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STUDYING THE IMPACT OF TECHNOLOGY TRANSFER SERVICES ON OPEN INNOVATION APPROACHES

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ABSTRACT
The aim of paper is to evaluate if technology transfer services of AREA Science Park support Open Innovation approaches realized by small and medium enterprises of Italian northeast region. An evaluation framework which crosses technology transfer services and Open Innovation approaches has been created. We have implemented the evaluation framework in eight case studies. The case studies have highlighted that the technology transfer services of AREA support the Open Innovation approaches. These services have produced completely positive outcomes for seven firms out of eight.
The research has highlighted that the evaluation framework has a limit as well: it evaluates only if there is an impact, it doesn't evaluate the quality of impact and its effects.

Keywords: Open Innovation, Technology Transfer Services, Evaluation Model, Case Studies.

INTRODUCTION
Recently it is attending the evolution of the "activities of innovation". In fact it is moving from research and development to connection and development. The first one is the traditional R&D model called Closed Innovation (CI), in which every innovation activity is realized wholly within the firms (Henkel, 2006). Instead, the second one is an original R&D model called Open Innovation (OI), in which knowledge is found far from the firm, while the activities of knowledge recognition, internalization and rearranging are made within the firms (Chesbrough, 2003). In the OI model, technology transfer offices play a fundamental role. These offices map and find external knowledge and facilitate the transfer, creating a *bridge* between firms and knowledge.

The aim of this work is to evaluate if technology transfer services of AREA Science Park – main Italian Science and Technology Park – have an impact on and support OI approaches realized by small and medium enterprises (SMEs) in Italian northeast region.

The case study research is the methodology followed. The case study research has been utilized both to analyze the technology transfer model (made up of stages and services) of AREA and to analyze the impact of technology transfer services (TTSs) on OI approaches.

By the literature analysis it has been possible to study the OI model and to map the technology transfer models. This analysis has highlighted a gap. The technology transfer models, we have found in literature, have only control activities, like feed-backs, but they haven't structured instruments to evaluate the impact of TTSs on firms. So we have realized an evaluation framework to study this impact for TTSs of AREA. Finally we have verified in eight firms if these services of AREA support the OI approaches of SMEs Italian northeast.

The paper is organized in seven sections. The first section describes the theoretical features of OI and technology transfer, while the second one describes the research methodology. In the third section we describe AREA and we analyze its technology transfer model, while in the forth section we propose the evaluation framework. The case studies are illustrated in the fifth section. The sixth one is dedicated to the discussion of case study results. Finally the last one deals with conclusions.

THEORETICAL BACKGROUND

Open Innovation

The Open Innovation (OI) model – formalized by Henry Chesbrough – is establishing itself like the reference model for innovation development in firms. It is characterized as spanning firm boundaries (Chesbrough, 2003). The traditional one is defined in contrast Closed Innovation. It can describe the traditional view of innovation as taking place entirely within one firm (Henkel, 2006).

The adoption of OI model involves as SMEs as large ones. The OI is the model through which SMEs have always made innovation, forced by insufficient resources and structural limitations. Recently OI is adopting by large companies as well. In fact in the past large companies adopted the traditional model of research and development, that now is becoming dangerous and fragile yet, cause the increasing business complexity. These firms need to change their own *modus operandi* and to choose new ways for innovation development.

The OI model builds itself on the increasing of firm knowledge which comes from external sources. Then within firms this knowledge is recognized, internalized and arranged again. These three activities change the role of R&D function which becomes to connect external knowledge coming from different actors. The main actors are: 1) internal teams of research (internal knowledge development); 2) research centres and universities (knowledge on demand); 3) other external actors like suppliers, consultants, companies of other industries, consortia, costumers, practical communities, competitors, etc. (connection of distributed knowledge).

The fundamental processes of OI are two. The first one is the acquisition of distributed knowledge present into universities, research centres and other actors. The second main process is the recombination and connection of internal knowledge with external one. The two OI processes are implemented by 10 OI approaches that differ from each other because of its knowledge source (internal or external) and its number of actors from whom the knowledge comes (single person or groups/community).

