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Openness and innovation: an empirical analysis in firms located in the Republic of San Marino

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Abstract

Opening up the innovation process to include collaboration with external partners is an increasingly common practice among firms. Today, also small and medium-sized firms appear to have understood the usefulness of forming alliances and building networks in order to compete in the knowledge economy. This paper aims to further investigate the actors, the phases of the innovation process, the dynamics and the determinants that prompt businesses in a small state such as San Marino, to collaborate in innovation beyond their company and territorial boundaries. A survey has been conducted among manufacturing companies operating in San Marino state with direct structured interviews to the company directors or persons in charge of R&D. Very few empirical analyses have been conducted in literature on this subject, and in general these analyses have not focused on Small and Medium Enterprises. Moreover, this paper investigated a territorial context (Republic of San Marino) which until now have never been analyzed in terms of innovation. From an academic point of view, the results fill a gap in the literature investigating the influence of competitive factors during the innovation process. Regarding the actors, the openness of NDP phases and the determinants of open innovation our study for the most part confirm the literature. The opening up of certain innovation activities is generally implemented with the aim of integrating and expanding new knowledge and skills and reducing a product's time to market. With regard to the variables that influence the openness of the innovation process, the most important are time, added service and environmental friendliness. From a management point of view, this paper is especially useful to company directors and government agencies in activating, supporting and guiding innovation policies.

Keywords: Open innovation, small firms, innovation process, survey, manufacturing firms, new product development.

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1. Introduction

In recent years, significant changes, undoubtedly associated with the 'globalization' of the economy, have influenced the generation and dissemination of technologies, and in so doing have profoundly affected the way firms behave. Over the last decade global markets have continued to demand new products at ever-increasing levels of complexity in ever-shorter amounts of time. These market pressures have led a growing number of companies to seize external opportunities in order to rapidly enhance their technological know-how and to avoid losing the competitive advantage gained by whoever arrives first on the market. This has meant the overturning of the traditional sequence of innovation processes 'technology based' firms employed, which provided a central role in the implementation of innovative projects in the R&D laboratories, and which, traditionally, relegated a marginal role to external sources (Autio and Laamamen, 1995).

The new approach, characterized by the company's ability to draw on a range of external sources to meet their needs for innovation, has been termed 'open innovation'. These new sources are chiefly made up of university laboratories, public and private research laboratories, small high-tech companies, public agencies responsible to the government for technology-intensive sectors, large firms with whom collaborative relationships can be established, but also and above all, suppliers and customers.

Particularly important for small and medium-sized firms is the need to access new knowledge in order to acquire ideas, raise the cultural level of their products and the knowledge base of their organization (Lee et al., 2010). Limitations in terms of economic-financial resources and management and technological training in fact hinder these firms from activating innovation processes. On the other hand, if small and medium-sized firms were strengthened in their innovation process, they could be at the centre of a new system and become a prime source for innovations in a competitive environment where larger firms prefer to concentrate on their core competencies. SMEs can play an important and distinct role in the innovation process, whereas many large firms act solely as a systems integrator (Rahman and Ramos, 2010).

However, the term 'open innovation' is not only related to methods of acquiring knowledge and technology, but also to activities aimed at finding external partners engaged in marketing innovation (Chesbrought and Crowther, 2006). Hence the phenomenon has two dimensions: the phase of acquiring knowledge and technology for the development of innovation (outside-in or technology exploration), and the phase of marketing the innovation itself (inside-out or technology exploitation). The strategy of technology exploration and technology exploitation depends on a number of corporate and contextual factors. The analysis conducted in the present study focuses on the first dimension (outside-in), setting as its objective the identification of the determinants that influence a firm's openness towards the external environment during the developmental phases of innovation.

A review of the literature reveals a gap in the investigation of the influence of competitive factors on the openness of the innovation process. For this reasons the attention was focused not only on the contextual determinants but also on the corporate determinants and the competitive factors. The aspect that most characterizes whether or not a firm adopts an open innovation approach is, in fact, the opening of their company boundaries and an increase in the number of collaborative projects and partners. Dahlander and Gann (2007) identify three types of openness: the different degrees of formal and informal protection, the number of sources of external innovation, the degree to which firms are reliant on informal and formal relationships with other actors.

In this paper we try to identify the degree of openness basically in terms of the number of external sources involved in each NPD phase of knowledge acquisition. The study was conducted among firms within the Republic of San Marino; i.e., a context characterized by mainly small and medium-sized firms, which until now have never been analyzed in terms of innovation, and by a negligible government policy in support of innovation. Since the process of product development is the focus of the analysis, the firms selected were those in the manufacturing sector, even though 56% of San Marino's businesses belong to the services sector – particularly banking and finance – and 23% of firms operate in the commercial sector. The results confirmed some studies in the literature regarding the actors involved, the activities most likely to be conducted by partnerships, and the determinants that influence the open innovation strategy and at least the results provided evidence regarding the factors influencing the openness in each phase of the innovation process. The paper is structured as follows: Section 2 outlines the theoretical framework; Section 3 describes the research questions and the investigative methodology used; finally, Section 4 reports the results of the quantitative analysis followed by the conclusions.

