

PAPER PUBLISHED IN
EUROPEAN JOURNAL OF OPERATIONAL
RESEARCH (EJOR)

Tamayo-Torres J.; Gutierrez-Gutierrez, L.J. and Ruiz Moreno, A. (2014): “The Relationship between Exploration and Exploitation Strategies, Manufacturing Flexibility, and Organizational Learning: An Empirical Comparison between Non-ISO and ISO Certified Firms”. *European Journal of Operational Research*, Vol.232, n.1, pp.72-86.

DOI: 10.1016/j.ejor.2013.06.040

The relationship between exploration and exploitation strategies, manufacturing flexibility and organizational learning: An empirical comparison between Non-ISO and ISO certified firms

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Abstract

The markets in which organizations currently operate require them to use behaviour based on both exploitation strategy and exploration strategy, each of which contributes fundamental benefits for the firm's success. Exploitation strategy attempts to obtain the maximum advantage from existing abilities, whereas exploration strategy searches for new ways for the organization to adapt. Further, since manufacturing markets are characterized by short product life, they require a high level of manufacturing flexibility, which can play a crucial role in the development of the exploitation and exploration strategies. This study analyses the relationship of manufacturing flexibility to exploitation and exploration strategies, taking into account an issue of maximum international scope: the implementation of ISO standards. In many international markets, ISO implementation is crucial in enabling organizations to be competitive. However, no consensus has been reached concerning the real benefits that these systems provide to the organizations that implement them. The main goal of our study is to analyse whether there are significant differences in the relationship of manufacturing flexibility to exploitation and exploration strategies in ISO 9001:2000 certified organizations and non-certified organizations. Our results show that most of the relationships analysed are only significant in ISO certified organizations. As an added value, the study analyses the relationship of exploitation and exploration strategies to organizational learning orientation and finds this relationship to be significant in all cases.

Keywords

- Manufacturing flexibility;
- Exploration;
- Exploitation;
- ISO certified;
- Organizational learning

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1. Introduction

Firms today compete in dynamic markets and must thus perform different tasks, explore new possibilities to adapt to future changes in the environment and exploit the abilities they have developed to fulfil current demands on the firm (Lavie & Rosenkopf, 2006). Research on exploration and exploitation strategies have evolved greatly, to the point of dominating the literature on organizational learning and the search for competitive advantage (Bessant, 2008 and Raisch et al., 2009). According to Resource Based View (RBV) (Amit and Schoemaker, 1993, Barney, 2001 and Peteraf, 1993), competitive advantage achievement, depends on resources and capabilities that are available in the organization. Exploration and exploitation strategies constitute an example of potential capacities for competitive advantage achievement. Thus, literature supports a positive relationship between exploration and exploitation strategies and organizational performance. Jansen, Van Den Bosch, and Volberda (2006) suggest that developing both behaviours permits the firm to improve its performance in dynamic environments. Cao, Gedajlovic, and Zhang (2009), as well, observed that a close balance of exploitation and exploration is more important for performance in smaller firms, because of the accessible resources available, than in larger firms, which have access to sufficient internal or externally located resources.

Today's markets are marked by short product life and dynamism environment, making manufacturing flexibility a competitive key for all firms and their production systems (Wang & Chuu, 2004). Anand and Ward (2004) demonstrate that achieving good fit between the specific environment and the flexibility developed is associated with improvement in performance. More recently, De Treville, Bendaham, and Vanderhaegue (2007) conclude that investment in manufacturing flexibility is profitable, as it obtains improvements in the firm's final performance. Greater manufacturing flexibility, combined with a competitive strategy appropriate for each sector, will enable the firm to adapt to changes in the environment or even to anticipate changes that may arise, which in turn give the firm a competitive advantage (Beach, Muhlemann, Price, Paterson, & Sharp, 2000). Examples of these competitive strategies should be obtained through the exploration and exploitation mentioned above (Adler et al., 2009). This study undertakes analysis of the relationship between manufacturing flexibility and exploration and exploitation strategies, as well as the relationship between these strategies and organizational learning, another possible source of competitive advantage for organizations (Rindova and Fombrun, 1999 and Senge, 1992). In fact, creating a learning context for the organization will increase the possibility for obtaining further competitive advantages (Senge, 1992). The literature has demonstrated the fundamental role that exploration and exploitation strategies play in organizational learning (Dixon et al., 2007, Gupta et al., 2006 and March, 1991).

The implementation of ISO standards is a phenomenon recognized internationally. ISO 9000 is a set of international standards for the development of quality management (QM) systems. According to Dick, Heras, and Casadesús (2008, p. 687), "ISO quality management system standards have proven to be a persistent and growing phenomenon". At the end of 2006, over 870,000 certifications had been granted in 140 countries worldwide (Heras-Saizarbitoria, Casadesús, & Marimón, 2011). However, understanding the effects of these standards on performance has always been a topic of great controversy (Benner and Veloso, 2008, Dick et al., 2008, Prajogo, 2011 and Terziovski et al., 2003). Some studies indicate that the 2000 version makes significant improvements in some practices where previous versions failed (Bayo-Moriones et al., 2011, Gotzamani, 2010 and Martínez-Costa et al., 2009), but there is still little consensus concerning the effects of these improved practices on performance (Dick

et al., 2008, Martínez-Costa et al., 2009 and Prajogo, 2011). “The superiority of the 2000 version is not clearly manifested in performance” (Martínez-Costa et al., 2009, p. 507). Some studies even argue that the massive implementation of the ISO Standard has led to an inability to differentiate the companies that benefit from implementation (Karapetrovic et al., 2010 and Kuo et al., 2009). In fact, the study by Benner and Veloso (2008) shows that early adopters obtain some benefits from ISO 9000, whereas later adopters only gain legitimacy advantages. To analyse this phenomenon, our study seeks to identify the differences between ISO 9001:2000 certified and non-certified organizations concerning relationships between the strategic variables mentioned above. Such analysis will contribute further evidence to strengthen the study by Tarí, Molina, and Castejon (2007), which was not able to include non-certified firms in their study of the relationship between quality management practices and the quality outcomes.

Given this focus, our study addresses two gaps in the literature. First, it seeks to determine whether a significant relationship exists between both manufacturing flexibility and exploration and exploitation strategies and organizational learning. Second, it seeks to determine whether these relationships differ in organizations that have and have not implemented the ISO 9001:2000 standard.

Based on the foregoing, this study proposes the following research questions:

1. Is there any significant relationship between dimensions of manufacturing flexibility and exploration and exploitation strategies?
2. Is there any significant relationship between exploration and exploitation strategies and organizational learning?
3. Is behaviour in the previous two relationships different in organizations that have implemented the ISO standard and those that have not?

This research contributes significantly to the QM literature by observing the differences between ISO-organizations and non-ISO organizations relative to the relationships between manufacturing flexibility, exploration and exploitation strategies, and organizational learning. The QM literature that focuses on ISO standards has attempted to identify the benefits of implementing this standard, but the conclusions reach no consensus. Our study attempts to develop this ambiguous field in greater depth, while also innovating in its analysis of relationships between these variables in this context. In a recent study of the productivity dilemma, Adler et al. (2009) include studies by Benner and Tushman (2003), which seek to determine the role of the ISO standard in explorative and exploitative behaviours. It is very important to analyse the association between ISO implementation and explorative and exploitative behaviours, since the routinization associated with this standard probably has repercussions for explorative and exploitative behaviors. This contribution may add to the lack of consensus on the benefits of the 2000 version (Martínez-Costa et al., 2009) and to the fact that, due to the widespread dissemination of the ISO standards, it is no longer possible to differentiate between them (Benner & Veloso, 2008). All of these factors make it very useful to study the contemporary situation in order to generate empirical support for the conclusions obtained. Our study also contributes to the strategic management literature. The study model proposed establishes a series of new relationships among strategic variables in the literature. Following the proposal of (Beach et al., 2000), we have linked manufacturing flexibility to competitive strategies, specifically to exploration and exploitation strategies, as well as to organizational learning. The knowledge generated by this research provides evidence for the literature that seeks to determine the right relationships and strategic configurations to achieve sustainable competitive advantage.

