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Performance Evaluation for Knowledge Transfer Organizations: Best European Practices and a Conceptual Framework

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1. Introduction

The importance of Knowledge Transfer Organizations (KTOs) for boosting innovative performance both at regional and firm level has been highlighted by literature and empirical research (Kodama, 2008; Laranja, 2009; Muller & Zenker, 2001; Muscio, 2010; Tether &Tajar, 2008). KTOs encompass a set of diversified institutions, both public and private in nature, such as science parks, incubators, business innovation centres (BICs), industrial liaison offices (European Commission, 2004; Reisman, 2005). Their mission is to be providers of knowledge intensive services to firms-receivers in the different phases of their innovation process (Howells, 2006) as well as to be part of a Knowledge Transfer (KT) infrastructure which promotes and facilitates networking activities between companies and public or private research institutions. Due to the increasing diffusion of KTOs operating in a regional innovation system and the variety of services provided, performance evaluation of these organizations is becoming paramount from different viewpoints. First, a measurement system by which different actors may gather performance information could help to overcome one of the main difficulties of creating a market for technological knowledge (Arora et al., 2001; Arora & Gambardella, 2010; Decter et al., 2007; Dosi et al., 2006; Lichtenthaler & Ernst, 2007), which is information asymmetry. Second, from the demand side, firms-receivers require a univocal method to compare and evaluate the offer of the different KTOs. Third, even KTOs need a performance measurement system on which they can rely to define their product/service portfolio and craft their competitive strategy at regional, national and international level. Finally, also local and regional institutions need to assess KTOs in order to define innovation policies and to allocate resources effectively. Despite the increasing need for measuring the effectiveness of KTOs, a still limited effort has been made by research to develop a performance measurement system based on a robust methodological framework. Approaches implemented by institutions and KTO associations like the IASP (International Association of Science Parks) or the European BIC Network, are based on multiple measures encompassing financial and economic metrics (for example the amount of investment made, the turnover generated, return on asset and return on equity), output indicators of the technology transfer process (for example the number of collaborative research agreements stipulated, the number of licenses executed or the number of spin-offs established) and input measures (such as physical space available, amount of staff expenses for HR development and number of research partners). Most of these approaches are not fully developed and show several drawbacks. For example, while measurement approaches allow the evaluation of a specific KTO in comparison with those of the same type (e.g. science park, BICs, incubators, industrial liaison offices), they do not provide stakeholders (promoters, political institutions, clients) with a commensurable 'benchmarking' of a same service provided by different KTOs (for instance the incubation service provided by a science park or by a BIC). Moreover, methods are still fragmented and based on different approaches.

The aim of this study is twofold. First, we wish to provide an in-depth review of the extant literature on knowledge transfer evaluation and a comparison among different measurement approaches adopted in outstanding European KTOs. Second, we want to elaborate an analytical and integrated model that makes it possible to monitor and compare the performance of a single KTO over time and against other KTOs.

The chapter is structured as follows. The next section highlights the growing relevance of KTOs for the competitiveness of regions and firms. The third section discusses the causes of the complexity of the evaluation of KTOs' performance (Bigliardi et al., 2006; Gardner et al., 2010) and presents a review of the different approaches to KT measurement diffused in the European context (Autio & Laamanen, 1995; European Commission, 2009; Guy, 1996; Hogan, 1996; Samtani et al., 2008). In the fourth section we develop an integrated analytical model for KT performance measurement bridging two main perspectives: the literature on Balanced Scorecard (BSC) management system (Kaplan & Norton, 1992; 2004; 2007; Kaplan et al., 2010) and the studies on the innovation value chain (Hansen & Birkinshaw, 2007; Roper et al., 2008). For the first time, the proposed model combines the different approaches and metrics for KT transfer measurement, analysed in the third section, within the comprehensive framework of BSC tailored according to the complexity and the specificities of KTO management and performance. Moreover, the model, through the proposed perspective of KT processes, makes it possible to position and assess a KTO according to the different phases of the innovation value chain covered by its services. Lastly, the chapter concludes with policy and managerial implications concerning the implementation of the proposed model.

The contribution of the chapter is twofold. It addresses a key issue of technological innovation management in a time of open innovation, that is knowledge transfer at both micro and macro level, and it provides an original analytical framework of performance measurement, grounded on extensive literature review and case analysis.

2. The growing market for research and knowledge transfer services

2.1 Introduction

The knowledge transfer process has been defined as the "intentional, goal oriented interaction between two or more persons, groups or organizations in order to exchange technological knowledge and/or artefacts and rights" (Amesse & Cohendet, 2001: 1459-1460).

The inherent difficulty of this type of process was the main driver of the birth of KT providers, such as science parks, whose main aim was to facilitate the access and exploitation of scientific knowledge by companies.

The key role played by science parks at the inception of knowledge transfer from university to industry was that of a catalyst, providing a location for an integrated interaction and cross fertilization (Bigliardi et al., 2006). Besides science park, the supply side of market of technology has been enriched by the birth and the entrance of a large set of different institutions (European Commission, 2004; Geuna & Muscio, 2009).

Their role has been changing over the last few decades and the set of services provided nowadays has widen due to related processes such as the quick pace of university research, its increasing convergence, the diffusion of an open innovation approach that intensified the complexity of the innovation value chain (Hansen & Birkinshaw, 2007) of the companies-receivers and their need for external competences and resources. The following two sections will briefly analyse the market of KT services and its recent evolutions, focusing on both the demand side of the firms-receivers and the supply side of the providers. In Section 2.2 we will discuss firms' emerging needs for KTO services at each stage of the innovation value chain; Section 2.3 will present the broadening set of services offered by KTOs and the wide range of organizations operating as knowledge providers. In the conclusions some preliminary implications for the performance evaluation of Knowledge Transfer Organizations will be drawn.

2.2 The emerging demand for KT services: Firm's needs and the innovation value chain

The evolution of technology transfer activities and of the role of KTOs can be understood by looking at the demand side of the market for KT services and considering the emerging challenges that innovative firms face as a driver of the quest for outside specialized partners-providers. KTOs act by complementing and stimulating firms' internal innovation processes and capabilities, which nowadays are not sufficient, in small as well as in large companies, to deal with scientific, technological and market changes and opportunities.

The expanding demand for KT services is related to macro challenges already highlighted by research on open innovation (Chesbrough, 2003; Gassman, 2006): globalization and its consequences in terms of economies of scale and time-to-market shrinking; technology intensity and the difficulties that even large companies have in coping with it; technology fusion and more interdisciplinary cross-border research; new business opportunities and the benefits of complementary partnerships, and finally the relevance of knowledge leveraging and market for ideas that promotes knowledge brokers.

At firm level, organizations are challenged to build up stronger and more efficient innovative processes, fostering not only the central activity of project development but also improving their overall innovation chain, from idea generation to its delivery to clients. This end-to-end approach to manage innovation processes, based on the comprehensive framework of innovation value chain, should guide not only managers, as already suggested by scholars (Hansen & Birkinshaw, 2007; Roper et al., 2008), but also KT providers willing to assist them in fostering innovation.

