Open innovation profile in small and medium-sized firms. The perspective of technology centres and business associations

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Abstract: This work seeks to understand and characterise the innovative profile of Portuguese SMEs within the context of open innovation. The analysis draws on interviews conducted with the business associations and technological centres in the moulds, footwear and automotive industries in Portugal. The study conducted here follows an exploratory approach. This study suggests that while open innovation is relatively widespread in its adoption of external knowledge, technology transfer outside the business is less commonplace. The innovation partners are varied, chosen based on competence and experience as well as their networking ability.

Keywords: open innovation; small and medium-sized enterprises; SME; relationships; innovation partners; Portuguese industries.

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1 Introduction

The concept of open innovation (Chesbrough, 2003) suggests that firms should pursue competitive advantage by searching external sources of innovation as well as external applications for internal technologies – either through new businesses or by licensing external applications of internal technologies. While Chesbrough (2003) considers that the necessary skills needed for generating large technological innovations are dispersed in a multitude of institutions other than firms, the firm must have the capacity to absorb and exploit the external knowledge emerging in the external environment (Cohen and Levinthal, 1990) and create value from it.

The novelty introduced by Chesbrough (2003) is the systematisation of some R&D organisational initiatives that a company can take in order to optimise its innovation pace by seeking and acquiring external sources of innovation.

The concept of open innovation relates to different collaboration models for generating innovation, with firms and external entities, as customers, suppliers, research institutions, competitors, start-ups and innovation intermediaries, working together (Chesbrough, 2006) challenging the conventional closed innovation model

While large companies and multinationals have been responsible for much research on the subject of open innovation (Bianchi et al., 2010; Christensen et al., 2005; Lecocq and Demil, 2006; Van de Vrande et al., 2009), the globalisation of markets has helped small and medium-sized enterprises (SMEs) to become strongly influential in the economies of many countries, given that they are the engine of economic and technological progress (Bruque and Moyano, 2007). However, open innovation has not been widely studied in SMEs (e.g., Lichtenthaler, 2008).

For the SMEs, the networks which give rise to the interaction between different actors represent a complementary response to the insecurity that results from the development and utilisation of technologies (Zeng et al., 2010). Therefore, connections are necessary between SMEs and other companies, research centres, suppliers and customers, in a dense network of innovation that allows them to share knowledge and benefit from complementary skills (Bullinger et al., 2004).

The literature reveals that there are few studies covering open innovation applied to SMEs, and very few studies looking at the relationships between SMEs and their innovation partners. As such, with the goal of widening the coverage of research in the area, it is our objective to characterise the innovation profile and the relationships that exist between the SMEs and their innovation partners, all within the context of open innovation and a multi-sector perspective. To this end, this work studies the relationships between SMEs and technological centres and business associations for the automotive, footwear and moulds industries. While the focus in this analysis is placed on SMEs, the particular business unit under analysis is that which deals with external relations, so as to be able to characterise the innovative profile of the SME and the involvement that they

have with the technological centres and business associations. In addition, this paper looks at the processes involved in understanding the requirements of the innovation partners, improving access to external knowledge, building mutually beneficial relationships and commercialising the internal knowledge for the Portuguese SME market.

The work presented here is exploratory in nature, providing an analysis of the results obtained through interviews conducted with business associations and technological centres for the moulds, footwear and automotive industry.

Following on from this introduction, the second section of the paper presents the theoretical foundations, drawing on an explanation of the topic under discussion. In the third section the methodology used is described. The fourth, fifth and sixth section give a characterisation of the automobile, moulds and footwear industries. The main results appear in the seventh section. Finally, a concluding summary and discussion of the results can be found in the eighth section, where limitations and recommendations resulting from the study are given along with suggestions for future work.

2 Literature review

The approach of open innovation (Chesbrough, 2003, 2006) describes one of the newest concepts in modern innovation management, which has subsequently become one of the most debated topics in the literature on innovation management (Huizingh, 2011).

Following Chesbrough (2003), the businesses that use an open model commercialise ideas which are both internal and external to the organisation. Specifically, they can commercialise internal ideas using channels which are outside their normal area of business, with the object of creating value for the organisation. As such, the barrier between the company and the surrounding environment becomes more and more porous, allowing innovation to move easily between the two environments (Chesbrough, 2003).

This new approach, besides incorporating technological innovation that comes from internal and external sources, involves different methods of accessing the market and multiple ways of selling innovation, offering the management a choice of business model, depending on what is most appropriate for the operations of the company, and may include intellectual property licensing, strategic alliances and venture capital.

