ANEXOS

ANEXO I.- Memoria en inglés

Diplomarbeit

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Theme: Study of the Open Innovation business model in Small and Medium sized enterprises within the engineering industry

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Aachen, den 22.08.2011

STUDY OF THE OPEN INNOVATION BUSINESS MODEL IN SMEs WITHIN THE ENGINEERING INDUSTRY

SUMMARY

The following project has been developed in the Werkzeugmaschinenlabor (WZL) Institute of the RWTH University of Aachen (Germany) in the Production Management department. It is a research project which principal objective is finding solutions for the improvement of the innovation management in small and medium size enterprises (SMEs) in the engineering sector, which due to their inherent limitations in size, economic and human resources are constrained in this practice, performing sometimes an inappropriate or even inexistent performance in innovation.

Due to the current changing environment engineering SMEs must face, characterized by high globalization, high competition and rapid advances in technologies, innovation becomes a key factor in these companies in order to remain competitive and differentiate themselves against competitors. That is the reason why solutions to maintain competitiveness and perform an adequate innovation management are especially important for these companies.

During the 20th century, the traditional Innovation practice in companies has been the Closed Innovation model. This innovation strategy was based in a protection of resources and in a vertical and internal development of products and technologies. Nevertheless, due to the new situation companies must face in the last years, characterized by an extension of the limits of knowledge and an increase of complexity in technologies, companies have the necessity of rethink and change their innovation strategy to a model which supports a more open approach.

As a way of improving the Innovation practice in manufacturing SMEs and to adapt these companies to the new requirements of the market, this project centers its research in the application of the Open Innovation model in engineering SMEs. Unlike the old paradigm, the Open Innovation model claims for the broaden of the limits of firms, the collaboration with third parties and the use of internal as well as external ideas in order to get products or technologies to market. This model has traditionally been applied to large companies, reaching good results in the innovation practice. However, the literature about the application of this method in SMEs, and in particular in engineering SMEs, is much less specially due to the inherent difficulties these companies have regarding economic and human resources, which limit their innovation performance.

Through this project, the weak spots engineering SMEs have towards the innovation practice will be analyzed and after having studied and described the barriers these companies must face in the innovation performance, possible solutions for an improvement in their innovation management will be tried to be found by the application of the Open Innovation model, coming up with several conclusions about the applicability and feasibility of the performance of this method in the innovation practice of engineering SMEs.

Table of contents

1- Introduction

Approach of the problem

Innovation has been become during years a key factor in order to achieve competitive advantage for companies against competitors. During the 20th century, innovation was seen as a vertical and closed process carried out entirely inside the companies. Nowadays, the situation is changing, and the extension of the limits of information and knowledge, as well as the shortening of the life cycle of products has led enterprises to rethink their innovation strategy in order to survive and to be competitive in the market.

To face these new challenges, the Open Innovation paradigm emerges. The Open Innovation model is a model promoted by the Professor Henry W. Chesbrough from the University of California, Berkeley. This paradigm claims for the use of internal and external ideas, as well as internal and external paths in order to get ideas to market. The Open Innovation model is based in the collaboration between different actors for the development of different ways to get products to market: outside-in way (outsourcing, buying IP, collaboration with customers, suppliers, competitors…) and inside-out way (venturing, licensing).

The approach of this project is focused on Small and Medium Size enterprises (SMEs) and particularly, SMEs in the engineering sector. These companies are specially limited in the innovation practice due to their restrictions in size, economic resources and labor force. However, innovation is seen as their only way to face the new changing business environment which is characterized by high globalization, high competition and reduction of deadlines.

Objectives of the project

The Open Innovation model has traditionally been applied to large companies, as they have more resources and possibilities for the practice of innovation. The previous literature has not been focused on SMEs and specially on engineering SMEs due to their inherent limitations regarding budget and labor force which influence in a negative way the innovation practice. Through this project, and after having analyzed the restrictions and weak points of engineering SMEs in the innovation performance, a study of the application of the Open Innovation model will be analyzed, in order to see in which degree the Open Innovation paradigm can help engineering SMEs to achieve a better practice in innovation.

The structure of the project will be the following: In chapter 2, the Open Innovation model will be described. At first, an explanation of the precedents of this model (the Closed Innovation paradigm) will be exposed in order to understand why the Open Innovation emerged, trying to make up for the limitations of the previous paradigm. Subsequently, a detailed analysis of the characteristics and practices within the Open Innovation model will be described.

In chapter 3, a study of the characteristics, limitations and strengths of engineering SMEs will be analyzed. It will constitute the basis in order to know which type of firms we are facing and the restrictions which must be overcome in their innovation practice.

In chapter 4, an analysis of former traditional practices in the management of innovation in engineering SMEs will be developed. It is important to review previous performances in

innovation in order to understand their weak points and how they could be made up for with the Open Innovation model. The barriers engineering SMEs must face in the innovation practice will be exposed, and their improvement will be the problem to solve in the next chapter.

In chapter 5, and after having understood the limitations in the traditional innovation practice carried out by engineering SMEs, some initiatives of the Open Innovation model, which can lead to a successful and better performance in innovation for these companies, will be described. These initiatives will be analyzed in the manufacturing SMEs context and under some important factors which will influence their application. According to this, some conclusions will be exposed about the applicability and usefulness of the initiatives of the Open Innovation model, analyzing if they are helpful in the innovation practice of engineering SMEs.

In chapter 6, the conclusions obtained after the analysis of the whole project will be described. It will be analyzed in which degree the Open Innovation model can be helpful, successful and applicable in engineering SMEs and which limitations must still be faced.

Finally, chapter 7 will contain the bibliography used to document this project.

2- Open Innovation model

Companies are continuously rethinking the fundamental ways in which they generate ideas and bring them to market. In the past, innovation was seen as an activity inside the organization, which was managed in closely steps. Research and Development (R&D) was developed internally and only large corporations were able to compete.

During the 20th century, innovation was seen as a key factor which had to be developed vertically: *"If you want something done right, you have to do it yourself"*[1]. Nowadays, the environment of innovation is changing: competition is increasingly global, resulting in shorter product life cycles and in a more broadly located and easily reachable knowledge. Innovation has become a key factor in competitiveness as emerging countries have quickly become strong competitors in low price and low cost products and services.[2] To face these new challenges, organizations must redefine their strategy towards a more open and collaborative performance in innovation in order to be competitive and survive.

According to this idea, the Professor Henry Chesbrough, from the University of California, Berkeley, promoted the concept of "Open Innovation" which is a paradigm that claims for different ways of innovation practices within the companies. *"Open innovation is a paradigm that assumes that firms can and should use external ideas as well as internal ideas, and internal and external paths to market, as the firms look to advance their technology"*[3]. The Open Innovation model is based in the collaboration between different actors in the development of different ways to get products to market: outside-in way (outsourcing, buying IP, collaboration with customers, suppliers, competitors…) and inside-out way (venturing, licensing…).

Consequently, according to the Open Innovation model, companies should look for external partners in order to get a rapid access to different technologies instead of developing everything by their own in a vertical model. If companies could use technology to link these outsiders into their development projects, they could develop these ideas more quickly and cheaply. [4]

The business model also plays a fundamental role in the Open Innovation paradigm. It defines the way of creating and capturing value and ensures the position of the organization in the value chain of the industry. The correct definition of the business model will be decisive in the commercialization of a technology as the technology by itself has no inherent value, it only gets value when it is commercialize through a business model. Many companies fail in their attempt to get a technology to market because of relying too much in their current business model, avoiding new opportunities which could be led by the adoption of a new and more adequate business model. [5]

[1] (Chesbrough, 2003: 20)
[2] Cf. (de Backer, López-Bassols & Martínez, 2008: 7)
[3] (Chesbrough, 2003: xxiv)
[4] Cf. (Bughin, Chui & Johnson, 2008: 36)
[5] Cf. (Chesbrough, 2003: xxiv)

Summing up the ideas previously exposed, the Open Innovation model is a paradigm which looks beyond the limits of the firm, which now can be gone beyond and become more flexible. The aim of the model is to claim for the use of all possible ways and ideas (internal and external) to get to market. Through this project, "Study of the Open Innovation Business Model in Small and Medium size Enterprises within the engineering industry", the characteristics of the Open Innovation model and its application within the engineering Small and Medium size enterprises for a better performance in innovation will be explained in detail.

Focusing on the current section of the project, in chapter 2.1 the old paradigm, the Closed Innovation model, will be described. The study of this model is necessary to understand how the Open Innovation model rose as a necessity to fulfill the deficiencies of this previous paradigm.

Chapter 2.2 is a description of the Open Innovation paradigm. With this new model, the actuation limits of the firm in terms of innovation broaden and new practices are explored. This model claims for the combination of both internal and external flows of action to get to market and to profit from products or technologies.

In chapter 2.3 the business model of the company will be treated. For the company, it is basic to have a solid and proper business model, as value arises only when a technology or a product is commercialized through a suitable business model. It is essential for the firms to choose the correct business model and to have an open view towards new business models which can come up.

Chapter 2.4 is a description of the weak points in the application of the Open Innovation model in the innovation management of a firm. The concept of Innovation should be integrated as a whole in the policy of the firm and managers should be trained in practices of innovation in order to achieve results.

Chapter 2.5 is an overview of how the Open Innovation model can evolve through the years. This model is in continuous growth, and the trends in its application are now changing, adapting to the new demands and situations. This chapter will be especially remarkable, as the following sections of this project will be focused on the application of the Open Innovation model in Small and Medium size enterprises, which is a new trend in the application of this model, as the tendency is evolving from the application of the model in large companies to SMEs.

To finish this first part of the project, chapter 2.6 includes some conclusions about the information exposed in the previous chapters.

2.1- The Closed Innovation paradigm

In the following chapter, the Closed Innovation paradigm, which has been the traditional performance in innovation during the past 20th century, will be described analyzing its weak points which have led to the appearance of the new Open Innovation model.

Until the 20th century, most companies based their innovation strategy in the Closed Innovation paradigm, which claimed the following: *"If you want something done right, you have got to do it yourself"*. [6]

The Closed Innovation paradigm is based in a vertical integration: companies must generate their own ideas and develop them, build them, market them, distribute them, service them, finance them and support them on their own. It is based in a closed, centralized and internal R&D. In order to do anything, one must do everything internally, from tools and materials to product design and manufacturing, to sales, service and support. The firm should rely on itself- and not feeble outside suppliers- for its critical technologies.[7]As it can be seen in Figure 1, the boundaries of the firm in the Closed Innovation paradigm are totally restricted and only ideas which are entirely developed inside the company find a way to get to market.

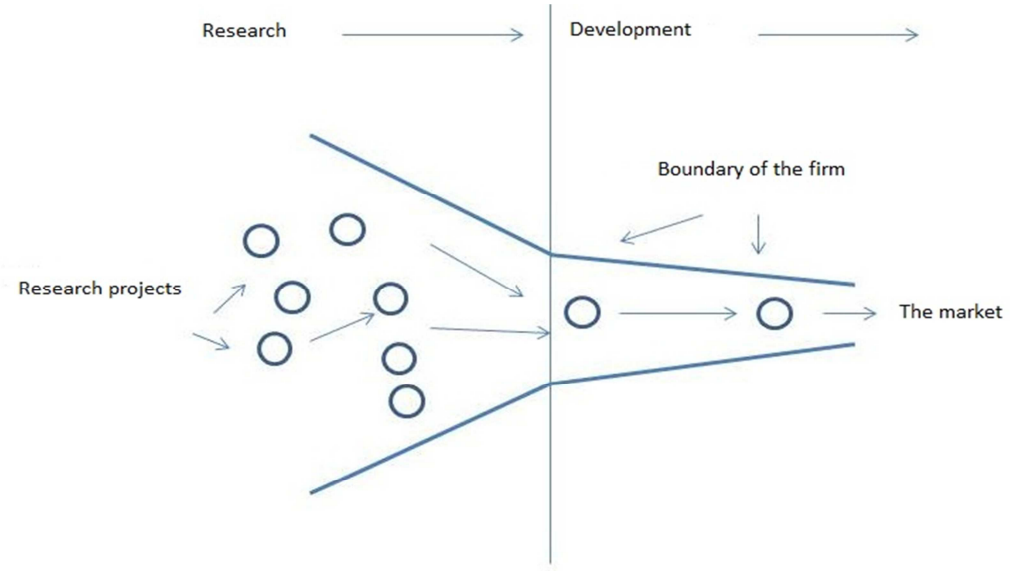

Figure 1: Closed Innovation paradigm[8]

Within this model, the lack of agreement between the Research and the Development (R&D) group can lead to a great number of ideas sitting on the shelf. On the other hand, ideas which do not fit with the business model of the company will be also sitting on the shelf until the company decides to commercialize them or not, taking the risk of leakage of technology out of the company by a start-up from the own company or by a third party. [9] Thus, as it can be seen in Figure 2, this paradigm supports the funnel analogy, as a large number of internal concepts are narrowed down to the ones that best fit the company's needs and the company's business

[6] Cf. (Chesbrough, 2003: 20)
[7] Cf. (Chesbrough, 2003: xx)
[8] (Chesbrough, 2003: xxii)
[9] Cf. (Chesbrough, 2003: xx-xxi)

model.[10] At the beginning, there are many ideas carried out by the R&D development. Finally, only the ones which fit with the business model of the company are going to get to market. Thereby, companies are limiting their success possibilities for an idea for not looking ahead to probably potential successful business models which could fit with it.

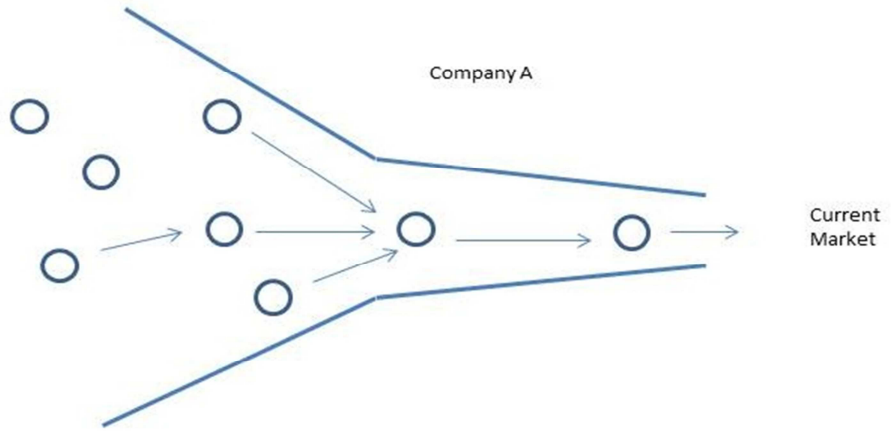

Figure 2: The knowledge landscape in Closed Innovation paradigm[11]

This Closed Innovation model worked well during the 20th century but towards the end of that century, the following factors caused the erosion of the Closed Innovation paradigm and the shift towards the Open Innovation paradigm[12]:

Erosion factor 1: Increasing mobility of workers

Talented engineers could shift from company to company, moved by incentives or lack of motivation in their current company, and knowledge moves with them. Consequently, knowledge is no longer static but dynamic and more easily reachable.

Erosion factor 2: The growth of the venture capital market

Workers whose projects have been sat on the shelf in the Closed Innovation paradigm can resort to pursue their discoveries on their own by start-up companies financed by venture capital.

If that new firm became successful, it would look outside for another technology to commercialize. Like this, the virtuous cycle of innovation is broken: the company that originally funded a breakthrough did not profit from the investment and the firm that did reap the benefits did not reinvest its proceeds to finance the next generation of discoveries.

Erosion factor 3: New options for ideas sitting on the shelf

In the Closed Innovation paradigm if a new project did not fit the business model of the company it would be sat on the shelf until the company would decide to get it to market or not

[10] Cf. (Chesbrough, 2003: xxi)
[11] Cf. (Chesbrough, 2003: 31)
[12] Cf. (Chesbrough, 2003: 34-41)

commercialize it. Thereby, tensions between the incentives of the research and the development group could lead to a buffer inventory of ideas sitting on the shelf.

As the new environment of innovation is changing and product life cycles are shorten and external options grow, these ideas sitting on the shelf might go outside on their own. Customers will not wait forever to better products to come and competitors will not make them wait for those products either. Workers whose projects were rejected to be commercialized within the Closed Innovation paradigm can find other ways to commercialize their ideas, for example, by licensing of technologies or by the creation of start-up companies funded with venture capital.

Erosion factor 4: The increasing capability of external suppliers

The increasing collaboration between firms and external suppliers supports the ability to apply the R&D investments in a wide variety of areas in less time than it would take if the company had to perform every function in the value chain on its own (as it was done in the old paradigm, in a vertical way).

On the other hand, these external suppliers are available to all corners, which place pressure on companies that have built up substantial inventories of R&D projects currently sitting on the shelf. This could enable the unused buffer inventory of ideas and technologies lying on the shelf between research and development to move out of the firm into the market, with or without the participation of the company that funded the original R&D.

2.1.1- From Closed Innovation Paradigm to Open Innovation paradigm

As the commercialization environment is changing, ideas can no longer be inventoried on the shelf. Product life shortens and customers will not wait forever to get a product or a technology, and competitors will not make them wait either. A company that fails in utilizing its technology may latter see variants of those ideas exploited by other firms. [13]

The explanation of the Closed Innovation paradigm and its limitations in the innovation practice has established the path to understand why the Open Innovation model arose. In the next chapter, the new paradigm will be explained in detail, analyzing its characteristics and differences in comparison with the old model.

2.2- The Open Innovation paradigm

Open Innovation is a term defined by the professor and executive director at the Center for Open Innovation at the University of California, Berkeley, Henry Chesbrough, in his book "*Open Innovation: The new imperative for creating and profiting from technology".*

The Open Innovation paradigm is nowadays rising as a replacement of the old Closed Innovation model, which weaknesses have already been mentioned. In this new model it is claimed that ideas can come from inside or outside the company and can go to market from

[13] Cf. (Chesbrough, 2003: 100)

inside or outside the company as well.[14] The Open Innovation paradigm combines knowledge and participation flows of different actors:

- Internal actors: to focus the organization strategy towards the development of the internal innovation and the capture of value in the value chain.
- External actors: to initiate innovation networks and knowledge with other parties and thus to expand their participation in the market.

In the new model, companies openly innovate with customers, suppliers, competitors, universities and research institutes as they increasingly rely on outside innovation for new products and processes. Increased co-operation in technology has become an important way of sourcing knowledge in order to generate new ideas and bring them quickly to market. [15]

In the new paradigm, companies can profit in different ways:[16]

- Exploitation of their own technology by multiple paths to market (inside the company-out)
- Exploration of external technology (outside the company-in)
- Management of Intellectual Property (IP) to profit from your rival's use. IP is no longer seen as a key factor to protect. With the new paradigm, companies should be active buyers and sellers of IP.

Unlike the old paradigm, the boundaries of the firm are no longer restricted; the boundaries between a firm and its surrounding environment are more flexible, enabling innovation to move easily between the two. Figure 3 shows how all possibilities to get to market are explored. The limits of the firm become flexible, and the company can profit from external R&D as well as license or sell in-house R&D which is not interested in commercialize.