2. Theoretical framework

Open innovation requires the company to open up its fixed boundaries so that valuable knowledge can flow in from the outside in order to create opportunities for the innovation strategy (Gassmann and Enkel, 2004). This approach has become an integral part of the business models of companies in recent years, during which time the literature has investigated this new paradigm, analyzing various aspects, such as the actors involved in the process of technology exploration and technology exploitation, their motivations to adopt an open approach, the phases of the innovation process that are more or less open to the outside, the barriers and the determinants of open innovation (variables in terms of context and business strategies) (Chesbrough, 2003; Gassmann and Enkel, 2004; Laursen and Salter, 2006; Enkel et al., 2009; Lazzarotti and Manzini, 2009; Keupp and Gassmann, 2009; Lazzarotti et al, 2010).

Actors

Innovators rarely innovate alone, instead they tend to form teams and coalitions in order to participate in networks and communities working together (Laursen and Salten, 2006). In the paradigm of open innovation, the innovation process is distributed among a large number of actors belonging to the system, for example: customers and suppliers, in particular for SMEs, (Gassmann, 2006), universities, and public research institutes (Tidd and Trewhella, 1997; Bigliardi and Dormio, 2009), competitors, consultant engineers, industrial associations, governments and non-profit intermediary organizations (De Jong and Hulsink, 2005; Laursen and Salten, 2006; Gassmann and Enkel, 2004, OECD, 2008).

Phases

In addition, there is the process of innovation divided into the following phases: idea generation and analysis, product idea development (product concept), design and engineering, production, and finally marketing (Ulrich and Eppinger, 2008; Munari and Sobrero, 2004). Collaboration with the external actors can develop at any phase of the innovation process (Chesbrough, 2003; van der Vrande, Lemmens and Vanhaverbeke, 2006). Empirical evidence shows that it is possible to classify the different modes of open innovation according to the number and type of partners firms involve, and the number and type of phases in the innovation process that are open to external collaboration (Lanzarotti and Manzini, 2009; Lichtenthaler and Ernst, 2009). Some studies find that the phases of the innovation process more open are the early ones (Lanzarotti et al., 2010).

Determinants and barriers

With regard to the variables that influence the adoption of open innovation, these can be divided into strategic and context variables. The context variables analyzed in the literature were the firm's size, the sector of activity, product features,

technological diversification, the degree of knowledge embodied in the product, the existence of a unit of corporate venturing, and international diversification. Regarding the first two (size and sector), some studies showed that larger firms acquire more from outside sources than small firms do (van der Vrande et al. 2009; Lichtenthaler and Ernest, 2009). This depends on whether the complexity of technological knowledge involved in their products prompts them to seek different sources of knowledge (Cassiman and Veugelers, 2006), or that they have the necessary resources to open organizational units committed to the search for partners (Rothaermel and Deeds, 2006). A conflicting opinion comes from Gassmann and Enkel (2004), who claim that nowadays, firm size is an increasingly less relevant factor. Even in terms of the specific nature of the sector, the literature is divided between those who say this does not affect the degree of openness towards the outside (Lichtenthaler and Ernst, 2009) and those who identify in the technological specialization of the sector and its speed, a determinant towards a strategy of openness.

The competitive strategy of a firm represents perhaps one of the most influential determinant in the approach towards open innovation. Today, in particular, the firm tend to focus on a superior technology strategy, composed by technology aggressiveness, technology timing and technology diversification (Brockhoff and Chkrabarti, 1988; Dìaz-Dìaz et al. 2006). The technology aggressiveness, is defined as the proactive exploration, retention and commercialization of radically new technological solutions (Abernathy and Clark, 1985; Brockhoff and Pearson,1992). Lichtenthaler and Ernst (2009) find that firms with an aggressive technological strategy tend to make external acquisitions to a lesser extent than firms with a defensive strategy. On the other hand, there seems to be a positive relationship between the emphasis on radical innovation and degree of intensity in research and development activities and the acquisition of external technologies (Calantone and Stanko, 2007; Lichtenthaler, 2008; Lichtenthaler and Ernst, 2009). Even the brand may be an aspect to consider, especially in a process of outbound open innovation, for example when the firm has expertise in development and marketing but does not have a recognizable brand in the relevant market (Gassmann and Enkel, 2008).