In the open innovation model, competing companies cooperate between themselves (coopetition), allowing an exponential increase in the R&D component in an attempt to generate joint solutions (Chesbrough, 2003, 2004). This model places value on team work, partnerships and joint-ventures. The objective is the transference and employment of knowledge by externalising intellectual property. In the open innovation model, a company can develop a particular technology that is not directly in-line with its core business. That technology can however be supplied to another company, meaning that the contribution as a whole that R&D as a business component provides to the final product is vastly increased (Chesbrough, 2004).

According to Chesbrough (2003), the main benefit of open innovation is the possibility of obtaining a significant amount of information and building a knowledge databank for the needs, applications and technological solutions that exist in both the academic and practitioner's domain. That is to say, an open innovation approach consists of collecting ideas from both internal and external sources; it does not restrict the way in which information is brought to market. Open innovation inspires companies to find the

most appropriate business model to make use of new findings, either by licensing, establishing partnerships or even employing venture capital (Chesbrough, 2003).

Chesbrough et al. (2006) states that open innovation is the utilisation of intentional flows of knowledge, entering and exiting the business, to accelerate the internal innovation and expand the markets for the external application of innovation. The first process refers to the so-called inbound open innovation and the second, out-bound open innovation (Huizingh, 2011).

Inbound open innovation is characterised by an outside-in process and involves opening up the innovation processes to looking at external knowledge (Lichtenthaler, 2011). These processes enrich the firm's own knowledge base by integrating supplier, customer and external sources of information (Enkel et al., 2009), making it possible to increase the innovation capacity of the company (Laursen and Salter, 2006; Lettl et al., 2006; Piller and Walcher, 2006). The importance of innovation networks as part of the process is well known (Dittrich and Duysters, 2007; Chesbrough and Prencipe, 2008; Enkel, 2010), along with new ways of integrating clients, such as crowdsourcing (Howe, 2008) mass customisation and integration of the client community (Piller and Fredberg, 2009), and the use of innovation intermediaries (Lakhani, 2008; Piller, 2009; Lee et al., 2009).

Out-bound open innovation embraces the inside-out processes. These processes refer to profits that are made by bringing ideas to market, selling intellectual property and multiplying technology through the transference of ideas from the external environment (Enkel et al., 2009). The companies that put in place inside-out processes as a key element of their business focus themselves on the externalisation of their knowledge and of the innovation, with the objective of rapidly bringing ideas to market that would not be possible using internal development. The decision to change the focus of business effort to outside the boundaries of the business implies the creation of value through licensing intellectual property and/or the multiplication of technologies, transferring ideas to other companies. The companies participate in other markets using the income from licensing, joint-ventures and spin-offs (Enkel et al., 2009).

While the majority of the studies agree that the activities associated with open innovation can be beneficial for SMEs as well as for large companies (Chesbrough, 2003; Chesbrough et al., 2006; Lichtenthaler, 2008), the largest part of the studies made to date have concentrated on large or multinational companies (Bianchi et al., 2010; Christensen et al., 2005; Lecocq and Demil, 2006; Van De Vrande et al., 2009).

SMEs are clearly different to large companies in the way in which they can make use of open innovation activities and the output from innovation. In comparison with large companies, SMEs have various limitations, such as the lack of R&D resources, unstructured innovation processes and underdeveloped internal capabilities (Chesbrough and Crowther, 2006; Lichtenthaler, 2008; Madrid-Guijarro et al., 2009). On the other hand, SMEs are generally less bureaucratic, more likely to take on risks, possess more specialised knowledge and are faster to react to new market demands, which together allows them to adopt open innovation activities (Christensen et al., 2005; Stam and Elfring, 2008; Vossen, 1998). As such, SMEs innovate in a different way to large companies and concentrate on building networks with other businesses, research centres, clients and suppliers (Kleinknecht and Reijnen, 1992; Bullinger et al., 2004).

SMEs depend on their capacity to innovate to become more competitive and sustainable. However, faced with the increase in competition and the rapid pace of

technological change, SMEs are often forced to develop products quickly and in an efficient manner. These requirements are challenging for an SME, which impinges on their ability to commit to innovation projects (Cooper et al., 2003; De Toni and Nassimbeni, 2003; Pittaway et al., 2004; Powell et al., 1996). The networks represent a complementary response to the insecurity brought on by the development of the use of new technologies, while also reducing the uncertainties associated with innovation (Diez, 2002).