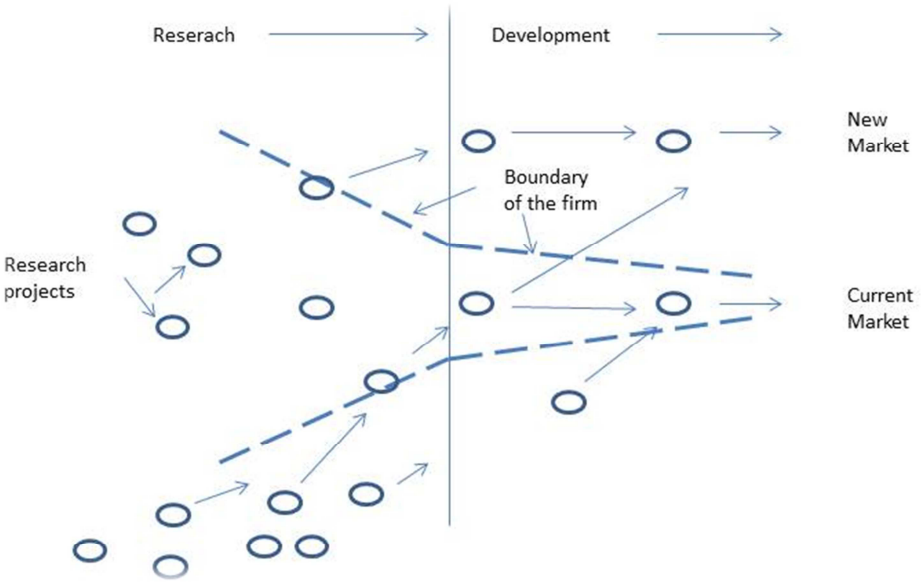

Figure 3: The Open Innovation paradigm[17]

[14] Cf. (Chesbrough, 2003: 43)
[15] Cf. (de Backer, López-Bassols & Martínez, 2008: 7)
[16] Cf. (Chesbrough, 2003: 24)

The projects sitting on the shelf, which were part of the cost of doing business according to the old paradigm, are now seen as revenue opportunities and potential new business platforms with the Open Innovation paradigm.[18] As the limits of the firm are broaden now, new ways to get these ideas out of the company can be found.

After having briefly introduced the Open Innovation paradigm, in the following sections it will be explained in detail, remarking its especial characteristics and lines of action.

2.2.1- Comparison between Closed Innovation and Open Innovation paradigm

In the following table, the principal characteristics of both models, Closed and Open Innovation, are exposed in order to emphasize the existing differences between the two paradigms.

Table 1: Comparison between the two paradigms[19]

Closed innovation principles	*Open innovation principles*
Belief that all the smart people work for the company	Belief that not all the smart people work for the company, thus there must be a collaboration between people inside and outside the firm
Vertical integration in the management of R&D, in closely and internal steps	Possibility of profiting from external R&D. Internal R&D is necessary to get a portion of the value in the value chain
Belief that the first who discovers the product or technology is the first who gets it to market	Possibility of profiting from a technology without carrying out the research
Focus on getting first to the market	Focus on building a solid business model
Focus on creating the most and best ideas inside the firm to get to market	Focus on using internal and external ideas as well as internal and external paths to get to market
Control over the Intellectual Property to avoid competitors to profit from it	The firm becomes a buyer and seller of Intellectual Property

The differences between the two paradigms are remarkable. It can be concluded that the Open Innovation differs from the old paradigm mainly in two points: the new model claims for profiting from the use of external R&D (also by carrying out some internal R&D as a way to get some value) and for the need of establishing a solid business model within the company instead of the focus on getting first to market.

The importance of carrying out some in-house R&D within the company was already mentioned as the only way the firm has to get some value from the value chain. In the next section, a more detailed explanation of the management of in-house R&D within the Open Innovation model will be exposed.

2.2.2- Internal Research and Development

In the past, R&D was seen as a key factor to protect against competitors. With the Open Innovation paradigm, the vision regarding the management of R&D changes drastically. For a

[17] (Chesbrough, 2003: 25)
[18] Cf. (Chesbrough, 2003: 52)
[19] (Chesbrough, 2003: xxvi)

successful management of R&D, innovators must complement in-house R&D with technologies from external sources (such as universities, start-ups and even competitors).

The Open Innovation model establishes that research takes a long time to be developed and to get outcomes. Thus, companies should not try to focus on developing all the technologies by themselves but to get what they need as soon as they need it, either from inside the company or from external sourcing (suppliers, customers, competitors, universities…). Then, internal R&D will also be necessary to retain a portion of the value in the value chain.[20]

Internal R&D becomes necessary to[21]:

- Identify, understand and select from the external knowledge available. Companies must be aware of the new advances in technology in order to be able to profit from external R&D and to combine it with their in-house R&D
- Fill in the missing pieces of knowledge not being externally developed
- Combine both internal and external knowledge
- Profit from exploitation of internal technology by selling it to external firms which can profit from it

To graphically visualize the effect of performing internal R&D, Figure 4 shows a comparative between firms from countries of the European Union (EU) which carry out internal R&D and firms which do not carry it out, obtained from a study of the Organization for Economic Co-operation and Development (OECD). According to the graphic, it can be concluded that firms which develop in-house R&D are much more innovative than firms without internal R&D. As it was already mentioned, internal R&D is a decisive factor towards innovativeness and it is as well necessary to claim a portion of the value in the value chain and to maintain the competitiveness of the company towards innovation. [22]

[20] Cf. (Chesbrough, 2003: 53)
[21] Cf. (Chesbrough, 2003: 53)
[22] Cf. (Chesbrough, 2003: 53)

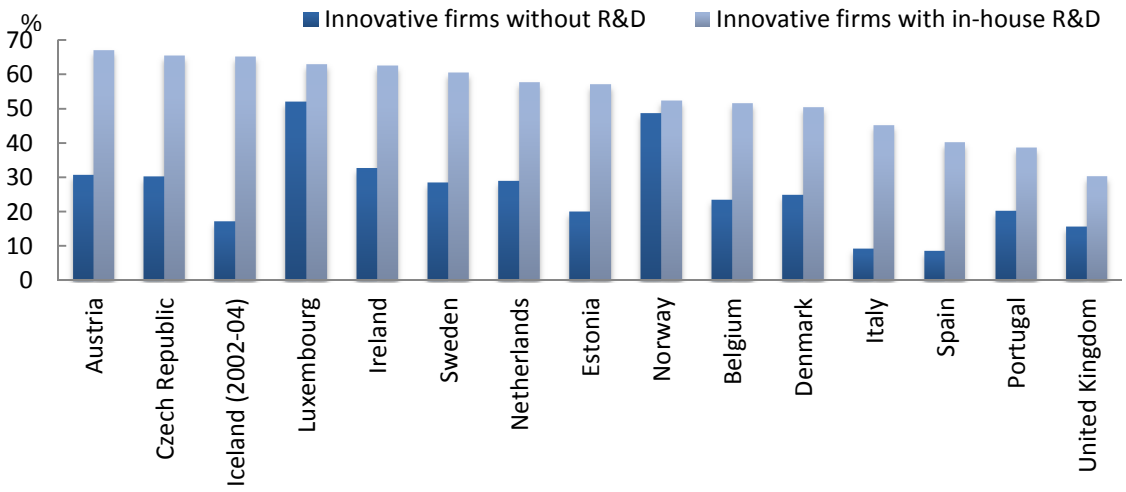

Figure 4: Innovativeness according to internal R&D in some EU countries (date 23.05.2011)[23]

Another factor which becomes important in the performance of the Open Innovation model is the managing of Intellectual Property. The treatment of IP changes drastically from the traditional practice, which claimed for a protection of it against competitors. In the next section, a detailed explanation of the new action regarding the managing of intellectual property within the new paradigm will be explained.

2.2.3- Managing Intellectual Property (IP)

In the old paradigm, IP was seen as a competitive advantage and the strategy of the firms was to protect it from competitors and to exclude rivals from using a company's own technology. In the Open Innovation model, the flow of knowledge changes and the IP concept evolves from Intellectual Property to Intellectual Partnering. [24] The boundaries of the firm are no longer fixed, and knowledge has become dynamic. Ideas can no longer be sat on the shelf, as they can be leveraged by competitors in the market. Thus, the sooner the ideas get out of the company, the better, as it is proved that the costs of moving too late are greater than the costs of moving too soon.[25]

With this new environment, licensing of intellectual property becomes a useful way of exploiting internal technologies or ideas which cannot be commercialized by the company. There is also a bountiful supply of potentially useful ideas outside the firm and the firm should be an active buyer and seller of IP.

However, still nowadays the managing of intellectual property is not easy and there are several problems in its performance which companies must face[26]:

- The difficulty of knowing the value of a patent beforehand. The ideal measure of IP should take the business model into account. Companies should manage IP to enhance and extend their business models and it should seek out new business models for

[23] (OECD, 2009)
[24] Cf. (de Backer, López-Bassols & Martínez 2008: 8)
[25] Cf. (Chesbrough, 2003: 57)
[26] Cf. (Chesbrough, 2003: 160)

discoveries which do not fit their present models, as ideas sitting on the shelf are now seen as revenue opportunities.

- The investment in IP is also difficult to determine beforehand.

Public knowledge and competition in Open Innovation

Due to the dynamic and abundant character of knowledge nowadays, from an Open Innovation perspective it is unlikely to exclude rivals from this knowledge for very long. The Open Innovation paradigm claims that the knowledge that can enhance the value chain should be public as this knowledge enhances the ability of firms in the ecosystem to advance the complementary products and services they make.[27]On the other hand, the knowledge that allows the company to get a portion of this value is the knowledge that companies should keep for themselves. This idea supports the Moore's Law which claims that technology must move at a certain rate. If technology advances slowly, customers will have fewer reasons to replace their old systems because these systems would become obsolete much more slowly. [28]

Another idea related to this topic that arises from the Open Innovation paradigm is that a little competition can be useful to enhance the innovation practice.[29] This can be seen as a pressure to companies in order to be more proactive towards innovation. If this pressure does not exist, companies will not have the necessity to improve their internal R&D, as technology would advance much more slowly.

After having treated the management of Intellectual Property, another important issue that emerges in the Open Innovation model is the suggested use of internal as well as external ideas to get to market. Many alternatives related to this topic are explored in order to search for all the possible ways of profiting. In the next chapter, an overview of the different paths the Open Innovation proposes to follow in order to get products or technologies to market will be explained in detail.

2.2.4- Ways of developing ideas within the Open Innovation paradigm

In the Open Innovation model, the company's solid boundaries are being transformed into a semi-permeable membrane that enables innovation to move more easily. The paradigm claims for the use of internal as well as external ideas in order to get products or technologies to market. Figure 5 describes a scheme of the different paths to get to market according to the Open Innovation paradigm. It can be seen how all the possible alternatives to get to market are explored.

[27] Cf. (Chesbrough, 2003: 172-173)
[28] Cf. (Chesbrough, 2003: 173)
[29] Cf. (Chesbrough, 2003: 173)

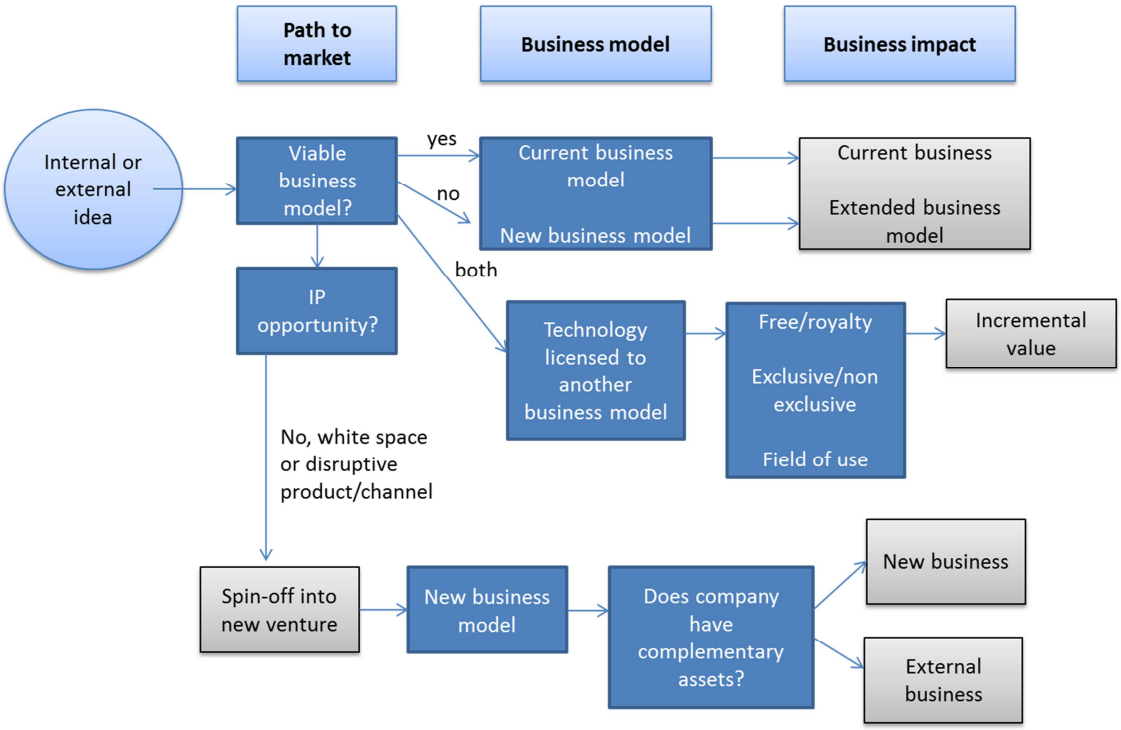

Figure 5: Alternative paths to market in the Open Innovation model[30]

In the Open Innovation model, there are mainly two ways of developing ideas and commercialize them to market: Exploitation of technology (inside-out) and exploration of technology (outside-in). In the following section, both ways will be explained, with their different options to get products to market. [31]

Exploitation of technology

It consists on the exploration of new ways of getting to market from inside the company to the outside. Companies can commercialize internal ideas through channels outside their current business in order to generate value for the organization. This way, companies can win revenue from in-house developed knowledge which are not interested in commercialize.

Firms can commercialize their in-house ideas outside the company through the following channels:

- *Startup companies, venturing, spin-offs*[32]: Ideas which would be sitting on the shelf in the old paradigm can be a source of revenues within the new model. Projects which do not fit with the business model of the company can be commercialized outside the company through new start-up or spin-off companies, normally financed with venture capital. These new ventures created in the company might decide not to commercialize a technology either. In that case, the technology would be available for external licensing to other companies which would be interested in developing the technology.[33]

[30] (Chesbrough, 2003: 188)
[31] Cf. (van de Vrande *et al.*, 2008: 7)
[32] Cf. (van de Vrande *et al*, 2008: 8)
[33] Cf. (Chesbrough, 2003: 55)

- *Licensing*[34]: Spin out intellectual property that was internally developed but that did not fit with the firm business model and that it would be better developed by others. It is an alternative channel for unlocking the economic value of unused patents by making the rights available to organizations that may have a greater interest in exploit the invention. [35]

  Smaller firms are more likely to license due to the lack of complementary downstream assets and the smaller risk of the licensee becoming a potential competitor. There are several factors which tend to affect positively in licensing agreements: the closer the technological profiles of the firms, the closer the market profiles of the firms and the more familiar they are with each other through prior agreements. [36]

Exploration of technology

It consists on the exploration of new ways to get to market from outside the company to the inside. Globalization broadens the choice of potential partners and new global innovation networks are created. Co-operation is now seen as a way of sourcing knowledge in order to generate new ideas and bring them quickly to the market. Companies cannot now wait to make all the research on their own, as customers are not going to wait for new products to come. Thus, they must get access to a technology as soon as they need it. [37]

The exploration of technology can be carried out through the following channels[38]:

- *Outsourcing* of technology and knowledge from outside partners like universities, research organizations, competitors, suppliers and customers. Participation of external actors in order to get a technology as soon as it is needed

- *Alliances* with external parties to share costs or resources

- *Joint ventures* with third parties to share costs and resources, normally financed by venture capital

- *Buying IP* from external parties to supply the lack of resources of the company

The ways to get to market in the Open Innovation paradigm previously exposed are summarized graphically in Figure 6. It can be concluded that Open Innovation opens the way to an Inter-organizational networking: R&D alliances between non-competing firms are created in order to get value. Companies must search for optimal network configurations, which can be the participation in new or existing companies, or even the collaboration with competitors. [39]

[34] Cf. (van de Vrande *et al.*, 2008: 8)
[35] Cf. (de Backer, López-Bassols & Martínez 2008: 29)
[36] Cf. (de Backer, López-Bassols & Martínez 2008: 30)
[37] Cf. (Chesbrough, 2003: 53)
[38] Cf. (van de Vrande *et al.*, 2008: 8)
[39] Cf. (van de Vrande *et al.*, 2008: 10)

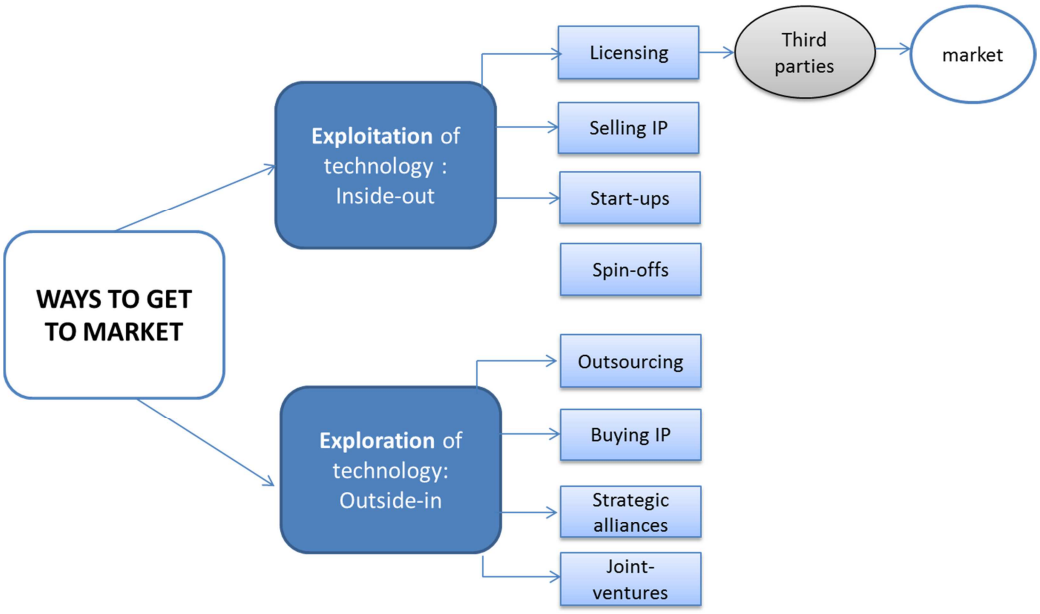

Figure 6: Ways to get to market according to the Open Innovation paradigm

Figure 7 shows the widening of the boundaries of the firm, and how the exploitation and exploration of external technologies fulfill the gaps of the in-house performance of the company. It is observed that in-house research projects can get to market as well as external technologies developed by third parties. The company no longer must carry out the whole R&D to profit from a technology.