The implementation of a strategy to achieve a competitive advantage requires the identification of skills and capabilities that differentiate a firm from its competitors. These capabilities are called competitive factors (Barney, 1991). The perceived importance of competitive factors can vary from one level of management to another, from nations and also from industries. Some scholars argued that in manufacturing firms the most important competitive factor is higher quality and then other factors such as reputation, time to market, brand identity, customer service, technological innovation, prices lower than competitors, availability of funds (Markland et al, 1995; Lau, 2000, Madrid-VanAuken-Garcia, 2007), up to the adoption of an ecological behaviour (Hong, Kwon and Roh, 2009).

With regard to the motivations that may prompt a firm to adopt an open innovation approach, the arguments can be linked to the market (to meet customer demand or remain competitive), but also to the gathering of new ideas and knowledge, reducing of fixed R&D cost and the time to market, improving innovation performance and stimulating change in the company, and, lastly, using creativity in the best way (EIRMA, 2003; Jacobs and Waalkens, 2001; Gassmann and Enkel, 2008). In particular for SMEs the most important motives for the adoption of open innovation practices are market-related ones and corporate renewal (van der Vrande et al., 2009). Conversely, regarding the barriers to open innovation, the main problems in managing interpersonal relations following an open approach are due to cultural diversity and organizational-management issues, in particular for SMEs (EIRMA, 2003; van der Vrande et al., 2009). Other barriers concern the availability of time, financial resources and managerial problems (van der Vrande et al., 2009).

3. Research questions and methodology

The aim of this study is to provide further knowledge about the innovation processes adopted by firms in a specific territory, which in this case coincides with a small state, and to validate certain hypotheses identified in the literature that concern open innovation approach. The research questions are:

1. What is the innovation profile of the firms under examination?
2. Who are the actors and what are the activities that are open to the outside?
3. What are the variables that influence the degree of openness in the development of a new product (NPD) and in particular which competitive factors influence the openness of the innovation process?

The sample of firms was selected by the National Association of San Marino Industry according to the following criteria:

- consider solely manufacturing firms since the focus of the analysis concerns the process of product development;
- select firms with a larger turnover and number of employees;
- give precedence according to the degree of internationalization;
- consider the presence of any research and development laboratories within the company;
- opt for firms participating in the EUREKA finance program (an European joint programme dedicated to the R&D performing SMEs).

The above criteria were used to select firms with previous experience in innovation processes, and which therefore might have opened their company boundaries to acquire ideas and knowledge for the purpose of innovation development.
In accordance with these considerations, forty-two firms were chosen, out of which thirty-six provided a sufficient amount of data for subsequent analysis. The official data of the Chamber of Commerce of San Marino show that the population under study

(manufacturing companies) is about 500 firms. Our sample is therefore 7.2% of the entire population. The machinery/automation sector dominated; for example, firms producing machines for processing marble, glass, plastics and packaging. These were followed at a distance by the chemical-pharmaceutical sector and the metal and woodworking industries. As might be expected, in 89% of cases these firms are SMEs with a consolidated history (see Table 1).

Table 1. Main characteristics of the sample of firms obtained

INDUSTRY		**DIMENSION**		**AGE**	
ICT, Pharmaceutical	24%	Small (<50 employees)	50%	Junior (0-10 years)	17%
Machine/Automation,	40%	Medium	39%	Adult (11-30 years)	44%
Chemical	18%	(49<employees<250)	11%	Senior (31+years)	39%
Metal and plastics	18%	Large (employees>250)			
Wood, Food, Paper, Textiles					

The survey was conducted by means of direct interviews with the owners or administrative directors of the firms involved. The interview was conducted on the basis of a questionnaire with mainly closed questions on the Likert scale. The questionnaire included the following areas of investigation: general information about the firm, the competitive environment and position of the company within the industry, the competitive strategy and the organization for innovation, the open innovation practices and the variables influencing the openness of the new development product. In order to measure the degree of openness of the phases in the innovation process, we have adopted a subjective measurement rather than relying on the number of transactions or on licensing revenues (Lichtenthaler and Ernst, 2009).

In more detail, the openness is measured by the following variables:

- The degree of openness, measured on the Likert scale (from 1 = phase entirely implemented internally, to 5 = phases entirely implemented externally), for each of the five phases of the innovation process: idea generation (O_gi), product idea development (O_sip), design and engineering (O_prog), production (O_prod), marketing (O_comm)
- concentration (few or no phases of the innovation process are open) / integration (many or all phases of the innovation process are open) of openness to collaboration, measured in terms of the number of phases in the innovation process open to the outside for each firm in the survey (O_NF = from 0 to 5),
- the average degree of openness of the entire innovation process (avO = from 2 to 5), obtained by considering the average degree of openness of each of the five phases with a value> = 2)

In addition, the variables whose influence was tested were found to be as follows:

- the size of the firms (DIM), measured by the number of employees,
- the technological intensity of the firms' industrial sector (IND), measured in (OECD, 2005): 1-low (wood, food, paper, textiles), 2-medium/low (metal products, plastic products), 3 - medium/high (machines/automation, chemical), 4 - high (ICT, pharmaceutical);
- the level of aggressiveness of the technological strategy (T_STR), (3 items inspired by Lanzarotti et al. 2010) calculated from the average of the responses given to the following 3 questions measured on the Likert scale (1 = highly agree, 5 = highly disagree): a) Do you invest in order to become technological leaders? b) Do you aggressively try to acquire new fields of activity? c) Do you seek to have an influence on the structure and rules of the sector through product features?
- the importance attached to each of the competitive factors listed in the questionnaire, measured on the Likert scale (1 = very low, 5 = very high) price (FC_p), quality (FC_q), time (FC_t) added services (FC_sa) eco-compatibility (FC_eco), know-how (FC_kh) organizational ability (FC_org), image and brand (FC_ib), availability of rare assets (FC_ass), patents (FC_brev), size of portfolio (FC_ap).
- the importance attributed to the motivations towards openness (listed in the questionnaire), measured on the Likert scale (1 = very low, 5 = very high): to expand knowledge (WHY_amp), to integrate skills (WHY_int), to stimulate creativity (WHY_creat), to reduce risks (WHY_risk), to reduce costs (WHY_cost), to reduce time to market (WHY_ttm)
- the importance assigned to the barriers to innovation (listed in the questionnaire), measured on the Likert scale (1 = very low, 5 = very high): a lack of financial resources (BARR_fin), level of risk (BARR_risk), internal resistance (BARR_int), consumer resistance (BARR_cons), suppliers' resistance (BARR_suppl), regulatory constraints (BARR_norm), lack of skills (BARR_comp), access to distribution channels (BARR_dch), management complexity (BARR_man).

With regard to data elaboration, frequency analysis and a permutation test on correlation using Spearman-type statistics (Pesarin and Salmaso, 2010) have been applied.

4. Results

4.1 General characterization of the innovative profile of the firms examined

From a first attempt to characterize the sample firms, it emerges that they consider the principal competitive factors to be quality,

organizational capacity and price, followed by the know-how they possess, the level of service and the time factor. Little importance, however, is attributed to image, environmental compatibility and the possession of patents. From an analysis of the importance attached to the individual phases of the innovation process, the most critical appear to be the early generation and development stages of the product idea, followed by the design stage. As for the role played in the innovation process by the various functions within the firm, R&D obviously predominates in importance, followed, in order, by the marketing function. A marginal role is attributed, however, to the functions of information technology and logistics. The structure selected for the organization of innovation activity is functional in type for 57% of cases, followed by 20% of cases in which the organization is informal. Less used are structures within each area of business (9%) or network (14%). Furthermore, an analysis of sources for funding innovation shows that the firms examined usually finance themselves, rarely resorting to credit institutions, and almost never to public funding. Finally, with regard to technology strategy, 58% (mean >3) indicate the pursuit of an aggressive technology strategy. Table 2 below shows the results of the innovation profile for the firms under examination, indicating for each entry the average value scored on the Likert scale (1 = very low, 5 = very high).

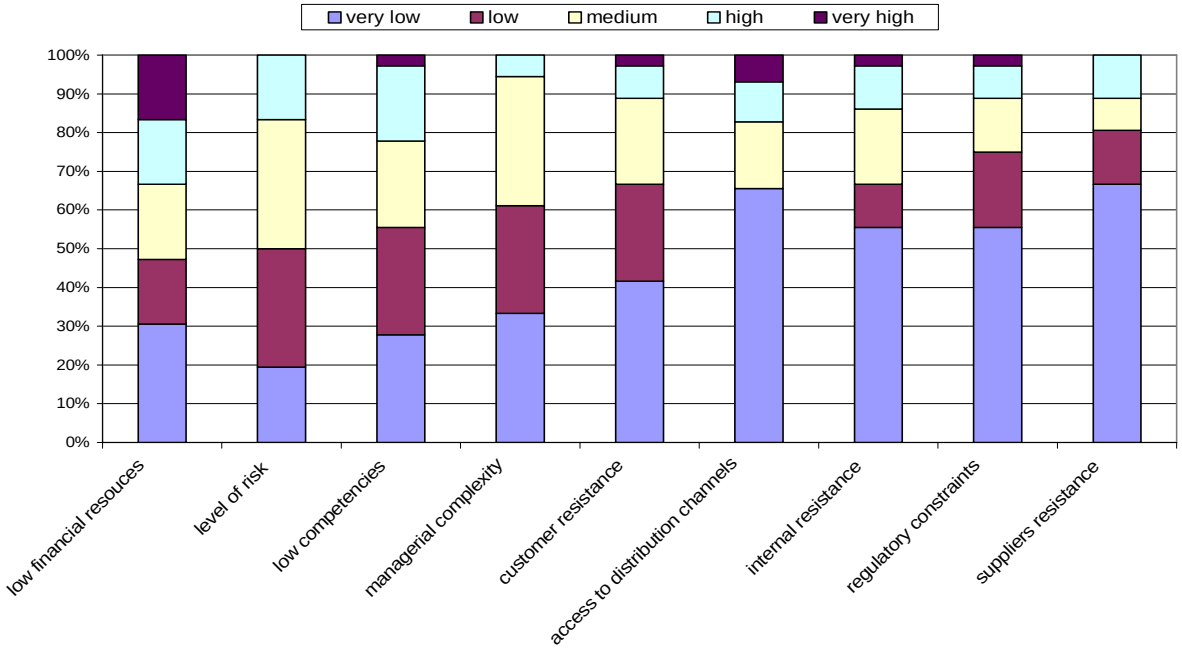
Table 2. General characterization of the innovation profile of the firms examined*