Various studies support the idea that open innovation activities can be translated into strategic benefits for the SMEs (Chesbrough and Crowther, 2006; Chesbrough et al., 2006; Gassmann, 2006; Laursen and Salter, 2006; Lee et al., 2009). Van De Vrande et al. (2009) suggest that the activities of open innovation can allow access to missing knowledge, reduce the costs of development, open up possibilities for risk sharing and improve the process of product development. By employing an approach of open innovation development, SMEs can benefit from the skills of enthusiasts and qualified programmers from all over the world, compensating for the limited resources at home (Henkel, 2006).

SMEs extensively use networks and external sources to boost their innovation process, where the key partners are universities, intermediaries, customers and suppliers (Zeng et al., 2010; Bercovitz and Feldman, 2007). The universities, research institutes, suppliers, customers and other partners have a valuable impact on the knowledge and on the process of innovation creation (Bullinger et al., 2004) while the social interactions based on confidence and cooperation play an important role in the coordination of the activities between SMEs (Brioschi et al., 2002). The largest positive impact on the level of new innovation comes from collaborative networks, which include different types of partners (Nieto and Santamaría, 2007). The innovation networks are often made up of a heterogeneous group of various actors, including representative firms, universities, technological centres and development organisations (Pekkarinen and Harmaakorpi, 2006). However, it is difficult to choose the appropriate external resources (Sapienza et al., 2004) and maintain a significant number of ties with the partners (Ahuja, 2000).

The innovation intermediaries play an important role in open innovation (Chesbrough, 2003). These intermediaries carry out a variety of activities in the innovation process (Howells, 2006), being described as the agents, brokers or marketplace (Chesbrough, 2006) helping find the equilibrium between technology and the market. Stewart and Hyysalo (2008) underline the idea that an intermediary, besides being a service supplier, market maker or knowledge broker for someone, are also architects in the way that they co-create and enable creation of creative knowledge. Intermediaries can have a vital role in the processes of innovation, where the technologies, the markets and the actors are unknown and where there is a necessity for collaborative action, acting as an architect of collective exploration (Agogué et al., 2013).

New studies should be developed to investigate this new role that innovation intermediaries can play, namely in specific situations of collaborative innovation (Agogué et al., 2013). It is equally important to gain a better understanding of the differences between sectors, given that open innovation depends on the particular characteristics of each industry (Schroll and Mild, 2012), incorporating the two processes of innovation (outside-in and inside-out) in the studies on open innovation (Schroll and Mild, 2011). In looking to seek out open innovation, the current study looks to trace a profile of the relationships with the innovation partners of Portuguese SMEs from different industries.

The existing studies have centred on large companies, mainly located in developed countries. However, open innovation also exists in smaller organisations (Lee et al., 2009; Van de Vrande et al., 2009). While the argument over the effect that firm size has on the efficacy of innovation is still ongoing, it is worth addressing the particularities of open innovation from the viewpoint of the intermediaries, with a focus on SMEs, given that they are the main players in the game of innovation (Maula et al., 2006).

3 Methodology

The objective of this study centres on the understanding and characterisation of the type of relationship that exists between Portuguese SMEs, in different industry sectors, and their innovation partners, in the context of open innovation.

The selection of the economic sectors was made based in the taxonomy of Pavitt's (1984) sectoral innovation, which is an influential approach providing a method for understanding the sectorial differences in relation to innovation. While *a priori* it is not possible to guarantee a match between the taxonomy proposed by Pavitt and the chosen sectors (given that they refer to SMEs) the research will be carried out for the following three sectors, due to their dynamism and importance for the Portuguese and European economy: the moulds, automotive and footwear industries.

As there was no single theory describing how SMEs interrelate with business associations and technology centres with regards to open innovation, for this study the option taken was to follow a qualitative approach. Given the nature of the current research, detailed interviews were held with the relevant business associations and technological centres for the three industries identified, as can be seen in Table 1

Table 1 Relevant entities providing interviews

	Association	*Technological centre*
Footwear industry	*APICCAPS* (Portuguese Footwear, Components and Leather Goods Manufacturers' Association)	*CTCP* (Portuguese Technological Centre for Footwear)
Moulds industry	*CEFAMOL* (Portuguese Association of the Moulds Industry)	*CENTIMFE* (Technological Centre for the Mouldmaking, Special Tooling and Plastics Industries)
Automotive industry	*AFIA* (Portuguese Association of Automotive Suppliers)	*CEIIA* (Centre for Excellence and Innovation in the Mobility Industry)

Source: The authors

These institutions were selected for being the most representative for each industry and for being orientated towards SMEs. Initially they were contacted by e-mail and subsequently by phone. An interview was scheduled with top executives in order to:

a explain the purpose of the research

b address the institution regarding the possibility of releasing information about the industry and SME innovation performance

c assess the possibility of further research studying the institution's involvement in technology transfer projects involving SMEs.