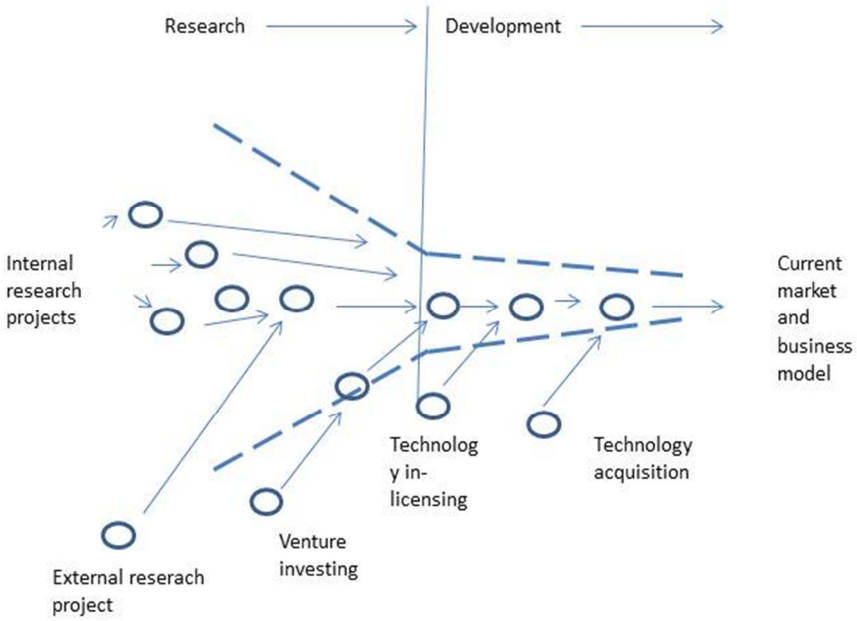

Figure 7: Extension of the limits of the firm in the Open Innovation paradigm. [40]

Now, an analysis of the different ways to get to market in the Open Innovation paradigm through an Ansoff's Matrix will be developed. This analysis will be useful to create an overview of the growth possibilities of the firm, and to analyze where the different ways of getting to

[40] (Chesbrough, 2003: 183)

market proposed by the Open Innovation model are, regarding product and market place. The matrix is exposed in Figure 8 and it is composed of four sections, which will be subsequently described:

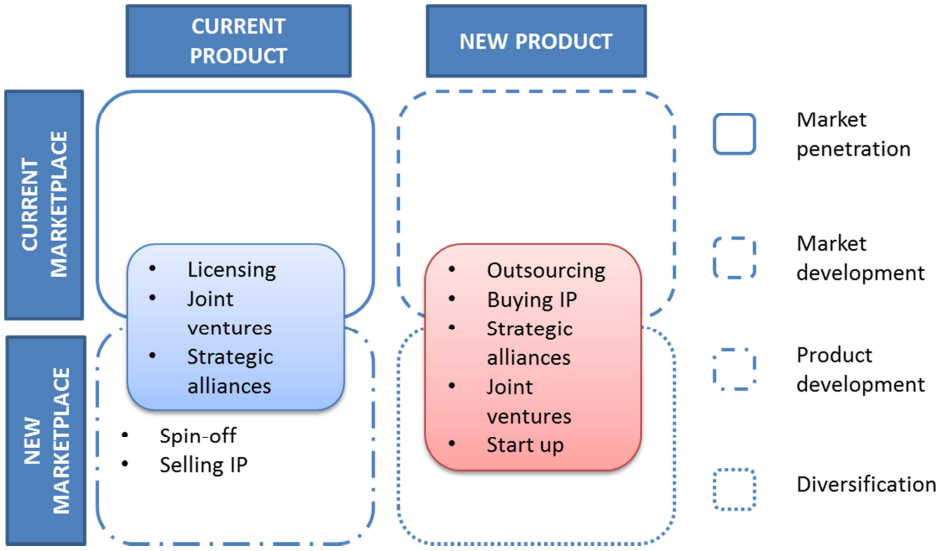

Figure 8: Ansoff's Matrix

- In the market penetration area, companies grow by the introduction in the current market with a current product. It is the case of joint ventures or strategic alliances, which companies turn to, to share costs and obtain the necessary economic resources in order to develop a current product in the current market.

- Market development is referred to the incorporation of a current product in a new market. It is the case of the spin-off companies, which emerge from inside the company to develop a product which the firm is not interested in commercialize. Selling IP also belongs to this sector, as a current product or technology of the firm is sold to third companies because the company is not interested in commercialize it. Strategic alliances and joint ventures can develop a current product in a new market as well.

- Product development and Diversification are referred to the incorporation of a new product to the current market place and the introduction of a new product in a new market place, respectively. In this case of study, the Open Innovation initiatives exposed belong to both sectors. In the case of outsourcing, a company acquires knowledge, product or technologies from third parties and can develop them later on in the same market place it was already focusing, or in a new one. It is also the case of strategic alliances or joint ventures, which the company can turn to in order to obtain some economic resources and develop new products in current or new markets. Start-up companies follow the same dynamic, as they arise to develop a new product in the current or a new market place.

After having analyzed the different ways the Open Innovation model proposes to get to market, in the following section, there will be exposed an analysis of the importance of

applying the Open Innovation model to all stages of the product or technology development in order to carry out a successful performance.

2.2.5- Open Innovation in the different stages of the product or process[41]

To make the most of Open Innovation, companies should integrate it into all stages of activity, from early-stage product ideation and R&D to late-stage marketing and sales.

Figure 9 shows the single steps of the product life cycle.

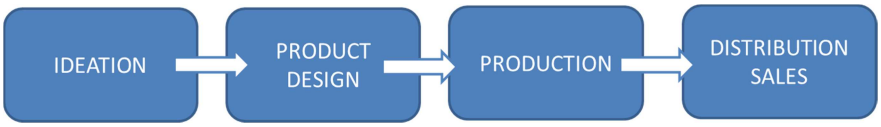

Figure 9: Product life cycle

In the *ideation* step, the conceptualization of new products and services is carried out. Open Innovation can have a big impact in this step, as disruptive technologies often come from thinking outside the box.

The following step, the *product design* is the sweet stop for Open Innovation. It is the phase where more discrete technical problems arise and require solutions. It is also the step where more collaboration between the firm and third parties (customers, suppliers, universities, competitors…) is needed, favoring networking and external collaborations.

The *production* step is the opportunity for suppliers to contribute to innovation. Often these innovations lead to reduced production costs or manufacturing flexibility.

Some of the most innovative products and services achieve their success at the last step, *distribution and sales*, which is composed of shipping, sales channel, strategy and merchandising.

Although a proper application of the Open Innovation practices in all the phases above mentioned is important to achieve innovative results at the end of the chain it is usually complicated to develop, due to the high costs implied. This is the reason why it takes place mainly in the early stages of a product or technology, without going further in the next steps. However, a more innovative practice in all stages of the product or technology is recommended in order to analyze all steps under an innovative performance and achieve better results at the end of the chain.

In the next chapter, the importance of a solid business model within the company will be argued. The capability of the company to choose the proper business model and to see beyond its actual business model will be crucial to get products to the market and to face new business opportunities.

[41] Cf. (Blackwell & Fazzina, 2008: 5)

2.3- Business model

The Open Innovation model claims that technology by itself has no inherent value. That value only arises when it is commercialized through a business model. The business model will permit to identify which missing pieces must be internally supplied and how to integrate both internal and external pieces together into systems and architectures. [42]

The different ways to capture value from a new technology are shown in Figure 10. The new technology can fit with the current business model and then be commercialized through it. On the other hand, if the new technology does not match with the current business model, there are two possibilities: either it is licensed to other firms which would do a better use of it, or it is launched to the market by a start-up company.

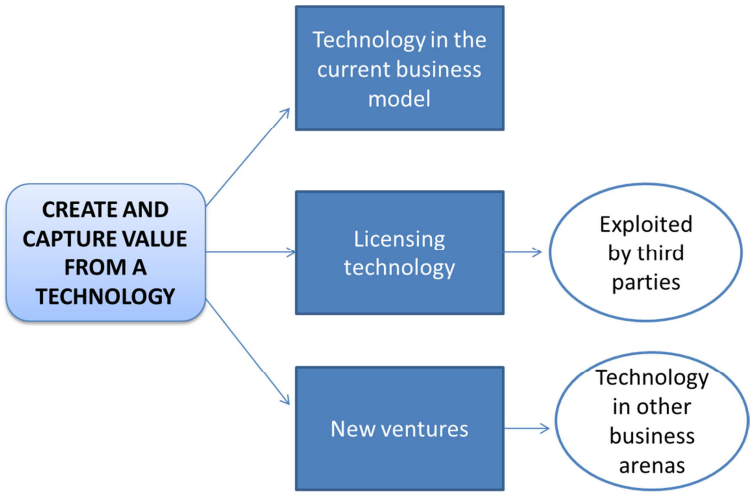

Figure 10: How to create and capture value from a new technology

The business model is composed by the following aspects[43]:

- Value proposition: Definition of the customer problem to solve.
- Market segment: Definition of the customers to target. Until there is not a focus on the customers the problem cannot be completely defined as it is not possible to know what to provide.
- Value chain: The objective is to deliver value to the customer at the end of the chain. The company must also be able to claim some part of this value to justify its participation. This is possible through the internal R&D.
- Cost structure and target margins: Definition of how much is the customer willing to pay for the product or service.
- Value network: Role that suppliers, customers, and third parties play in influencing the value captured from the commercialization of an innovation. Building strong connections to a value network can leverage the value of a technology. Failure to construct such value network can diminish a technology's potential value.
- Competitive strategy: Definition on how to compete strategically: cost, differentiation…

[42] Cf. (Chesbrough, 2003: 63-64)
[43] Cf. (Chesbrough, 2003: 64-65)

Figure 11 shows the business model as a cognitive map. The firm's realization of economic value from its technology depends on its choice of business model, rather than from some inherent characteristics of the technology itself.

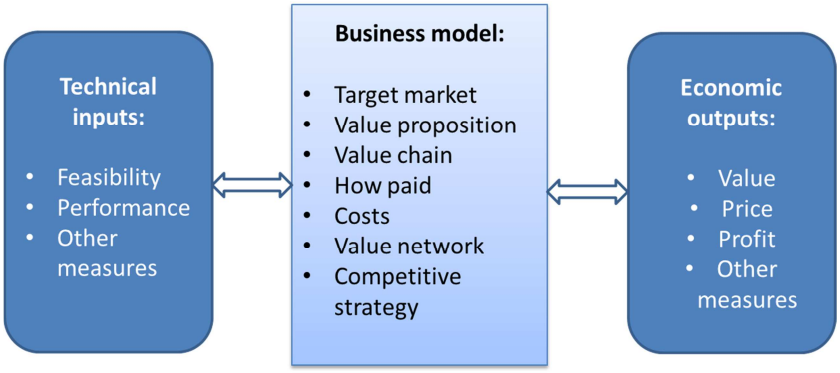

Figure 11: The business model scheme[44]

It is probable that a firm misses a better business model because it conflicts with the firm's current model. The more successful the business model of the firm has been in the past, the more attached the firm is to it, and the harder to recognize the information that may point the way to a different and perhaps better model. [45] A company focused too internally is prone to miss a number of profit opportunities because many of them will fall outside the organization's current business or will need to be combined with external technologies to unlock their potential. [46]

It can be finally concluded that in the new paradigm, companies must be aware to recognize possible future business models which can fit better with their technologies, instead of rejecting these technologies because they do not match in the first place with the current business model of the company.

In the next chapter, an overview of how the management in Open Innovation should be developed is given. To carry out an adequate innovative performance, managers must be trained in innovation and innovation practice must be seen as an independent part with special treatment within the strategy of the company.

2.4- Open Innovation management

Open Innovation management requires qualification and knowledge. It is necessary to understand the true needs, strengths, weaknesses and overall, the technology position of the company.

Some companies which try to apply an Open Innovation model fail in their attempt. Some of the reasons which can justify this failure are[47]:

[44] (Chesbrough, 2003: 69)
[45] Cf. (Chesbrough, 2003: 183)
[46] Cf. (Chesbrough, 2003: 37)
[47] Cf. (Blackwell & Fazzina, 2008: 2-3)

- The not-invented-here syndrome: It refers to the refusal to buy or use existing products or technologies from external sources. Some companies still believe that they have the enough know-how to carry out in-house discoveries and show their refusal to profit from external discoveries. This performance faces the Open Innovation paradigm, which claims that external sourcing can be used as a way to get to market by profiting from out-house R&D, carrying out at the same time some in-house R&D to get a portion of the value at the end of the value chain.

- Poor management focus and endorsement: The lack of qualification of managers in innovation practices can lead to a bad performance of Open Innovation. Some basic qualities must be required in innovation managers: risk-taking, networking and collaborative attitude is crucial for the successful application of the Open Innovation paradigm. Another problem related to the poor management of innovation within the companies is that the initiative of the innovation management is usually limited to one individual person, or a very few people, who usually have other responsibilities, which does not allow them to focus on innovation management as an independent duty with special treatment.

- Lack of process for finding, vetting and leveraging outside sources of innovation: Lack of external contacts and resources as companies sometimes rely too much in their internal know-how, rejecting the networking possibility. This is especially remarkable in Small and Medium size Enterprises, which normally due to their autonomous performance they have few external contacts. This fact will be exposed in detail in the following sectors of the project, which will especially focused on SMEs in the engineering sector.

- Concerns about intellectual property rights: Some companies are still reluctant to be active buyers or sellers of IP as they are still attached to the past paradigm, where IP was seen as a key factor to protect and was used as a competitive advantage towards innovation. However, Open Innovation claims for the use and profit of external as well as internal IP. If the company carries out a discovery which is not interested in commercialize, it can be licensed outside the firm to other companies which can get profit from it. In the other way round, the company can also become an active buyer of outside IP and profit without research.

- Normally, companies only focus their open innovation efforts at very early stages of implementation: Some companies apply the Open Innovation model only in the early stages of the product. Innovation should be a continuous process and it should take part in all the stages of the product or process in order to be successful and achieve valuable results at the end of the value chain.

- Few companies have a point of contact whose principal function is innovation implementation: Sometimes innovation is not seen as a task by itself in the company. This leads to bad practices of innovation, carried out but not qualified personnel.

Definitely, the challenge in the Open Innovation practice is to identify what changes in perspectives and practices are needed to open and keep open, those flows. It is not just about outsourcing R&D or buying technology, instead it is about building a portfolio of deep relationships and networking to provide access to technology, meeting technology needs and capture related opportunities. [48]

In the next chapter, the future paths towards the evolution of the Open Innovation model are going to be described in detail. The Open Innovation model is in continuous growth, as new demands according to companies are appearing, thus the new paradigm must adapt to these new requirements and evolve with them.

2.5- Future trends in the Open Innovation paradigm

Open Innovation is still growing and evolving in new and different streams. The character and requirements of the companies are changing and the Open Innovation paradigm must redefine its action lines to be suitable and applicable in the new situations. In the following chapter, some new streams towards the Open Innovation model is evolving are going to be described.[49]

Industry penetration

The first aim of the Open Innovation paradigm towards outsourcing was providing the company of resources it was lack of, reducing overcapacities, cutting costs and reducing risks. Subsequently, the vision is changing and outsourcing in Open Innovation is seen as a fundamental way of enhancing the value creation in the value chain.

Size: From large companies to SMEs

Traditionally, the Open Innovation paradigm has been applied to big companies which had enough resources and budget to carry out networking and collaborative alliances with other companies, universities and research centers. The Open Innovation practices were not so often applied in Small and Medium size enterprises as they have some inherent problems according to their size and lack of economic resources which led to an autonomous and traditional innovation performance. Moreover, during years, the competitive advantage of SMEs was to protect and leverage their intellectual property, unable competitors to profit from it.

However, nowadays the trend is changing and the number of SMEs applying the Open Innovation model is enhancing. In order to face the new challenges the business environment establishes, which are characterized by high competition and globalization, SMEs must adopt an innovative strategy to remain competitive and survive. By collaborative networking and creating alliances with third parties, they are able to make up for some of their limitations in resources, research and development and intellectual property. A proper training of managers of SMEs in the Open Innovation practice can lead these companies to achieve many successful results.

[48] Cf. (Hastbacka, 2004: 2)
[49] Cf. (Gassmann, Enkel & Chesbrough, 2010: 215-217)

The study of how the Open Innovation model can be applied in Small and Medium size Enterprises will be exposed in detail through the content of this project, in the section “Open Innovation in SMEs within the engineering industry”.

Processes: From stage gate to probe-and learn

There is a new trend to more iterative and interactive probe-and-learn processes, which support the Open Innovation practice, as these processes imply an early interaction with customers, suppliers and R&D partners.

Structure: From autonomous management to alliances

Traditionally, most companies tried to develop technologies by their own, avoiding competitors to profit from their discoveries and considering their intellectual property and researches as a competitive advantage.

However, modern technology is becoming so complex that even large firms cannot afford to develop it by their own, without any help. A vertical management of R&D is no longer possible even in large firms, thus partnerships and collaborations between third parties are necessary to carry out the researches.

Intellectual property: From protection to partnering

In the traditional model, Intellectual Property was protected from competitors and was used as a competitive advantage against them. With the appearance of the Open Innovation model, intellectual property started shifting to the concept of intellectual partnership. Patents are there to create incentives for inventors and entrepreneurs to invest in innovations.

Nevertheless, this is still a problematic topic in the Open Innovation paradigm. The determinants of successful tradable patents still need to be identified. There are still some gaps in the definition of how much is the profit from patenting or how much should be the investment on it in order to get something of commercial value. Some minimal protection in intellectual property is also essential. Balancing risk-taking and promoting cumulative innovation are challenging social questions which companies must still face.

Figure 12 shows graphically how the trends are evolving in the Open Innovation paradigm.

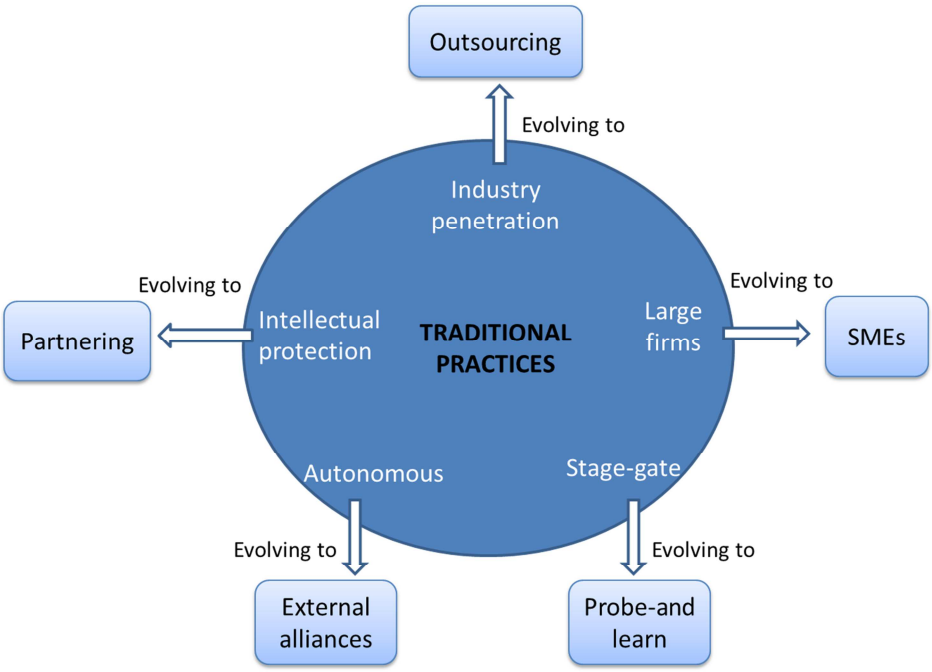

Figure 12: Future trends in the Open Innovation paradigm

After having analyzed the different aspects and characteristics of the Open Innovation model and in order to conclude with this first part of this project, in the following chapter some conclusions about the principal action lines of the Open Innovation paradigm are going to be exposed.

2.6- Conclusions

A study of the main characteristics of the Open Innovation model has been already exposed in the previous chapters of the project. According to them, the following conclusions according to the paradigm come up:

- *The boundaries of the firm are no longer restricted:* The Open Innovation paradigm claims that the limits of the firm can be gone through as companies should make use of external and internal ideas as well as external and internal paths in order to get to market. The combination of both external and internal flows will lead to new channels and ways of commercialization of technologies, and thereby new possible profit opportunities for the company.