Importance of competitive factors		**Importance of functions within the firm in the innovation process**		**Importance of the phases of the innovation process**	
Quality	4,22	Research and Development	4,24	Idea generation	4,19
Organizational ability	4,17	Marketing and sales	3,35	Product idea development	4,06
Price	4,08	Production	3,29	Design and engineering	4,00
Know-how	4,00	Post sales service	3,17	Marketing	3,81
Additional service	4,00	Information Technology	2,86	Production	3,64
Time	3,97	Logistics	2,15		
Amount of available funds	3,56	**Frequency of resorting to funding sources**		**Aggressivity of the technology strategy**	
Image and brand	3,36	Self-financing	4,42	average	3,5
Eco-compatibility	3,19	Bank loans	2,56	Standard deviation	0,82
Rare assets	3,17	Public financing	1,72		
Patents	2,47	Other	1,14		

*average values obtained (1=very low, 5=very high).

Finally, the most significantly felt barriers to innovation were perceived as the lack of financial resources, high risk and lack of skills. Considered to be of little significance are resistance within the firm or from suppliers, regulatory constraints and access to distribution channels. (Fig.1)

Figure1. Barriers to innovation



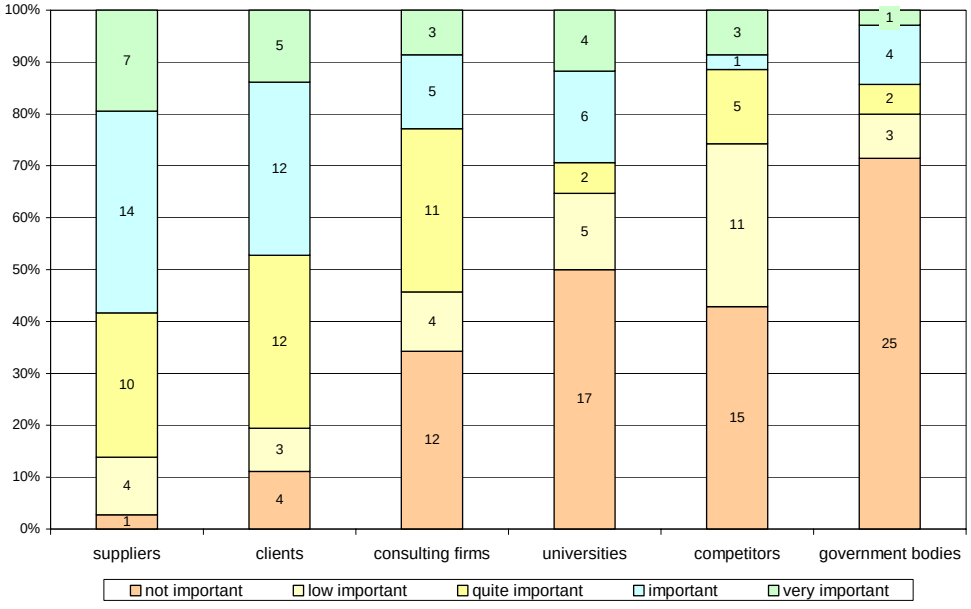
4.2 The actors and the openness of the innovation process