All the six institutions confirmed their willingness to cooperate in the field research. The collection of data involved tape-recorded, in-depth, semi-structured interviews, with the head of the institutions as well as with top executives responsible for the relationships and projects with SMEs. The interviews addressed the following topics:

- institutional and firm level R&D activities
- technology transfer management and property rights
- collaboration with external partners in innovation projects
- management/relationship with innovation partners.

The use of semi-structured interviews favoured a qualitative approach and allowed the interviewees' points of view to be included while at the same time gaining an understanding of the topics addressed from the institutional point of view. As a complement to the analysis, secondary data was sourced for the industries and institutions studied.

In order to analyse open innovation activities in small and medium-sized firms the data gathered were used to theorise about those activities (Langley, 1999). The methodology followed throughout the study generated a great deal of data, which is one of the main challenges of qualitative studies (Miles, 1979). An inductive, sequential and critical perspective was followed in order to deal with this situation, according to the general guidelines of Miles and Huberman (1984) and Riley (1990).

The interviews conducted with the different institutions emphasised the need to understand their perspective on the practices surrounding innovation for the respective industry that they represented.

This initial methodological step, with an exploratory dimension, allowed some knowledge to be collected concerning the different industries, and was found to be extremely useful in organising and framing the study objects under analysis.

4 The automotive industry in Portugal

The automotive industry in Portugal has undergone various alterations over the last few years, both at the level of assembly lines and at the level of component suppliers.

In the 1990s the automotive industry in Portugal was composed on around a dozen assembly lines throughout the country. Currently the automotive industry is comprised of five main actors: PSA Peugeot Citroën, Toyota Caetano Portugal, Mitsubishi Fuso Trucks Europe, Volkswagen Autoeuropa and V.N. Automóveis.

In total, the assembly operations in Portugal were responsible for the production of 163,561 vehicles during 2012. The majority of national automobile production is made up of light passenger vehicles (70.6% of the total of all vehicles) (ACAP, 2013).

In 2012, 97.8% of national production was exported, namely to the European market.

The automotive components industry in Portugal is also very important for the Portuguese automobile sector, having consistently grown over the years (AFIA, 2008).

The automotive components industry in Portugal covers the following subsectors (AFIA, 2010):

1 electric and electronic equipment

2 interior fittings

3 floorpans, brakes, suspension, steering and wheels

4 engines and their ancillaries

5 exterior fittings

6 moulds and their tooling

7 metallurgy

8 organic and chemical products

9 support services.

In 2011, the number of companies in the automotive components industry in Portugal totalled 180. In 2011, the level of business in the automotive components industry reached 7,517 million euro, of which 1,530 million euro went to the national market (AFIA, 2012).

The main customer of the national components suppliers is the Volkswagen group, which holds a dominant position for the industry as whole.

The supply chain breakdown shows that 55% of turnover comes from tier 1 suppliers, 25.2% from tier 2 suppliers and 7% from tier 3 suppliers (AFIA, 2010). In addition, 12.8% of sales come from aftermarket supplies.

The automotive sector in Portugal is one of the most dynamic and innovative sectors of the national economy. The production of motor vehicles and their components makes up one of the main exporting sectors in Portugal.

An important characteristic of the automotive industry is that it is based on a myriad of SMEs with limited endogenous potential for carrying out technological development (R&D) (Moreira, 2008) and on some multinational original equipment manufacturers (OEMs) that have been influential in the creation of endogenous knowledge (Moreira and Carvalho, 2012). However, the poor transference of technology between SMEs and multinational OEMs has been consistently observed. The business associations and the technological centres have played an important role in the transference of knowledge and technology between project stakeholders.

5 The footwear industry in Portugal

The footwear industry in Portugal includes activities involving footwear components and leather goods. The main actors in this industry are: the suppliers of raw materials, the suppliers of components, the suppliers of production accessories and the footwear manufacturers.

This industry is basically composed of SMEs, as a result of some of the larger companies operating in Portugal having left or closed. In the case of those companies that produce components and leather goods, their size has become smaller over time, reflecting a general trend for firms within the business cluster (APICCAPS, 2011).