- *Networking becomes a basic performance in the innovation practice:* Open Innovation claims for a collaborative attitude with external parties such as third companies, universities and research centers. With these collaborations, costs and resources can be shared and thus, reduced. The lack of resources of some companies can be made up for with external agreements and collaborations.

- *Outsourcing is seen as a new way to get to market*: Outsourcing is understood as a way of getting products to the market, by profiting from a technology which has not been developed inside the company. Companies should get access to technologies as soon

as they need them, instead of waiting to develop all by their own in a vertical way. The product life cycle shortens and customers are not going to wait forever to get a technology, and competitors are not going to make them wait either.

- *Some Internal R&D in the company is necessary to get some value:* Profit from external R&D is a key factor in the Open Innovation paradigm, but internal R&D is needed in order to get some portion of the value in the value chain. The Open Innovation model claims that companies should be active buyers and sellers of R&D, which faces the traditional performance which pled for a protection of the in-house discoveries.

- *A solid business model is essential for getting products to market:* The business model plays a fundamental role as it selects the products and services to focus on. The technology only acquires value the moment it is commercialized through a business model, as it has no inherent value by itself. The company must have the vision to adapt to future business models which can fit better its characteristics, as many products or ideas can be rejected in the first place because of not being suitable with the business model of the company and thereby, many profit opportunities can be lost.

- *Companies should be active sellers and buyers of Intellectual property:* In the Open Innovation paradigm, the concept of Intellectual Property shifts to Intellectual Partnering. In the old paradigm, Intellectual Property was seen as a key factor to protect from competitors. However, in the Open Innovation paradigm, companies become active buyers and sellers of technology. Companies can benefit from others' technologies by buying IP from third parties, as well as licensing their own discoveries in case they do not want to commercialize them. Internal and external flows can allow the exchange of knowledge with the market and companies must be active buyers and sellers of technology.

- *Belief that not all the valuable knowledge lies in the company:* The Open Innovation model claims for a collective intelligence. External knowledge is as important as internal knowledge. The combination of both flows of knowledge will lead to the best way of commercialization of technologies.

- *Companies must be aware of the risk of the innovation practice:* An Open innovation performance requires a certain investment without knowing any outcome. There is always the risk of harming the company through an Open Innovation strategy. Thus, the adoption of an Open Innovation strategy is connected with a certain unknowable risk, which requires a certain risk acceptance of the company executives[50]

- *Managers must be trained in the innovation practice:* To carry out a successful management of Open Innovation, managers must be qualified in the field and be innovative as well. The more innovative the manager is, the more innovative he will be

[50] Cf. (de Backer, López-Bassols & Martínez 2008: 7)

when it comes to the definition of the innovation management process and formulation of innovation strategies.[51]

Figure 13 graphically shows the conclusions previously established as the most relevant in the Open Innovation practice.

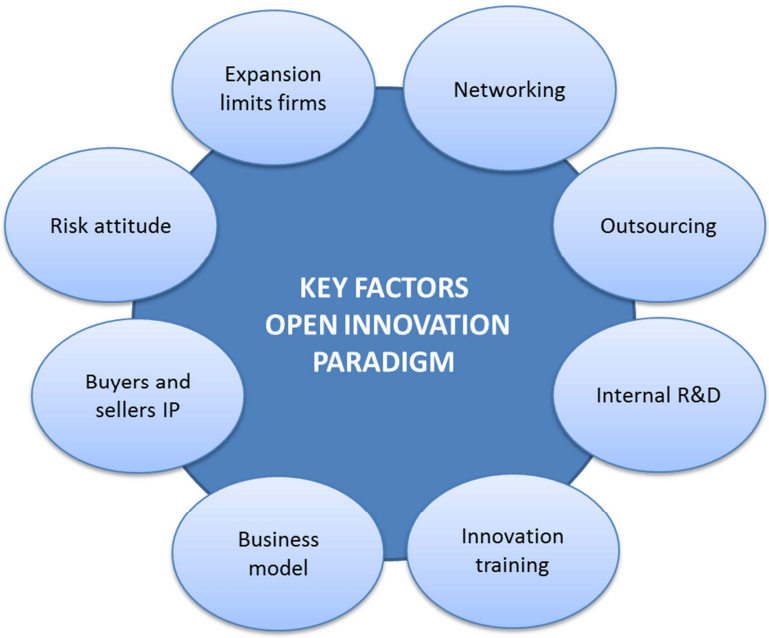

Figure 13: Open Innovation factors

In the next section of the project "Small and Medium-sized enterprises in the engineering sector", the general action lines of SMEs and specially of engineering SMEs will be analyzed. It will be the starting point in order to understand which problems and characteristics we are facing and in order to search for solutions for an improvement of their performance.

[51] Cf. (de Backer, López-Bassols & Martínez 2008: 7)

3- Small and Medium-sized Enterprises in the engineering sector

Micro, Small and Medium-sized Enterprises (SMEs) play a central role in the European economy. They are a major source of entrepreneurial skills, innovation and employment.
In the enlarged European Union of 25 countries, some 23 million SMEs provide around 75 million jobs and represent 99% of all enterprises.[52]

These SMEs are the backbone of the economy in Europe, and supporting them is one of the main priorities of the European Commission for economic growth, job creation and economic and social cohesion.

However, SMEs have some inherent limitations due to their size and lack of economic and financial resources which lead sometimes to a complicated, limited or even inexistent innovation practice within the company. In this third part of the project, a detailed analysis of the characteristics, strengths and weaknesses of SMEs will be carried out. This analysis will be subsequently necessary to detect which limitations they have in the innovation performance and how these limitations could be supplied with the Open Innovation model, which study will be carried out in the fifth part of this project, "Open Innovation model applied to SMEs within the engineering industry".

The content of this third part of the project is the following: chapter 3.1 contains a classification of Small and Medium size enterprises according to the new definition of SMEs established by the European Commission. It is important to identify how SMEs are classified, in order to establish an overview of their general characteristics.

In chapter 3.2, a general analysis of strengths and weaknesses of SMEs will be exposed. This study is necessary to understand their general action lines and limitations and to have a general vision of the problem we are facing.

In chapter 3.3, the analysis will be focused on engineering SMEs, which are the specific subject of the study of this project. Manufacturing SMEs must face some particular challenges: the increasingly and competitive demanding markets, the changing globalization, the advances in technology and the reduction of lead times. The general characteristics of the SMEs in the engineering sector will be analyzed to create the basis for the main objective of study of this project: improve the innovation practice of engineering SMEs by the application of the Open Innovation paradigm.

Finally, in chapter 3.4 some conclusions about the general actuation lines of engineering SMEs will be exposed, according to the analysis carried out in the previous chapters.

[52] (European Commission, 2005: 5)

3.1- General classification of Small and Medium size enterprises

To understand the problem we are facing, it is important to make a general classification of the characteristics of Small and Medium size enterprises. There are many criteria to classify them, but according to the new SME definition established by the European Commission on 1st January 2005 (Figure 14), the classification is as follows:

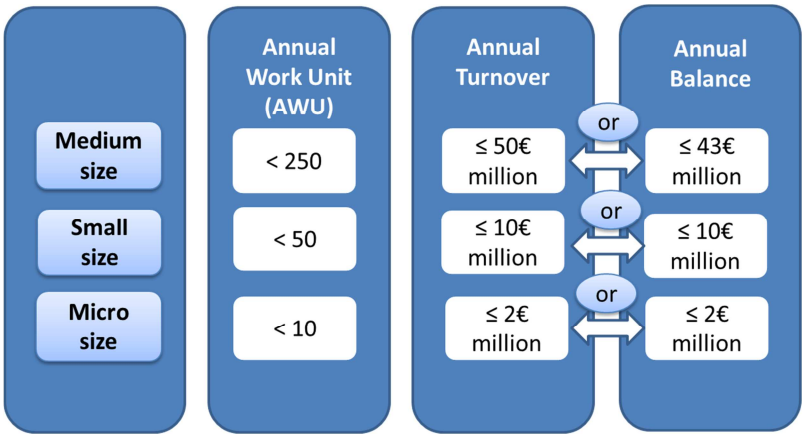

Figure 14: Classification of SMEs[53]

The principal criterion which is going to be used in order to classify them is the Annual Work Unit, mainly due to its easiness to be determined. The account of the Annual Work Unit includes full-time, part-time and seasonal stuff[54]:

- employees,
- persons working for the enterprise being subordinated to it and considered to be employees under national law,
- owner-managers
- And partners engaged in a regular activity in the enterprise and benefiting from financial advantages from the enterprise.

3.1.2- Statistics of companies according to the size in European Union-26 (EU-26)

As it was already mentioned, SMEs represent the backbone of the economy in Europe, as the big majority of enterprises within the EU attend the classification of SMEs. Figure 15 corroborates this fact, showing a statistical study of the percentage of SMEs and large enterprises in the EU-26, according to the European Commission:

[53] (European Commission, 2005: 14)
[54] (European Commission, 2005: 15)

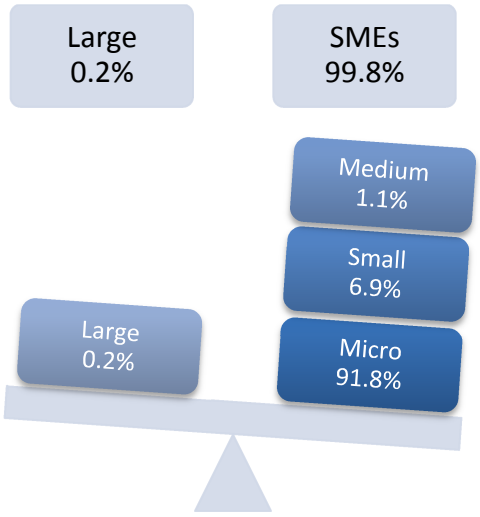

Figure 15: % Number of enterprises in the EU-26 Average (2005)[55]

It can be observed how the big majority of enterprises in Europe are SMEs, while large enterprises represent only the 0.2% of the business environment. This fact supports the necessity of paying special attention to small and medium size enterprises, as they constitute the basis for the European Economy.

In the next chapter, an overview of the general characteristics of SMEs will be exposed. It will constitute the basis to understand which strengths these enterprises have and which limitations they must face.

3.2- General characteristics of Small and Medium size enterprises

In both developing and developed countries, SMEs play important roles in the process of industrialization and economic growth. Apart from increasing per capita income and output, SMEs create employment opportunities, enhance regional economic balance through industrial dispersal and generally promote effective resource utilization considered critical to engineering economic development and growth. [56]

3.2.1- Analysis of the strengths of SMEs

Small and Medium size enterprises have some inherent strengths and advantages in comparison with large companies. It is important to be aware of the strong points of these companies in order to maintain them or improve them, as they can also be competitive advantages against competitors.

STRENGTHS[57]	
• Closeness to customers	Better development and understanding of their particular requirements through interaction and involvement with their customers.

[55] (European Commission, 2008: 1)
[56] Cf. (Migiro & Wallis, 2006: 3)
[57] Cf. (Salavou, Baltas & Lioukas 2004: 1092-1093)

• Flexibility and adaptability	Flatter structures, more informal management approaches than large firms. Adaptability to customer needs and requirements.
• Strategic orientation	More focused on customer's problems.
• Cross-functional working	Teams formed by people from different departments. Less unidirectional flow of information. On the other hand, SMEs cannot sometimes afford another way of working as they have limited number of employees and in some cases they have to develop several different works at the same time.

3.2.2- Analysis of the weaknesses of SMEs

It is obvious that Small and Medium size enterprises are lack of some economic, financial and labor force resources mainly due to their size. In the following table, the weak points of SMEs are going to be analyzed, in order to be aware of their limitations and study how to improve their weaknesses.

WEAKNESSES	
• Limited purchasing power of customers[58]	Excessive reliance on few customers. If they lose contact with one of their clients, it will lead to high loses for the firm.
• Excessive administrative regulation[59]	Administrative regulations and bureaucracy complicate the action performance of SMEs. Among the administrative regulation problems SMEs must face, it is worth highlighting the communication problems with authorities, complicated provisions and procedures and the regulatory obligations.
• Few availability and high costs of appropriate human resources[60]	Lack of economic resources or incentives to keep qualified personnel in the firm. They are constrained in hiring and maintaining high qualified labor force.
• Few exportation performance[61]	Few attitudes towards exporting due to their traditional autonomous performance. They are also limited in exportation due to the import tariffs of the destination countries and their lack of capital. European SMEs tend to rely more on EU internal markets due to the importance of the EU-wide harmonized standards.
• Lack of knowledge of foreign markets[62]	Autonomous and vertical action lines within the SMEs which lead to an ignorance of external practices and of the business environment.
• Few foreign business partnerships[63]	Due to the lack of knowledge of foreign markets already mentioned, the external connections are

[58] Cf. (European Commission, 2007: 5)
[59] Cf. (European Commission, 2007: 5)
[60] Cf. (European Commission, 2007: 5)
[61] Cf. (European Commission, 2007: 15)
[62] Cf. (European Commission, 2007: 5)
[63] Cf. (European Commission, 2007: 17)

	almost inexistent and few SMEs (only 5% of SMEs in the EU-27 during the year 2007)[64] perform this type of alliances.
• Scarce of resources[65]	Due to their size and their economic restrictions, they cannot compete with large firms in investment or equipment.
• Skepticism towards formal training[66]	Belief inside the company that training is not necessary as it is enough with the in-house knowledge of the firm. Training takes also time and money to carry it out, that is why some SMEs are not willing to introduce it.
• Need of flexibility[67]	Excessive dependency on customers, which limits the SMEs performance.
• Inability to develop significant R&D activities or implementing new technology[68]	Lack of economic resources to invest in technology or equipment and lack of in-house knowledge to carry it out.
• Incapability to hire non-local labor	The larger the firm, the more likely it is to hire non-local labor. SMEs are limited by their size, economic difficulties and ignorance of external sources and markets.
• Constriction in affording high investments in product technology[69]	Lack of economic resources. This situation may force SMEs to seek innovations along the value chain that require less capital investment and lesser reliance on qualified staff.
• Constriction in some strategic alternatives[70]	Limited due to their size. This situation may force SMEs to seek types of innovation that larger firms cannot provide and use it as their competitive advantage.
• Poor skills and knowledge acquisition through training[71]	Not qualified personnel at first instance. Some SMEs cannot afford the training due to economic reasons or lack of resources and some of them do not find it necessary.
• Poor learning attitude[72]	Due to their autonomous and insular tradition, belief inside the company that they can develop everything in-house, without turning to learning or external sources.
• Limited external contacts[73]	Managers are not used to collaborations or networking. Insular vision of the company and not awareness of environmental changes, which can lead the firm to lose their market place.
• Poor management skills and lack of quality management[74]	Managers tend to do many different works, without focus. Usually they are not well qualified for the innovation practices and they are lack of risk-taking attitude.
• Inability to implement new forms of	Due to a poor management performance, SMEs lack in

[64] Cf. (European Commission, 2007: 17)
[65] Cf. (Mc Adam, *et al.,* 2007: 386)
[66] Cf. (Mc Adam, *et al.,* 2007: 386)
[67] Cf. (Mc Adam, *et al.,* 2007: 386)
[68] Cf. (Salavou, Baltas & Lioukas, 2004: 1093)
[69] Cf. (Salavou, Baltas & Lioukas, 2004: 1093)
[70] Cf. (Salavou, Baltas & Lioukas, 2004: 1093)
[71] Cf. (Laforet & Tann, 2006: 363)
[72] Cf. (Laforet & Tann, 2006: 363)
[73] Cf. (Madrid Guijarro, García & van Auken, 2009: 467)
[74] Cf. (Jayawanar, Mcpherson & Wilson, 2006: 24)

organization	their attempt of adapting their business to new forms of organization.
• Limited access to credit and financial services[75]	Due to their size and economic difficulties they have no alternative ways of financing what leads to poor investment in personnel or technical equipment, among other problems.

Among the weak points which have been mentioned above, Figure 16 shows a percentage comparative with the most important weaknesses which SMEs in the European Union-27 must face. According to a study developed by the European Commission during the years 2005 to 2007, the three more remarkable difficulties SMEs in EU-27 afford are the problems with the purchasing power of customers, the problems with administrative regulations and the lack of skill labor.

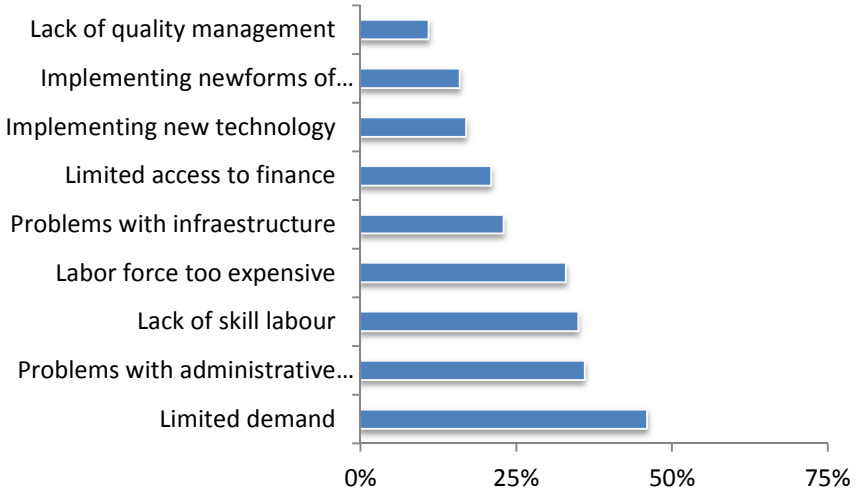

Figure 16: Percentage of Difficulties/problems encountered by SME's during 2005-2007[76]

Through this chapter, a general overview of the most important strengths and restrictions of SMEs has been analyzed. After having focused the problem in general lines, the following chapter is going to study SMEs in the engineering sector, which is the particular subject of study of this project. Understanding the general strong and weak points of these companies will establish the context for a possible improvement of their performance in innovation terms.

3.3- Small and medium size enterprises within the engineering industry

Manufacturing sectors in EU are submitted to a rapid transformation. The opening of markets and the expansion of global giants are changing the competitive landscape. In the new global business environment, engineering SMEs are being subjected to increased pressures and requirements for information and knowledge management, quality, flexibility and new organizational forms.[77]

[75] Cf. (Migiro & Wallis, 2006: 2)
[76] (European Commission, 20007: 8)
[77] Cf. (Salavou, Baltas & Lioukas, 2004: 1092)

One of the challenges manufacturing SMEs must face is to survive in the new competitive environment, with increasingly demanding markets, dramatic changes due to globalization, advances in technology and reduction of lead times. To overcome these challenges, SMEs must adopt a new performance, characterized by becoming more productive and efficient, which will require technology implementation. They also must be more innovative, which requires a high level of knowledge through learning and effective exploitation of that knowledge. This last point will be especially treated through the next chapters of this project, as the study will be specially focused on the innovation performance of engineering SMEs, trying to find solutions for their limited innovative performance by the application of the Open Innovation model.

Through the following section, a detailed analysis of the general characteristics of engineering SMEs will be carried out. Their strong points and weaknesses will be studied to establish the basis to understand which problems they must face according to their definition, and how their limitations can be overcome.

Subsequently in the other parts of the project, the innovation performance of engineering SMES will be in particular studied and an analysis of the availability of the application of the Open Innovation model will be exposed.

3.3.1- Analysis of the strengths of engineering SMEs

Engineering SMEs have some inherent advantages, which are going to be analyzed and can be important to identify possible competitive advantages against competitors

STRENGHTS	
• Product differentiation and multiple incremental innovations[78]	Due to their manufacturing character, product differentiation can be used as a competitive advantage to market.
• Closeness to customers[79]	Due to their limited size and external contacts, they normally have closer relationships with customers and better understanding of their requirements and needs. This leads to a fewer uncertainty in the development of projects.
• Informal environment[80]	Due to their size and number of employees, there is a less unidirectional flow of information. Less hierarchy and more risk-taking attitude as engineering SMEs are normally run by owners.
• Adaptability to customer's needs and requirements[81]	Bigger flexibility and closeness to customers, sometimes focusing on one single client.