Thus, emerging needs for KTO services can be analysed, according to the innovation value chain model, by breaking down the innovation process into the following phases: knowledge generation, transformation and exploitation.

In the early stage of *knowledge generation*, firms are engaged in activities of monitoring scientific advancement and scouting for new ideas that are increasingly complex and risky.

First, according to the OECD, scientific progress is driven by the convergence of research fields. The interaction between some research disciplines, such as physics and chemistry, may lead to new research areas; moreover, where this interaction is not yet strong enough "space between fields may become the ground for a new area" OECD (2010). Second, due to technological convergence (Daim et al., 2009; Mendonça, 2009; OECD, 2010) that more recently affects not only high-tech companies but also medium and low-tech ones, new product or service concepts are likely to emerge at the intersection of different sectors. Consequently, firms need KTOs' assistance to analyse in-depth their own and other industries' state-of-the-art and trends, to forecast technological scenarios and scan patents data sets in search of ideas that are carrier of radical innovations and thus far from their in-house prior knowledge. Indeed, the value of new and distant fields is difficult to evaluate in itself and in relation to a firm's technological requirements; consequently there might be a need for complementary services of demand articulation and of semantic translation of domain specific knowledge into a language closer to firms' communication codes (Bessant & Rush, 1995; Carlile, 2004; Gassmann et al., 2011; Hagardon & Sutton, 1997; Howells, 2006; McEvily & Zaheer, 1999). Moreover, new business opportunities might arise outside organizational boundaries; therefore there is an increasing call for activities of business intelligence and validation of new business initiatives, especially in case of the start-up of a new company.

The second phase of the innovation value chain, *knowledge transformation*, is the stage during which "ideas must be turned into revenue-generating products, services, and processes" (Hansen & Birkinshaw, 2007: 125). It encompasses, for instance, processes of concept development, prototyping and validation, field test and launch, post-launch review (Howells, 2006). Fierce competition on prices and time-to-market spurs firms to focus their in-house knowledge transformation activities and complement them with external services (Tether and Tajar, 2008) of providers, that can deliver them better and faster and with whom firms can share innovation costs and the risks of flawed projects. When a firm decides to outsource to a KTO, its search ranges in terms of partners such as laboratories, research institutes or universities and in terms of geography. Today, this search might go well beyond the national boundaries. Consequently, firms might need a broker able to tap into a network of local and international providers, to support the activation and the coordination of multi-institutional projects (Corley at al., 2006; Fleming & Waguespack, 2007). Furthermore, considering the shortage of resources for R&D, firms might need assistance in implementing innovation projects financed by public institutions and programmes.

Finally, in the last stage of the innovation value chain, firms *exploit and disseminate* the newly developed knowledge and seek to profit from innovation: a new product, process or service is commercialized, patents are licenced. In this phase firms, especially those with limited resources, must find ways to ensure that innovative solutions, that are delivered to the marketplace, are protected by professional patent policy, are properly financed and commercialised.

Along with the different stages of the innovation value chain, firms can choose among a wide array of "ideas": from shopping for *raw ideas* through licensing (which implies contacting inventors directly) to buying *ready-to-market concepts* and competences (licencing enriched by

R&D collaboration agreements) to finally buying *ready-to-market products*, which are products or services ready for launch (for instance, acquiring a company) (Nambisan & Sawhney, 2007). Each type of "shopping" decision, given the different knowledge and contractual arrangement features that it implies, requires a specific competent support from a KTO.

In contrast to this broad set of requirements at each stage of the innovation value chain, firms still face several obstacles in finding suitable partners and in collaborating with them. As highlighted recently, the decision about who to collaborate with to create an effective network can be difficult, particularly for SMEs (Lee et al., 2010). Results of the Community Innovation Survey confirm the propensity of firms to rely on traditional sources. Institutional sources are less frequently consulted than internal or market sources; and cooperation is easier with suppliers or customers than with consultants, commercial labs or private R&D institutes and even than with universities or public research institutes (Parvan, 2007). This problem is even more complicated considering that firms should decide not only with which partners to collaborate but also how these collaborations should be organised: as a competitive market or as a collaborative community (Boudreau & Lakhani, 2009). As recently shown, because the dynamics of communities and markets are inherently different, a firm has to carefully understand which one is more coherent with its innovation value chain and even with a specific project (Boudreau & Lakhani, 2009). Consequently, innovative organizations might need external assistance for internally auditing their objectives and innovation processes and for choosing the right set of interactions and relationships with outside partners.

Firms' reluctance to use the market of KT activities points to additional KTO services whose aim is building upon the inside capabilities of the firm. These services are for instance training programmes that help organizations to reinforce their absorptive capacity, to develop the culture of collaboration (Lee et al., 2010) for better cognitive and cultural closeness to research institutes, factors that favour subsequent forms of face-to-face collaboration (Balconi & Laboranti, 2006).

The positive impact of KTOs on the firms' innovation value chain can also be considered as an intermediate effect of the role they play within a specific region or innovation cluster. KTOs acting as intermediaries embedded within a geographical area can spur technological spillovers and knowledge-sharing by increasing the network density among universities, research centres and companies. Moreover, KTOs that hire qualified employees (some of whom on temporary contracts) can also foster researchers' mobility, thus positively affecting knowledge flows within a region (Breschi et al., 2005). Finally, KTOs might foster entrepreneurship by incubating start-up projects and favouring spin-offs.

2.3 The differentiated supply side: Knowledge transfer services and providers

Triple helix initiatives, involving academia, government and industry, have spurred, since the 1970s in the USA and the 1980s in Europe, the birth of a number of actors whose task it is to facilitate the transfer of scientific knowledge from universities to firms-receivers. The triple helix model ascribes to the university a third mission, in addition to research and teaching, namely nurturing economic and industrial development (Etzkowitz & Leydesdorff, 2000). In other words, universities are requested to implement actions in order to favour the effective exploitation by companies of the scientific knowledge generated in the academic labs. However, the knowledge transfer process between these two systems is characterised by high transaction costs and cognitive distance that hamper the direct contribution that universities can offer toward the commercialization of viable technologies (Gilsing et al., 2011; Kodama, 2008; Polt et al., 2001; Yusuf, 2008) (Figure 1). First, the establishment of university-industry linkages implies high search costs, since firms need to invest more time and resources in seeking and assessing academic partners than they do with those belonging to their supply chain. This can be ascribed, on one hand, to information asymmetry that makes it difficult for firms to stay up-to-date on the state-of-the-art projects and the related results carried out at the university and, on the other hand, to the uncertainty about the future output deriving from the application of general and theoretical knowledge. Moreover, the information asymmetry and the uncertainty which characterize the TT process also generate high bargaining costs in terms of negotiation and coordination of the parties. Indeed, "firms and universities are exposed to different incentive schemes that shape their interest in the transfer process" (Gilsing et al., 2011: 4). Scientists aim to contribute to the generation of public knowledge through dissemination; whereas firms want to appropriate the advantages deriving from the rapid commercialization of products/services that embody the new knowledge. This leads to the identification of complex solutions to overcome motivation problems and to increase the reliability among partners. Finally, the differences between universities and firms in terms of systems of perception, interpretation and evaluation, as well as of ''shared meanings'' linked to the organizational culture generate barriers to the combining of knowledge.