From the practical point of view, this study also makes a series of contributions. First, the results obtained facilitate strategic managerial decision making to achieve the best possible adaptation of the firm to its environment. Along these lines, we propose a framework for action through which managers can configure the productive strategy of their organization. To achieve this, we introduce manufacturing flexibility, analyse through three dimensions that enable us to understand how to put it into practice and manage it. Similarly, we contribute significant knowledge on which dimensions of manufacturing flexibility are related to exploitation and exploration behaviours. We thus show firm managers how to initiate a joint strategy to improve organizational performance (Vokurka, Lummus, & Krumwiede, 2007). Further, this study follows the most recent research in proposing that both behaviours are compatible and not mutually exclusive, or orthogonal, a concept that has been considered a crucial part of the study in the operations management literature in recent years (Adler et al., 2009). Finally, managers face the decision whether to implement models and norms of quality management in their organizations. In this case, one of our most significant contributions is that this study enables us to understand the benefits -if they exist- of implementing the ISO standard relative to the variables studied. This information should be evaluated in deciding whether to implement the ISO standard, the initiative that has created the most controversy, not only from the academic but also from the professional perspective.

This paper is structured as follows: Following this introduction, we present a literature review and a series of hypotheses related to three areas: exploration and exploitation strategies and manufacturing flexibility; manufacturing flexibility and Quality Management, with special attention to ISO standards; and exploration and exploitation strategies and organizational learning. We then describe the methodology and the analysis performed. Subsequently, we discuss the results obtained and present the main conclusions, limitations, and recommended directions for future research.

2. Theoretical background and hypotheses

2.1. Exploration and exploitation strategies and manufacturing flexibility

Since the preliminary study by March (1991), research on exploration and exploitation strategies have evolved greatly, to the point of dominating the literature on the organization's technological innovation, design, internal and external adaptation to the environment, and organizational learning, as well as the search for competitive advantage (Benitez-Amado, Llorens-Montes, & Perez-Arostegui, 2010).

March (1991, p. 71) defines the term exploration as "search, variation, risk-taking, experimentation, play, flexibility, discovery and innovation" and exploitation as "refinement, choice, production, efficiency, selection, implementation, and execution." Both concepts have completely different goals. In terms of application, exploitation is oriented to the short term, to workers, and to the specific functioning of the firm, whereas exploration has significance in the long-term and is oriented to the development of new knowledge to resolve the problems that the firm faces (March, 1996). Exploratory behaviour seeks to win the technology race in new niches or to achieve competitive advantages to develop new products or technologies (Beckman, 2006). Exploitative behaviour seeks to increase efficiency, reduce periods without sales, and increase the reliability or precision of all activities through actions to reduce change in the organization's processes (March, 1996). "Ambidexterity is thus likely to require both internal and external knowledge processes as well as their integration across organizational boundaries" (Raisch et al., 2009, p. 689).

The literature on strategic management also analyses the concept of manufacturing flexibility. This concept has become a key competitive criterion for many manufacturing organizations (Oke, 2005). Beach et al. (2000) indicate that manufacturing flexibility can be used strategically in many different ways. They recommend that it must be one of the dimensions of a system's competitive strategy, along with price, quality, and reliability. We find different definitions of manufacturing flexibility throughout the literature. Sethi and Sethi (1990) consider it to be a set of elements that are designed as a whole and carefully related in order to facilitate the adaptation of processes and equipment to all production tasks. Upton (1994, p. 73) established a popularly accepted definition, "the ability to change or react with the least time, cost, damage or performance".

While there is general consensus in defining manufacturing flexibility, the main problem lies in measuring it. Like many authors who have written on the topic, Sethi and Sethi (1990) suggest measuring this term by establishing a classification of the different dimensions of flexibility that can be developed in the organization. Some authors argue for using the dimensions of manufacturing flexibility to facilitate study (Gerwin, 2005 and Koste et al., 2004). These differences prevent the establishment of a fixed model of measurement. As firms possess their own characteristics in dynamic and evolving environments, each firm develops new ways of acting and thus new ways of measuring these movements (Gupta & Somers, 1992). Based on the literature discussed, we have chosen three dimensions of measurement to determine how flexible production firms are and to study whether manufacturing flexibility can affect the development of exploration and/or exploitation. These dimensions are routing flexibility, material handling flexibility, and machine flexibility.

The choice of these dimensions is established by Gerwin's taxonomy, which presents a group of 7 dimensions, which include these three, defined by primary dimensions of manufacturing flexibility. These primary dimensions, refer to fundamental and complementary components related to the specific task of the worker, e.g. modification in the sequence of production tasks, the possibility of manipulating the raw materials, and changing the specific production machinery. D'Souza and Williams (2000) and Koste et al. (2004) in turn show us the importance and relevance that these dimensions can have for the firm's adaptation to its competitive environment.

Environments characterized by demand, competition, and technological uncertainty require firms to pursue exploration and exploitation activities (Patel, Terjesen, & Li, 2012). In twenty-first century competition, firms with a high degree of ambidexterity can develop both, perfecting existing resources and developing new competencies through high manufacturing flexibility. For example, firms with a high degree of manufacturing flexibility will facilitate ambidextrous behavior, improving existing processes and pursuing novel possibilities. This behaviour involves being able to change the firm's production routing to encourage the development of exploitative activities and the search for new knowledge from outside the firm. In contrast, low manufacturing flexibility will not be able to implement knowledge, either that learned by individual workers or by the firms as a whole.

Vokurka et al. (2007) defined routing flexibility as the number of alternative paths for producing an element through a production system. In analysing this dimension, we must consider the variety of parts of the product that can be produced by an alternate route (Gerwin, 1993). The literature also refers to the cost that the firm incurs by developing the new alternate route, the possibility of reducing this cost to improve entrepreneurial performance, and the total cost of the product (Vokurka et al., 2007). Ozmutlu and Harmonosky (2005) considered that routing flexibility allows firms to shift the production

sequence and make assignment in cost reduction, demonstrating the importance of the concept and its relationship to the organization's cost strategy.

Whereas the methods of applying exploitation in the firm seem to be choosing the right course of action, adopting standard products, assuming a formal structure, defining and measuring performance by eliminating redundancies, creating routes, specializing, etc. (Levinthal & March, 1993), one of the goals of exploration is to find new alternatives to improve current ones (March, 1991). We can thus affirm that strategic behaviours¹ seek new ways to adapt to the environment (Cao et al., 2009) and different possibilities for improving organizations' production. One of the firm's options for adapting and improving the production process is to search for knowledge, whether through entrepreneurial innovation or through the reorientation of its own abilities. In other words, establishing new production routing in the firm, whether by re-establishing some parts of the firm or by implementing a new process, enables the firm to change production routing, facilitating the firm's strategic behaviour (Koste et al., 2004). According to the foregoing, we formulate the following hypothesis:

H1a. Routing flexibility is positively related to exploration and exploitation strategies.

Material handling flexibility is defined as the ability to move different products through installations, including the loading and unloading of raw materials, transportation between machines and the storing of materials within the manufacturer's possibilities (Gupta, 1993). According to Beach et al. (2000), creating user guides and giving personnel access to materials creates a healthier and more secure environment for the worker, while also offering an opportunity to privilege flexibility over the relation between superior and subordinate. Material handling flexibility has been considered one of the most important dimensions in the literature, based on its indication of improvement delivery times (Sawhney, 2006).

This dimension enables the employee to work according to his or her knowledge and to exploit the capacity to adapt to what the machine needs or requires of him/her (Dixon et al., 2007), associated with exploitative behaviours. On the other hand, this change involves investigating new forms of work, which is, creating new ways of working for the worker and co-workers within the freedom granted by superiors. Such practices encourage continuous innovation in the organization (Corso & Pellegrini, 2007), referring to explorative behaviours. We therefore propose H1b:

H1b. Material handling flexibility is positively related to exploration and exploitation strategies.

Machine flexibility is defined as the number and variety of operations that a machine performs without incurring higher transition costs or great changes in the performance obtained (Sethi & Sethi, 1990). Numerous studies assert the importance of this concept, e.g. the study by Wahab, Wu, and Lee (2008), which shows us that flexible machines can be used to support multiple priorities and that one degree of machine flexibility is consistent with a reduction in setup costs.

To measure this dimension, authors recommend using different concepts, such as the number of different tasks that a machine can perform (Chen & Chung, 1992), the cost to the firm occasioned by the change to another machine during periods of non-use, and the configuration cost (Petroni & Bevilacqua, 2002). As we have seen, one of the most important aspects of the firm's strategic behaviour is improvement in production costs. If machine flexibility seeks the reduction of costs and waiting time, exploration and/or exploitation also attempt to reduce

these production costs, whether in the short term through the exploitation of abilities or in the long term through the exploration of new ideas and products (Miller, Zhao, & Calantone, 2006).

Machine flexibility, in turn, attempts to reduce machine utilization time (Wahab et al., 2008) and can be achieved by improving the use of workers or obtaining information through external sources. We thus propose that:

H1c. Machine flexibility is positively related to exploration and exploitation strategies.

