering only Italian responses)

Dependent Variable	Independent Variable	Alternative	Pr(>|z|)	Significance	Estimate	Coefficient
Have a Quality	Product	Manufacturing	0.0269	*	3.296	27.021

Management Department						
	Geographic	Multinational	0.0519	.	3.207	24.703

Table 50. *Logistic regression results: Having a quality management department – Companies Survey (Considering only Italian responses)*

Table 51. Having a quality management department – Companies Survey (Considering only Chilean responses)

Dependent Variable	Independent Variable	Alternative	Pr(>|z|)	Significance	Estimate	Coefficient
Have a Quality Management Department	Intercept	-	0.000113	***	1.856	6.4
	Size	Medium	0.000322	***	-2.231	0.107
	Size	Small	0.001545	**	-2.039	0.13

Table 51. *Logistic regression results: Having a quality management department – Companies Survey (Considering only Chilean responses)*

Table 52. Knowledge about quality management methodologies and tools – Students Survey (Considering Italian and Chilean responses)

Dependent Variable	Independent Variable	Alternative	Pr(>|z|)	Significance	Estimate	Coefficient
Know Lean Manufacturing	Intercept	-	2×10^{-16}	***	-1.395	0.247
	Country	Italy	2×10^{-16}	***	2.874	17.719
Know Six Sigma	Intercept	-	4×10^{-16}	***	-1.112	0.328
	Country	Italy	5×10^{-13}	***	1.675	5.34
Know Lean Six Sigma	Intercept	-	2×10^{-16}	***	-2.349	0.095
	Country	Italy	2×10^{-7}	***	1.494	4.457

Know Total Quality Management	Intercept	-	2×10^{-16}	***	-2.224	0.108
	Country	Italy	7.75×10^{-16}	***	2.160	8.671
Know ISO 9000	Intercept	-	4.36×10^{-7}	***	-0.626	0.534
	Country	Italy	0.0000546	***	0.885	2.424
Know Control Charts	Intercept	-	2×10^{-16}	***	-1.150	0.316
	Country	Italy	2×10^{-16}	***	3.295	26.976
Know MRP	Intercept	-	2×10^{-16}	***	-1.508	0.221
	Country	Italy	9.25×10^{-14}	***	1.768	5.858
Know Project Charter	Intercept	-	2×10^{-16}	***	-1.44	0.237
	Country	Italy	2×10^{-16}	***	1.967	7.152
Know Kanban	Intercept	-	9.41×10^{-16}	***	-1.094	0.334
	Country	Italy	6.35×10^{-15}	***	1.836	6.27
Know Check Sheets	Intercept	-	2×10^{-16}	***	-2.111	0.121
	Country	Italy	0.00032	***	1.012	2.752
Know Pareto Chart	Intercept	-	5.48×10^{-10}	***	-1.074	0.341
	Country	Italy	7.16×10^{-12}	***	1.666	5.293
	Graduated	Yes	0.0000915	***	0.859	2.362
Know DMAIC Cycle	Intercept	-	2×10^{-16}	***	-3.222	0.039
	Country	Italy	0.0112	*	1.078	2.938
Know Poka-Yoke	Intercept	-	8.88×10^{-16}	***	-3.746	0.023
	Country	Italy	1.58×10^{-11}	***	3.312	27.442
	Graduated	Yes	0.049	*	-0.747	0.473
Know Gantt Chart	Intercept	-	2×10^{-16}	***	1.605	4.979
	Country	Italy	0.034	*	-0.55	0.577

Know PDCA Cycle	Intercept	-	2×10^{-16}	***	-3.518	0.029
	Country	Italy	1.53×10^{-7}	***	1.978	7.233
	Working	Yes	0.00804	**	0.989	2.688
Know FMEA	Intercept	-	2×10^{-16}	***	-2.437	0.087
	Country	Italy	2×10^{-16}	***	3.958	52.351
	Working	Yes	0.0392	*	0.717	2.048
Know QFD Matrix	Intercept	-	2×10^{-16}	***	-3.43	0.032
	Country	Italy	2×10^{-16}	***	4.964	143.212
Know CTA	Intercept	-	2×10^{-16}	***	-1.169	0.31
	Country	Italy	0.0221	*	0.536	1.709
Know TPM	Intercept	-	2×10^{-16}	***	-2.185	0.112
	Country	Italy	0.00195	**	0.906	2.476

Table 52. *Logistic regression results: Knowledge about quality management methodologies and tools – Students Survey (Considering Italian and Chilean responses)*

Table 53. Knowledge about quality management methodologies and tools – Students Survey (Considering only Italian responses)