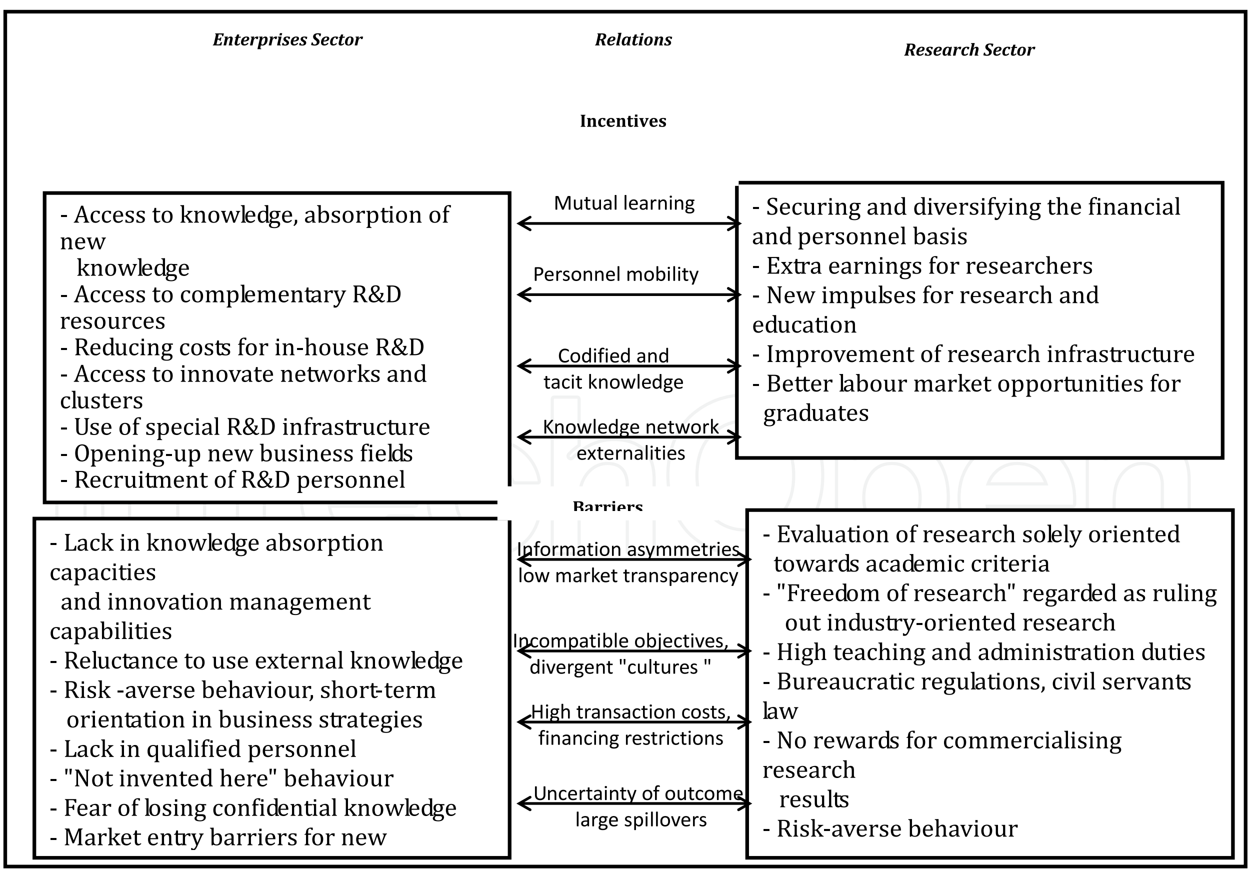

Fig. 1. Incentive and barriers on the relationship between firms and Public Research
Source: Polt et al., 2001

In order to increase the closeness between the different actors as well as to reduce the search and bargaining costs that this KT process implies, different types of organizations have been sponsored by public institutions over the last few decades. KTOs are knowledge-intensive providers which aim to facilitate the interaction between these heterogeneous actors and to support the exploitation of the research results of universities by industrial firms. For instance, science parks have been established in order to nurture innovative environments in which firms and academic institutions can interact via informal channels favouring knowledge spillover. Examples of well-known science parks include Stanford Research Park and Research Triangle Park of North Carolina in the US (Link & Link, 2003), Cambridge in the U.K. and Sophia-Antipolis in France (Longhi, 1999; Keeble et al., 1999). Another type of KTO, the academic incubator, has the mission to foster the creation of start-up firms based on university-owned or licensed technologies (Phan et al., 2005). Moreover, technology transfer offices or industrial liaison offices have been established in order to reduce the information asymmetry typically encountered in the scientific knowledge market through the management of intellectual property rights generated by scientists (Macho-Stadler et al., 2007).

As discussed in the previous sections, the complexity of applying scientific knowledge, the technological convergence trend which calls for multidisciplinary research, and the fierce competition on prices and time-to-market, spur firms to focus their in-house R&D and complement it with external scientific knowledge (Tether & Tajar, 2008). In this regard, in order to meet the firms' requirements, recent research highlights that KTOs are expanding rapidly and further typologies are emerging, such as business innovation centres, innovation agencies, R&D labs, technology consultants, technical testing and analysis labs (Comacchio et al., 2011; Consoli & Elche-Hortelano, 2010; Laranja, 2009). Moreover, studies show that KTOs are progressively evolving in terms of wider TT services portfolios and additional roles performed. Considering the three main phases of the innovation value chain, the offer of KTOs nowadays encompasses a broad range of services concerning (Howells, 2006; Lee et al., 2010; Muller & Zenker, 2001; Spithoven et al., 2010):

- *knowledge generation*: KTOs continuously scan the evolution of the scientific environment and describe the path to follow in order to integrate the technology to products and services (foresight, forecasting and technology roadmapping); they enable receivers to articulate their ideas and needs about new scientific and technological knowledge (demand articulation); they gather information and identify the potential collaborative partners (scanning and information processing);
- *knowledge transformation*: besides providing prototyping, testing and validation facilities, KTOs manage the process of knowledge re-engineering through in-house R&D and its recombination with the knowledge generated by heterogeneous partners;
- *knowledge exploitation*: KTOs support firms to assess and manage their inventions for Intellectual Property (IP) protection; they identify market opportunities, develop business plans, provide training and support for the commercialization of new products and services.