The 10 approaches are: 1) Mass Customization; 2) Lead Users; 3) Customer Toolkit; 4) Freedom of action; 5) Research collaborations; 6) Technological Brokering; 7) Virtual communities; 8) Supplier/costumers and consultants partnership; 9) Coopetition; 10) Practical communities. The classification of such approaches is in Figure 1 (Lot, 2005). Some instruments support every OI approach: patents, licensing, database, regulations and venture capitals.

So the OI model is made up of three elements: actors, approaches and instruments.

Technology transfer

If the most common view of technology is “a tool” (Bozman, 2000), the technology is a tradable good to be bought and sold on the market (Arora et al., 2001). The technology transfer is viewed as the movement of knowledge and technology via some channel from one individual or firm to another (Devine et al., 1987; Gibson and Smilor 1991; Inkpen and Dinur, 1998). But the technology transfer can be viewed also as an active process, during which technology is carried across the border of two entities. These entities can be countries, companies, or even individuals (Kingsley et al., 1996). The technology transfer is defined also as the know-how about the transformation of operational technologies and processes, material technologies and knowledge technologies (Hickson et al., 1969; Wilson, 1986).

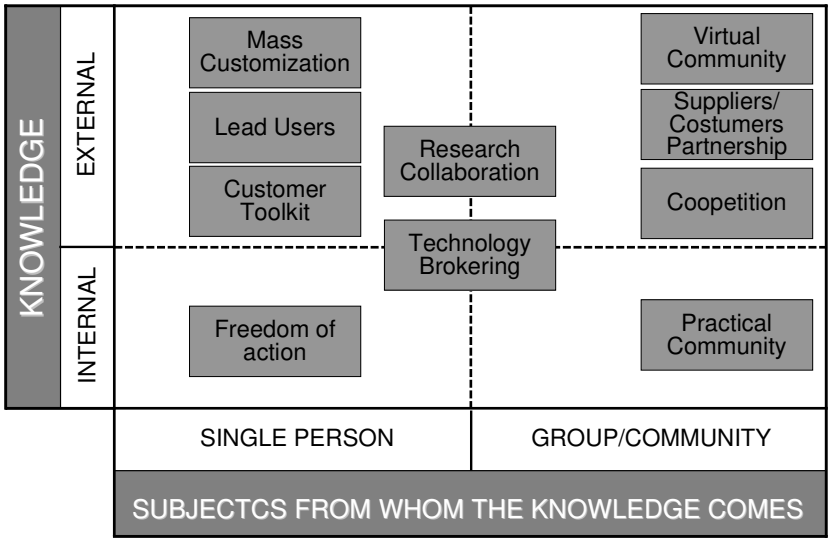

Figure 1 – Classification of Open Innovation approaches (De Toni and Lot, 2005)

The definitions of technology transfer vary also in relation to scientific subject (Zhao and Reisman, 1992) (Table 1):

Table 1 – Definitions of technology transfer divided into some scientific subjects

		OTHER DEFINITIONS	MAIN AUTHORS
SCIENTIFIC SUBJECT	**Economy**	define technology on the basis of the properties of generic knowledge, focusing particularly on variables that relate to production and design	Arrow (1969) Johnson (1970) Dosi (1988)
	Sociology	link technology transfer to innovation and view technology as a design for instrumental action that reduces the uncertainty of cause–effect relationships involved in achieving a desired outcome	Rogers (1962) Rogers and Shoemaker (1971)
	Anthropology	view technology transfer within the context of cultural change and the ways in which technology affects change	Foster (1962) Service (1971) Merrill (1972)

During the technology transfer process many actors with diverse outlooks and interests are involved. Cause these things its management is often conducted along unclear lines of responsibility and authority (Janis, 2003). The actors of technology transfer can be divided in two main classes: the actors that offer skills for innovation, mainly universities and research centres, and the actors that search skills, like firms, consortia, industrial zones, etc. (Figure 2).