Dependent Variable	Independent Variable	Alternative	Pr(>|z|)	Significance	Estimate	Coefficient
Know Lean Manufacturing	Intercept	-	0.00877	**	1740.652	Inf
	Graduation Year	-	0.00876	**	-0.861	0.422
	University	Yes	0.0428	*	1.750	5.756
	Know Lean Six Sigma	Yes	0.04862	*	1.343	3.832
Know Six Sigma	Professional Training	Yes	0.039939	*	2.237	9.374
	By Myself	Yes	0.005713	**	2.192	8.955

	Know Lean Six Sigma	Yes	0.000405	***	1.933	6.911
Know Lean Six Sigma	Intercept	-	0.002377	**	-2748.919	0
	Graduated	Yes	0.004563	**	2.974	19.581
	Graduation Year	Yes	0.002401	**	1.358	3.888
	Working	Yes	0.031919	*	-1.805	0.164
	Know Six Sigma	Yes	0.000198	***	2.378	10.793
	Know TQM	Yes	0.000109	***	2.038	7.681
Know Total Quality Management	Intercept	-	0.025824	*	-0.492	0.611
	Know Lean Six Sigma	Yes	0.000568	***	1.485	4.418
Know ISO 9000	Internship	Yes	0.00974	**	1.696	5.452
Know DMAIC Cycle	Intercept	-	2.7×10^{-7}	***	-3.575	0.028
	By Myself	Yes	0.0176	*	1.619	5.048
	Know TQM	Yes	0.0225	*	1.648	5.200
Know SIPOC Diagram	Intercept	-	9.48×10^{-6}	***	-4.454	0.011
	Know Lean Six Sigma	Yes	0.0198	*	2.598	13.437
Know Control Charts	Know Lean Manufacturing	Yes	0.00461	**	1.810	6.11
	Know TQM	Yes	0.04091	*	1.660	5.255
Know Pareto Chart	Know ISO	Yes	0.00425	**	1.180	3.253
Know FMEA	Intercept	-	0.00643	**	2628.721	Inf
	Graduated	Yes	0.00725	**	-2.686	0.068
	Graduation Year	Yes	0.00645	**	-1.300	0.272
	Working	Yes	0.02192	*	2.308	10.061
	Know TQM	Yes	0.01897	*	1.470	4.344
Know Bottleneck Identification	Graduated	Yes	0.0022	**	1.441	4.227
Know MRP	Intercept	-	0.0004	***	-2.360	0.094

	Know Lean Manufacturing	Yes	0.00014	***	2.541	12.693
	Know TQM	Yes	0.01087	*	1.055	2.873
Know Project Charter	Know Lean Manufacturing	Yes	0.000786	***	1.688	5.409
Know QFD Matrix	Job	Yes	0.01646	*	-2.135	0.118
	Know Lean Manufacturing	Yes	0.00273	**	1.670	5.311
	Know TQM	Yes	0.02239	*	1.357	3.886
Know Tree Diagram	Intercept	-	0.00263	**	0.580	1.785
	Job	Yes	0.03066	*	-2.371	0.093

Table 53. *Logistic regression results: Knowledge about quality management methodologies and tools – Students Survey (Considering only Italian responses)*

Table 54. Knowledge about quality management methodologies and tools – Students Survey (Considering only Chilean responses)

Dependent Variable	Independent Variable	Alternative	Pr(>|z|)	Significance	Estimate	Coefficient
Know Lean Manufacturing	Intercept	-	0.000899	***	1955.416	Inf
	Graduation Year	-	0.000883	***	-0.969	0.379
	University	Yes	5.396×10^{-8}	***	3.026	20.615
	Professional Training	Yes	0.014024	*	1.522	4.584
	Job	Yes	0.002234	**	2.475	11.883
	By Myself	Yes	1.04×10^{-9}	***	2.975	19.604
	Know Six Sigma	Yes	0.032558	*	-1.194	0.302
	Know Lean Six Sigma	Yes	0.00516	**	1.855	6.392
	Know ISO 9000	Yes	0.006693	**	-1.278	0.278

Know Six Sigma	Intercept	-	2.79×10^{-14}	***	-3.176	0.041
	University	Yes	3.96×10^{-13}	***	3.776	43.640
	Know Lean Six Sigma	Yes	2.15×10^{-9}	***	5.298	200.066
	Know ISO 9000	Yes	0.00425	**	-1.200	0.301
Know Lean Six Sigma	Intercept	-	1.65×10^{-10}	***	-4.618	0.009
	University	Yes	0.000167	***	-2.536	0.079
	Know Six Sigma	Yes	1.57×10^{-9}	***	5.246	189.869
	Know TQM	Yes	0.004062	**	1.946	7.004
Know Total Quality Management	Intercept	-	2.7×10^{-15}	***	-3.861	0.021
	University	Yes	0.00000334	***	2.454	11.637
	Professional Training	Yes	0.00632	**	1.660	5.260
Know ISO 9000	Intercept	-	2.87×10^{-13}	***	-2.769	0.062
	Graduated	Yes	0.021267	*	0.859	2.362
	University	Yes	7.67×10^{-15}	***	3.980	53.552
	Internship	Yes	0.004295	**	2.793	16.341
	Professional Training	Yes	0.00015	***	2.640	14.011
	Job	Yes	0.000948	***	2.749	15.632
	By Myself	Yes	2.31×10^{-9}	***	2.833	17.006
	Know Lean Manufacturing	Yes	0.000244	***	-1.838	0.159
	Know Six Sigma	Yes	0.0000509	***	-1.762	0.171
	Know TQM	Yes	0.041358	*	-1.148	0.317
Know Control Charts	Intercept	-	2×10^{-16}	***	-1.512	0.220
	Know Lean Manufacturing	Yes	0.0074	**	0.886	2.425