More recently, KTOs have started to fulfil a further activity throughout the innovation value chain of firms, namely the intermediation between firms-receivers and their scientific and technological partners. A recent research study describes this activity in terms of roles performed by KTOs, which can act as (Johnson, 2008): *mediators or arbitrators* in cases of

TYPOLOGIES	MISSION STATEMENT
Experimental station	Carrying out pre-competitive industrial research and development analysis, testing and experimentation of products, processes and new technologies, technical and scientific dissemination of knowledge and documentation in specific sectors at the national level.
Scientific park and technological hub	Promoting the economic development and competitiveness of regions and cities by creating new business opportunities and adding value to mature companies; fostering entrepreneurship and incubating new innovative companies; generating knowledge-based jobs; building attractive spaces for the emerging knowledge workers; enhancing the synergy between universities and companies.
Technological transfer office	Supporting the academic staff to identify and manage the organization's intellectual assets, including protecting intellectual property and transferring or licensing rights to other parties to enhance prospects for further development.
Incubator	Accelerating the growth and success of entrepreneurial companies through an array of business support resources and services that could include physical space, capital, coaching, common services, and networking connections.
Business Innovation Centre	Offering a range of integrated guidance and support services for projects carried out by innovative SMEs, thereby contributing to regional and local development.
Chamber of commerce special agency and laboratory	Furthering the development and expansion of technological innovation through the offer of services that meet the requirements of the firms associated to the Chamber of commerce.
Territorial development enterprise	Gathering and coordinating scientific, organizational and financial resources in the region in order to transfer acquired information on new production processes and research results to the entrepreneurial context.
Topic centre	Promoting a specific industry or a specific technological area inside a geographical context.
Multi-sector centre	Supplying of diversified services to firms operating in several sectors.
Public research organization	Performing research in its own Institutes, promoting innovation and competitiveness of the national industrial system, promoting the internationalization of the national research system, providing technologies and solutions to emerging public and private needs, offering advice to the Government and other public bodies, and contributing to the qualification of human resources.

TYPOLOGIES	MISSION STATEMENT
Laboratory of applied research and/or testing and analysis	Supplying qualified services of research and development, analysis and testing to client firms.

Table 1. Typologies of KTOs and mission statements
Source: Comacchio et al. 2011

dispute, thus facilitating contract negotiation for the accomplishment of a project; *sponsors and distributors* of funding for innovation efforts; *filters and legitimators* of projects that are worthy of support; *technology brokers* acting as a repository of information about technology experts and new technology opportunities and as a bridge between seekers and solvers of innovative solutions; *resource/management providers* in terms of project management practices that can be helpful in facilitating R&D collaboration.

The variety of KTO types (European Commission, 2004) and their differentiated offer (see Table 1) together with their relevance in promoting innovation and entrepreneurship at the firm level as well as at regional level raise the issue of identifying the appropriate criteria to assess the effectiveness of the knowledge transfer process performed by these organizations.

2.4 Summary: Why it is important to evaluate the KTOs' performance

The importance of evaluating the performance of KTOs has become paramount due to the increasing need for companies to rely on providers and intermediaries that are able to support them during the different phases of the innovation value chain. In order to nurture a market for what KTOs offer, there is a quest for more information about their characteristics in terms of services/products provided as well as for the performance they are able to achieve. The availability and the diffusion of this information may contribute to reduce the asymmetry, and thus increase the transparency of the transactions which occur in the market for knowledge. Promoting the disclosure of the capabilities and performance of KTOs may be beneficial from different points of view.

First, KTOs identifying their value proposition and assessing their performance are better able to define their product/service portfolio and craft their competitive strategy at regional, national and international level. Second, from the demand side, firms-receivers can use a univocal method to compare and evaluate the offer of the different KTOs, thus they may benefit from the reduction of transactional costs related to the search for and the selection of appropriate partners, as well as the monitoring of the results attained. Finally, local and regional stakeholders, such as universities, institutions and policy makers, may define their innovation policies and allocate resources effectively.

However, the variety of KTOs that have been set up over the last few decades together with the progressive broadening of their mission and the heterogeneity of stakeholders with different perspectives increase the complexity of the evaluation process. In the following section, we will present different approaches and attempts to KTO performance assessment, highlighting their strengths and weaknesses.

3. Knowledge transfer evaluation and a comparative analysis of European best practice

3.1 Introduction: The challenge of evaluating KTOs

During the last decade, European and local institutions have sponsored initiatives to identify methodologies in supporting KTOs to define their KT objectives, to assess the way these objectives are being fulfilled, and to set up permanent monitoring systems that can guarantee the evaluation of performance over time (European Commission, 2009; Guy, 1996). However, the attempts towards the definition of an evaluation system of KTOs have encountered several difficulties that can be ascribed to the characteristics of KTOs and the specific features of the knowledge transfer process.

First, KTOs present a high level of heterogeneity in terms of mission statements and business models adopted. Indeed, the institutional statements are often too broad, encompassing a wide range of aims that make it difficult to identify the KT objectives to set, monitor and evaluate. Moreover, each type of KTO has its own particular aims to pursue, increasing the difficulties of making comparisons across categories of KTOs (Hogan, 1996). Furthermore, the strategy and the subsequent business models implemented are determined by multiple stakeholders who show different expectations regarding the KTO performance measurement system. On the one hand, local and regional institutions aim to obtain an objective approach to measure allocated resources and to plan future investments consistently with the regional policy guidelines; on the other, firms want to obtain a performance appraisal tool that enables them to compare KTOs and select the effective partner to involve in their innovation process (Bigliardi et al., 2006). This makes designing a common performance measurement system, that conciliates these multiple interests, highly complex.

Second, the broad services portfolio provided nowadays by KTO increases the complexity of performance measurement due to the fact that each type of service should be assessed by a set of specific indicators. Furthermore, the knowledge contents transferred by KTO are characterized by different levels of tacitness and uncertainty that generate complexity in identifying their value. Indeed, a KTO may provide explicit and codified knowledge more easily valuable in a market for technological knowledge (such as the licensing of IP rights or the testing and prototyping of activities), but also knowledge characterized by a high degree of uncertainty and tacitness that makes it difficult to define appraisal metrics (for instance the promotion and coordination of research projects for new product development).

Third, the measurement of the impact of the KT process encompasses both the macro and the micro level of analysis, since the KTOs' activities have an effect on the single firm-receiver as well as on the local economic environment (region, industrial cluster) in which the KTO operates. This generates problems in terms of data availability and accessibility concerning the benefits attained by the local system and the receivers, but also in terms of isolating the results that can be ascribed to the specific intervention of KTOs (Gardner et al., 2010; Guy, 1996).

Finally, KTOs do not produce instant results. Indeed, the impact of the KT process on the firms-receivers and on the local environment takes time to emerge, whereas many of the costs are incurred when the service is provided (Gardner et al., 2010; Hogan, 1996), as in the case of the spin-off processes and research programs.