The Portuguese footwear industry employs around 33 thousand people and exports more than 68 million pairs of shoes per year. In recent years, the production level of this industry has fallen as a result of a number of exogenous shocks that have hit the industry, reinforcing the intensity of competition (APICCAPS, 2011).

The footwear industry in Portugal has a particular specialisation in leather footwear (80% of the total), where ladies footwear is the most important in this segment with 47.2% of leather footwear. Safety footwear has a total of 1.5% of all footwear production. Both ladies footwear and safety footwear are more important in value terms than in the quantity produced, given the high level of their average price (APICCAPS, 2011).

The footwear industry in Portugal, in contrast to the automotive industry, does not have multinational companies that serve as an anchor for the production chain. There is a large number of SMEs that have come to develop skills in the conception and design of products. The role of CTCP and of APICCAPS has been to act as important catalysers in the transference of technology through becoming involved in international projects for certification of products and technology.

6 The moulds industry in Portugal

The moulds industry in Portugal is notable for its high level of technological development and for the fact that its capacity to innovate has launched it into the international marketplace. Supporting its position in the market has been its focus on competitive factors such as the relationship between price, quality and delivery times (CEFAMOL, 2013).

At the time of writing, this sector is made up of around 450 companies, basically SMEs, dedicated to design, development and manufacture of moulds and special tools. These companies are concentrated in the main in the regions of Marinha Grande and Oliveira de Azeméis, employing around 7,640 specialised workers (CEFAMOL, 2013).

The moulds industry in Portugal is one of the main players at world level in the manufacture of moulds, currently exporting more than 90% of its production (CEFAMOL, 2013).

In 2012, the total production reached a turnover of 569 million euro, of which 512 million euro were from exports, where the main markets were Germany (21%), Spain (20%), France (17%), Brazil (4%) and the Czech Republic (4%) (CEFAMOL, 2013). At a sectoral level, the automotive industry is the main customer absorbing 74% of production. The electrical/electronics/home appliance sector is also an important customer, representing 14% of demand (CEFAMOL, 2013).

The moulds industry, while structurally based on SMEs as in the footwear industry, has two big advantages:

a It has as its main downstream industry the automotive industry, with its high level of technology usage

b Its main customers are multinational companies from the automotive sector. While the innovation and transfer of technology are implicitly present in the relationships, the role of the technological centres has not been studied.

7 Main results

The automotive industry in Portugal is frequently confronted with the need to innovate, faced with the demands of the international OEMs. Its innovation processes are based on its capacity to develop new solutions and new methods of production for its products, even though strictly speaking, the majority of the companies do not have a R&D department. The R&D activities are, as such, the responsibility of a multidisciplinary team, brought together to work on a specific project.

Searching for and acquiring external technology is done based upon the demands of the market and for the most part, due to cost factors, it is carried out on a case-by-case basis. As a general rule, the technology is produced together with the partners, but there is no policy or strategy defined for the management of the technology produced by the internal R&D activities. Faced with the existence of surplus technology, there are no procedures for commercialising this type of technology.

Working together with external partners on innovation projects has the objective of widening the skills base of the companies and integrating skills from heterogeneous areas. Companies in this way are seeking to increase their size and critical mass for creating opportunities and external supply. Sharing and reducing the costs and risks associated with the innovation process is an additional objective that also underlies the partnerships established.

Innovation partners are chosen based on their competence, even though confidence is key for making an innovation project work. The CEIIA has a preeminent role in mobilising projects, generally choosing the enablers that make up part of its network.

The existing collaborations appear, for the large part, in the shape of consortiums, with the signing of protocols for cooperation and partnership and confidentiality agreements. The sources of collaboration include: universities (Oporto, Minho, Aveiro and UTL), research centres (CEIIA), suppliers, customers and companies from other sectors. The competing entities are avoided and the governmental institutions appear only as a source of financing.

The collaboration with the partners is most evident for the phases of experimentation/prototype design and engineering, and the collaboration is formally put in place with recourse to organisational functions that oversee the projects.

The relationships that are established are long term, typified by partnerships, alliances and organisational networks. All the partners decide how the solutions are to be implemented, albeit only within their own area of work, given their specific knowledge of the problem to be resolved.

The companies formally evaluate the objectives and the potential risks of collaboration, analyse and select the potential of the partners and evaluate the different possible organisational forms for collaborating, employing a formal and explicit process. The progress is monitored, with the final performance being formally measured, and the reasons for the success of failure of the collaboration are given, mainly by imposition of the co-financiers (COMPETE, QREN) that require that reports are drawn up detailing the

performance and results. Companies use internet-based systems for sharing information and communicating, and employ tools that facilitate the development of new products developed collaboratively. The resulting products from the projects can be produced and subsequently commercialised or give rise to other new projects.