2.2. ISO standards and manufacturing flexibility

The QM initiative that has generated the most discussion concerning its effect on organizational performance and organizational flexibility is the implementation of ISO standards. The controversy over the effects of implementing ISO 9000 standards is well-summarized in the study by Kuo et al. (2009), which identifies two views of the relationship. One view is favourable, stating that ISO 9000 leads to continuous improvement and greater employee awareness of quality issues, constituting a good first step toward TQM. The other view is negative, arguing that firms pursue rapid certification without seeking a true commitment to quality and thus increase bureaucracy, reducing innovation and flexibility. As Terziovski et al. (2003) demonstrated the true motivations for ISO certification are predictors of the results obtained.

If we examine this issue in greater depth, we find that various studies criticize the 1994 version of ISO for incorporating TQM practices in an incomplete way (Reimann & Hertz, 1996). The results of studies of the 1994 version show that ISO requirements do not lead to implementation of TQM in the organization (Martínez-Costa et al., 2009).

Recent studies of the 2000 version seem, however, to show that ISO standards do approach TQM. Various authors argue that the 2000 version of the ISO standards moves organizations a significant step toward TQM (Bayo-Moriones et al., 2011, Gotzamani, 2010 and Martínez-Costa et al., 2009). According to Martínez-Costa et al. (2009, p. 497), “the previous version was often referred to as a quality assurance system at best, but the 2000 version includes elements of TQM philosophy that separates it from a mere quality assurance system”. Along these lines, various studies identify specific points of improvement in the 2000 version of the ISO standards.

For example, Kuo et al. (2009) find significant differences between organizations before and after they implement ISO 9001:2000 with respect to six TQM practices -leadership, strategic planning, customer and market focus, measurement and analysis, human resource focus and process management-. Martínez-Costa et al. (2009) state that ISO 9001:2000 includes the principle of continuous improvement missing in the previous versions. Further, this study focuses on the “soft elements” of TQM, identifying them as an integral part of ISO 9001:2000. Other research identifies innovations in practices such as management commitment, continuous improvement, customer management and human resource management (Dobb, 2004). The results of an empirical study by Martínez-Costa et al. (2009) show that ISO 9001:2000 organizations apply TQM in greater depth than do ISO 9000/1994 organizations, although this difference does not translate into improvements in performance. The significant differences in TQM practices between organizations were found in suppliers, design, process management, and leadership.

Bayo-Moriones et al. (2011) analyse flexible work practices in firms with ISO 9000:2000. According to these authors, the principles of the 2000 version stress involvement, participation, communication and employee training, but the requirements do not make these aspects specific: “the requirements of the ISO 9000:2000 standard are modest with regard to promoting employee involvement and they focus almost exclusively on aspects related to training and competencies. Nevertheless, the principles underlying the standard clearly stress the need and to value employees’ contributions” (Bayo-Moriones et al., 2011, p. 35). The results obtained show partial support for the hypothesis that firms with ISO 9001:2000 implement flexible work practices to a greater extent than firms without ISO 9001:2000. Finally, Gotzamani (2010) observes that the 2000 version improves significantly over the 1994 version in four areas: managerial commitment, process management, focus on the customer, and continuous improvement and establishment of objectives.

We thus find support in the literature for stating that the practices that can benefit manufacturing flexibility are developed to a greater extent in firms that implement ISO 9001:2000. Examples of these practices could be customer focus (Dobb, 2004, Gotzamani, 2010 and Kuo et al., 2009), continuous improvement (Dobb, 2004, Gotzamani, 2010, Kuo et al., 2009 and Martínez-Costa et al., 2009), process management (Gotzamani, 2010, Kuo et al., 2009 and Martínez-Costa et al., 2009), and human resource management (Bayo-Moriones et al., 2011, Dobb, 2004 and Kuo et al., 2009). Further, empirical studies find that organizations with ISO 9001:2000 show benefits related to manufacturing flexibility, such as customer satisfaction, decreasing lead time, meeting the delivery date (Karapetrovic et al., 2010), higher supplier performance, process quality (Kuo et al., 2009), streamlined work processes, and consistent work flow (Bhuiyan & Alam, 2005). According to these arguments, we establish the following hypothesis:

H2. Organizational manufacturing flexibility degree is statistically different in ISO 9001:2000 certified organizations than in ISO 9001:2000 non-certified organizations.

Establishing a relationship between the three dimensions of manufacturing flexibility studied and the environment of organizations certified with ISO 9001:2000 enables us to draw some conclusions. If we examine the practices that justify the relationship between dimensions of manufacturing flexibility and exploration and exploitation strategies, we find a direct correspondence between them and the improved practices in the 2000 version of ISO. This is the case for improved process management in ISO 2000 and improved production processes, which are proposed by Koste et al. (2004) to justify the relationship between machine flexibility and exploration and exploitation strategies. The same occurs for the dimension of routing flexibility with human resource management and employee involvement, using employees’ knowledge and empowering employees (Corso and Pellegrini, 2007 and Dixon et al., 2007); as well, material handling flexibility is related to continuous improvement and finding new alternatives to produce (March, 1991) or eliminating redundancies (Levinthal & March, 1993). Following the line of argument established in this study, the environment created by ISO 9001:2000 certified organizations contributes, to a greater extent than that of non-certified organizations, to the relationship between dimensions of manufacturing flexibility and exploration and exploitation strategies. The line of argumentation permits us to establish the following hypothesis:

H3. The relationship between organizational manufacturing flexibility and exploration and exploitation strategies is different in ISO 9001:2000 certified organizations and ISO 9001:2000 non-certified organizations.

2.3. Exploration and exploitation strategies and organizational learning

Exploration and exploitation are strategic options that the firm possesses to act in response to its competitors (Li, Lin, & Chu, 2008). The concepts of exploratory and exploitative learning (March, 1991) have emerged as two premises of organizational learning that enable the firm to adapt (Gupta et al., 2006). Organizations must learn to adapt to their environment, and learning is the correct organizational response to the existing uncertainty (Lei, Hitt, & Bettis, 1996). García-Morales, Llorens-Montes, and Verdu-Jover (2006) believe that the fundamental role of learning mechanisms consists of modifying existing knowledge to adapt to the competitive environment. According to the Resource Based View (RBV), this knowledge plays a fundamental role in the competitive advantage achievement (Grant, 1996). Within the process of regenerating organizational knowledge proposed by these authors, renovation involves combining the phases of exploration and exploitation of existing knowledge to strengthen this relationship. According to Levin (2000) organizations learn primarily from the established routines and past behaviour of their individuals, but members of an organization also interpret their environment to identify their experiences in it and develop new concepts. Therefore, we establish the fourth hypothesis:

H4. Exploitation and exploration strategies are positively related to organizational learning.

3. Research methodology

3.1. Target population and questionnaire procedure

The data used in this study come from a cross-sectional study that attempts to analyse the manufacturing flexibility, organizational strategic behaviours, and quality management perspective of organizations operating in the Spanish manufacturing sector. The data were collected through a cross-sectional telephone questionnaire administered directly to general managers or the head of the production department of the firms. We hired a private company that specialized in telephone questionnaire to perform the study. One of the authors explained the content of the questionnaire to the interviewers, who then began data collection. To gather the data, the interviewers telephoned the landlines of the individuals in the sample. This phase of the study lasted 5 days and was performed by 7 interviewers. The interviews were recorded and then codified electronically to avoid possible errors during the development of the questions.

To establish the total number of organizations in the Spanish manufacturing sector, we used the SABI2 database. Logically, the study was focused on firms belonging to manufacturing sector, as variables observed match this sector. Besides, two conditions were then applied to the set of Spanish manufacturing organizations. Firstly, according to Upton (1994), all organizations with small manufacturing programs (less than 5 manufacturing workers) were excluded, as their characteristics differ substantially from those discussed in the theoretical argument and would require minimal operating structure and specific study (Hair, Anderson, Tatham, & Black, 2004). The criterion for eliminating small organizations was based on the guidelines of the Fourth European Directive.³ Secondly, we required that organizations have provided the phone number of either the general managers or the head of the production department. We preferred that respondents have sufficient in-depth knowledge of the questions asked to ensure that the responses obtained were reliable. After applying these two conditions, the resulting organizations were reduced through simple random sampling to obtain a final sample of 1850 organizations.