The aforementioned causes of complexity in achieving a uniform methodology for the evaluation of KTOs explain the wide diversity of approaches implemented by these organizations so far. This section provides a review of the extant methods used in assessing the performance of KTOs drawing on initiatives and best practices identified in the European context. The review aims to identify the set of core areas of evaluation and the related Key Performance Indicators (KPIs) which are likely to be common to all KTOs, in order to find convergence in appraisal methods. Drawing on institutional reports elaborated by European KTOs associations (such as the Association of European Science and Technology Transfer Professionals ASTP, the European BIC Network or the Pan-European Network of Knowledge Transfer Offices ProTon) as well as on appraisal tools elaborated by some European KTOs, the following sub-sections will present and discuss two main sets of KPIs related to two macro-areas of evaluation, which are the *output* of the KT process (in terms of research results, economic-financial returns and impact on firms-receivers and the local innovation system) and *input* (the structural, human and social capital of the KTOs which enable them to provide KT services).

3.2 Output evaluation

The evaluation approach which focuses on the results attained by the KTO may embrace three key areas.

The first area aims to capture the level of effectiveness of the KTO in achieving its KT goals, such as establishing high-tech firms in the region or promoting research collaborations between academia and firms. In this regard, metrics should assess both intermediate and final outputs of the knowledge transfer process. For instance, the effectiveness a KTO whose goal is to nurture the creation of new firms through incubation services can be assessed by monitoring the number of tenants hosted by the KTO (intermediate output) but also the enterprise survival rate following graduation (final output).

Table 2 shows in the first column the main aims included in the mission statement of KTOs: i) to establish channels of communication and collaboration between firms and research institutions; ii) to promote the commercialization of intellectual property rights generated by scientists; iii) to nurture entrepreneurship in the local innovation system; iv) to support the creation of new companies. For each area of evaluation the second column reports the Key Performance Indicators that are usually used to monitor the achievement of the KT goals.

Area of evaluation	**Key Performance Indicators**
Research activities	• Number of collaborative research agreements stipulated during the year where both firms, universities, institutions and other KTOs participate in the design of the research project, contribute to its implementation and share the project outputs • Number of collaborative research agreements stipulated during the year with other trans-regional or international KTOs

	• Number of contract research agreements stipulated during the year where all research is performed by the KTO • Number of consultancy agreements stipulated during the year where the KTO provides expert advice without performing new research • Number and type of pre-competitive research programs initiated during the year by established labs • Number and type of conventions stipulated during the year with established labs aiming at the concurrent development of products/processes • Number of scientific publications published during the year, with their relative impact factor • Number of patent researches carried out during the year
IP exploitation	• Total number of licenses executed during the year • Number of active spin-off companies with a formal license agreement with the KTO • Number of active spin-off companies with a formal equity agreement with the KTO • Number of spin-offs established during the year • Active spin-off companies' average during the year • Enterprise Survival Rate of spin-off companies
Entrepreneurship promotion	• Number of events organized during the year to promote entrepreneurship • Number of people that attended events to promote entrepreneurship • Number of training events/number of training hours organized during the year • Number of people that attended training events
Enterprise creation	• Average incubator space occupancy rate (%) • Average incubation time (years) • Number of tenants in incubators • Total employment by tenants • Number and type of new product prototypes launched by incubated firms • Number of start-ups created during the year • Number of jobs created in start-ups in the year • Enterprise Survival Rate (within the incubation period) • Enterprise Survival Rate (3 years following graduation) • Total numbers of contacts for enterprise creation • Number of feasibility studies created during the year • Number of enterprise creation projects during the year • Number of business plans produced during the year

Table 2. Key Performance Indicators of KTOs' knowledge transfer output
Sources: Area SciencePark, 2011; Arundel & Bordoy, 2010; Bigliardi et al., 2006; EBN, 2011; European Commission, 2009; Piccaluga et al., 2011.

Area of evaluation	Key Performance Indicators
Impact on the firms-receivers and the local innovation system	• Growth in turnover in companies attributed to KTO intervention • Number of jobs created in companies attributed to KTO intervention • Number of collaborative relationships and joint ventures among local, extra-regional and international firms favored by KTO • Number and type of environmental improvement carried out in collaboration with KTO • Investment flows installed by KTO from other regions or from foreign countries • Personnel flows installed by KTO from other regions or from foreign countries • Laboratories of extra-regional or foreign firms installed by the KTO

Table 3. Key Performance Indicators of KTOs' impact
Sources: Bigliardi et al., 2006; EBN, 2011; European Commission, 2009.

Area of evaluation	Key Performance Indicators
Financial returns	• Total turnover for services and its trend • Total turnover for area location and its trend • Total license revenue and its trend • Total financial value of all research agreements and its trend • Revenues generated during the year from profits and/or sales of equity in spin-offs in which the KTO holds equity • Financial autonomy (own current revenues / endowment)
Economic performance	• Total revenues per FTE member of KTO staff • ROA and its trend • ROE and its trend • Average number of start-ups per FTE member of KTO staff • Average number of jobs created per FTE member of KTO staff • Average number of business plans created per FTE member of KTO staff • Average number of companies assisted per FTE member of KTO staff • Cost per job created with the support of a KTO • Public financial contribution per job created • Average number of start-ups per 100K€ of KTO • Average number of jobs created per 100K€ of KTO income • Average number of business plans created per 100K€ of KTO expenditure • Average number of companies assisted per 100K€ of KTO income

Table 4. Key performance indicators of KTOs' financial and economic returns
Sources: Area SciencePark, 2011; Arundel & Bordoy, 2010; Bigliardi et al., 2006; EBN, 2011; European Commission, 2009; Piccaluga et al., 2011.

A second area of result concerns the evaluation of the success of the KT process, therefore its impact on the firms-receivers' performance and on the economic growth of the region (table 3). It is worth bearing in mind that these effects require a long period of time to emerge, and they are mediated by the innovation activities carried out by each receiver and by the different actors operating in the local innovation system.

The last area of result encompasses the financial and the economic performance attained by the KTO (Table 4). The related KPIs capture the ability of the KTO to generate financial returns from the supply of its services and to attain efficiency.

3.3 Evaluation of inputs

The measurement approach based on input relies on the Intellectual Capital model (Edvinsoon, 1997), often used by KTOs in their annual disclosure activities. Table 5 shows the Intellectual Capital components and the related KPIs tailored for the KTOs:

- *Structural capital*: this represents the "organizational value left when employees go home", and it is also defined as "the organizational capability, including the physical systems used to transmit and store intellectual material" (Edvinsoon, 1997). The structural capital of KTOs is related to research infrastructure that enables the knowledge transfer (research labs, equipment, etc.) as well as the portfolio of IP rights which represents the potential commercialization of public science.
- *Human capital:* this encompasses the competence, skills, and the relevant knowledge possessed by employees of KTOs. Research shows that the level of education and the continuous investment on employees' competency development not only enable KTOs to provide high-quality KT services but also to assume an intermediation role between firms and universities (Comacchio et al., 2011);
- *Relational capital*: this comprises the set of resources rooted in relationships that the KTOs establish with research and institutional partners (universities, research labs, policy makers) and with the firms-receivers.