By way of example, at the time of writing, a research and development project exists, known as Mobicar, that was born out of an initiative from the Unit for the Competitiveness and Technology of the Mobility Industries in collaboration with other similar units for the information technology, communications and electronics industries and the energy industries, as part of the Program for Electric Mobility (Mobi.E). This takes on the design, development, testing and showcasing of the main modules that are shaped by the new requirements for mobility (seats, exterior fittings, interior fittings and engines) and energy and information, with applications to different platforms for electrical mobility environments (micro cars and passenger cars, among other applications).

This project involves 17 partners, of which 12 are companies from the most diverse areas of the automotive industry (VN Automóveis, CABELAUTO, CaetanoBus, EFACEC, FLEX2000, Inapal Metal, IPETEX, Manuel Soares Gonçalves, MOLDIT, Rimsys, SIMSEG, TMG) and five are entities from the Scientific and Technological System (CEIIA, CeNTITVC, Sports Faculty of the University of Oporto, Engineering Faculty of the University of Oporto, University of Minho).

The plan of work is phased, with the intellectual property held by the entity which develops it, in as much as each partner contributes with their area of specialisation. The last phases involve the integration of the final product and lastly the management and diffusion.

The innovation projects arise mainly within the same structure as the project described above.

The footwear industry in Portugal has shown a growing dynamism in its innovation activities. Its continuous development draws on an innovation plan where various projects coexist, running alongside one another.

R&D activities are mainly organised departmentally focusing on product, process and organisational innovations. Marketing innovation, although less common, is increasingly demanded. The CTCP is the principal driver of R&D in this industry, promoting the implementation of incremental innovations, in the most varied areas of the daily activities of these companies.

The search for external technology occurs explicitly, on a case-by-case basis. The technology sought is conditioned by the demands of the clients and by a perspective of efficient usage of resources. No surpluses emerge from the production of internal technology.

The objectives of the cooperating firms that participate in innovation projects focus on widening the core skills of the companies and on reducing and sharing the costs of the innovation process.

When it comes to choosing partners, the CTCP has a dominant role, although the client for its part can suggest some partners. As a rule, it is the final goal that determines the partners, while it is still the case that the criteria used for the choice focus on competency and mutual confidence.

The consortium is the most frequent way for firms to collaborate in this industry. The network is open but confidential, with the know-how retained exclusively by the company driving the project under development. The main phases of collaboration focus

on the experimentation and design of prototypes, the engineering and the production, where each company works in their area of specialty.

The sources of collaboration are diverse: universities, research centres (INSEC, PIEP), customers, suppliers, indirect competitors and companies from other sectors.

The CTCP has organisational and management capacities that help support an innovation process start-up. The relationships with partners are long-term, integrated into organisational or partner networks. The CTCP leads the network management, although all partners have the chance to contribute within their area of specialty.

The management of the relationship among partners is a formal process; the companies evaluate the objectives and risks of the collaboration, in the same way that they select a potential partner. The progress and the potential problems are monitored and the final performance is formally measured. During the collaboration the companies utilise an online platform with a knowledge base, allowing easy sharing and communication of information between all of the participants.

The network is continually active, being constantly fed with new ideas and new projects.

The moulds industry in Portugal has certain defining characteristics which make it unique within the panorama of national industry.

R&D activities of these companies are fundamentally organised by the way of single projects; however, a small number of companies have begun to invest in the creation of dedicated departments for these activities.

The involvement in partnerships with the customers opens the way for product and process innovations in the design of new solutions.

In this sector an explicit search is carried out for the external technologies that could be acquired, namely at the level of base supplies, where the specific needs of the companies themselves and of their clients' dictate the search demand. No transference occurs at the level of internally developed technology, in the sense that no surpluses emerge from internally produced technologies.

The partnerships that are established in innovation projects can have various underlying objectives, depending on the specific cases. The choice of partner comes down to aspects such as common interests, experience in the area and previous relations. The relationships that are established between companies are not formal, arising as a result of projects and occasionally they can occur in a cooperative context.

The sources and/or partners in the collaboration are varied, with universities, research centres, customers, suppliers, competitors and public entities among some of the partners sought.

The research, development and innovation collaborative projects mainly come about in the experimentation, design engineering and production phases. The management of these projects, as a rule, is the responsibility of CENTIMFE, although all of the partners can participate actively in the decision making process.