The questionnaire was developed after an extensive review of the literature on manufacturing flexibility, exploitation and exploration strategies, and organizational learning orientation. Once designed, the questionnaire was pre-tested by three manufacturing managers, which

enabled us to clarify possible ambiguities and correct mistakes. From the initial sample of 1854 organizations, we obtained 231 valid questionnaires, a global response rate of 12.49%. For this study, we decided to eliminate from the 231 responses received, organizations that had implemented the EFQM model of business excellence, since these firms could distort the results if they were included in either the group of ISO 9001:2000 non-certified organizations or that of ISO 9001:2000 certified organizations. This led to the elimination of 15 organizations, leaving 216 useful responses for our study. All the ISO organizations included in the analysis were certified with 2000 version of ISO standards. None of these organizations were recognized with a later certificate, such as 2008 version.

We will now examine possible sample bias. First, to determine whether there were differences between respondents and non-respondents, we performed several *t*-tests to compare the average population to that of the sample for the variables of number of employees and total annual sales. Besides, sampling error was calculated (6.03%). This error is caused by observing a sample instead of the whole population and its maximum level in social science studies is 10% (Scandura & Williams, 2000). This result corroborates the sample's representativeness. Second, we analysed the difference in the variables observed for early and late respondents. As none of the *t*-test results indicate any significant difference between these groups, we can affirm that two groups of respondents do not introduce significant bias into the final results of the study.

3.2. Sample demographics

All of the responses used in the research come from in Spain, although the firms may operate in either national or international territory. All respondents held the position of general manager or head of the production department. All of the organizations belong to the manufacturing sector, although they have different production configurations. The sample is distributed between the different production systems as follows: job shop (3.24%), batch flow (26.38%), line flow (16.20%), continuous flow (13.88%), Just-In-Time (0.09%), Flexible Manufacturing System (32.87%), and others (6.48%). Of the total of 216 organizations, 3.70% reported annual sales of 1 million Euros or less, and 7.40% had annual sales between 1 and 7 million Euros. About 76.85% of the firms reported annual sales between 7 and 40 million Euros, and the remaining 12.04% annual sales over 40 million Euros. As to number of employees in the firms asked, 13.89% had 50 or fewer employees, 43.05% from 51 to 250 employees, 32.87% from 251 to 1000, and 10.18% over 1000 workers. Finally, the 216 organizations are divided into 100 organizations without ISO 9001:2000 certification and 116 organizations with the ISO 9001:2000 certification. We will discuss this division in greater depth later as one of the fundamental issues in this study.

3.3. Measures

All variables have been considered as reflective variables as related literature has treated them (see Karuppan and Ganster, 2004 and Chang et al., 2006 for manufacturing flexibility, Yalcinkaya et al., 2007 and Patel et al., 2012 for exploration and exploitation strategies, or Ruiz, Molina, and Lloréns (2009) for organizational learning).

3.3.1. Manufacturing flexibility

Following the trend of the most recent studies, which use few dimensions to measure manufacturing flexibility (Patel et al., 2012), we chose three dimensions to measure this variable: machine flexibility, material handling flexibility, and routing flexibility. All three dimensions were measured through the scales proposed in the study by Larso (2004). The

validity and reliability of the data obtained and the importance of Larso's study for subsequent research led us to choose this study as the source of the measurement scales for the three dimensions of manufacturing flexibility. Both the items on this scale and those in the following scales were accompanied by a 7-point Likert-type scale (0 = totally disagree; 7 = totally agree). All of them are included as Appendix A.

3.3.2. Exploitation and exploration strategies

Various studies measure exploitation and exploration strategies successfully. But we are interested in Mom, Van Den Bosch, and Volberda (2007) because they relate exploitation and exploration strategies to mechanisms of coordination and decision making, it fits our study best. For these reasons, we chose and adapted six items from Mom et al. (2007) to measure exploitation strategy and five items to measure exploration strategy.

3.3.3. Organizational learning orientation

The capability of organizational learning has received much more theoretical attention than empirical. Dixon et al. (2007) defines it as "the ability to assimilate and apply new knowledge to adapt to new conditions". Previous measures differ widely in their assumptions, procedures and objectives. We chose the scale developed by Kale, Singh, and Perlmutter (2000) because it is more closely connected to this research, reflects the different prior trends well, and has a scale whose validity has been verified in detail. We used the first two items from this scale and added two additional items based on the study by Edmondson (1999) to compose a multi-item scale of organizational learning. These items have been duly adapted to the present study.

3.3.4. ISO certification

ISO certification is analysed using a categorical variable. The organizations that possess the ISO 9001:2000 certification chose this variable, and those without the certification did not.

3.4. Tests for reliability and validity

This section analyses the reliability, unidimensionality, convergent validity, and discriminant validity of the scales used in the study. First, to determine the scales' reliability, we calculate the Cronbach α . Some of the items were eliminated, as they did not provide Cronbach α higher than the recommended value of 0.7 (Nunally, 1978) (see Table 1). Besides, to test convergent validity, we calculate the average variance extracted (AVE) values (see Appendix B). All the scales showed values higher than minimum recommended (Gupta and Kim, 2008 and Lu et al., 2007). Second, to ensure the scales' unidimensionality, we performed an exploratory factor analysis, which showed that the items in each scale explained a single factor. To perform both of these tests, we used the statistical programme SPSS 15.0.

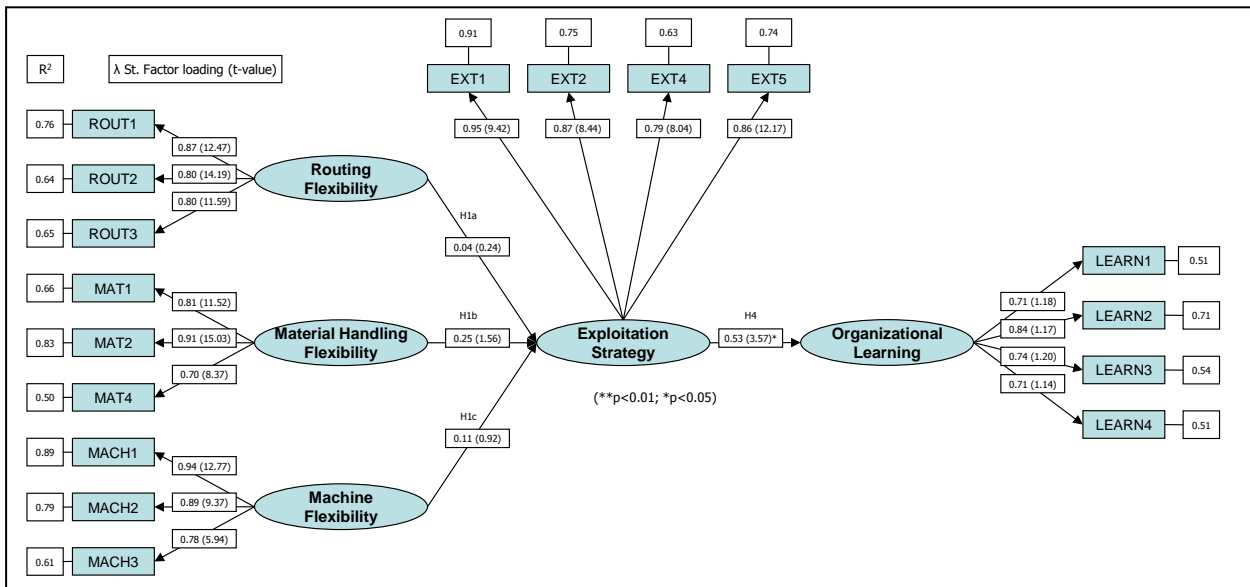
Table 1. Descriptive statistics and reliability analysis

Variable	Cronbach's α	Group	Mean	SD	Correlations					
Routing Flexibility	0.832	Group 1 (n=100)	4.7304	1.38091	1					
		Group 2 (n=116)	4.6472	1.50423						
Material Handling Flexibility	0,863	Group 1 (n=100)	4.8233	1.39218	.440*	1				
		Group 2 (n=116)	5.0057	1.34774						
Machine Flexibility	0,872	Group 1 (n=100)	4.7835	1.70456	.373*	.397*	1			
		Group 2 (n=116)	5.0632	1.43316						
Exploitation Strategy	0.889	Group 1 (n=100)	5.2025	1.12630	.145*	.221*	.224*	1		
		Group 2 (n=116)	5.2522	.94034						
Exploration Strategy	0.821	Group 1 (n=100)	5.1300	1.29465	.247*	.211*	.159*	.140*	1	
		Group 2 (n=116)	4.9871	1.24099						
Organizational Learning Orientation	0.912	Group 1 (n=100)	5.6346	1.20608	.228*	.202*	.106	.262*	.409*	1
		Group 2 (n=116)	5.9846	.97625						