Area of evaluation	**Key Performance Indicators**
Structural Capital	*R&D assets* • Number of years since establishment • Number of research laboratories hosted by the KTOs • Number of high-tech firms hosted by the KTOs • Total square meters available • Average square meters available for incubation activities of owned incubators • Average square meters available for research activities • Value of fixed assets (plant, machinery, etc.) • Total expenditures on infrastructure • Total expenditures on technology transfer activities (patent portfolio management costs, contract costs, etc.) • Total expenditures on basic and applied research (staff dedicated to research, capital expenditures on new equipment, etc.)

Area of evaluation	**Key Performance Indicators**
	IP assets • Number of invention disclosures received during the year • Total number of priority patent applications • Number of priority patent applications submitted in the year • Number of patents granted in the year
Human Capital	*Size, breakdown and level of education of staff* • Total number of KTO staff in full-time equivalents (FTEs) – including all professional, administrative and support staff for knowledge transfer activities • Number of permanent staff • Number of temporary staff • Number of contract staff • Number of professional staff (FTEs) • Number of graduates • Number of post-graduate degrees and doctorates *Competences development* • Number of training days • Number of participants in training courses • Total staff expenses for training • Total staff expenses - HR development *Retention* • Staff turnover • Average seniority of staff • Employee satisfaction (work environment), evaluation scale 1-5
Relational Capital	*Partners* • Number of partners • Number of new partnership established during the year • Number of foreign partners • Number of R&D partners • Number of institutional partners *Receiver satisfaction* • Number of KTO firms-receivers • Number of new KTO firms-receivers acquired during the year • Customer satisfaction: positive comments from participants in KT initiatives • Number of complaints from receivers

Table 5. Key performance indicators of KTOs' intellectual capital
Sources: Area SciencePark, 2011; Arundel & Bordoy, 2010; Bigliardi et al., 2006; EBN, 2011; European Commission, 2009; Piccaluga et al., 2011.

KTOs which have a structured, multidisciplinary, and international network of partners are able to obtain critical information more rapidly, to involve complementary partners in joint research programs and to more easily access the circuit of financed innovation projects (Adler & Kwon, 2002; Nahapiet & Ghoshal, 1998). Moreover, the activation of a network of external qualified relations increases the identity and the reputation of the KTO within the innovation system.

The relational capital also captures the customer relationships developed by the KTOs. In this regard, metrics rely on follow-up procedures or satisfaction surveys.

3.4 Summary

This section provided a review of the recent debate on the difficulties and opportunities of measuring KTOs' performance. Furthermore, the in-depth analysis carried out has shown the state-of-the-art of metrics and indicators used by KTOs and institutions to evaluate knowledge transfer benefits. This analysis has shed light on the fragmentation of practices implemented by KTOs, in terms of aims, areas of results and metrics.

According to a recent article, which provides a broad analysis of methods for quantifying and qualifying the benefits of KT around the world, four key issues have to be taken into account: inputs vs outputs, quality vs quantity, subjectivity vs objectivity and time series vs cross-sectional analysis (Gardner et al., 2010). We would contribute to this discussion, providing new implications for each issue, on the base of our in-depth analysis of evaluation practices and related indicators in Europe.

- *Inputs vs outputs:* Our analysis suggests that both inputs and output indicators are used. The first as a measure of stock of resources and of activities occurred, the second as evaluation of results achieved. However, they are rarely used in an integrated manner within the same measurement system.
- *Quality vs quantity:* While it is difficult to distinguish between the quality and quantity of results, an issue could be raised with accuracy of quantitative indicators, for instance the simple number of agreements does not inform about how many of them have been completed successfully. Also, our in-depth analysis shows that there is a first attempt to provide both measurements for a more accurate picture of results attained; however, especially in the area of research activity and IP exploitation, quantitative indicators overwhelm qualitative ones.
- *Subjectivity vs objectivity:* Objective evaluations should be preferred instead of subjective descriptions and measures. Approaches analyzed in this section rely on objective and measurable indicators. Beside this advantage, we maintain that objectives metrics should be related to the specific strategy and mission of a KTO, in order to signal effectively the coherence between results obtained and strategic aims pursued by a provider.
- *Time series vs cross-sectional analysis:* Evaluation could follow two methods: time series, namely the comparison within the same organization of results over time, and cross-sectional analysis, that is an inter-organization snapshot of results at one moment. Our analysis suggests that a comprehensive framework could help not only to investigate within the same organization trends and causal relationships among actions and

performance, but could also help to find an overall accurate framework for worthy comparisons among different types of KTOs.

In the following section we will discuss how the KTO performance management system could be improved by providing a preliminary comprehensive frame that draws on the Balanced Scorecard (BSC) approach, in order to bring within an overall integrated and coherent model different indicators of KTO performance.

4. An analytical model for the measurement of KTOs: A balanced scorecard approach

4.1 The balanced scorecard approach

Among the seminal performance measurement models, the Kaplan-Norton Balanced Scorecard continues to be the most referenced framework in the literature (Kaplan & Norton, 1992; 2004; 2007; Kaplan et al., 2010). This is due to its ability to support firms' strategic learning, namely "gathering feedback, testing the hypotheses on which strategy was based, and making the necessary adjustments" (Kaplan & Norton, 2007: 159). Indeed, the BSC helps firms to articulate their vision and to define in clear and operational terms the results that they aim to achieve. Moreover, the BSC is a comprehensive frame that enables companies to get a feedback system thanks to the specification of the causal relationships between performance drivers and objectives: "Companies build their strategy maps from the top down, starting with their long-term financial goals and then determining the value proposition that will deliver the revenue growth specified in those goals, identifying the processes most critical to creating and delivering that value proposition, and, finally, determining the human, information, and organization capital the processes require." (Kaplan & Norton, 2004: 55). Figure 2 provides a representation of the four perspectives (financial, customer, internal process, learning and growth) and the relationships with a firm's strategy.