The relationships are generally long-term and part of organisational networks. The management is not formal, with no analysis of performance or results, except when they are projects involving national or international financing.

Table 2 lays out the results obtained from the interviews with the associations and the technological centres for the respective industries.

Table 2 Summary of the results obtained from the business associations and the technological centres

			Automotive industry AFIA and CEIIA	*Footwear industry APICCAPS and CTCP*	*Moulds industry CEFAMOL and CENTIMFE*
1	Research and development activity (R&D)	Organisation of R&D	Organised by projects under the control of a multidisciplinary team	Organised by departments, with multidisciplinary teams	Organised in unique projects
		Main focus of R&D	Product and process innovation occurs incrementally	Product, process, organisational and marketing innovation occurs incrementally.	Product and process innovation occurs incrementally
2	Management of technology transference/rights to internal and external property	The search for and acquisition of external technologies	No pro-active searching takes place	An explicit search is carried out on a case-by-case basis	An explicit search is carried out
		Situations where the search and acquisition of external technologies occurs	A demand made by the market; competition; cost factors	Requested by the client, search for resources (machinery)	Specific needs of the client
		Surplus/management of technology developed internally	No procedures for the management of internally developed technology exist	No surplus technologies exist	No surplus technologies exist
3	Management/ relationships with the innovation partners	Type of relationship with the innovation partners	Long-term relationships, partnerships, alliances, organisational networks	Long-term relationships, partnerships, organisational networks	Long-term relationships, partnerships, organisational networks
		Position of the partners in the innovation network	All the partners have a say in decision making, in relation to their area of specialty	Each partner has a say in their area of specialty	All the partners have decision making power in their area of specialty
		Management of the relationship with the partners	The partners' relationship is monitored and evaluated using management techniques	The relationship management employs informal monitoring and evaluations	Informal management, based on experience
4	Collaboration with external partners on innovation projects	Objectives of collaboration	Widen the skills base; Reduction and sharing of costs and risks associated with the innovation process	Widen the skills base, integrate heterogeneous skills, reduce/share the costs associated with the innovation process	Varied interests, depending on each case
		Basis on which the partner is chosen	Confidence, competence, references from sector partners	Competence, mutual confidence	Common interests experience in the area, previous relationships
		Form of technological collaboration	Consortiums	Consortiums	Projects, informal relationships.
		Partners/sources of technological collaboration	Universities, research centres, clients, suppliers; other industries' firms	Universities, research centres, clients, suppliers, indirect competitors other industries' firms	Universities, research centres, clients, suppliers, indirect competitors
		Main phases of collaboration with the partners	Experimentation, prototype development, engineering	Experimentation, prototype development and design, engineering, production	Experimentation, prototype development, engineering, production
		Organisational and management activities at the beginning of the innovation process	Organisational functions exist that govern the collaboration	An operational unit manages each project	An operational unit exists to manage the collaboration project

8 Concluding remarks and discussion of results

With the introduction of open innovation, the internal skills of the company are no longer sufficient. Faced with this new paradigm, changes have occurred to the way in which companies generate new ideas and how these ideas are brought to market. More specifically, companies must use internal and external knowledge to accelerate their innovation, being able to utilise internal and external ideas and internal and external pathways for reaching the market.

Looking at the current state of the open innovation field of research reveals that its nascent state is reflected in the existence of some gaps that are deserving of a more focused analysis. The analysis carried out here shows that research has placed an emphasis on large technological companies, where the concept was first developed, mainly in developed countries. A substantial number of publications are based on qualitative approaches using case studies.

This work sought to shed some light on open innovation practices in SMEs. In order to complement the existing literature, this analysis focused on gaining an understanding of the relationship between SMEs and technology centres, given that no previous studies have analysed this collaborative exploratory innovation process.

This work sought to explore the field of open innovation using interviews with relevant business associations and technological centres, seeking a wider perspective of the viewpoint that these entities have regarding the companies that belong to the three different industries.

Our main contribution is the identification of the important role played by technology centres as active players in their role as intermediaries in the innovation process with SMEs.

In accordance with the results obtained via the interviews, it can be stated that the companies from the three industries studied are opening up their innovation processes, by way of utilising input from external partners and/or by way of externally marketing technologies that were developed internally. However, the results of the innovations are closed, destined for the benefit of a small group of companies. As such, it can be said that while the adoption of the open innovation model has not fully internalised, SMEs in the three studied industries reveal the existence of a private open innovation, in accordance with the typology of Huizingh (2011).