3.3.2- Analysis of the weaknesses of engineering SMEs

[78] Cf. (Brophey & Brown, 2009: 328)
[79] Cf. (Laforet & Tann, 2006: 365)
[80] Cf. (Laforet & Tann, 2006: 365)
[81] Cf. (Laforet & Tann, 2006: 365)

On the other hand, manufacturing SMEs have also some weak points due to their size and limitation of resources. It is important to know which weaknesses we are facing, in order to look for possible solutions for them.

WEAKNESSSES	
• Value of patent protection is low for mechanically-based industries[82]	Intellectual property protection is normally broadly ineffective for mechanical assembled products. This group is less affected by jurisdictional effect resulting from differing intellectual property regulations.
• Engineering SMEs usually get to market through a single product[83]	In some cases, due to their size and their economic and financial restrictions, they cannot broad their product range even if this were considered strategically desirable.
• No possibility of investment in technology and equipment[84]	Due to economic reasons and lack of resources they are restricted in reaching new markets and affording new products or technologies. However, implementation and development of new technologies is basic for engineering SMEs to remain competitive against competitors, thus this is a remarkable weak point to analyze and improve.
• No possibility of investment in training [85]	They cannot enhance workforce skills due to lack of time or resources. On the other hand, training is seen inside the firms as a waste of time and they normally rely in their own in-house knowledge, instead of improving their personnel's skills. Training is one of the most important ways engineering SMEs have in order to reach competitive advantage and differentiation against competitors. Thus, this is also a remarkable weak point to analyze and try to improve.
• Customer dependency[86]	It is caused due to their limited size. It can have significant consequences on the R&D activities, productivity and profitability. It can cause a big impact on the development and risk levels of SMEs. As the firm responds to the needs of only a few customers, it can be quite vulnerable due to a higher level of business risk. A relatively small decrease in a major client's sales can entail a large decrease in the SMEs sales or an increase in demand for the client's product can force the small manufacturer to invest in added production capacity.
• Impossibility of developing products by themselves[87]	Technology is becoming more complex every time and even big companies normally cannot afford developing a new technology or product by their own, thus the case of manufacturing SMEs is much more dramatic. To face this limitation, collaboration with third parties is needed to carry out researches. On the other hand, old SMEs are not often opened to

[82] Cf. (Brophey & Brown, 2009: 328)
[83] Cf. (Laforet & Tann, 2006: 363)
[84] Cf. (Laforet & Tann, 2006: 364)
[85] Cf. (Laforet & Tann, 2006: 364)
[86] Cf. (Laforet & Tann, 2006: 372)
[87] Cf. (Laforet & Tann, 2006: 372)

	networking or collaboration due to their traditional autonomous management, their lack of external contacts and their overreliance in the in-house capabilities of the company.
• No recruitment of high qualified personnel[88]	Due to economic restrictions, SMEs cannot either manage to keep qualified personnel inside the firm. Labor force is one of the most important competitive advantages companies should develop in order to face challenges and competitors.
• Priority in recruiting external experienced staff than in training internally[89]	Poor attitude towards learning and training as it is often seen as a waste of time and resources. Due to their traditional and autonomous tradition, there is an overreliance in the firm capabilities.
• Unwilling to explore external sources of knowledge and collaboration[90]	Due to economic restrictions and their traditional autonomous character they try to develop everything in the firm in a vertical way. There is an overreliance in the firm's capabilities and knowledge. They are usually not aware of environmental changes, what can lead the firm to lose its market place
• Over-reliance on their internal know-how based on experience[91]	Due to their autonomous character and their vertical management. This fact leads to a poor attitude towards learning or training.
• Limited ambitions to grow[92]	They normally prefer to keep their market place instead of reaching new markets. Sometimes it is due to economic restrictions and other times due to a poor risk-taking attitude or lack of awareness of the business environment. This attitude can lead to lose of possible profit opportunities due to their growing limitation.
• Low investment in innovation[93]	Due to economic restrictions and lack of resources, they cannot afford investments in product or technology innovation, as well as they cannot provide the necessary training in innovation to the managers in charge.
• Poor management skills[94]	Managers tend to do all the work and are not always enough qualified. Low risk-taking attitude when the company is not run by the owners, due to the fear of being laid off.
• Limited internationalization and exportation [95]	Poor options to grow due to economic reasons or lack of resources. Few external contacts, autonomous and vertical management
• Higher competition of Asian markets[96]	SMEs must adopt strategies to be competitive and look for differentiation against these competitors.
• Difficult to be creative due to cultural and historical constraints[97]	Poor innovation attitude in traditional companies with a vertical autonomous management. Low capability of analyzing their own capabilities and of trying new

[88] Cf. (Laforet & Tann, 2006: 376)
[89] Cf. (Laforet & Tann, 2006: 376)
[90] Cf. (Laforet & Tann, 2006: 376)
[91] Cf. (Laforet & Tann, 2006: 376)
[92] Cf. (Mosey, Clare & Woocock, 2002: 176)
[93] Cf. (Madrid Guijarro, García & van Auken, 2009: 467)
[94] Cf. (Madrid Guijarro, García & van Auken, 2009: 467)
[95] Cf. (Madrid Guijarro, García & van Auken, 2009: 467)
[96] Cf. (Madrid Guijarro, García & van Auken, 2009: 468)

	possibilities, what can lead to a possible loss of profit opportunities.
• Loose division of labor[98]	Especially managers tend to do cross-functional work, covering many areas without focus. Specialization promotes focus and innovation.
• Minimal use of planning, training and liaison devices[99]	Inefficient management performance due to their incapability to hire enough qualified personnel and their incapability to provide the necessary training on the field.
• Manufacturing sector characterized by intense global competition, rapid technology changes and product variety proliferation[100]	The expansion of Asian markets and the competition of the manufacturing firms which arose in Eastern Markets have changed the business landscape. There is an increased competition which engineering SMEs must face through innovation, which will be the key factor for their survival and to maintain the competitiveness in the market place.

In the following chapter, some conclusions regarding the characteristics previously analyzed will be exposed.

3.4- Conclusions

As it was already described during the third section of the project, SMEs constitute the backbone of the European economy, as the majority of companies in the EU-27 attend the classification of Small and Medium size enterprises. Thus, it is essential to understand their limitations and strengths, in order to be able to improve their performance, which is basic for the stability of the European economy. In previous chapters, the general characteristics of SMEs and in particular of the SMEs in the engineering sector have been analyzed. It was important to establish the basis in order to know which problem we are facing.

According to general characteristics of SMEs, some aspects must be pointed out:

- Due to their limited size and resources, SMEs must face some problems, among them, the most important can be considered the ones related with the limited possibilities of reaching new customers, the administrative regulations problems and the problems related with the labor force (incapability to maintain, hire and train employees)

Focusing on engineering SMEs, we can conclude that in order to survive in the new changing environment, they must adapt their performance to the new business landscape that is emerging and which is characterized by: globalization, high competition, advances in technology and reduction of lead times. They must reinvent their strategy to face these new challenges. After having analyzed their characteristics, strengths and weaknesses, some conclusions can be exposed:

[97] Cf. (O'Regan, Ghobadian & Sims, 2005: 45)
[98] Cf. (O'Regan, Ghobadian & Sims, 2005: 45)
[99] Cf. (O'Regan, Ghobadian & Sims, 2005: 46)
[100] Cf. (Laforet, 2009: 188)

- They have some inherent strong points due to their size, such as closeness to their clients, better understanding of their requirements, and more flexibility to their requests.

- On the other hand, they must face some problems which limit their performance to the new challenges. The most relevant weaknesses can be summarized as follows:
    - Incapability of investment in technology or equipment, which should be one of the most important competitive advantages of engineering SMEs
    - Incapability to hire qualified personnel, which is also considered as one of the most important competitive advantages of engineering SMEs
    - Increasing global competition
    - Incapability of investment in training which leads to poor management and labor skills

The study of these problems and the analysis of how to improve them will be essential in order to face the challenges before exposed and to reach a competitive performance in such a competitive and changing environment.

To conclude and to summarize what was above explained, Figure 17 shows graphically the conclusions already exposed. On the one hand, it shows the common problems SMEs and engineering SMEs must face, and on the other hand it shows the particular problems engineering SMEs must overcome due to their specific definition.

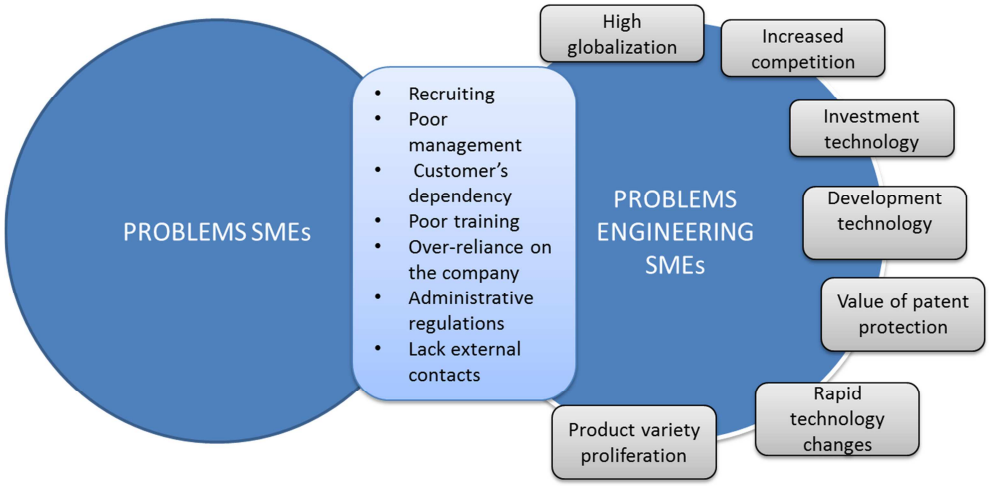

Figure 17: Common and particular problems in engineering SMEs in comparison with traditional SMEs

4- Traditional innovation practices in manufacturing SMEs

The European globalization in the manufacturing sector has increased the level of competition in all sectors, and firms which do not have the resources or which are not able to adapt to the new changing conditions, disappear. In this changing environment, innovation becomes a key factor in competitiveness and SMEs have to find innovations to survive.

The importance of innovation is also enhanced by the shortening of the product life cycles, the increased technological capabilities of firms and the rapidly changing customer demands.[101] Small firms that do not embrace innovation within their core business strategy run the risk of becoming uncompetitive because of obsolete products and processes. On the other hand, small and medium sized firms which apply innovation as a core business strategy increase their productivity, growth potential and likelihood of survival.[102]

According to this fact, innovation is a main factor to study in engineering SMEs. Through it, manufacturing SMEs can create competitive advantage against competitors and reach better positions at the market place. Through this forth part of the project, an overview of the traditional innovation practices in manufacturing SMEs will be carried out in order to understand their weak points and be able to improve and overcome their limitations.

The content of this section will be as follows: in chapter 4.1, the different streams in the innovation practice will be described, in order to understand in detail the types of innovation and their main characteristics.

Chapter 4.2 gives an overview of the strategic orientation in the innovation practice. It describes which factors are more important for the innovation performance and which guidelines should be followed to a successful innovation practice.

In chapter 4.3 an analysis of the traditional innovation practices in SMEs of the manufacturing sector will be exposed. It is basic to know the strong points engineering SMEs have towards innovation and how they used them until now, in order to maintain them and improve them for a competitive performance. On the other hand, there will be many weaknesses in the innovation practice which are important to know, in order to look for optimal solutions. The analysis of the barriers towards innovation will be the basis to the subsequently study of how the Open Innovation model could be applied to supply the limitations of engineering SMEs in the innovation performance.

Chapter 4.4 provides a SWOT (Strengths, Weaknesses, Opportunities and Threats) analysis of the traditional characteristics of engineering SMEs towards innovation in order to know which strengths, weaknesses, opportunities and threats we are facing in the practice of innovation in this field of action.

To finish with this fourth part of the project, chapter 4.5 contains the conclusions which will come up after the previous analysis.

[101] Cf. (Madrid Guijarro, García & van Auken, 2009: 466)
[102] Cf. (Madrid Guijarro, García & van Auken, 2009: 466)

4.1- Types of innovation: product, process and management innovation

Before analyzing the traditional innovation practices in manufacturing SMEs is important to know which types of innovation can be faced. Regarding the Open Innovation paradigm, innovation is seen as an invention implemented and taken to market.[103]

There are three types of innovation practices, which are shown in Figure 18. Depending on what is performed or improved by the innovation practice it can be established: product innovation, process innovation and management innovation. In the following, these three types of innovation will be described in detail.

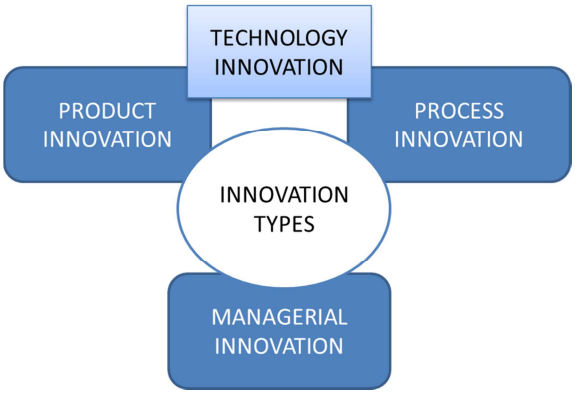

Figure 18: Types of Innovation practice

4.1.1- Product innovation

It is referred to the changes in products or commercialization of new products. Developing new products is a thoroughly complex activity and not many new products achieve successful results. With the current business environment (high globalization, high competition, reduction of lead times) is very important to develop products that provide a genuine competitive advantage in order to excel.

Management of product innovation

The most important guidelines in the product innovation performance can be summarized as three: strategy, leadership and performance.[104]

- Strategy: Analysis of the companies' performance towards the product innovation practice. It can be analyzed through different factors such as external and internal orientation, departmental integration, staff creativity, employee attitude and involvement…
  The strategy is focused on generate profit; improve marketing and sales, efficiency and motivation.

- Leadership: It is important in the area of competition and greater customer demands. A leadership towards a good performance in product innovation requires the

[103] Cf. (Chesbrough, 2003: ix)
[104] Cf. (O'Regan, Ghobadian & Sims, 2005: 46)

development and nurturing of competences, creativity, charisma, inspiration and stimulation. It also claims for the encouragement of new ideas, flexibility and ambitious targets.

- Performance: It is referred to the ability of an object to produce results in a dimension determined a priori, in relation to a target. It is measured by effectiveness, efficiency, growth and productivity. For determining the performance of an organization, it is required the selection and measuring of a set of key variables to allow the organization to detect its competitive position. [105]

4.1.2- Process innovation

It is referred to changes which take place in the manufacturing processes or in the acquisition of new equipment. This innovation is mainly important as one of the key factors of engineering SMEs is the development and implementation of technologies.

Process innovation is essential to maintain competitive prices. It is affected negatively by internal barriers in manufacturing SMEs such as human resources and weak financial position, as well as lack of economic resources.

The combination of both product and process innovation is referred as technology innovation.

4.1.3- Managerial and systems innovation

Innovation is not only about having good ideas, it is also necessary to manage them, improve them and to be able to anticipate markets and technologies.

Managerial innovation refers to the changes in the organizational structure of the company and in the administrative process. It is important to maintain a flexible and durable management and organization to perform successfully.

After having established an overview of the different types of innovation engineering SMEs can face, the organizational innovation study will be the next step. Creating a strategy in the innovation performance will be essential for achieving successful results at the end of the value chain, by considering the innovation practice as an independent duty in the performance of the company.

4.2- Strategic orientation towards innovation. Organizational innovation

Success in today's extremely competitive environment requires excellence throughout the organization. This will lead to a better management performance and to a more solid structure towards possible external changes.

Organizational innovation expresses the firms' proclivity towards the initiation and implementation of a strategy to develop different types of innovations (technological, administrative, product and process). It can be measured by the number of product

[105] Cf. (Mok Kim Man & Azizi Wafa, 2008: 147)

innovations.[106] It is observed that organizations in a turbulent environment tend to be more likely to choose a differentiation strategy compared to organizations in a stable environment. Organizations implementing their differentiation strategy enjoy high-income growth as compared to organizations implementing cost leadership and focus strategy.[107]

There are some factors which affect directly to the organizational innovation and which are exposed in Figure 20. These factors are the internal characteristics and limitations of the firm and the external barriers which restrict their performance. On the other hand, for a successful organizational innovation practice, there are some variables which must be controlled inside the company, and which can also be seen in Figure 19.

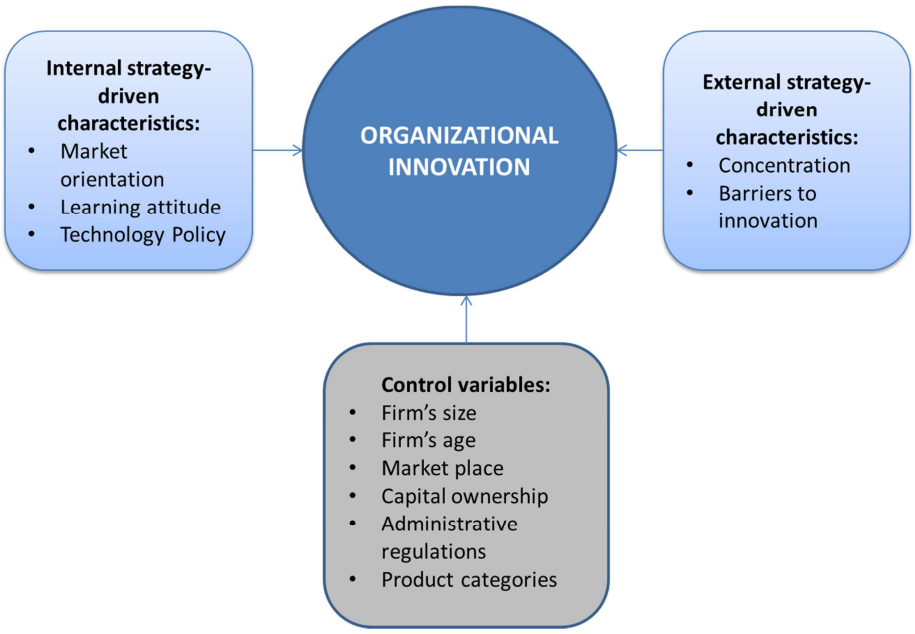

Figure 19: Conceptual model of Organizational Innovation[108]

In the following, a study of the internal and external characteristics which influence the organizational innovation as well as the variables to control is going to be carried out.

4.2.1- Internal characteristics affecting organizational innovation:

They are aspects affecting the strategic orientation of the firm. These are the factors which are dependent on the in-house performance of the company. They must be studied in order to evaluate the organizational innovation action of the firm.