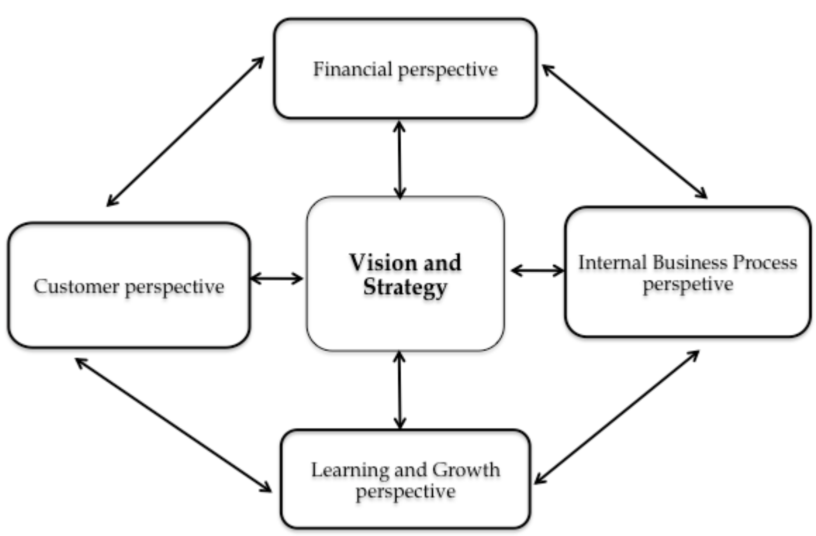

Fig. 2. The Balanced Scorecard Framework

The BSC framework has been widely applied in many manufacturing and service industries, but only recently has been extended to the research setting (Bremser & Barsky, 2004; Eilat et al., 2008; Sartorius et al., 2010; Wang et al., 2010). Drawing on the KT and BSC literature, we provide a preliminary contribution to this debate re-conceptualising the Balanced Scorecard coherently to the KTO context.

4.2 The balanced scorecard of KT

4.2.1 Introduction

The BSC strategy map (Fig.3) provides a framework for linking intangible assets to shareholder value creation through four interrelated perspectives: financial, customer, internal process, learning and growth. We suggest that this scheme is a coherent architecture by which the fragmented evaluation system of KTOs could be unified. Moreover, this framework provides a strategic way of thinking about performance assessment of KT services, useful for providers, receivers and policy-makers. Indeed a well-developed and comprehensive performance measurement systems could reduce the barriers that hamper the relationship between demand and supply of services (Polt et al., 2001).

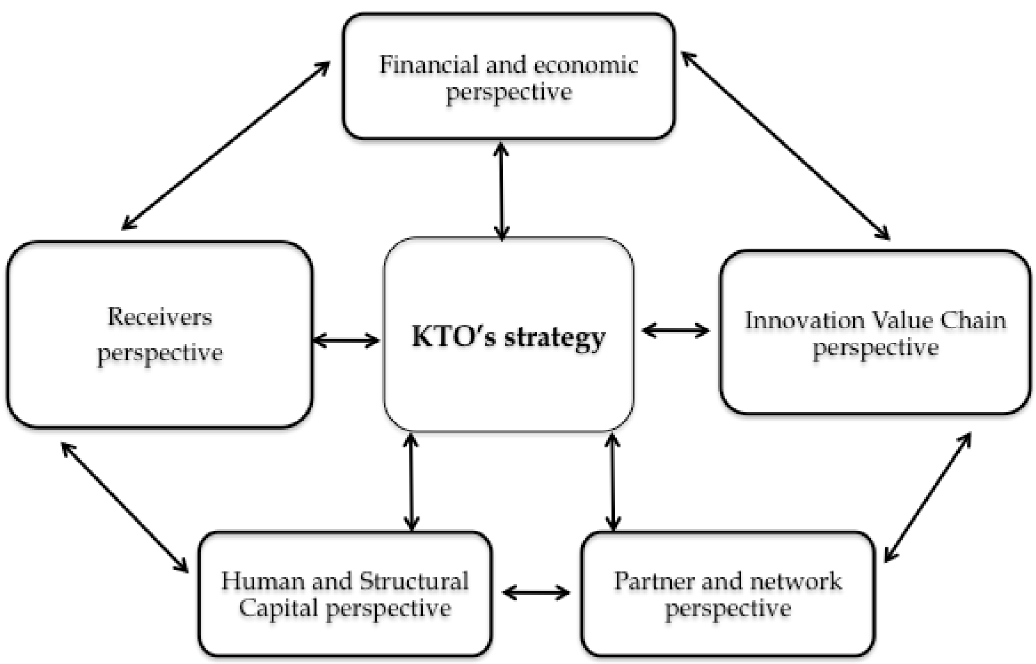

Fig. 3. The Balanced Scorecard Framework for KTO

4.2.2 The managerial perspectives of BSC applied to KTOs

The four managerial perspectives of the BSC provide KTOs' management with a comprehensive tool to measure performances along different but integrated dimensions. We propose that each dimension of the BSC could be adapted to the specific activities pursued by KT bodies. Accordingly in the following discussion each dimension of the original BSC frame is presented and is adjusted in order to be applied to the context of the market of knowledge transfer services. We finalize the discussion of each dimension by giving some examples of key indicators that can be used, coherently with metrics of KTO performance management, presented in Section 3.

The *Financial Perspective* describes the tangible outcomes of the strategy in financial terms, such as profitability, revenue growth and cost efficiency. It can be conceived as the final result of the cause-effect relationship among the other three dimensions of the scorecard (learning and growth performances affects internal business processes, which impact on customer outcomes, which finally drive financial results). This perspective applied to KTOs' performance measurement encompasses metrics related to the capability of the organization to gather external resources through its knowledge transfer services. It regards both the short-term profitability generated by commercialized services, the productivity and the efficiency of business processes as well as long-term financial sustainability of research and intermediation activities. Examples of financial performance indicators are the following: total turn-over from services, amount of public funded projects, ROA, costs. Moreover, within this perspective the impact of KTOs on a local innovation system is considered and measured by economic indicators, for instance personnel and investment flows attracted by KTOs in the region.

The *Customer Perspective* looks at customers' satisfaction with the product or services delivered by a firm and their loyalty. We suggest that as far as a KTO is concerned, customer perspective could be applied to acquisition of clients such as firms and to their retention. However, considering the brokerage role that KTOs play across firms and research institutes, this perspective could be extended to other clients such as Universities or private research bodies. Moreover, the relationships between a KTO and receivers could be characterised by different degrees of interdependences and duration. This dimension could be re-defined as *Receivers Perspective* in order to measure the performance of the overall receivers network. Beside the well known indicators of customer satisfaction and retention, other indicators are those that measure the network size, namely number of clients or agreements and network dynamics, such as partners development rate. Finally, indicators of social network analysis could be applied to assess the structural features of a KTO's ego network namely degree centrality.