*Correlation is significant at the 0.05 level (two tailed)

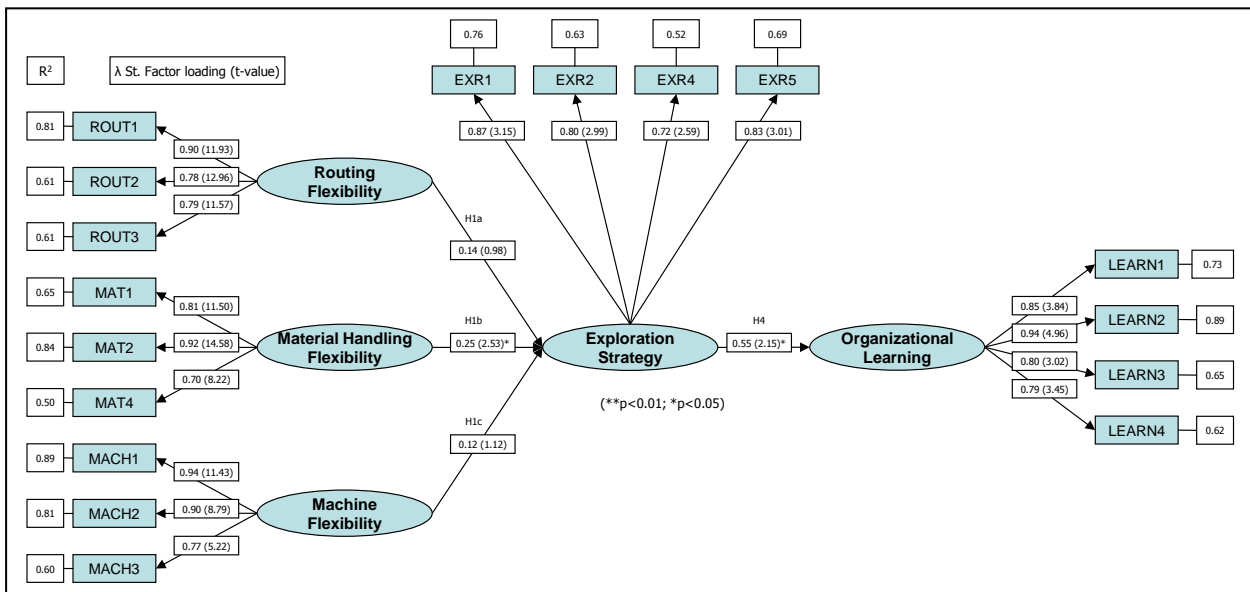
Next, all scales were subjected to a confirmatory factor analysis (CFA) using the computer programme LISREL 8.53, which demonstrated the scales' convergent validity. All of the scales show results higher than the established minimums. According to Hulland (1999), three conditions must be fulfilled for convergent validity to exist. First, the factor loadings must be significant ($t > 1.96$; $p < 0.05$). Second, they must be greater than 0.4. Finally, individual reliability (R^2) must be greater than 0.5. Fig. 1, Fig. 2, Fig. 3 and Fig. 4 show all of the values for the factor loadings, their significance, and their reliability.

Figure 1. Structural modelling of the relationships between dimensions of manufacturing flexibility, exploitation strategy, and organizational learning orientation in ISO 9001:2000 non-certified organizations



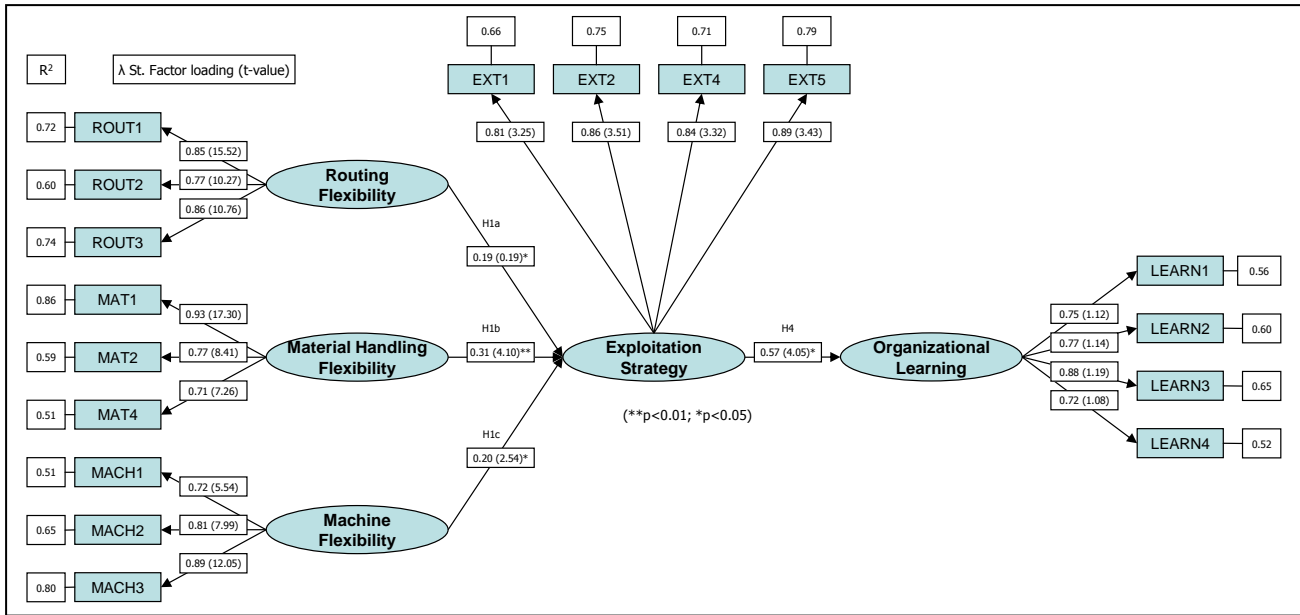
* p < 0.05; ** p < 0.01 (only for hypothesis relationships)

Figure 2. Structural modelling of the relationships between dimensions of manufacturing flexibility, exploration strategy, and organizational learning orientation in ISO 9001:2000 non-certified organizations



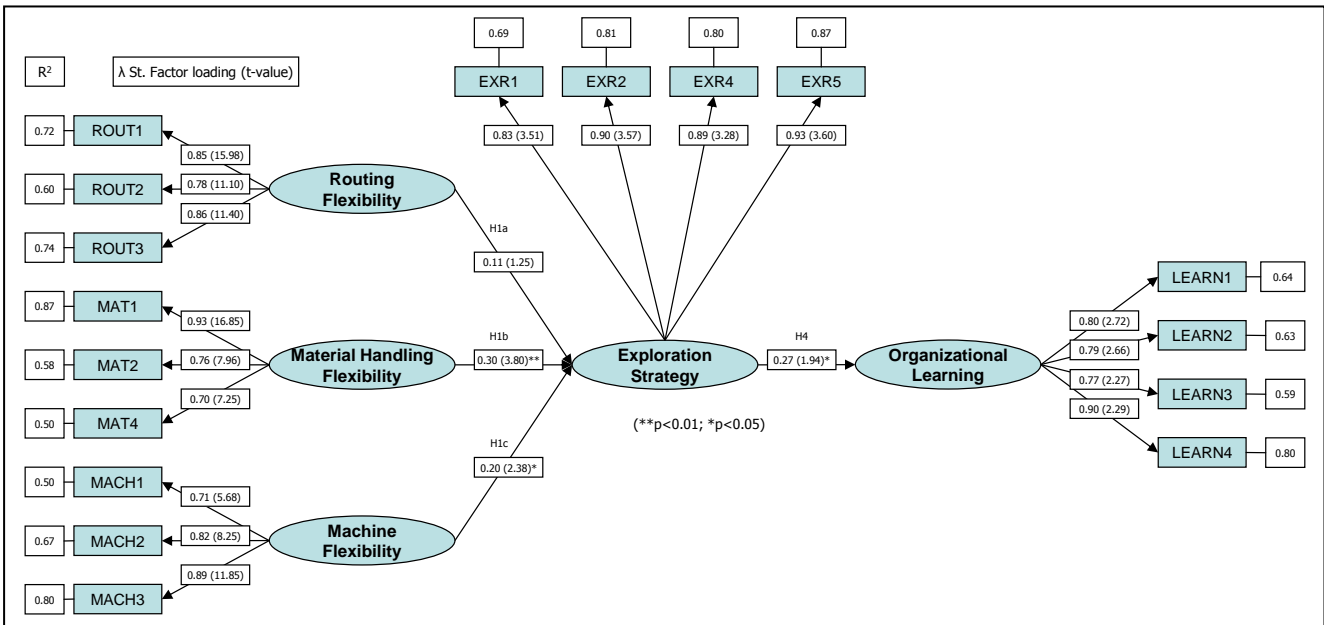
* p < 0.05; ** p < 0.01 (only for hypothesis relationships)

Figure 3. Structural modelling of the relationships between dimensions of manufacturing flexibility, exploitation strategy, and organizational learning orientation in ISO 9001:2000 certified organizations



* p<0.05; ** p<0.01 (only for hypothesis relationships)

Figure 4. Structural modelling of the relationships between dimensions of manufacturing flexibility, exploration strategy, and organizational learning orientation in ISO 9001:2000 certified organizations



* p<0.05; ** p<0.01 (only for hypothesis relationships)

Finally, to complete validation, we analysed discriminant validity, following Howell, 1987 and Szulanski, 1996. We compared the correlation value observed in the CFA to the correlation value calculated for the case of perfect correlation. The correlation value calculated should be greater than the value observed. In all cases, the results show that the value calculated was greater than that observed, ensuring discriminant validity.