An interesting aspect is to understand with which actors firms collaborate. Table 3 shows the intensity measured from the average value, and the frequency of openness for the types of collaborators and for the phases of the innovation process. What emerges first and foremost is the importance of customers and suppliers as partners in almost all phases of the innovation process. The last row of the Table shows the overall level of importance of the various actors. Suppliers are the key actors involved in all the phases, but rarely in the phase related to marketing. Next come the clients, used by nearly all the firms for the generation (89%) and development (53%) of the product idea, and for marketing the product (56%). Frequent collaboration occurs with supporting firms, used in the phase of generating the product idea (56%); however, for the development of the product idea such recourse is not common (19%), but the intensity of the phenomenon is quite considerable: the level of external input is, on average, almost equal to internal input. The role of competitors as collaborators is, however, more frequent in the development of the product idea (61%) and in its design (50%), but at a low intensity in both cases, which indicates a limited level of supplementary input to activities conducted internally (average value = 1.29). In the idea generation's phase, collaboration with competitors is less frequent (25%) but at a higher intensity (average value = 2.11). Collaboration with universities, however, mainly occurs during the development of the product idea phase (41.7%), and with less frequency and intensity during the phase of idea generating (33%). Lastly, in the context analyzed, the role of institutions and government agencies in supporting innovation seems almost absent.

Table 3. Average level and number of firms using openness analyzed by phase and subject

Average level of openness for phase and subject							
	Clients	Suppliers	Supporting firms	Competitors	Universities	Government Bodies	*Tot. medium for phases*
Idea generation	**3,11**	**3,00**	1,56	2,11	1,56	1,11	*2,01*
Product idea development	2,06	**2,80**	**2,50**	1,29	2,03	1,34	*1,97*
Design and engineering	1,86	**2,68**	2,03	1,40	1,57	1,09	*2,33*
Production	1,37	2,49	1,60	1,20	1,00	1,06	*2,15*
Marketing	2,31	1,80	1,36	1,20	1,11	1,06	*1,86*
Tot. average for subject	*2,15*	*2,55*	*1,81*	*1,44*	*1,45*	*1,13*	
Number of firms using openness for each phase and subject							n. respondents
Idea generation	**32**	**30**	**20**	9	12	2	36
Product idea development	**19**	**27**	7	**22**	15	6	36
Design and engineering	16	7	8	**18**	10	1	36
Production	7	**23**	4	10	0	1	36
Marketing	**20**	12	4	6	3	1	36

Fig.2. Importance of the contribution to innovation by the various subjects



The Fig.2 illustrates the importance of various external partners in the innovation process. In particular, it can be seen that 71% of the firms consider government institutions and agencies to be useless or superfluous; on the contrary, suppliers, customers, and to a lesser extent supporting firms are considered important or even crucial to the success of the innovation process.

When analyzing the phenomenon for each phase of the innovation process, the external contribution still remains partial, inasmuch as it is integrated with activities carried out internally. In Table 4 below it can also be seen that the phases most frequently opened are Idea Generation (61%) and Product Idea Development (53%), but with low intensity, whereas the phases of Design and Engineering, and Production, exhibit a lower frequency (50%) but a higher intensity. In other words, the first two phases of the innovation process are opened very frequently, but only in order to complete activities carried out internally, whilst the following two phases are opened less frequently but with greater intensity. The Marketing phase is the least open, both in terms of frequency and intensity.

Table 4:Openness in the phases of the innovation process

The intensity of openness in the phases of the innovation process	**average value[2]**	**% "open" firms**
Idea generation	2,0	61%
Product idea development	2,0	53%
Design and engineering	2,3	50%
Production	2,2	50%
Marketing	1,9	44%

[2] 1 = activity is completely internal, 2 = mostly internal, 3 = internal and external, 4 = mostly external, 5 = completely external

4.3 Variables influencing open innovation

Table 5 below shows the results obtained, highlighting the correlation with significance measured by the p-value <0.1

Table 5. Speerman Type correlation test*

S-value	DIM	IND	T_STR	FC_p	FC_q	FC_t	FC_sa	FC_eco	FC_kh	FC_org	FC_ib	FC_ass	FC_brev	FC_ap
O_gi	0.202			-0.094	0.099	0.209 (0.098)	0.189	0.524 (0.000)	0.182	0.100	0.199	0.039	0.066	0.003
O_sip	0.123			0.118	-0.059	0.264 (0.036)	0.202 (0.094)	0.185	-0.150	0.114	0.094	-0.122	-0.045	0.013
O_prog	0.202			0.224 (0.067)	-0.143	0.305 (0.02)	0.133	0.164	-0.028	0.041	-0.074	-0.115	0.018	-0.062
O_prod	-0.137			-0.045	0.003	0.228 (0.082)	0.154	-0.060	0.168	0.119	0.014	-0.212	0.203 (0.091)	0.204 (0.073)
O_com	0.095			0.016	-0.052	0.123	-0.077	0.095	-0.062	0.117	0.219 (0.081)	0.207 (0.095)	-0.099	0.035
O_NF	0.172			0.012	0.043	0.387 (0.010)	0.254 (0.056)	0.306 (0.021)	0.094	0.048	0.041	0.077	-0.034	-0.039
AvO	0.012			0.080	0.052	0.261 (0.064)	0.360 (0.013)	-0.083	0.131	0.179	0.180	-0.146	0.141	0.302