INTERNAL CHARACTERISTICS AFFECTING ORGANIZATIONAL INNOVATION	
Market Orientation[109]	It directly affects the innovation performance in a positive way: - Market oriented firms tend to be more innovative because they are able to react faster to the evolving customer needs. - Positive relationship between market orientation and

[106] Cf. (Salavou, Baltas & Lioukas, 2004: 1093)
[107] Cf. (Mok Kim Man & Azizi Wafa, 2008: 149)
[108] Cf. (Salavou, Baltas & Lioukas, 2004: 1093)
[109] Cf. (Salavou, Baltas & Lioukas, 2004: 1094)

	improved company performance. - Market orientation is linked with employee morale and satisfied customers. - In industries where critical supplies are difficult to obtain, an important aspect of market orientation is to secure the necessary supplies in order to meet customer expectations and to operate effectively.[110]
Learning attitude[111]	It directly affects the innovation performance in a positive way: - By the enhancement of the innovative attitude as firms are more capable to assimilate new ideas - Continuous learning as a way to achieve competitive advantage - More attention to facilitate the generation and assimilation of new ideas and to advance employees skills and competencies through the exchange of knowledge (information, experience).
Technology policy[112]	It directly affects the innovation performance by: - Reflecting the commitment of a firm to innovation - Recruiting technical personnel, committing funds to new technology development

The internal characteristics which affect the innovation strategy and performance in a company have been already exposed. Their study is important to take into account which internal aspects affect the strategic orientation of a firm towards the innovation practice, as a way to control them towards a better performance of innovation. The conclusions which come up about how these aspects affect the innovation strategy can be summarized as Figure 20 shows.

[110] Cf. (Laforet, 2009: 189)
[111] Cf. (Salavou, Baltas & Lioukas, 2004: 1096)
[112] Cf. (Salavou, Baltas & Lioukas, 2004: 1097)

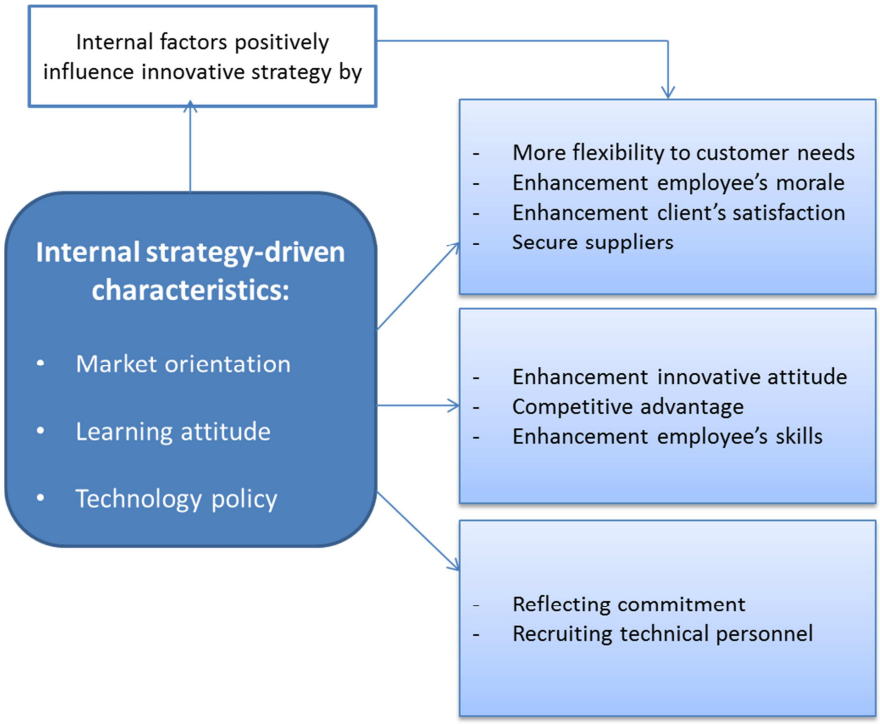

Figure 20: Internal characteristics of the firm affecting organizational innovation

4.2.2- External characteristics affecting organizational innovation

These external characteristics are affected by the external barriers and limitations from the business environment. The competitive structure must be defined.

EXTERNAL CHARACTERISTICS AFFECTING ORGANIZATIONAL INNOVATION	
High degree of industry concentration and barriers to entry[113]	In the new changing environment, the high competition and globalization complicate the companies' performance, which must look for competitive advantages to stay in the market place and survive. Competition and industry concentration provide incentives to innovation, as companies must adapt to the new situation, and innovation is the key factor to do it.
Impact of competitive pressure on firms' innovative behavior [114]	Intense competition may lead to few initiatives to innovate due to the big pressure companies are exposed to. On the other hand, a lack of competition makes innovation less necessary and reduces the stimulus to be the first in producing something and bringing it to market

Some knowledge about the external barriers which affect the innovation strategy the firm can adopt is important in order to know how to face the possible problems that can emerge from the external environment. Figure 21 schematizes the conclusions exposed above.

[113] Cf. (Salavou, Baltas & Lioukas, 2004: 1097)
[114] Cf. (Salavou, Baltas & ,Lioukas 2004: 1098)

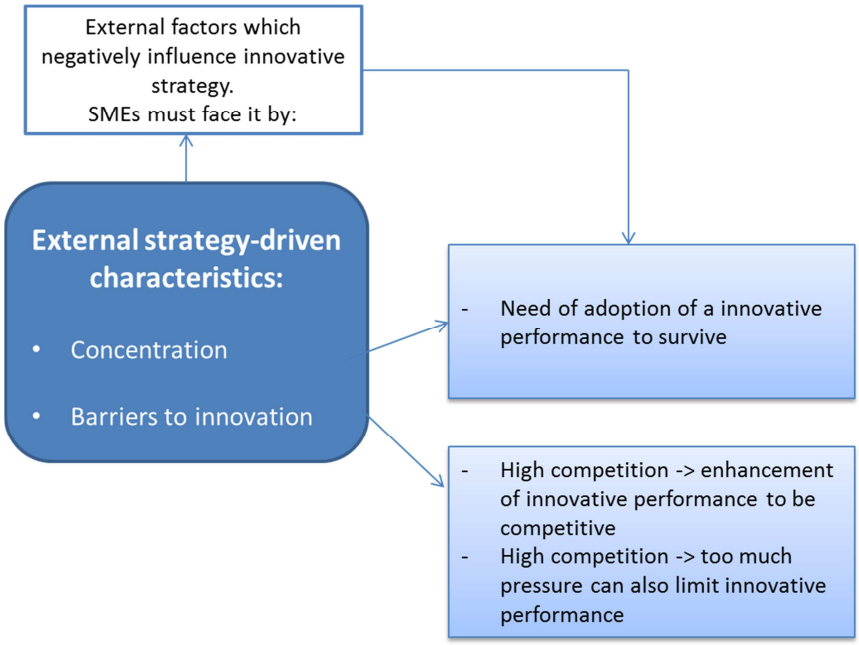

Figure 21: External characteristics of the firm affecting organizational innovation

4.2.3- Variables to control

There are some parameters in the company which are subject of analysis in the study of the organizational innovation performance. Depending on the proper firms' characteristics, the innovation practice will change. In the following part, the parameters which have a big influence in the innovation performance and how they affect it will be defined.

VARIABLES TO CONTROL[115]

Firm Size	Larger firms tend to be more innovative as they have economic facilities and resources as well as more qualified personnel. Large companies take on more radical innovations, which often require additional funds for technical work, capital investment for plant and equipment as well as marketing and promotions compared to small companies. [116]
Firm Age	Older firms are less receptive to innovation. They are usually managed in an autonomous and vertical way. New companies are normally more inclined towards innovation as they need to conquer a space in the market place
Firms' market share	A firm with a well-defined market share and position is more inclined towards innovation as they know which customer to target and therefore which are their requirements and needs
Manager run firms	They are less innovative than owner-run firms. Innovation attitude implies an unknown risk of failure. According to this, hired managers will be less inclined to take this risk, because of the possibility of being laid off
Structure of the workforce	The more bureaucratic stuff the firm has, the less inclined to innovation it is
Product categories	Firms operating with many product categories are more inclined towards innovation as they have more opportunities

[115] Cf. (Salavou, Baltas & Lioukas, 2004: 1100-1105)
[116] Cf. (Laforet, 2009: 189)

Highly competitive environments	for product-related changes Firms which operate in competitive environments tend to have a more innovative attitude as they need to conquer a space in the market place in order to survive.

The factors above exposed affect directly to the innovation performance. To finish this chapter, a summary of the variables which affect innovation and in which way (positive or negative) they do it, will be exposed in Figure 22.

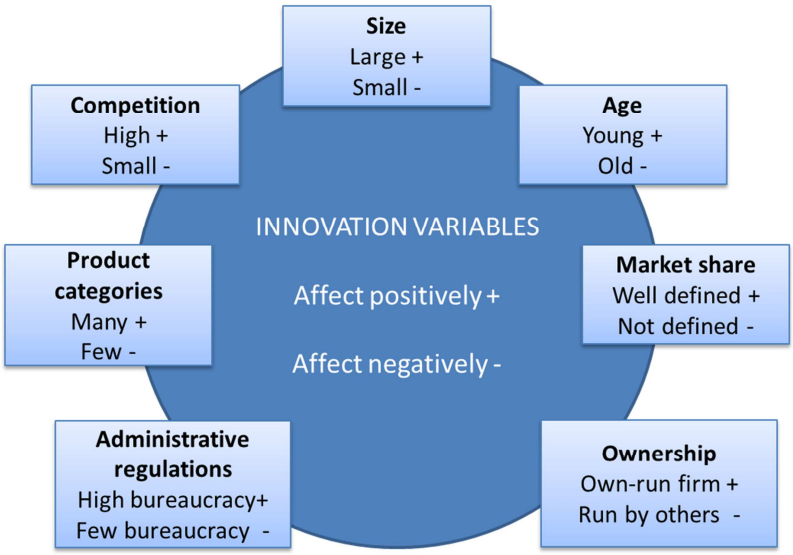

Figure 22: Variables to control affecting the innovation strategy

The study of these the internal characteristics, the external barriers and the variables to control will influence and define the organizational innovation practice carried out by the company.

In the following chapter, the innovation practice traditionally applied to engineering SMEs will be analyzed. This will be the basis to understand which limitations in the innovation performance of manufacturing SMEs can be supplied by the Open Innovation paradigm.

4.3- Innovation in engineering SMEs

As it has been mentioned in the previous content of the project, the innovation practice is a key factor for engineering SMEs in order to achieve competitive advantage in the new business environment they take place, characterized by high globalization, increased competition and reduction of deadlines.

The theoretical conception of innovation applied to manufacturing Small and Medium sized enterprises must not adopt the "little big business" concept[117]. That means that engineering

[117] Cf. (Mc Adam *et al.*, 2007: 386)

SMEs need to understand the process of innovation from an SME context and not as linear scalar of big organizations. SMEs must be seen as a unique business context for the innovation performance to be successful.

In previous chapters, the basis of the definition of engineering SMEs, its limitations and strengths have been analyzed. That was important to put the situation into context. In the following section, the particular analysis of its inherent strengths and restrictions towards the innovation practice are going to be exposed. This will be the starting point in order to establish which difficulties must be overcome in the innovation performance of manufacturing SMEs, and how they can be improved by the application of the Open Innovation model, which will be the subject of the study in the following part of the project "Open Innovation model applied to SMEs within the engineering industry",

4.3.1- Inherent strengths of Engineering SMEs towards innovation

Due to their definition, engineering SMEs have some own features inclined towards the innovation practice. It is important to be aware of these strengths in order to maintain them to remain competitive. The strong points of manufacturing SMEs for the innovation performance are:

STRENGTHS OF ENGINEERING SMEs TOWARDS INNOVATION	
• Customer focus and closeness to customers[118]	Better understanding of customer needs and requirements towards innovation. Bigger collaboration between firms and clients. The commercial uncertainty is reduced and there is a greater possibility that customers will accept an innovation suggestion made by the company.
• Flexibility[119]	Due to their size they do not have many customers, thus there is a bigger chance of flexibility and adaptation to customer's requests in innovation or changes.
• Short communication lines[120]	Due to their size and their limited number of clients, there are more informal management approaches than in larger firms. Thus, they have more adaptability to customer needs and requirements according to innovation.
• Little filtering of proposals [121]	Better flow of communication in the innovation process due to the reduced number of employees in the company.
• Owner-run firms[122]	Strong interest in product development and technological change as part of the characteristics and strengths of an innovative culture.
	Engineering SMEs are normally own-managed. The risk-taking attitude is higher in this kind of firms because the fear of being laid off due to an unsuccessful innovation strategy disappears. The pro-innovation attitude is higher in this case.

[118] Cf. (Raymond & St-Piérre, 2004: 24)
[119] Cf. (Salavou, Baltas & Lioukas, 2004: 1092)
[120] Cf. (Laforet & Tann, 2006: 365)
[121] Cf. (Laforet & Tann, 2006: 365)
[122] Cf. (Madrid Guijarro, García & van Auken, 2009: 467)

4.3.2- Barriers to innovation in Engineering SMEs

On the other hand, engineering SMEs have some inherent limitations which complicate the innovation performance. In addition to the general limitations of SMEs (size, labor force skills, economic and financial resources) some problems due to their manufacturing character must be studied as well (high globalization, high competition, impossibility of developing technologies or improve them).

The barriers to innovation subject to study can be classified as internal and external. Internal barriers to innovation will contain all the in-house limitations the company has according to its proper character and definition. External barriers to innovation will refer to the limitations imposed by the external environment of the engineering and SMEs sector. Both barriers will be exposed in the following section.

INTERNAL BARRIERS TO INNOVATION IN ENGINEERING SMEs

• Few resources for training and development[123]	Due to their economic difficulties and their lack of time and resources they cannot afford a proper training for their employees. This fact can lead to a bad practice of innovation for managers or employees due to their ignorance in the issue. This barrier is especially relevant because labor skills are one of the most important competitive advantages firms should use in order to differentiate with competitors. Thus, his limitation must be studied in order to improve it for a better performance of innovation.
• Lack of financial resources and alternative ways of finance[124]	Limited access to credit and financial services. Poor maintenance or replacement of machinery, inability to purchase required materials and services or to expand. This situation will lead to problems in the innovation strategy because of the inability to develop a new product or implement a technology.
• Employees in a multi-role capacity[125]	No focus or specialization of employees or managers. Not totally qualified employees in the innovation practice. Innovation it is often not seen as a proper task to carry out, with an independent treatment, what leads to an incomplete or bad practice of it.
• Difficulties to free up the time for employees to receive training[126]	Due to their limited number of employees, they sometimes must develop a multi-role capacity carrying out multiple tasks. In addition to the poor learning attitude, companies fail in their attempt to free up employees to receive training in innovation. Moreover, there is an over-reliance on in-house knowledge and capabilities of the firm what leads to a rejection of the need of providing training to employees or managers (apart from the incapability of

[123] Cf. (Mc Adam *et al.*, 2007: 387)
[124] Cf. (Migiro & Wallis, 2006: 2)
[125] Cf. (Mc Adam *et al.*, 2007: 387)
[126] Cf. (Mc Adam *et al.*, 2007: 387)

	many SMEs to provide it due to their economic limitations).
• Constrained to support highly qualified and competent personnel[127]	Economic difficulties to hire and retain qualified personnel. Low incentives for workers to stay in the firm. As it was already mentioned, labor force, and in particular workers trained in the innovation practice, are seen to be one of the most important competitive advantages companies can have against competitors. Due to their incapability to have skilled employees, sometimes engineering SMEs are not able to keep their market place and fail in the attempt of being competitive.
• Constrained in affording heavy investments in production technology[128]	One of the most important factors to maintain competitiveness in the engineering sector is the investments in production technology. Due to economic limitations, manufacturing SMEs are constrained in this aspect. This limitation may force SME to seek innovations along the value chain that require less capital investment and lesser reliance on qualified staff in order to keep their market place and try to keep on being competitive.
• Difficulties to introduce innovations in the core production technology[129]	Due to their inherent limitation in economic resources, they cannot afford the process or product innovation practice as it requires R&D (very costly and time consuming to carry out) and big budgets. This situation often leads to the loss of their market place and competitiveness.
• Not many strategic alternatives due to their size[130]	Theoretically, engineering SMEs should be more likely to seek types of innovation than larger firms cannot provide, as the only way manufacturing SMEs have to face innovation and be competitive. However, due to their economic and labor force limitations engineering SMEs are not in a position to change their innovation strategy (in case they already have one) to one which could better fit their necessities.
• Difficulties to invest in new technologies and equipment[131]	Technology improvement and performance must be one of the competitive advantages for engineering SMEs to keep their market place. Nevertheless, due to their lack of economic and human resources, most of them cannot afford them, staying behind the rhythm of large companies in technology improvement or implementation, and not being able to compete against them.
• Customer dependency[132]	On the one hand, closeness to customers was seen as a strong point for engineering SMEs as they could be more flexible to the innovation requirements of its clients, and customers were also more willing to

[127] Cf. (Salavou, Baltas & Lioukas, 2004: 1093)
[128] Cf. (Salavou, Baltas & Lioukas, 2004: 1094)
[129] Cf. (Salavou, Baltas & Lioukas, 2004: 1094)
[130] Cf. (Salavou, Baltas & Lioukas, 2004: 1094)
[131] Cf. (Laforet & Tann, 2006: 367)
[132] Cf. (Laforet & Tann, 2006: 372)

	accept possible innovation suggestions of the firm, due to the close flow of communication between them. However, on the other hand, a very close relationship with customers can also lead to restrictions in the innovation performance inside the company imposed by customers.
• No recruitment of workers from the higher educated sector[133]	Due to their economic limitations, they often cannot afford to recruit employees with high qualification in the innovation practice. In addition, they often prefer external recruitment of experienced staff than training staff internally what results in a poor attitude to learning and in a non-enhancement of staff knowledge and skills.
• Unwilling to explore external sources that could lead to business benefits[134]	Due to their traditional, autonomous and vertical character, they are not used to explore external sources of knowledge in the innovation practice, and they have not many external contacts either. This attitude can lead to a limitation in their possibilities to grow through a product or process innovation performance. This turns out to be an obstacle in the further acquisition of technological and organizational expertise.
• Over-reliance on their internal know-how expertise[135]	Due to their autonomous and vertical management they resign themselves to their in-house knowledge performance in innovation, or they over-rely on it. A lack of external knowledge in the innovation practice can lead to a loss of the market place or stay behind the new implementations and strategies which come up to face the new business environment and requirements.
• Problems of attitude towards learning[136]	Over-reliance in their in-house knowledge which leads to a rejection in providing training in innovation to their managers and employees. This situation can lead to a stay behind position in the market place or even a loss of competitiveness against competitors.
• Problems of networking[137]	In the new practices of innovation, networking is seen as a key factor in order to get knowledge or technologies from external sources, which internally could not be developed. In traditional engineering SMEs, with owner-run managers, an over-reliance on the in-house capabilities will limit the networking performance. They also have lack of external contacts due to their vertical management. They often lean on the Not Invented Here syndrome, a limitation imposed by them to buy or use technology which has not been developed in-house. In addition to the poor networking attitude, some SMEs cannot afford collaborations with external parties, due to their economic limitations.