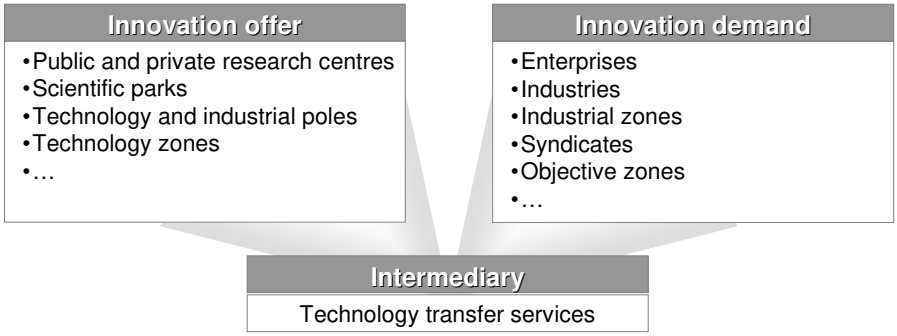

Figure 2 – Actors of technology transfer process

In the last years the process of technology transfer involves also the transfer of knowledge. In fact knowledge is the third productive factor with capital and labour (Rullani, 2004). The

knowledge transfer is the process of a systematically organized exchange of information and skills between entities (Wang et al., 2004). It is defined also like a process through which one unit (e.g. group, department or division) is affected by the experience of another one (Argote and Ingram, 2000).

Many technology transfer models in literature formalize the technology transfer processes. In Table 2 we have analyzed the six main models according to their main features.

Table 2 – Main features of main technology transfer models

		MAIN AUTHORS					
		Flannery, Spivey and Alter III (1994)	Lee and Gaertner (1994)	Kingsley, Bozeman and Coker (1996)	Malik (2002)	Gorschek, Wohlin, Garre and Larsson (2007)	Liao and Hu (2007)
PRELIMINARY ACTIVITIES	Analysis of the market needs	x	x			x	
	Study of state-of-art					x	x
	Laboratory test		x			x	
	Choice of tranfer strategy	x		x	x		
TRANSFER ACTIVITIES	Construction of transfer mechanism						x
CONTROL ACTIVITIES	Feed – back loop		x		x		

Evaluation models of technology transfer

The literature analysis about technology transfer models has highlighted a gap. In spite of many authors define technology transfer and describe technology transfer models, these models haven't structured instruments to evaluate the impact of TTSs on the innovative activities realized by firms.

RESEARCH METODOLOGY

The case study research is the methodology followed (Eisenhardt 1989, Yin 1994). Starting from the literature analysis, the research consists of three steps.

Step 1. First of all case study of AREA has been realized. We have formalized its technology transfer model and stages and we have in-depth analyzed the TTSs which AREA gives companies during the technology transfer process.

Step 2. Starting from previous analysis we have created an evaluation framework in order to verify the impact of AREA TTSs on OI approaches of firms.

Step 3. Finally we have realized eight case studies (SMEs of Italian northeast region) to evaluate if the TTSs have had an impact on OI approaches of firms using the evaluation framework of step 2. The eight firms have received some TTSs of AREA and they have been selected by defined factors (number of technology services and type of technology services received, function affected by the service, etc.). The case studies have been realized by semi-structured interviews directed to entrepreneurs and managers. During every interview the topics discussed have been three: 1) the OI approach realized by firm; 2) type of TTSs received; 3) results obtained.

AREA SCIENCE PARK

Features of AREA

AREA Science Park is the main multi-sector Science and Technology Park. It is localized in Trieste (Italian northeast). It gives firms many important and high quality services for company innovation and it promotes a growth of firms through technology development and innovation.

One of the most important services offered by AREA is technology transfer. In fact AREA is a centre which wants to integrate the "world of research" and firms and to support the innovative capabilities of regional firms, thanks to a great net of relations between different actors as well.