	Know TQM	Yes	0.00421	**	1.219	3.384
Know Pareto Chart	Intercept	-	3.61×10^{-9}	***	-0.786	0.455
	Know Lean Six Sigma	Yes	0.000603	***	1.54	4.664
Know PDCA Cycle	Intercept	-	1.95×10^{-7}	***	-4.202	0.015
	Job	Yes	0.0311	**	2.178	8.830
	Know Lean Manufacturing	Yes	0.017	*	1.743	5.714
Know FMEA	Intercept	-	2×10^{-16}	***	-2.736	0.064
	Know Lean Manufacturing	Yes	0.0000289	***	1.706	5.510
Know 5s	Intercept	-	2×10^{-16}	***	-2.164	0.114
	Professional Training	Yes	0.01615	*	1.222	3.394
	Know Lean Manufacturing	Yes	0.00234	**	1.131	3.100
	Know Lean Six Sigma	Yes	0.00465	**	1.387	4.002
Know Check Sheets	Intercept	-	2×10^{-16}	***	-2.559	0.077
	Job	Yes	0.00993	**	1.531	4.624
	By Myself	Yes	0.00611	**	1.129	3.093
Know Bottleneck Identification	Intercept	-	0.00075	***	0.471	1.602
	Know Six Sigma	Yes	0.00875	**	0.845	2.329

Table 54. *Logistic regression results: Knowledge about quality management methodologies and tools – Students Survey (Considering only Chilean responses)*

Appendix 5. *Kolmogorov-Smirnov analysis*

Table 55. Results of the Kolmogorov-Smirnov analysis

Italy		Responses	Surveyed Companies	Cumulative Percentage of Responses (F1)	Cumulative Percentage of Surveyed Companies (F2)	K-S Value (max [F1(x) – F2(x)])
Type of Product	Manufacturing	44%	38.2%	44%	38.2%	5.8%
	Service	38%	53.3%	82%	91.5%	9.5%
	Hybrid	18%	8.5%	100%	100%	0%
Enterprise Size	Large	38%	44.6%	38%	44.6%	6.6%
	Medium-Sized	20%	23.3%	58%	67.9%	9.9%
	Small	20%	22.3%	78%	90.2%	12.2%
	Micro	22%	9.8%	100%	100%	0%
Geographic Scope	Multinational	54%	63.9%	54%	63.9%	9.9%
	National	32%	21.2%	86%	85.2%	0.9%
	Regional	6%	4%	92%	89.1%	2.9%
	Local	8%	10.9%	100%	100%	0%
Capital	Private	88%	94.2%	88%	94.2%	6.2%
	Public	6%	4.2%	94%	98.4%	4.4%
	Public-Private	6%	1.6%	100%	100%	0%
		Responses	Surveyed Companies	Cumulative Percentage of Responses	Cumulative Percentage of Surveyed	K-S Value

Chile				(F1)	Companies (F2)	(max [F1(x) – F2(x)])
Type of Product	Manufacturing	21.2%	25.2%	21.2%	25.2%	4%
	Service	63.6%	64.6%	84.8%	89.9%	5%
	Hybrid	15.2%	10.2%	100%	100%	0%
Enterprise Size	Large	37.4%	43.4%	37.4%	43.4%	6%
	Medium-Sized	27.3%	21.9%	64.6%	65.2%	0.6%
	Small	22.2%	26.8%	86.9%	92%	5.1%
	Micro	13.1%	8%	100%	100%	0%
Geographic Scope	Multinational	33.3%	41.9%	33.3%	41.9%	8.5%
	National	39.4%	39.7%	72.7%	81.5%	8.8%
	Regional	10.1%	6.5%	82.8%	88%	5.2%
	Local	17.2%	12%	100%	100%	0%
Capital	Private	86.9%	95.1%	86.9%	95.1%	8.2%
	Public	6.1%	1.9%	92.9%	96.9%	4%
	Public-Private	7.1%	3.1%	100%	100%	0%

Table 55. *Results of the Kolmogorov-Smirnov analysis*

Chapter 9: References

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