If we analyse the results in the light of the two central forces of open innovation – outside-in and inside-out processes – there is a notable development in the internal utilisation of the external knowledge and a lack of strategy and vision for externally marketing the internal knowledge.

The companies internally utilise the knowledge extracted from their network, enriching their knowledge through integration with the innovation partners. However, difficulties in commercialising the results of the innovation projects is common to all the industries studied, while the main phase in the relationship is that of design and engineering. Everyone benefits from the network but each partner is the keeper of the know-how and of their products, within their area of specialty.

As such, the only open innovation strategy adopted is that of internalisation of technologies through seeking out and acquiring external technology. In the specific case of the footwear industry, spin-offs only happen if no other company yet exists in the specific area. In the case of the automotive industry, some examples can be found of

external licensing. In this sense, evidence exists of an opening up of the activities of innovation but the acceptance of the open innovation model is limited.

Clearly the companies wish to join in partnerships with the technological centres to be able to use the external knowledge provided, by both the technological centres acting as brokers matching the demand and supply of ideas, technologies and knowledge, and the partner companies acting as networking units connecting to the experts well beyond the firm's boundaries.

The type of partnerships and projects is different from industry to industry. The CENTIMFE and the CTCP are anchor partners in the R&D processes and the 'strong arm' of the companies, working as a connecting point between the various actors in the industrial ecosystem. For the SMEs the choice of partner is highly centralised in the technological centres, given that these are responsible for finding projects, nationally or internationally. To all effects, the companies do not know what skills the other firms have, with no database in existence that allows a search for partners to take place; it is because of this that the technological centres have become indispensable. The technological centres play an active role in the deployment and control of projects. For their part, the stakeholders seek to internalise new knowledge and explore new solutions.

The role that CEIIA has played in the automotive industry has been different, given that it has sought to develop new concepts at a national level, choosing its partners for the project.

The type of innovation partners is varied and depends on each case. Moreover, government institutions are not frequently involved and direct competitors are avoided. The moulds industry shows some openness to coopetition strategies, evidently a result of its culture and its specific characteristics.

There are various types of involvement in projects with technological centres. However, it was stated that the majority of the SMEs look for long-term relationships as part of organisational networks or by way of consortiums. Underlying the choice of partners is competency and experience. There are varied sources of collaboration, where the partners that are most sought after are universities, technological centres, customers and suppliers. Clearly this could reveal a necessity that firms have to make up for their R&D deficiencies, following a structured perspective while making use of the relationships with the technological centres.

According to the data supplied, SMEs for the three industries analysed did not show big behavioural differences in the way they approach open innovation, which leads one to believe that the degree of openness in the innovation models does not appear to be related to the specificities of the industry but more so a need for a supporting public policy intervention for the Portuguese industrial sector, traditionally characterised as having a lack of large companies or technologically highly intensive firms.

One of the main limitations is that while the results obtained can be considered important at this initial stage, they only reflect one side of the argument – that of the institutions that were interviewed, i.e., they do not incorporate the reality of the companies as they see it. The question can be asked if the Portuguese SMEs from these industries see themselves reflected in the results obtained. Would it be the case that differences exist between the perspective of the associations and the technological centres and that of the reality of the companies? In this sense, it is equally important to listen to the companies of each industry to gain an understanding of the conceptualisation of the results obtained.

Another limitation of this study is linked to the fact that an in depth analysis was not conducted by type of innovation (radical or incremental) projects. The analysis did not address either type of involvement of the partners, which could lead to different results.

For further work some recommendations can be made for future perspectives:

1 To complement the study of the relationship between technological centres and business associations by focusing on the SMEs. As such, it would be possible to understand how it is that one views the other as stakeholders in the project analysed.

2 To study the role of the innovation intermediaries in open innovation, taking into consideration the type of innovation, as well as the involvement and/or the type of partner. It is necessary to know what the consequences are for the SMEs, as well as querying the role of the technological centres, the technology transference institutions as anchor institutions in the process and the diffusion of innovation.

3 Given that the relationships between the SMEs and the technological centres and business associations seem relevant, it is necessary to take into consideration the role that the large multinationals, mainly in the automotive sector, have in their relationships with the SMEs from the automotive and moulds industry. If on the one hand it is known that the OEMs work as production anchors, their role as anchors for diffusing new technologies and in the process of innovation are unknown.

Public policy as a structural element for business competitiveness needs to be analysed, so as to be able to assess how it is that the sectorial system of innovation can be made more dynamic.

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