4. Data analysis

To contrast the hypotheses proposed, we first divided the total research sample (216 responses) into two groups. The first group was composed of the 100 organizations that answered that they were not certified with the ISO 9001:2000 standard. We call this group “Group 1: ISO 9001:2000 non-certified organizations”. The second group was composed of the 116 organizations that stated that they did possess the ISO 9000:2000 certification. This group was called “Group 2: ISO 9001:2000 certified organizations”. The sample distribution between the two groups was even, such that the results were not influenced by unbalanced distribution of the sample. Table 1 includes descriptive statistics of observed variables.

4.1. Analysis of variance (ANOVA)

In order to contrast the second hypothesis, we performed a variance analysis to compare the degree of manufacturing flexibility between the two groups created. The ANOVA test is widely used in the literature and has been demonstrated to be an appropriate tool for comparing the means of two groups (Lu, Liao, & Yang, 2008). The results obtained are included in Table 2. For the three dimensions of manufacturing flexibility studied (routing, material handling and machine), we find no significant differences between the two groups analysed, which indicates that Hypothesis 2 is not supported. Although it is not the purpose of this study, it is interesting to observe significant differences only occur for the variable of organizational learning (Table 2). We will develop this issue further in the discussion section.

Table 2. Analysis of Variance (ANOVA)

Variable	F	Sig.
Routing Flexibility	.177	.674
Material Handling Flexibility	.954	.330
Machine Flexibility	1.717	.192
Exploitation Strategy	.125	.724
Exploration Strategy	.684	.409
Organizational Learning Orientation	5.552	.019**

***p<.01; **p<.05

We also developed a retrospective power analysis for the different samples and obtain medium power (Table 3) (Cohen, 1992).

Table 3. Retrospective power analysis.

	Exploitation strategy		Exploration strategy	
	ISO non-certified	ISO certified	ISO non-certified	ISO certified
χ^2	250.74	202.57	250.52	262.11
Degrees of freedom	112	112	112	112
<i>n</i>	100	116	100	116
Power	.561	.4373	.561	.5883

Alpha value = 0.05; *n** ISO non-certified = 856; *n** ISO certified = 994.

To contrast the remaining hypotheses and analyse the relationships between the variables, we used Structural Equation Modelling (SEM), employing the programme LISREL 8.53. Both groups have the minimum sample size to run SEM, according to SEM literature (Hair et al., 2004 and Hulland et al., 1996). Recent studies in operations management field, use SEM with similar or even lower samples (Gutiérrez Gutiérrez et al. (2012) or Bernroider and Schmöllerl, 2013 and Dowlatshahi and Cao, 2006).

To ensure that there is no multicollinearity between the variables analyzed, we calculated the variance inflation factors (VIF) and the condition index. The results obtained (see Appendix B) take values below the maximum recommended (Kleinbaum, Kupper, & Muller, 1988), eliminating the possibility of multicollinearity.

The fit indices used to estimate the measurement models are presented in Table 4. With the exception of the RMSEA (Root Mean Square Error of Approximation), these fit indices were chosen because of their abilities to adjust for model complexity and degrees of freedom (Kaynak, 2003). Although the RMSEA is sensitive to model complexity, it is one of the most informative criteria to demonstrate absolute fit (Byrne, 1998).

Table 4. Summary of the contrast of hypotheses

	Exploitation strategy		Exploration strategy	
	ISO Non-certified	ISO Certified	ISO Non-certified	ISO Certified
H1a. Routing flexibility	Not significant	Significant	Not significant	Not significant
H1b. Material handling flexibility	Not significant	Significant	Significant	Significant
H1c. Machine flexibility	Not significant	Significant	Not significant	Significant
H2. MF different ISO Vs Non-ISO	Not significant			
H3. MF Relation different	Significant			
H4. Organisational Learning	Significant			

Fig. 1 and Fig. 2 (ISO 9001:2000 non-certified organizations) and Fig. 3 and Fig. 4 (ISO 9001:2000 certified organizations) depict the SEM results of the relationships between the dimensions of manufacturing flexibility and the exploitation and exploration strategies to organizational learning orientation. Each path in the figure indicates the associated hypothesis, as well as the estimated path coefficients and *t*-values (*t*-values for path

coefficients greater than 1.96 are significant at $p < 0.05$; t -values for path coefficients greater than 2.58 are significant at $p < 0.01$).

The results obtained (Table 5) show that none of the dimensions of manufacturing flexibility has a significant relationship to exploitation strategy in the ISO non-certified organizations. In the case of the ISO certified organizations, all three dimensions—routing ($t = 2.19$, $p < 0.01$), material handling ($t = 4.10$, $p < 0.01$) and machine ($t = 2.54$, $p < 0.05$) flexibility—have a significant relationship. For ISO non-certified organizations, only the dimension material handling ($t = 2.53$, $p < 0.05$) has a significant relationship to exploration strategy. For the ISO certified organizations, both material handling ($t = 3.80$, $p < 0.05$) and machine flexibility show a significant relationship ($t = 2.38$, $p < 0.05$). According to these results, H1a, H1b and H1c are partially supported.

Table 5. Summary of the contrast of hypotheses

	Exploitation strategy		Exploration strategy	
	ISO Non-certified	ISO Certified	ISO Non-certified	ISO Certified
H1a. Routing flexibility	Not significant	Significant	Not significant	Not significant
H1b. Material handling flexibility	Not significant	Significant	Significant	Significant
H1c. Machine flexibility	Not significant	Significant	Not significant	Significant
H2. MF different ISO Vs Non-ISO	Not significant			
H3. MF Relation different	Significant			
H4. Organisational Learning	Significant			

The results of the model show that relationship significance differs depending on the group analysed, supporting Hypothesis 3. Finally, as to Hypothesis 4, the four models show a significant relationship between exploitation and exploration strategies and organizational learning, enabling us to accept Hypothesis 4 ($t = 3.57$, $p < 0.01$; $t = 2.15$, $p < 0.05$; $t = 4.05$, $p < 0.01$; $t = 1.94$, $p < 0.05$).

5. Discussion of results and further directions for research

The main goal of this study was to determine whether a positive relationship exists between the three dimensions of manufacturing flexibility and exploration and exploitation strategies, and to confirm whether this relationship differs in organizations that have or have not implemented ISO 9001:2000. We also analysed the relationship between exploration and exploitation strategies and organizational learning. The results obtained for the hypotheses proposed enable us to draw a series of conclusions that we will now discuss, blocking them into three main areas.

First, the results show that no significant differences exist in the levels of the dimensions of manufacturing flexibility between organizations with and without ISO 9001:2000. Lundmark and Westelius (2006) analyse Swedish SME's with ISO 9000:1994 certifications that also received the 2000 certification and find that the main risk associated with this implementation is excessive bureaucracy which, according to the managers, could reduce flexibility. Similarly, Heras-Saizarbitoria et al. (2011) state that the main risk of implementing ISO 9001 is the bureaucratic workload involved. Our results enable us to determine, however, that ISO

9001 has no negative effects on manufacturing flexibility compared to firms without ISO 9001. Thus, issues such as material handling system modification, machine operations variation and production routing change are neither undermined nor bureaucratized by ISO 9001. There are two possible explanations for these results. First, the absence of differences may be due to issues beyond the implementation of ISO 9001. We believe this possibility to be incorrect, since, for example, “Principle 4: process approach” pursues issues such as “lower costs and shorter cycle times through effective use of resources” and “focusing on the factors such as resources, methods, and materials that will improve key activities of the organization” (ISO, 2012). The other reason, the one this study indicates to be most probable, is that, as Gotzamani (2010) affirms, ISO 9001 leads to a significant decrease in bureaucracy, which in our case does not undermine manufacturing flexibility. This result is important if we consider the debate in the literature concerning the effects of the ISO Standard on flexibility in the organization (Kuo et al., 2009). Thus, although ISO 9001 does not lead to an increase in manufacturing flexibility, it seems possible that the risk of bureaucracy and rigidity in this area have decreased in the 2000 version.