It is necessary to highlight that the regional firms, which are the target of AREA services, are small and medium ones. These firms need great innovative capabilities in order to survive in the global market. Also they can't support R&D department and they realize especially incremental innovations. TTSs of AREA are the intermediaries and facilitators of the know-how and technology flows of research centres and universities.

Technology transfer model and services of AREA

It has been possible to formalize the technology transfer model of AREA, thanks to the literature analysis and the AREA case study.

The model is made up of two macro-stages, called *hidden*, which firms don't perceive, and *comprised*, which the firms perceive. Every macro-stage is completed by many stages in succession through which the technology transfer process is realized. In Table 3 the technology transfer model of AREA is represented.

Table 3 – Technology transfer model of AREA

MACRO-STAGE	STAGE	DESCRIPTION OF STAGE
Hidden	1 Interpretation of the financial mandate	Every technology transfer is supported by public financing. In this stage receiver sectors of technology transfer services, geographical zones, enterprise dimensions, etc. are identified
	2 Identification of the receiver enterprises	After a previous selection defined in the financial mandate, other selections are made by crossing different database of regional enterprises, etc.
	3 Formulation of the intervention program	It is the definition of program by which the transfer technology activities develop themselves
	4 Presentation of the program	AREA advertises the transfer technology program
Comprised	5 Acquisition of the enterprise agreement	This is the first contact with an enterprise
	6 Inspection in enterprise	The inspection follows door-to-door methodology: the technology transfer experts visit the enterprises and know the top management
	7 Evaluation of hidden needs of innovation	Technology transfer experts evaluate the innovation needs which enterprises have
	8 Finding of necessary competences to satisfy innovation needs	It is mapping and finding technical and knowledge competences and it is creating a bridge between knowledge and enterprises
	9 Project start	The formulation of a transfer technology project makes concrete the transfer technology services
	10 Execution of the project/ Development of innovation	In this stage the transfer technology services (described later) are realized or the research project is defined. The AREA research projects let us know a number of possible innovation projects which the enterprise can realized
	11 Feedback	It is evaluating the technology services received
	12 Strengthening of relation	The strengthening of relation is made up of by a recurring call in order to verify new opportunities of collaboration or to involve the enterprises in interesting activities

The TTSs (Table 4), which AREA realizes in the stage 10 *Execution of the project/Development of innovation*, are 15 and they have been classified into 5 macro classes: 1) Information for

innovation, 2) In/Out Analysis, 3) Skills finding for innovation, 4) Assistance to adopt the innovation and 5) Assistance to enterprise creation.

Table 4 – Technology transfer of AREA

MACRO CLASS	CLASS
1. Information for innovation	Patent and documental research
	Technology monitoring
	Quality certification
	Studies of interest
	Web research
2. In/Out Analysis	Patent Analysis
	Benchmarking
	Technology audit
	Industry studies
3. Skills finding for innovation	Patent support
	Skills finding
4. Assistance to adopt the innovation	Study, design and development of innovative solutions
	Technical feasibility study
	Innovation implementation aid
5. Assistance to enterprise creation	Enterprise creation

THE EVALUATION FRAMEWORK

It is necessary to create an evaluation model of impact of TTSs because the main literature models haven't a structured evaluation instrument. So the framework realized is the instrument which allows us to verify if TTSs of AREA have had an impact on OI approaches of firms.

Starting from the formalization of technology transfer model of AREA and starting from the study of features of AREA TTSs and of OI approaches, the framework has been created. This framework is a matrix which crosses the 15 TTSs offered by AREA with 10 OI approaches (Table 5). The cells marked with an 'X' define which OI approaches are supported by TTSs of AREA.

Every TTS supports only some OI approaches. 'Study, design and development of innovation solutions' and 'Technical feasibility study' are the services which support the greatest number of OI approaches. In fact 'Study, design and development of innovation solutions' supports 8 approaches out of 10, 'Technical feasibility study' supports 7 approaches out of 10. 'Patent support' has no any impact on OI approaches, because of its features.