S-value	WHY_amp	WHY_int	WHY_creat	WHY_risk	WHY_cost	WHY_ttm	BARR_fin	BARR_risk	BARR_int	BARR_cons	BARR_suppl	BARR_norm	BARR_comp	BARR_dch	BARR_man
O_gi	-0.067	0.015	0.096	0.055	0.136	0.025	0.237 (0.058)	0.030	0.102	-0.223	-0.161	-0.389	0.140	-0.122	-0.224
O_sip	-0.088	-0.044	0.157	0.161	0.247 (0.079)	0.055	0.219 (0.089)	0.012	0.150	0.163	0.149	-0.151	0.173	-0.061	-0.081
O_prog	0.159	0.094	0.037	0.224 (0.087)	0.334 (0.026)	0.053	0.247 (0.071)	0.178	0.159	0.024	0.027	-0.126	0.160	0.120	0.048
O_prod	0.048	-0.069	-0.126	-0.172	0.007	-0.266	-0.223	0.170	-0.008	0.274 (0.048)	0.045	-0.006	-0.122	-0.201	-0.046
O_com	-0.032	-0.040	-0.162	0.419 (0.006)	0.334	-0.050	-0.150	0.011	0.140	-0.291	-0.040	-0.283	-0.039	-0.017	-0.146
O_NF	0.103	0.042	0.091	0.285 (0.036)	0.438 (0.002)	0.151	0.159	0.264 (0.048)	0.265 (0.042)	0.075	0.057	-0.196	0.258 (0.063)	0.058	0.122
avO	-0.097	-0.077	-0.058	-0.031	0.078	-0.347	0.020	0.001	-0.020	-0.106	-0.153	-0.241	-0.303	-0.283	-0.261

* Results that have significance, i.e. with p <0.1, are highlighted in gray and the p-value is given in brackets

In the sample analyzed, the variables: firm size, technological intensity of the industrial sector and industry, and aggressivity of the technology strategy, have not been shown to affect openness, either at the level of an individual phase in the innovation process, or at the level of the innovation process taken as a whole.

In relation to the motivations, the opening up of the innovation process occurs primarily in order to integrate and expand the firm's expertise and to reduce time to market, while it is less used for reducing costs and risks and for stimulating creativity (Table 6). It is a widespread phenomenon, since as many as 34 firms out of a total of 36 collaborate, even if the degree of openness in most cases is not high (32/36). The external contribution thus supplies an integration with the innovation activities carried out within the firm.

Table 6. Motivations and intensity in opening up the innovation process

Why open ?	**average value[1]**
To integrate skills	3,56
Increase knowledge	3,44
Reduce the time to market	3,42
Stimulate creativity	3,08
Reduce costs	2,97
Reduce risks	2,53
[1] 1=highly agree, 5=highly disagree	

It appears that the overall average degree of openness is influenced solely by the importance attached to competitive factors: product development time and the offer of added service.
Moreover, openness is found to be less concentrated on a few phases of the innovation process as the importance given to the following competitive factors:

- time, added service and eco-compatibility,
- risk and cost factors as motives for choosing openness,
- risk factors, resistance within the firm and a lack of expertise as barriers to innovation.

However, when analyzing the individual phases of the innovation process, the following variables emerge as influencing the degree of openness:

- the competitive factors of time and eco-compatibility, and the factor of availability of financial resources as a barrier, positively correlated with the degree of openness in the generation of idea phase;
- the competitive factors of time and added service, the factor of cost as a motive and the factor of availability of financial resources as a barrier, positively correlated with the degree of openness in the development of the product idea phase;
- the degree of openness in the design phase is influenced by the competitive factors of price and time, by the motivational factors of risk and cost, and by the scarcity of financial resources;
- the degree of openness in the production phase is influenced by the competitive factors of time, availability of patents, size of the product portfolio, and the consumer resistance barrier;
- the degree of openness of the last phase, i.e., marketing, is influenced by competitive factors of image and brand, and by the availability of rare assets, in addition to the motivational factor of risk.

It is therefore clear that the degree of openness is influenced by different variables, depending on the phase of the innovation process under consideration, although the competitive factor of time and the barrier of risk are influential in almost all the phases.