In this first area of conclusions, it is also significant that differences appear when we compare the levels of organizational learning orientation in ISO and non-ISO firms. There is a gap in the literature concerning the relationship between ISO implementation and organizational learning. Benner and Veloso (2008) provide one justification for this greater orientation to learning, as they argue that the repetition of the standardized processes proposed by ISO increases the benefits of learning by doing (Benner and Tushman, 2003 and Levinthal and March, 1993). On the other hand, Oliver (2009) concludes from an analysis of 277 ISO-certified Australian companies that organizations that practice true commitment to quality philosophy develop the right environment for learning. Our results support the recent study of Fernández and Gutiérrez (2011). These authors found significant differences in organizational learning degree between non-ISO, ISO and TQM firms, showing an increase from non-ISO to ISO firms, and from ISO to TQM firms. Independently of ISO implementation, the literature finds positive relationships between organizational learning and QM practices such as leadership, policy strategy, people, partnership resources, and processes (Lloréns Montes et al., 2003 and Ruiz et al., 2005). Given these results and, as observed, the fact that the ISO 2000 version of the standard stimulates these practices to a greater extent (Bayo-Moriones et al., 2011, Dobb, 2004, Gotzamani, 2010, Kuo et al., 2009 and Martínez-Costa et al., 2009), it seems logical that organizational learning is also stimulated to a greater extent. The results obtained contribute knowledge to help to fill the gap in the literature and advance in the line of the research proposed by Lo and Chang (2007) that firms in which the ISO 2000 version stimulates organizational learning develop a quality culture that progresses toward TQM.

The second and main contribution of this study emerges from our examination of the firms that have implemented ISO 9001:2000, which shows all of the relationships between the dimensions of manufacturing flexibility and exploitation and exploration strategies to be significant except one (routing flexibility for exploration strategy). For firms without ISO 9001:2000, however, only one of the six possible relationships (material handling for exploration strategy) is significant.

Overall, practices such as customer focus, continuous improvement, teamwork, human resource management, and process management, which are reinforced in the 2000 version of the ISO standard (Bayo-Moriones et al., 2011, Dobb, 2004, Gotzamani, 2010, Kuo et al., 2009 and Martínez-Costa et al., 2009), may contribute to the reason that manufacturing flexibility affects exploitation and exploration strategies significantly, creating a more favourable environment for the relationship. According to Westphal, Gulati, and Shortell (1997), for example, continuous improvement pursues the organization’s perfection of

processes and products through refinement of the firm, whereas Gupta and Singh (2002) argue that organizations develop machine flexibility to reduce the periods of configuration and waiting for the products that they produce in order to increase the organization's productivity continuously. Thus, both practices show a clear relationship. Process management, understood as the set of activities that aim to manage and improve the processes that generate goods and services (Anderson, Rungtusanatham, & Schroeder, 1994), are clearly related to manufacturing flexibility, as they seek the ultimate adaptation of the firm to achieve better productivity (Beach et al., 2000). On the other hand, we observe that teamwork stimulates projects to improve specific processes for the internal improvement of the firm (Schonberger, 1994). Similarly, Chen et al. (1992) treat material handling flexibility as the joint capacity of workers to translate the different raw materials to storage areas or unloading centres. These conclusions follow the lines of proposals which affirm that, to avoid the risk of standardization, bureaucratization, or excessive managerial control that can come with QM, this system should be implemented with a clear organic orientation, thus facilitating the continuous adaptation of the organization and its members to guarantee long term survival. To achieve this goal, the various academic studies mentioned have shown the importance of deep implementation of practices such as customer focus, continuous improvement, process management, employee involvement, teamwork, and empowerment.

We can also examine the results of the dimensions independently of each other. For the dimension of routing flexibility, the results only show a significant relationship to exploitation strategy in ISO-certified firms. In related arguments, Levinthal and March (1993) find that exploitation is based on the redefinition of existing capacities in the firm to search for efficiency and improvement of costs, and Vokurka et al. (2007) defines routing flexibility as the number of efficient alternate paths for producing an element through the production system. All of these factors constitute part of the form of management proposed by the ISO standard, which pursues such aspects as making continual improvement in the system through measurement and evaluation (Principle 5) and making continual improvement in products, processes, and systems an objective for every individual in the organization (Principle 6) (ISO, 2012). Further, we have mentioned that the literature also supports significant improvements in practices such as process management (Gotzamani, 2010, Kuo et al., 2009 and Martínez-Costa et al., 2009) and continuous improvement (Dobb, 2004, Gotzamani, 2010, Kuo et al., 2009 and Martínez-Costa et al., 2009). We find that the dimension of material handling flexibility is significantly related to both exploration and exploitation strategies in ISO firms. Corso and Pellegrini (2007) conclude that the way of working is improved by giving the worker a free path and that material handling flexibility is the dimension related to the worker (Koste & Malhotra, 1999), justifying the external search for new knowledge through material handling flexibility, that is, exploration. Further, Dixon et al. (2007) proposes improvement through the principle of teamwork, which explains the exploitation of abilities, through research on new ways of working, the creation of new modes of working for both the worker and his/her colleagues, and the freedom that the worker receives from his or her superiors, fostering continuous innovation in the organization. Human resources practices are also stimulated in the 2000 version (Bayo-Moriones et al., 2011, Dobb, 2004 and Kuo et al., 2009), as the third principle establishes that, "People at all levels are the essence of an organization and their full involvement enables their abilities to be used for the organization's benefit" (ISO, 2012). In the case of exploration, however, the relationship is also significant for non-ISO firms; issues that can stimulate exploration, such as worker involvement or teamwork, do not turn out to differentiate the two groups. Finally, for the third dimension, machine flexibility, the relationships are only significant in ISO firms. Machine flexibility seeks ways of reducing the utilization time of machines in the organization and their cost (Wahab et al., 2008). These activities improve over time, first through the experience accumulated among the workers and standardization of processes

(Patel et al., 2012), which corresponds to exploitation, and second through study of competitors' production practices (Petroni & Bevilacqua, 2002), which corresponds to exploration. The ISO standard pursues both management and standardization of processes and continuous improvement (ISO, 2012), indicating a direct correspondence between these two concepts.

Third and last, we stress that all of the cases analysed show a positive and significant relationship between exploitation and exploration strategies and organizational learning. Baum, Li, and Usher (2000) treat the concepts from this perspective, justifying the importance of exploration through experiments planned by the firm for possible changes in processes, and of exploitation through the refinement and reuse of routines. Further, Nielsen (2006) determines that the main knowledge management activities—such as the creation, integration, and exploitation of the firm's knowledge—can generate flows that modify current knowledge of organizational resources and capacities. Finally, since organizations must learn to adapt to changes in the environment, exploratory learning and exploitative learning (Gupta et al., 2006) constitute the correct organizational response to the existing uncertainty (March, 1991). Organizations reduce this uncertainty through the concepts that they capture from their environment, grounding the firm in organizational learning (Lei et al., 1996). The foregoing confirms the need to harmonize both behaviours in the framework of twenty-first century firms. Following the Resource Based View of the firm (Amit and Schoemaker, 1993, Barney, 2001 and Peteraf, 1993) and the recent dynamic capabilities view (Eisenhardt and Martin, 2000, Helfat et al., 2007, Teece et al., 1997 and Teece, 2007), the development of capabilities related with organizational learning and knowledge creation constitutes a potential source of sustainable competitive advantage, which will contribute to improve organizational performance.

5.1. Implications for practice

Now that we have discussed the results, we will discuss the main implications for practitioners. In the competitive market in which we live, managers should take into account the different factors involved in searching for competitive advantage. For that purpose, organizational learning capabilities (Patel et al., 2012), ambidexterity (ÓReilly & Tushman, 2008) and manufacturing flexibility (Beach et al., 2000) could be good examples of capabilities that according to RBV (Amit and Schoemaker, 1993, Barney, 2001 and Peteraf, 1993) and dynamic capabilities view (Eisenhardt and Martin, 2000, Helfat et al., 2007, Teece et al., 1997 and Teece, 2007) could lead to the competitive advantage obtaining. In this section, we attempt to summarize the aspects that managers should develop to enable the achievement of competitive advantage.