[133] Cf. (Laforet & Tann, 2006: 376)
[134] Cf. (Laforet & Tann, 2006: 376)
[135] Cf. (Laforet & Tann, 2006: 376)
[136] Cf. (Laforet & Tann, 2006: 376)
[137] Cf. (Laforet & Tann, 2006: 377)

• Problems of employees participation in new ideas[138]	Due to their economic limitations, they often cannot hire qualified personnel in the innovation practices. Moreover, the risk-taking attitude of employees is often low, due to their fear of being laid off because of an unsuccessful innovation practice.
• Problems of retaining good workers[139]	Few incentives (economic, progress in the company) which can be provided to employees to stay in the company.
• Limited ambitions to grow[140]	Due to their limitations they often cannot apply any other strategy than continuing with their products and customers, without exploring new possibilities or sources. In addition to it, they often do not have the enough knowledge to develop a new strategy or to grow in other direction. This often turns out to a low risk strategy and, with the new business environment in a rapidly changing market this option is risky to adopt.
• Low risk strategy[141]	Sometimes due to their lack of labor skills and management knowledge in the innovation practice, they often do not have a risk-taking attitude. As the success of some innovations implies an unknown risk which cannot be known in advance, they prefer not taking the risk, limiting their performance and staying in the same market place, even though the business environment keeps on changing.
• Manager and employee's resistance towards innovation and changes[142]	Employees and innovators often question the value of a strategy that embraces innovation, especially in owner-managed firms .This attitude is based on a bad practice of the innovation performance, normally because of ignorance or a bad training on the issue. Poor communication lines between managers and employees, existing corporate norms, weak human resources practices and lack of commitment of top management can lead to this attitude.
• Problems in flow of information[143]	Due to an incompetent practice of innovation, the flow of information between managers and employees on the issue is inefficient. This situation turns out to a resistance of employees in the application of innovation practices or changes.
• Coordination of all departments to carry out innovations[144]	Due to their limited number of employees, often there is not a particular department focused completely in the innovation practice. With this situation and in order to develop an innovation strategy, there must be a coordination of all departments, which sometimes it is hard to reach.
• Problems to find new customers[145]	The rejection of a customer to apply a process or product innovation performance can lead to the search of new customers in order to be competitive

[138] Cf. (Laforet & Tann, 2006: 372)
[139] Cf. (Laforet & Tann, 2006: 377)
[140] Cf. (Mosey, Clare & Woocock, 2002: 176)
[141] Cf. (Mosey, Clare & Woocock, 2002: 176)
[142] Cf. (Madrid Guijarro, García & van Auken, 2009: 467)
[143] Cf. (Madrid Guijarro, García & van Auken, 2009: 467)
[144] Cf. (Madrid Guijarro, García & van Auken, 2009: 468)
[145] Cf. (Madrid Guijarro, García & van Auken, 2009: 468)

	and survive. Due to the traditional, autonomous and vertical action lines of engineering SMEs, they are limited in finding new customers, as they have lack of external contacts and external sources.
• Underestimation of an innovation activity[146]	Due to their few practice in the innovation performance and their incapability to afford the exposure and time involved in the patenting process, they can sometimes underestimate an innovation activity and thus, lose a profit possibility.

External barriers to innovation in engineering SMEs are caused by the environment which surrounds the firm. SMEs need to find their place in the business environment; thus, they must carry out a strategic development in product innovation, market expansion and network extension. [147]

External environment consists of variables such as opportunities and threats which are beyond the control of the organization: competitors, customers, suppliers, regulators, associations… They play an important role in determining an organization's success or failure.

The external barriers which affect the firms are going to be exposed in the following:

EXTERNAL BARRIERS TO INNOVATION IN ENGINEERING SMEs[148]

• *Limited external contacts*	This fact can be seen as an internal limitation as it has been exposed in the previous section, because it is a result of the autonomous and vertical practice of engineering SMEs. On the other hand, the external sources and contacts is an environment factor. The closed management some engineering SMEs develop turns out to poor attitudes towards networking and collaboration in the innovation practice.
• Global competition	In the manufacturing sector, one of the problems SMEs must face is the global competition. Asian and Eastern markets are rising and engineering SMEs can hardly compete against such low costs. A very high competition environment is seen to be a limitation in the innovation practice.
• *Lack of information*	Due to their autonomous and vertical performance, they are lack of external sources and connections, which limits the innovation practice.
• Economic uncertainty and turbulent operating environments	The new business environment is defined by changing markets, increasing appearance of competitors, short product cycles, rapid technological changes and intense rivalry. These factors can negatively affect innovation, as sometimes engineering SMEs stay behind their competitors due to their proper limitations.

[146] Cf. (Madrid Guijarro, García & van Auken, 2009: 468)
[147] Cf. (Mok Kim Man & Azizi Wafa, 2008: 153)
[148] Cf. (Madrid Guijarro, García & van Auken, 2009: 470)

After having analyzed the internal and external barriers of the innovation performance engineering SMEs must face, a SWOT analysis and the conclusions of this forth part of the project will be exposed in the next chapters. This will be the guideline for the application of the Open Innovation model to supply the limitations of engineering SMEs in the innovation practice. This study will be carried out in the fifth and last part of the project.

4.4- SWOT analysis: Factors affecting Innovation Management in SME's

Through a SWOT (Strengths, Weaknesses, Opportunities, Threats) analysis, the competitive situation of the company will be analyzed, in its external environment (market place) and its internal characteristics (internal situation) in order to come up with the strengths, opportunities, weaknesses and threats of the manufacturing SMEs towards the innovation practice.

4.4.1- Description of the SWOT method

A SWOT analysis is a strategic planning method used to evaluate the Strengths, Weaknesses, Opportunities and Threats involved in a project or in a business venture. It involves specifying the objective of the business venture or project and identifying the internal and external factors that are favorable and unfavorable to achieve the objective.

The Strengths, Weaknesses, Opportunities and Threats of the company are referred to:

- Strengths: Capabilities, resources and thus competitive advantages that must be used to exploit opportunities. They belong to the internal environment of the company.
- Weaknesses: Aspects which limit or reduce the development capability of the company. They are a threat of the firm and thus must be controlled and overcome. If weaknesses cannot be converted in the company, they should be minimized or avoided. They belong to the internal environment of the company.
- Opportunities: The external environmental analysis may reveal certain new opportunities for profit and growth.
- Threats: Every external force which can prevent the implementation of a strategy, reduce its effectiveness or enhance the risks for its implementation. They belong to the external environment of the company.

4.4.2- SWOT analysis

After having explained the method, the exposition of the SWOT analysis regarding the innovative competitiveness and situation of the engineering SMEs can be seen in Figure 23.

SWOT ANALYSIS: Issues affecting Innovation Management in SMEs

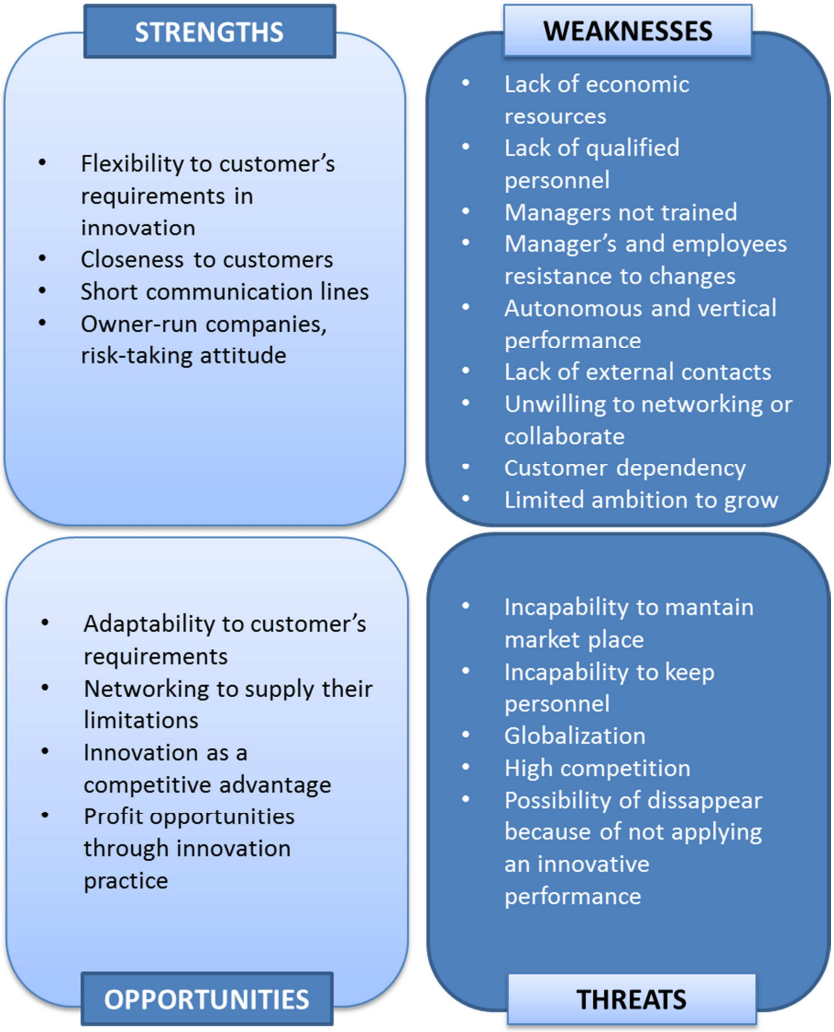

Figure 23: SWOT analysis

In the SWOT analysis, it should be paid attention to the weaknesses which cannot be converted, in order to minimize them or avoid them. The most limiting weaknesses we can find in the innovative performance of engineering SMEs are the lack of economic resources, the customer dependency and the impossibility to hire high qualified personnel. Special attention should be paid to these points, because as these factors can hardly be avoided, they can evolve in threats by the external environment.

The following subject of the study of this project will be the attempt of improving the innovative performance of engineering SMEs and specially the points in which it is more limited, like the weaknesses which have already been mentioned.

Now that the limitations and strong points of manufacturing SMEs towards innovation have been exposed, some conclusions about this part of the project will be exposed. These conclusions will establish the basis in order to think about solutions and improvements of its innovation practice through the incorporation of the Open Innovation model.

4.5- Conclusions

SMEs' success and survival depends on the degree in which they incorporate innovation into their business strategy, especially because of the actual increasing global competition. Small firms that successfully embrace innovation increase their chances of growth and survival. [149]

SMEs need commitment in the practice of innovation, and recognize it as a broad strategic process before embarking on a program that will consume resources and become ineffective through a risk adverse culture, which is prevalent in many SMEs. [150]Understanding barriers to innovation can aid the development of firm strategies and government policies that contribute to economic growth, job creation and increased wealth.

Through this forth part of the project, the general guidelines of a successful management in innovation have been explained. Subsequently, the special characteristics, weaknesses and strengths of manufacturing SMEs towards the innovation practice have been analyzed. This will be the starting point in order to apply the Open Innovation paradigm in the possible weaknesses of the engineering SMEs in order to improve their innovation practice or overcome its limitations.

In the following, some conclusions which have come up about the good practice of the innovation performance in the engineering SMEs are going to be exposed. The awareness of good practices in the innovation performance will be important in order to apply it in engineering SMEs and maintain them in the following application of the Open Innovation model.

- SMEs must apply their own innovation concept instead of adopting the "*little big business"* conception[151]: Engineering SMEs need to understand their own characteristics and barriers as small firms, instead of trying to be linear scalar of big organizations in the management of innovation. Effective development of innovation within SMEs requires both an understanding of innovation and the context of SMEs. The attempt of applying the innovation practices valid for large companies will result in a possible unsuccessful performance.

- When SMEs grow, they must focus on innovation management instead of having an over reliance on technological innovation[152]. An over-reliance in their in-house capabilities will lead to an autonomous and vertical performance and lack of external

[149] Cf. (Madrid Guijarro, García & van Auken, 2009: 466)
[150] Cf. (Madrid Guijarro, García & van Auken, 2009: 466)
[151] Cf. (Mc Adam *et al.*, 2007: 386)
[152] Cf. (Madrid Guijarro, García & van Auken, 2009: 468)

contacts and collaborations. This attitude may also lead to a limited practice of innovation.

- Higher levels of profitability in SMEs firms which are product and process innovators than the ones which are only product or process innovators[153].

- Benchmarking may lead to improvements in the innovation practice by comparing the firm's practices with others[154]. By understanding the competitive environment, companies are able to look for competitive advantages to survive or face competitors. Engineering SMEs must be aware of the changing environment in order to adopt themselves to the new characteristics and requirements and be competitive and survive.

- Close relations with customers may lead to a better practice of innovation, as it reduces uncertainty and it is more probable that they will accept innovation projects[155]. On the other hand, an over-reliance on a few customers can lead to a limitation of the company's possibilities to grow and evolve.

- Training of employees and managers in the innovation as the only way to perform a successful innovation practice: qualified personnel with the appropriate skills constitute one of the most important competitive advantages of the firm against competitors.

- Motivation of management and labor force[156] as a pillar basis in the innovation practice: Workers must be proactive in the innovation process and in the learning and risk-taking attitude for a good development of innovation. They must participate with their own ideas and they also must have an active attitude towards training.

- Competent leadership: Leaders must show an active strategic commitment to research and technological change. A top management plays a multiple role, fosters a creative environment and listens to new ideas. Both leaders and workers must be motivated towards risk-taking attitude. Leaders with vision, capacity to plan ahead and enthusiasm exploit external opportunities for inward investment and information gathering. [157]

- Firms with less bureaucracy[158] have shorter communication lines, more involvement with work force and better flow of communication. The performance of the innovation practice is easier.

[153] Cf. (Brophey & Brown, 2009: 334)
[154] Cf. (Laforet & Tann, 2006: 365)
[155] Cf. (Raymond & St-Piérre, 2004: 24)
[156] Cf. (Laforet & Tann, 2006: 365)
[157] Cf. (Laforet & Tann, 2006: 366)
[158] Cf. (Laforet & Tann, 2006: 365)

- Participation of all parts in the innovation process[159]: From shop floor to personnel and office staff. The criteria for evaluating new product projects must be known by everyone in the company in order to have a good flow of information. This will lead to a higher motivation of managers and employees in the innovation performance.

- Own-run firms are more proactive towards innovation as the owner is more willing to take risk initiatives without the fear of being laid off.

- Firms with external contacts and information about market opportunities, changes in technology and government policy can redefine their innovation strategy and find potential advantages of becoming more innovative[160]. It is important to have an external vision of competitors and to be aware of the environment in order to find or realize about new revenue opportunities in the innovation process. SMEs often have to rely on the external resources or knowledge for product innovation. It is a mechanism to leverage market competitiveness and limitations for product innovation

Figure 24 summarizes the conclusions which have come up according to the factors which are inclined towards a good practice in the innovation performance.

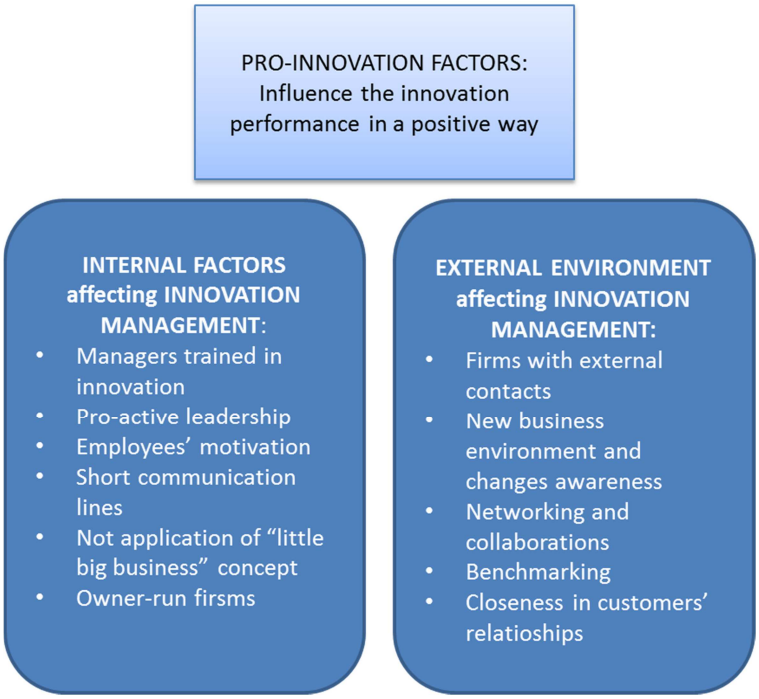

Figure 24: Conclusions about the Innovation practice

[159] Cf. (Laforet & Tann, 2006: 372)
[160] Cf. (Laforet & Tann, 2006: 367)

5- Open Innovation model applied to SMEs within the engineering industry

As it has been discussed through the content of the project, the innovation practice has become a competitive advantage in manufacturing SMEs in order to keep their market position and survive due to the new changing business environment they must face: high competition, high globalization, reduction of deadlines and rapid advances in technologies.

The study of the application of the Open Innovation model has traditionally been applied in large companies, as they have more resources for an easier action of innovation. However, the application of the Open Innovation paradigm in SMEs is not often analyzed due to the inherent limitations of these companies in economic resources and labor force. Nevertheless, the application of some initiatives of this model can result in a successful performance of innovation within these companies and can be seen as a way of overcoming their difficulties in the innovation practice.

After having analyzed the characteristics, strengths and weaknesses of manufacturing SMEs in the previous chapters of the project and being aware of the problems these companies must face regarding innovation, a study of the applicability of some Open Innovation initiatives in engineering SMEs will be performed, with the aim of finding some possible solutions for the improvement of their performance in the innovation practice.

The content of this fifth part of the project will be the following: chapter 5.1 will contain a description of the Open Innovation initiatives which will be suggested in order to improve the innovation performance of engineering SMEs.

In chapter 5.2, the description of several factors which will influence the success in the application of the Open Innovation initiatives in manufacturing SMEs will be exposed.

In chapter 5.3 and after having described the Open Innovation initiatives which could be useful for the improvement of the innovation performance in SMEs and the factors which would affect them on its applicability, both parameters will be analyzed in order to come up with conclusions about the usefulness and helpfulness of the Open Innovation model in order to improve the innovation practice in engineering SMEs.

In chapter 5.4, the conclusions about the applicability of every Open Innovation initiative in the performance of innovation of the engineering SMEs will be described.

In chapter 5.5 the general and final conclusions about this fifth part of the project will be described, analyzing which Open Innovation initiatives can have a helpful character and which ones should be rejected for an improvement of the innovation performance of engineering SMEs.

5.1- Open Innovation initiatives subject of study for a better innovation practice in engineering SMEs

After having analyzed the barriers to innovation in engineering SMEs, a description of some initiatives proposed by the Open Innovation paradigm for a good practice of innovation is going to be exposed. Subsequently in next chapters, an analysis will be carried out in order to determine which initiatives could be useful for overcoming some of the weaknesses of these companies regarding innovation and for an improvement of the innovation management within the manufacturing SMEs. The Open Innovation initiatives subject to study are the following:

5.1.1- Joint ventures

Nowadays, even large companies fail in their attempt to develop complex technologies or products by their own, in a vertical way, due to their lack of resources. This fact is even more pronounced in SMEs because their lack of resources is more dramatic.

A joint venture can be a way of overcoming the lack of resources problem. It is a long term business agreement in which parties agree to develop, for a finite time, a new company. Both parties are equally invested in the project in terms of money, time and effort to build on the original concept.

Joint ventures are a way of getting to market promoted by the Open Innovation model as it is claimed that companies should have access to technology as soon as they need it, instead of waiting to develop everything by their own, because competitors will emerge and clients are not going to wait forever to get their products.

5.1.2- Spin-offs

They are corporations which emerge from sections of a former company which split off into a separate business. Normally they are dependent upon licensing or assignment of technology for initiation from a public research institute. [161] Regarding intellectual property, university spin-offs use patents as their business, unlike start-up companies. Intellectual patents are the output of the technology business.

Generally, the parent company supports the Spin-off company by investing in the new company, being customer of it, and providing services to it. The spin-off company takes assets, intellectual property, technology and existing products from the parent organization. The Spin-offs companies are a way of getting to market promoted by the Open Innovation model to offer the opportunity to develop ideas sitting on the shelf which did not fit with the companies' business model.

5.1.3- Strategic alliances

It is an agreement between two or more parties, in order to share costs and resources and secure common interests. It is a mutual coordination of strategic planning and management in

[161] Cf. (BVCA, 2005: 13)

order to achieve long term objectives. Each organization will work independently and no separate entity is formed.

As joint ventures, it is a way of getting to market promoted by the Open Innovation model, to get access to resources the company cannot afford by itself.