Furthermore every OI approach is never supported by all services offered. 'Technological brokering' and 'Research collaborations' are the approaches which are supported by the greatest number of TTSs. 'Technological brokering' is supported by 14 services out of 15 and 'Research collaborations' is supported by 13 services out of 15.

The evaluation framework gives us the possibility to verify if the TTSs of AREA have supported firms, in function of the OI approaches realized, but it doesn't evaluate quantitatively the effect – positive or negative – of these services. Actually this evaluation could be possible through case studies of firms.

Table 5 – Evaluation framework of impact of technology transfer services of AREA

TYPES OF AREA TECHNOLOGY TRANSFER SERVICES			OPEN INNOVATION APPROACHES									
Macro class	Class		Mass customization	Lead users	Customer toolkit	Freedom of action	Research collaborations	Technological brokering	Virtual communities	Suppliers, customers and consultants partnership	Coopetition	Practical communities
Information for innovation	Documental research	Patent and documental research				X	X	X				
		Technology monitoring				X	X	X			X	
	Quality certification							X		X		X
	Studies of interest					X	X	X	X			X
	Web research						X	X	X			
In/Out Analysis	Patent Analysis					X	X	X				
	Benchmarking						X	X			X	X
	Technology audit						X	X				
	Industry studies						X	X		X	X	X
Skills finding for innovation	Patent support											
	Skills finding					X	X	X	X			X
Assistance to adopt the innovation	Study, design and development of innovative solutions		X	X	X	X	X	X		X	X	
	Technical feasibility study		X	X		X	X	X		X	X	
	Innovation implementation aid			X		X	X	X		X	X	
Assistance to enterprise creation	Enterprise creation						X	X		X		

CASE STUDIES

Here we evaluate if TTSs offered by AREA support OI approaches realized by SMEs. The framework just described has been the instrument which allows us this evaluation. The evaluation of eight firms (case studies) has been realized by semi-structured interviews directed to entrepreneurs and managers. Interview topics were OI approaches, TTSs received and results obtained. TTSs of AREA have supported positively the OI approaches for seven firms out of eight, while they don't support completely positively the OI approaches for just one.

We describe in-depth only the best case study. The overall results of cases are described in Table 6.

Table 6 – Case studies results

FIRMS	*Firm 1*	*Firm 2*	*Firm 3*	*Firm 4*	*Firm 5*	*Firm 6*	*Firm 7*	*Firm 8*
INDUSTRY	Food industry	Mechanical industry	Mechanical industry	Food industry	Nautical industry	Mechanical industry	Computer science	Paper manufacture
SALES	2.300.000 € (2007)	570.000 € (2007)	1.850.000 € (2007)	110.000.000 € (2007)	500.000 € (2007)	3.500.000 € (2007)	135.000 € (2007)	150.000 € (2007)
NUMBER OF EMPLOYEES	12 (2007)	10 (2007)	23 (2007)	138 (2007)	2 and 5 partners (2007)	14 (2007)	5 (2007)	70 (2007)
PRODUCTS	Decaffeinated coffee	Mechanical equipment for food industry	Anticorrosive coating for heat exchanger	Spirits	Boats maintenance	Electric motors	Knowledge sharing software tools	Wrapping paper and glossy paper
CRITICAL SUCCESS FACTORS	•Key role of quality control •High technology of production process	•Market niche •Importance of regulations •Very innovative products	•High quality services •Technology development •Continuous formation •Internationalization	•Key role of quality control •High performance business agent •Internationalization	•Price policies •Marketing policies	•High quality products •Market monitoring	•Intellectual capital •Continuous formation •Market niche	•Design •High performance business agent •High quality products
OPEN INNOVATION APPROACHES	•Technological brokering •Research collaborations	•Consultants partnership •Research collaboration •Technological brokering	•Freedom of action •Research collaboration	•Technological brokering •Research collaborations	•Suppliers/costumers partnership	•Technological brokering	•Freedom of action •Costumers partnership	•Technological brokering •Freedom of action
TRANSFER TECHNOLOGY SERVICES	•Patent and documental research •Industry study •Study, design and development of innovative solutions •Technical feasibility study	•Patent and documental research •Web research •Patent analysis •Skills findings •Technical feasibility study	•Skills findings •Study, design and development of innovative solutions	•Skills findings	•Skills findings	•Skills findings	•Enterprise creation	•Skills findings
OBJECT OF IMPACT	•Product •Process •Organization •Marketing	•Product	•Product	•Product	•Product •Process	•Product	•Marketing	•Product
ADVANTAGES	•Increase of public image •Resolution of process technical problems •Spin-off creation	•Entering in new markets •Access to some financing •New products marketing •New patents •Resolution of product technical problems	•Laboratory control of new products	•Resolution of process technical problems	•New employs •New collaborations with laboratories for wood tests •New collaborations with companies of other industries	•New public image •Reduction of customer service costs •Increasing of sales •Creating durable research collaborations with University	Support to: •Business plan drafting •Market researches •Managerial education •Acquisition of costumers	•10 new ideas for new products
OUTCOME	POSITIVE, TT services have an impact on every OI approach	POSITIVE, TT services have an impact on every OI approach	POSITIVE, TT services have an impact on every OI approach	POSITIVE, TT service has an impact on OI approach	POSITIVE, TT service has an impact on OI approach	POSITIVE, TT service has an impact on OI approach	POSITIVE, TT service has an impact on only one OI approach (Customers partnership)	NEGATIVE, TT service has an impact on OI approach, but new ideas are technically unfeasible