5. Discussion and Conclusions

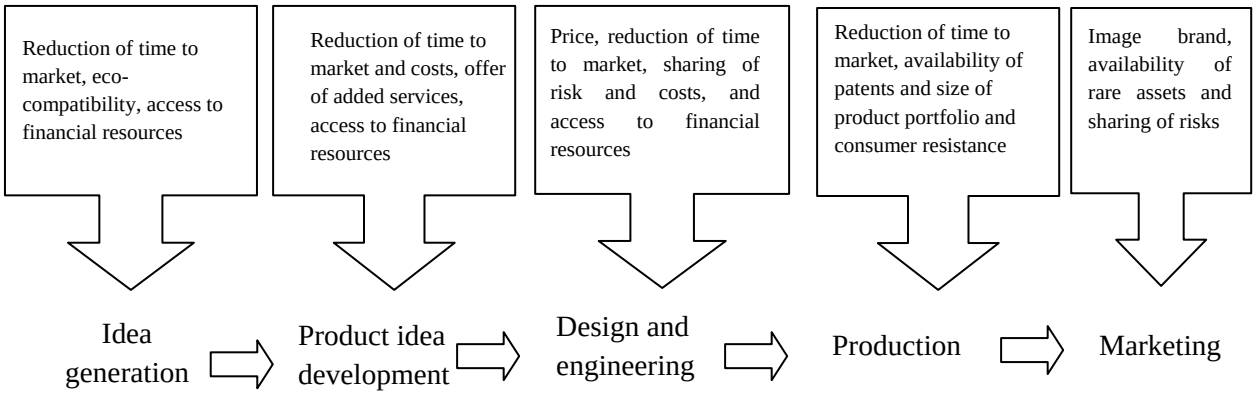
The sample examined was equally divided between small and medium-large firms, with 60% belonging to high-tech sectors and with an average company age of about 30 years, synonymous with an extensive and mature experience in each relative sector. In answer to the first research question, the San Marino firms are of a limited size, they attach little importance to owning patents as a competitive factor, whereas they consider more relevant factors to be price, quality and organizational ability, with most of them adopting an aggressive technology strategy. However, they are still tied to traditional organizational frameworks for the development of innovation processes.

Regarding the actors involved in collaboration, it was found that in the early phases of the process the firms collaborate most frequently in all areas of the innovation process with suppliers and customers (Gassmann, 2006). Frequent collaboration occurs with supporting firms and universities in the phase of developing the product idea and with competitors in the idea generation phase. Few collaborations are instead with the government bodies. The opening of the innovation process appears to be a widespread phenomenon but one with little intensity. In particular, it emerged that in the first phases of the innovative process more than half the firms are open to collaboration, in order to complete tasks accomplished internally, and thus probably maintaining control of the phase in course. As the innovation process proceeds, however, openness becomes less frequent but somewhat more important in its intensity until the marketing process is reached, which is the least affected by the phenomenon.

According with Gassmann and Enkel (2004), the firm's size do not have a significant correlation with the openness of innovation process. Also the technology intensity of the sector is not an important determinant for open innovation (Lichtenthaler and Ernst, 2009). With regard to the motivations, the opening up of certain NPD activities is generally implemented with the aim of

integrating and expanding new knowledge and skills and reducing a product's time to market (van der Vrande et al., 2009). The strategic factors that significantly influence the adoption of open innovation in the whole NPD process are time, added service and environmental friendliness (which impact on the number of open phases). The barries on innovation, are in the three first phases of the NPD process mainly the availability of financial resources, while the lack of skills, the level of risk and internal resistance correlated positively with the number of open phases in the innovation process (as is typical for small and medium-sized firms).
For specific reference to the influence of competitive factors in each stage of the NPD see Figure 3.

Figure 3. Competitive factors that influence openness in each phase of the innovation process



These results provide important information in understanding San Marino's industrial structure, and represent a preliminary work, useful to policy makers as they consider the future creation of a Science and Technological Park to support the research and development activities of the State's firms.

Although the survey sample was composed of a small number of firms, it can act as a pilot sample that can be used to test the quality of the questionnaire. The scientific implications of this study aim to confirm or refute claims identified in the literature, and to examine in greater depth the paradigm of open innovation in an industrial context typical of the Italian situation; i.e., characterized by small and medium-sized firms that lack the support of pro-innovation policies.

Purely managerial considerations may be:

- San Marino firms are ones that develop limited innovative processes and use traditional organizational and management practices for the innovation process;
- Firms attach significant importance to openness to the outside for the acquisition of new knowledge and ideas, activities that are particularly hampered by the limited size and relative isolation of the territorial context in which they are located;
- For this reason the government should promote public and private organizations that devote support to innovation processes and are useful in enlarging the circle of contacts of these firms;
- The reduction of time to market, the sharing of risks and costs and the access to financial resources as determining variables in openness towards the outside, demonstrate how the need for innovation is still tied to costs and time in reaching the market, and only slightly to the technological contents or design that might permit these firms to make a leap forward in the level of innovation and competitiveness of their products.

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