5.1.4- Networking

The Open Innovation paradigm claims that collaboration is basic in order to carry out research and development in companies which are lack of resources and which cannot afford to develop a technology or product by itself, in a vertical way. With networking, R&D alliances between non-competing firms are created in order to get value and to develop technologies or products.

5.1.5- Buying Intellectual Property

In the Open Innovation model, it is promoted that companies which are lack of resources to develop technologies or products must need external collaboration in terms of intellectual property in order to carry out R&D. Unlike to the old paradigm, where intellectual property was seen as a key factor to protect from competitors, in the Open Innovation paradigm the concept of Intellectual Property shifts to Intellectual Partnering. Companies should become active buyers and sellers of technology, benefiting from other's technologies by buying IP from third parties.[162]

5.1.6- Carrying out Internal Research

In the past, R&D was seen as a key factor to protect against competitors. Within the Open Innovation paradigm the vision regarding the management of R&D changes. For a successful management of R&D, innovators must complement in-house R&D with technologies from external sources (such as universities, start-ups and even competitors).

According to the Open Innovation model, internal R&D becomes necessary to[163]:

- Identify, understand and select from the external knowledge available. Companies must be aware of the new advances in technology in order to be able to profit from external R&D and to combine it with their in-house R&D
- Fill in the missing pieces of knowledge not being externally developed
- To combine both internal and external knowledge
- To profit from exploitation of internal technology by selling it to external firms which can profit from it

[162] Cf. (Chesbrough, 2003: xxxi)
[163] Cf. (Chesbrough, 2003: 53)

5.1.7- Selling Intellectual Property

Licensing of intellectual property is a way of exploiting and benefiting from internal technologies or ideas which cannot be commercialized by the company due to incompatibility with its business model or internal conflicts according to the Open Innovation paradigm.[164]

Spinning-out intellectual property is an alternative channel for unlocking the economic value of unused patents by making the rights available to organizations that may have a greater interest in exploit the invention. [165]

5.1.8- Outsourcing

Outsourcing is a contractual agreement involving an exchange of services and payments. It is a practice promoted by the Open Innovation model as a way of exploration of technology. Some advantages of outsourcing are: costs' sharing, access to intellectual property and wider experience and knowledge, access to talent …

According to the Open Innovation paradigm, research takes a long time to be developed and to get outcomes, thus companies should not try to focus on developing all the technologies by themselves but to get what they need as soon as they need it, either from inside the company or from external sourcing (suppliers, customers, competitors, universities…).[166]

5.1.9- Pro-learning attitude

Continuous learning is seen as a way to achieve competitive advantage in the Open Innovation model. Learning can enhance the innovative attitude as firms are more capable to assimilate new ideas. It can also advance employees' skills and competences through the exchange of knowledge (information, experience). [167]

5.1.10- Risk-taking attitude of managers

An attitude towards innovation implies carrying out some risks, as it is not possible to know in advance if an innovation is going to be successful or not for the company.

Leaders, managers and workers must be motivated towards risk-taking attitude to carry out a good innovation performance. [168]

5.1.11- Training of managers in Innovation Management

Leaders must show an active strategic commitment to research and technological change. A top management plays a multiple role, fosters a creative environment and listens to new ideas. Both leaders and workers must be motivated towards risk-taking attitude. Leaders with vision,

[164] Cf. (Chesbrough, 2003: 56)
[165] Cf. (de Backer, López- Bassols & Martínez, 2008: 29)
[166] Cf. (Chesbrough, 2003: 53)
[167] Cf. (Salavou, Baltas & Lioukas, 2004: 1094)
[168] Cf. (Laforet & Tann, 2006: 366)

capacity to plan ahead and enthusiasm exploit external opportunities for inward investment and information gathering. [169]

5.1.12- Innovation applied in all development phases of the product

To make the most of Open Innovation, companies should integrate it into all stages of activity, from early-stage product ideation and R&D to late-stage marketing and sales.[170]

5.2- Factors subject to analysis which influence the application of the Open Innovation initiatives in engineering SMEs

The capacity of the application of the Open Innovation initiatives exposed before depends on the character and inherent definition of these companies. According to this, the study of the application of the Open Innovation initiatives will be carried out through some parameters which can influence the success or failure of these initiatives in their application in engineering SMEs. These factors and their assessment are described in the following:

DEGREE OF EVALUATION of the Open Innovation initiatives regarding some factors which influence their performance in engineering SMEs

FACTOR	0 ⊗	1 ○	2 ◔	3 ◑	4 ◕	5 ●
Usefulness	No correlation	Not very useful				Very useful
Applicability	No correlation	Impossible to apply				Easy to apply
Costs	No correlation	Less costly				Very costly
Time for application	No correlation	Less time consuming				Very time consuming
Profit possibilities	No correlation	Few profit possibilities				High profit possibilities
External collaboration	No correlation	Few collaboration needed				High collaboration needed
Training of employees	No correlation	Few training needed				High training needed
Participation employees	No correlation	Few participation needed				High participation needed

5.3- Exposition of the graphic

The following graphic combines the Open Innovation initiatives mentioned before and the factors subject to study in order to determine which degree of applicability these initiatives have in order to perform a better practice of innovation in engineering SMEs.

OPEN INNOVATION INITIATIVES

[169] Cf. (Laforet & Tann, 2006: 366)
[170] Cf. (Blackwell & Fazzina, 2008: 2)

FACTORS SUBJECT TO STUDY which influence the application of OI in engineering SMEs	Joint ventures	Spin-off companies	Strategic alliances	Networking	Buying IP	Internal Research	Selling IP	Outsourcing	Training employees	Risk-taking attitude	Training of managers	Innovation all phases
Usefulness	◕	◑	◕	●	◕	◕	◕	●	●	◕	●	◕
Applicability	◑	◔	◑	◕	◑	◔	◔	◕	◑	◕	◑	◔
Costs	◕	◕	◑	◑	●	●	○	◕	●	◑	◕	◕
Time	◕	◕	◕	◑	◑	●	⊗	◕	●	◑	◕	◕
Profit possibilities	◑	◑	◕	◕	◕	◑	◕	◕	◕	◑	◕	◑
External collaboration	●	◔	●	●	●	◔	●	●	◕	◔	◑	◑
Training of employees	◕	◔	◕	●	◕	●	⊗	●	⊗	●	⊗	●
Participation of employees	◕	●	◕	●	◕	●	◕	◕	●	●	⊗	●

Table 2: Open Innovation model applied in engineering SME's

After having exposed the graphic, some conclusions about the applicability and feasibility of every Open Innovation initiative as a solution for the weaknesses in the innovation practice of engineering SMES are going to be described.

INITIATIVE	WEAKNESSES	CONCLUSIONS
Joint ventures	• External contacts needed • High costs involved • Training employees: must be aware of advances in technology	It is a very useful initiative to provide the company of resources that cannot develop internally in a vertical way. Once the over-reliance on the internal capabilities of the company is overcome and the necessity of the collaboration with third parties is understood within the company, it can be concluded that the creation of joint ventures turns out to be very feasible in its application
Spin-offs	• Loss of qualified staff • High costs involved	This initiative turns out to be very useful in order to get access to ideas which cannot be developed within the company. Nevertheless, its application is totally limited in engineering SMEs due to its reduced number of employees, being unaffordable for these companies to lose part of the staff to create the new company. It can be concluded that it must not be paid special attention to the development of this initiative
Strategic alliances	• External contacts needed • High costs • Collaborative attitude needed	As it was explained in the creation of Joint ventures, it is a very useful practice in order to provide the company of some resources it cannot develop internally. Although some obstacles such as the costs involved and the attitude of employees must be overcome, it can

		be concluded that it turns out to be a feasible practice for the innovation performance in engineering SMEs
Networking	• External contacts needed • High costs involved • Collaborative attitude needed • Training of employees/managers	It is one of the most useful practices in the performance of Innovation in engineering SMEs to overcome its limitations in resources. A collaborative attitude from employees and an understanding of the limitations of the company and the need of turning to collaboration with third parties as the way of getting access to resources the company cannot develop internally is needed to perform this initiative within the company. It can be concluded that it should be paid special attention to the development of this practice as it is quite feasible and useful for the innovation practice of these companies
Buying IP	• External contacts needed • High costs involved • Training of employees: must be aware of the advances in technology	It would be very useful to get access to research the company cannot develop internally due to its proper restrictions. Nevertheless, due to the high costs involved and the need of knowledge of employees regarding the advances in technologies, this initiative is unlikely to be applied in engineering SMEs with successful results. It can be concluded that it should not be paid special attention to the development of this practice
Internal R&D	• High costs involved • Qualified personnel required • Long time to get results	It would be a very useful practice in engineering SMEs to differentiate themselves from competitors by advances in technology and research. However, due to their limitations in economic resources and qualified personnel, the development of internal R&D turns out to be unaffordable in these companies, needing to turn out to external parties to get access to products or technologies. It can be concluded that it should not be paid special attention to the performing of this practice as it is hardly feasible in these companies
Selling IP	• External contacts needed • High costs involved	It would be very useful to profit from unused technologies developed by the company but this initiative it is not affordable for engineering SMEs due to their incapability to perform internal R&D, which is the starting point to sell IP. It can be concluded that it should not be paid special attention to the developing of this initiative, as it is hardly feasible for these companies
Outsourcing	• High costs involved • Training employees required • External contacts needed	It is a very useful practice to provide the company of resources it cannot develop internally. Once the problems regarding economic resources and the over-reliance from employees and managers on the internal capability of the company are overcome, it turns out to be a very feasible practice for the innovation performance of these companies. It can be concluded that special attention should

		be paid to the performance of this initiative within the company as one of the only ways it has to get access to products or technologies it cannot develop
Training employees	• High costs involved • Denial from employees to receive training • Time: difficulty to free up employees from their duties to receive training	It is a very useful practice in the innovation performance of engineering SMEs as it constitutes the basis for a successful innovation performance. A positive attitude from employees to receive training and an awareness of the limitations of the company are required. It can be concluded that it should be put special attention to this practice as it is quite feasible and very useful for a correct and subsequent practice of innovation, as the skills and knowledge of employees are seen to be one of the most important competitive advantages engineering SMEs have to face competitors
Risk-taking attitude	• Training of employees required • Denial from employees to take decisions	In the taking innovative decisions, there is an inherent risk which cannot be known beforehand. Due to the ignorance of the innovation practices from the employees and their lack of qualification, in many cases they do not take risky decisions due to the fear of being laid off afterwards. It can be concluded that it must be paid special attention to the performance of this initiative as it establish the basis for a correct practice and awareness of the innovation practice within the company
Training managers	• High costs involved • Denial to receive training • Time: difficulty to free up managers from their duties	This initiative is one of the most important ones in order to carry out a successful performance in innovation. However due to an over-reliance on the capabilities of the company, normally managers show their denial to receive training. Thus, it should be paid special attention to the development of this initiative as it constitutes the starting point for the application for the success of an innovative strategy and as the skills of employees and managers are one of the most important competitive advantages engineering SMEs have in order to differentiate themselves from competitors
Innovation all phases	• High costs involved • Long time • Training of employees required	It is a successful initiative in order to have a control on the Innovation performance in all phases of the development of the product and not only in the first ones. Nevertheless, the application of this initiative is not very realistic due to the limitations of the company in economic resources, the reduction of production lines and the lack of qualified employees. It can be concluded that it must not be paid special attention to the performance of this initiative as its application is hardly feasible

5.4- Conclusions

After having carried out the analysis of the applicability of some Open Innovation initiatives in engineering SMEs, Figure 25 shows a graphical comparative of the usefulness and applicability of every initiative previously suggested.

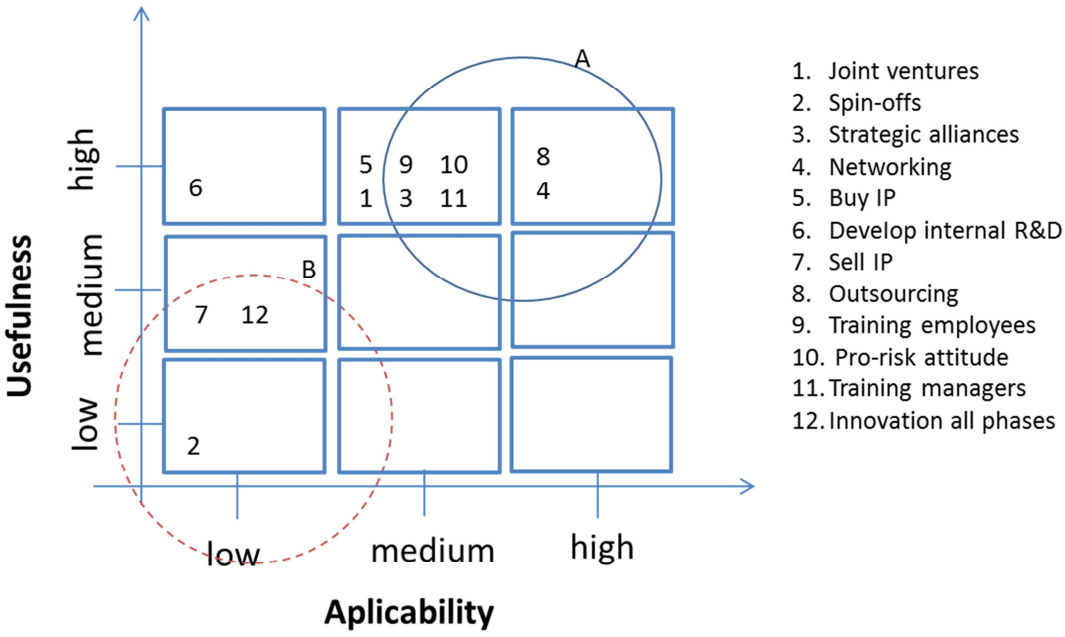

Figure 25: Usefulness-Applicability graphic comparing the different OI initiatives

On the one hand, initiatives under circle A are the ones combining high applicability and high usefulness and thus, they are the initiatives to which more attention should be paid as they are the most feasible ones to improve the innovation performance in engineering SMEs. Among these initiatives, networking and outsourcing can be found as a way of providing the company of resources it cannot internally developed. Training of employees and managers and a positive attitude towards risky decisions turn out to be highly applicable and feasible, establishing the basis for a correct practice of innovation. It can be concluded that the initiatives mentioned must be subject of study for an improvement of the innovation performance in engineering SMEs, being the ones which can lead to better results in this issue.

On the other hand, initiatives under circle B are the ones combining low usefulness and low applicability in the improvement of the innovation performance in engineering SMEs. Among these initiatives, it is worth highlighting the creation of spin-off companies, the selling of I.P and the implementation of innovation in all phases of the creation of the product or technology. These initiatives do not turn out to be applicable due to the limitations of engineering SMEs in costs and staff resources, and it must not be paid special attention to their development as positive results are not going to be reached.

There are also some initiatives which did not came up with such extreme results, and which are quite useful but the degree of applicability is medium. This is the case of developing internal R&D, the buying of IP or the creation of joint ventures. As it was said, these initiatives could be very useful for these companies, but they are restricted in their application. This is the reason why companies should not focus all their effort on the performance of these initiatives, as good results are doubted to be found.

In general it can be concluded that the most of the Open Innovation practices proposed are not affordable for engineering and manufacturing SMEs due to their lack of economic, size and personnel resources, which restrict the application of these initiatives. Nevertheless, there are some practices such as networking, outsourcing and training of employees and managers to which special attention and time should be paid in their implementation as they can constitute a solution to overcome the barriers and limitations engineering SMEs have regarding innovation.

In the next section, some conclusions about the whole content of the Project are going to be described, analyzing subsequently the future trends proposed to be followed.

6- Conclusions about the project

Through the content of this project different branches have been analysed. On the one hand, the general characteristics and situation of manufacturing SMEs regarding innovation have been described. Due to the new changing environment these companies face (High competition, high globalization, and rapid advances in technology) they must re-think their innovation strategy in order to remain competitive and survive in the marketplace. It was determined that due to the limitations in size, staff and economic resources these companies have, they are restricted in the innovation performance not being able to compete against large companies in this issue, what in many cases leads to a loss of their competitiveness and their subsequent disappearance. Thus, the development of an innovation strategy is a basic aspect to improve in the action lines of manufacturing SMEs as is one of the few resources they have to differentiate themselves from competitors and to keep their marketplace and survive.

On the other hand, a study of the Open Innovation model was developed. The Open Innovation paradigm is a method which emerges to face the requirements the new business environment demands and to overcome the limitations the traditional practice in the innovation performance during the 20th century had. Unlike the old paradigm, this model claims for the widening of the limits of the firms, the use of internal and external paths and ideas to get products and technologies to market and the collaboration with third parties as a way of providing the company of resources it cannot develop in a vertical and internal way. This model was traditionally applied to large companies, as they have more resources and feasibilities to develop an innovation performance, achieving good results. Unlike large companies, engineering SMEs have some limitations which limit their innovation practice and this the reason why there is no much literature precedents regarding the application of the Open Innovation model in manufacturing SMEs as a way of improving their innovation performance.

In order to change the mentioned trend, through this project a study of the application of the Open Innovation model in engineering SMEs was developed, in order to come up with solutions to overcome their barriers and limitations in their innovation practice. To develop this study and after having analysed the characteristics and barriers to the innovation practice engineering SMEs face, some initiatives of the Open Innovation model were proposed, which theoretically could be useful for an improvement of the innovation performance in these companies. After the analysis it was established that most of the initiatives suggested could turn out to be very useful to improve the innovation performance in engineering SMEs, specially to provide themselves of the resources they cannot develop in a vertical way, but the applicability of these initiatives was not very likely due to the lack of economic and staff resources of these companies. Among these initiatives, the development of internal R&D, the buying and selling of I.P and the creation of Spin-off companies could be found. Thus, the development of these initiatives should be rejected in the company, as their application does not turn out to be feasible.

It is worth highlighting that after the analysis and after having understood the limitations of manufacturing SMEs in costs and staff, some initiatives came up to be highly applicable and

useful to improve the innovation performance of these companies. Among these initiatives, the networking and outsourcing were established as a way of providing the company of resources it cannot develop in-house, through the collaboration with external parties. It is also suggested the training of employees and managers and the positive attitude towards risky decisions as very useful and quite feasible initiatives for a correct application of an innovation strategy within the company. Thus, it is established that special attention should be put on these initiatives mentioned as they are the most feasible in a real performance of engineering SMEs and they can lead to positive results in the innovation practice and to an improvement of the innovation performance of these companies.

In general it can be concluded that the innovation practices in engineering SMEs still must be subject of study to reach big improvements, as it still constitutes a weak point in the lines of action of these companies and at the same time is a basic factor to improve their competitiveness and differentiate themselves from competitors. Understood the barriers towards innovation these companies must face, an awareness of the new innovation practices which emerge with the Open Innovation model can turn out to be very useful in manufacturing SMEs to change their traditional perspective in the innovation performance and to face the new challenges the market requires and to which these companies must adapt themselves.

Future trends

The content of this project is mainly theoretical, trying to find solutions for an improvement of the Innovation practice in engineering SMEs. As it was already mentioned and unlike the application of Open Innovation model in large companies, what has been successfully applied in many examples, the literature precedents about the application of the Open Innovation model in manufacturing SMEs are not very wide, due to the limitations these companies face in the innovation performance.

This is the reason why this project wants to establish the application of the Open Innovation model as a way of providing solutions for engineering SMEs in the innovation practice. At the same time, this project wants to establish the basis and the starting point for a project consisting of the analysis during a proper period of time of the application of the Open Innovation initiatives suggested in real manufacturing SMEs, in order to know in which degree the proposed initiatives can be useful to improve the performance of these companies in the innovation issue and to compare the results obtained after the analysis in real companies to the theoretical results obtained through the content of this project.

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