Firm 7, a firm of computer science industry with 5 employees, is the firm which has obtained the best results of the eight case studies. It has been set up by a researchers' team of an excellent research centre in mathematics, physics and neuroscience in Trieste. Firm 7 produces software solutions for knowledge sharing in research communities. Its success critical factors are intellectual capital, continuous formation, niche market, made up of universities and research centres.

The OI approaches implemented are 'Freedom of action' and 'Customers partnership'. In fact Firm 7 utilizes the innovative capabilities of internal team to realize new software solutions, while costumers are the main drivers of innovation. 'Enterprise creation' is the TTS of AREA realized in Firm 7. It is the most important of all services offered by AREA. The service of 'Enterprise creation' is realized by the support to business plan drafting, by preliminary market analysis, by managerial education and by research of costumers. This service of AREA has had a positive impact on marketing activities of Firm 7.

CASE STUDIES RESULTS

The analysis of case studies has highlighted that:

1. TTSs support really the OI approaches realized by SMEs selected.
2. The TTSs have an impact especially on product and process activities, because the target of AREA services (SMEs) are oriented much more to production. Some services have an impact on marketing and organization activities as well.
3. The advantages obtained after the TTSs allow the firms especially to reduce technical problems of processes, to realize new products and to acquire new market share.
4. The services allow the firms to create and to strengthen collaborative relations among SMEs, universities and research centres, companies of other industries and test laboratories.
5. Seven firms out of eight have obtained positive results.
6. Just one firm hasn't obtained totally positive results, because of a great internal technical impossibility to resolve problems, not on account of inefficient services of AREA.

CONCLUSIONS AND FUTURE DEVELOPMENTS

We evaluate if TTSs of AREA have an impact on OI approaches realized by SMEs of Italian northeast region. An evaluation framework has been created – crossing OI approaches and TTSs of AREA – in order to evaluate this impact. This framework has been implemented in eight case studies.

The analysis of case studies has highlighted that:

- TTSs really support the OI approaches realized by SMEs selected.
- The TTSs have an impact especially on product and process activities.
- The advantages obtained allow the firms to reduce technical problems of processes, to realize new products and to acquire new market share.
- Seven firms out of eight have obtained completely positive results.

The evaluation framework has some limits. It is valid only for TTSs of AREA and it evaluates only if the TTSs support the OI approaches, but it doesn't evaluate if this support has a positive or negative impact. The main aim of future research is to create an instrument for quantitative evaluation of the results of TTSs in order to create an instrument which quantifies the importance of impact.

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