One of the main objectives of the study has been to analyse the differences between ISO and non-ISO organizations relative to the variables studied. The results obtained permit us to draw a series of conclusions that managers should take into account, above all the decision whether or not managers should implement the ISO standard. First, the implementation of the ISO standard does not involve significant change on the level of manufacturing flexibility, an issue that managers should evaluate carefully, since one of the main criticisms of the previous version of the standard and even of this one is the bureaucracy, paperwork, etc. In this sense, the absence of increasing bureaucracy in 2000 version constitutes an important contribution, as previous version were criticized because of it. This issue, together with the results that show higher levels of organizational learning in ISO organizations, supports the managerial decision for ISO implementation. Second, the relationships between manufacturing flexibility and exploration and exploitation strategies are only significant in ISO organizations. To facilitate these positive relationships, we have presented the organic orientation to human

issues as a possibility for promoting QM from the perspective of managers. This strategy avoids the risk of standardization or bureaucratization.

Independently of ISO implementation, the significant, positive relationships that appear between dimensions of manufacturing flexibility and exploration and exploitation strategies also enable us to draw some practical conclusions. The results confirm the positive relationship between manufacturing flexibility and exploration and exploitation strategies. We wish to emphasize to managers the need to implement manufacturing flexibility as a way to foster both the exploration of new knowledge and the exploitation of the capacities of their workers or company. In this way, we attempt to solve the productivity dilemma posed by Adler et al. (2009). This study argues that firms should be efficient through exploitation of workers' capabilities and effective through exploration of new knowledge for the firm. We demonstrate that this dilemma can be managed through manufacturing flexibility and thus urge manufacturing managers not to feel obliged to decide between one option and the other but to develop both options. We also indicate which dimensions can benefit them. All three of these dimensions are directly related to the firm's value chain, two of them to operations (routing and machine flexibility) and the third to the inbound logistic (material handling flexibility). Thus, manufacturing flexibility fosters not only the development of exploration and exploitation behaviour but also the search for competitive advantage through value chain management.

Secondly, Schreyögg and Sydow (2010) try to explain the need for fluidity or stability, relating the term of need for flexibility in the firm and organizational ambidexterity. The authors introduce the theoretical study, but we are trying to solve the problem with the empirical analyse.

Thirdly, the study by Patel et al. (2012) of the relationship between manufacturing flexibility and ambidexterity behaviour has a limitation in the sample used, as it only addresses small companies and thus does not permit generalization to all kinds of firms. Our study establishes a generalization to all kinds of firms, since our sample is a set of different kinds of firms.⁵ We thus encourage managers to develop these two options, exploration and exploitation, simultaneously. This conclusion attributes more significance to studies on ambidexterity, which have acquired great importance in recent years.

5.2. Limitations and future research

Finally, among the limitations of our study, we must include the fact that ISO 9001:2000 implementation is examined using a categorical variable instead of a compound construct. This means that neither the time that has elapsed since the certification nor the possible simultaneity of other QM initiatives is evaluated. In the methodology, we eliminated EFQM firms, but no other initiatives were taken into account (Six Sigma, TQM, etc.). Together with the cross-sectional character of the research, this factor somewhat limits generalization from these results. Longitudinal research that analyses a greater number of cases as well as effects on the real results of organizations would enrich the literature. Further, segmenting a larger sample to take into account the implementation of other QM initiatives closely related to manufacturing activities, such as Six Sigma or Lean Manufacturing, would provide more detailed knowledge of the specific benefits of each initiative. Moreover, the results show a medium retrospective power analysis that must be treated with care.

We can also study whether the learning obtained through both behaviours produces significant improvements in the firm, whether direct improvements in manufacturing

flexibility, real reduction in production time or cost, improvement of production facilities, or, ultimately, improved performance.

Acknowledgement

This work has been developed with funding and collaboration of the Ministry of Science and Innovation and the European Union. Project I+D ECO2010-15885.

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Appendix A: Questionnaire

PART I: MANUFACTURING FLEXIBILITY

Please indicate the degree you disagree or agree which each statemente regarding the flexibility of your manufacturing plant:

Strongly disagree = 1	2	3	4	5	6	7= Strongly agree
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Routing flexibility

- | | |
|---|---------------|
| 1. A route can process products/parts, which differ greatly to one another. | 1 2 3 4 5 6 7 |
| 2. A route can process a variety of product/parts. | 1 2 3 4 5 6 7 |
| 3. Route changes can be made quickly.. | 1 2 3 4 5 6 7 |
| 4. Alternate routes do not increase costs. | 1 2 3 4 5 6 7 |
| 5. Alternate routes do not decrease quality of products/parts. | 1 2 3 4 5 6 7 |

Material handling flexibility

- | | | | | | | | |
|--|---|---|---|---|---|---|---|
| 1. The material handling system can transport materials of different sizes. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 2. The materials handling system can transport a wide variety of materials. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 3. Changing a material handling path is inexpensive. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 4. Changing a material handling path is quick. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 5. The choice of material handling path does not affect the material transfer time. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 6. The choice of material handling path does not affect the efficiency of material transfer. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 7. The choice of material handling path does not affect the material transfer cost (in €). | 1 | 2 | 3 | 4 | 5 | 6 | 7 |

Machine flexibility

- | | | | | | | | |
|--|---|---|---|---|---|---|---|
| 1. Typical machines can use many different tools. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 2. Machines can perform operations, which are not very similar to one another. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 3. Machines can perform a high variety of operations. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 4. Machines produce equal quality for all operations. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 5. Machines are equally reliable for all operations. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |

PART II: EXPLORATION AND EXPLOITATION ACTIVITIES

Please indicate the degree you disagree or agree which the following steps the activities of your company last year:

<i>Strongly disagree</i> = 1	2	3	4	5	6	7= <i>Strongly agree</i>
------------------------------	---	---	---	---	---	--------------------------

- | | | | | | | | |
|--|---|---|---|---|---|---|---|
| 1. Our activities search for new possibilities with respect to products/services, processes or markets. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 2. Our activities try to evaluate diverse options with respect to products/services, processes or markets. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 3. Our activities are focused on strong renewal of products/services or processes. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 4. Our activities require quite some adaptability of ourself. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 5. Our activities require you to learn new skills or knowledge. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 1. We develop activities of which a lot of experience has been accumulated by yourself. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 2. We develop activities which serve existing (internal) customers with existing services/products. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 3. We develop activities of which it is clear to us how to conduct them | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 4. We develop activities primarily focused on achieving short-term goals . | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 5. We develop activities which we can properly conduct by using our present knowledge.. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 6. We develop activities which clearly fit into existing company policy. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |

PART III: ORGANIZATIONAL LEARNING

Please indicate the degree you disagree or agree which the following steps the activities of your company last year:

<i>Strongly disagree</i> = 1	2	3	4	5	6	7= <i>Strongly agree</i>
------------------------------	---	---	---	---	---	--------------------------

- | | | | | | | | |
|--|---|---|---|---|---|---|---|
| 1. The organization has learned or acquired much new and relevant knowledge over | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|--|---|---|---|---|---|---|---|

the last three years.	
2. Organizational members have acquired critical capacities and skills over the last three years.	1 2 3 4 5 6 7
3. The organization's performance has been influenced by new learning it has acquired over the last three years.	1 2 3 4 5 6 7
4. The organization is a learning organization.	1 2 3 4 5 6 7

Appendix B

Table 1. Average Variance Extracted^{1,2} (AVE)

Average Variance Extracted (AVE) (Non-ISO / ISO firms)			
Exploitation model		Exploration model	
Routing	.681 / .686	Routing	.678 / .687
Material	.661 / .653	Material	.642 / .648
Machine	.762 / .654	Machine	.766 / .656
Exploitation	.757 / .726	Exploration	.650 / .792
Learning	.566 / .594	Learning	.721 / .665

1= Average variance extracted (AVE) = (sum of squared standardized loading)/[(sum of squared standardized loadings) + (sum of indicator measurement error)].

2= Recommended value AVE>0.5

Table 2. Tolerance index and Variance inflation factors (VIF)

Variable	ISO Companies		Non ISO Companies	
	Tolerance	FIV	Tolerance	FIV
Routing	.822	1.216	.652	1.533
Material	.748	1.336	.725	1.379
Machine	.819	1.221	.738	1.355