The *Internal Perspective* regards the key internal processes that make up the value proposition to customers, thus those processes by which a firm is able to meet customers' needs. From a knowledge transfer point of view this dimension should consider client's requirements that are tightly related to the phases of the innovation value chain. Consequently, we suggest to reconceptualise this dimension as *Innovation Value Chain perspective*. The measures it includes assess whether a KTO is able to act as an external competent partner along the three main phases: knowledge generation, transformation and exploitation. Indicators for the knowledge generation phase are related to three main areas of results: i) basic research (number of scientific publications per year, number of patent researches carried out during the year); ii) technology scouting (number of technological audit provided); iii) brokerage (number of events organised to promote networking among innovators). Indicators of results in the second phase of knowledge transformation are the following: type of conventions stipulated during the year aiming at the concurrent development of products/processes and number of application for patent; number of research and development projects; number of training events organized; number of prototyping and testing services provided; etc. Indicators of results in the third phase of knowledge exploitation are: number of application for patent; number of business plans;

BSC perspectives	Area of results	Sample metrics
Financial Perspective	Profitability of KT services	• Total turnover for services and its trend; Total license revenue and its trend
	Financial sustainability	• Financial autonomy; amount of public founded research projects
	Productivity	• Total revenues per KTO employee; ROA and its trend
	Economic impact on local innovation system	• Personnel flows installed by KTO from other regions or from foreign countries
Receivers Perspective	Network size	• Number of clients • Number of agreements
	Network structure	• KTO degree centrality
	Network dynamics	• Customer retention rate • New clients development rate • Customer satisfaction • Number of complaints from customers
Innovation Value Chain Perspective	Knowledge Generation	• Basic research (number of scientific publications per year, number of patent researches carried out during the year) • Technology scouting (number of technological audit provided) • Brokerage (number of events organised to promote networking among innovators)
	Knowledge Transformation	• Number and type of conventions stipulated during the year aiming at the concurrent development of products/processes • Number of research and development project • Number of training events organized • Number of prototyping and testing services provided
	Knowledge	• Number of application for patent • Number of business plans • Number of spin-offs established during the year

BSC perspectives	**Area of results**	**Sample metrics**
	Exploitation	• Active spin-off companies' average during the year • Number of tenants in incubators
Human and Structural Capital Perspective	Human capital	*Size, breakdown and level of education of staff* • Total number of KTO staff in full-time equivalents (FTEs) • Number of graduates and post-graduate degrees and doctorates *Competences development* • Number of training days • Number of participants in training courses *Retention* • Staff turnover, average seniority of staff or satisfaction
	Structural capital	*R&D assets* • Total expenditures on infrastructure • Total expenditures on technology transfer activities • Total expenditures on basic and applied research *IP assets* • Number of invention disclosures received during the year • Number of patents granted in the year
Partner and Network Perspective	Network size and quality	• Number of partners • Number of new partnership established during the year • Number of external consultants; • Skill and capabilities provided by partners.
	Network dynamics	• Composition of partners and relationships over time

Table 6. The Balanced Scorecard of KTOs

number of spin-offs established during the year; active spin-off companies' average during the year; number of tenants in incubators, etc.

The *Learning and Growth Perspective* is the dimension that measures the intangible assets of an organization. As argued by Kaplan and Norton (2004: 54) "the objectives in this perspective identify which jobs (the human capital), which systems (the information capital), and what kind of climate (the organization capital) are required to support the value-creating internal processes". The same dimensions could be applied to KTO in which research activity relies both on human competencies and prior R&D experience, thus we suggest to name this aspect as *Human and Structural Capital Perspective*. Coherently, indicators are those traditionally used to measure KTO intangible input and already presented in Section 3, a sample of which is: indicators of *size, breakdown and level of education of staff (*total number of KTO staff in full-time equivalents (FTEs), number of graduates and post-graduate degrees and doctorates), indicators of *competences development (*number of training days or number of participants in training courses) and finally indicators of *retention and satisfaction (*staff turnover, average seniority of staff or satisfaction). Concerning *structural capital* some indicators are those of *R&D assets (*total expenditures on infrastructure/on technology transfer activities /on basic and applied research) and of *IP assets (*number of invention disclosures received during the year, number of patents granted in the year).

In addition to human and structural capital a further enabler of the competitive advantage of KTOs is the network of external contractors and organizational partners by which a KTO provides its services, such as consultants, researchers. Thus, accordingly with the most recent contributions on BCS in R&D settings (Lazzarotti et al., 2011) we enrich the original BCS map with an additional dimensions of KTO performance measurement: *Partner and Network Perspective.* Indicators are the following: number of partners, number of new partnership established during the year and number of external consultants; skills and capabilities provided by partners (network size and quality) and composition of partners and relationships over time (network dynamics).

Table 6 shows the BSC framework tailored for KTOs setting, illustrating the five complementary perspectives and the related area of results and indicators. The fragmented measurement systems presented in the Section 3 are therefore composed in a comprehensive framework.

5. Conclusion

In this chapter, after having illustrated the main drivers of the evolution of the market of knowledge transfer services, we maintained the relevance of the evaluation of KTO performances, notwithstanding its intrinsic difficulties. Grounding our discussion on an in-depth analysis of key indicators used in Europe to measure knowledge transfer performances, we highlighted the limits of the extant evaluation systems, specifically we argued that they are fragmented and disentangled from the strategy of KTOs. In line with these critiques we maintained that a performance measurement system based on an integrated frame such as the BSC has several advantages and positive effects.

First, as an assessment tool, it helps to overcome the main barriers between the demand and supply of KT services. From the point of view of firms-receivers, a BSC might increase transparency, lower information asymmetries reducing transaction costs (Polt et al., 2001).

Second, as a managerial tool, the BSC helps KTO to craft their strategy in terms of key services offered, targeted receivers served, core competences to mobilize internally and externally in order to achieve financial and economic returns (Bremser & Barsky, 2004). Moreover the description of the multiple strategic goals a KTO wants to accomplish through the five BSC perspectives might simplify the selection of the most appropriate measures (Kaplan, 2010).

Third, this comprehensive scheme could become a monitoring tool for policy makers willing to make cross-sectional comparisons of providers based on a univocal method, in order to manage resource allocation and support regional development.

In terms of future lines of research, we suggest that from a theoretical point of view the model could benefit from further conceptual development in two directions: by a more in-depth analysis of each perspective and related metrics and by an analysis of the causal relationships among perspectives within a KT organization. From an empirical point of view a field work by case studies could be a first test of the theoretical model to understand how much this framework is implemented by KTOs.

We also draw some preliminary managerial implications for KTO, considering how this framework could be applied by a KTO, for instance what information is easily available to implement the framework and how much detailed the frame should be to meet the different stakeholders expectations.

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It is widely accepted that technology is one of the forces driving economic growth. Although more and more new technologies have emerged, various evidence shows that their performances were not as high as expected. In both academia and practice, there are still many questions about what technologies to adopt and how to manage these technologies. The 15 articles in this book aim to look into these questions. There are quite many features in this book. Firstly, the articles are from both developed countries and developing countries in Asia, Africa and South and Middle America. Secondly, the articles cover a wide range of industries including telecommunication, sanitation, healthcare, entertainment, education, manufacturing, and financial. Thirdly, the analytical approaches are multi-disciplinary, ranging from mathematical, economic, analytical, empirical and strategic. Finally, the articles study both public and private organizations, including the service industry, manufacturing industry, and governmental organizations. Given its wide coverage and multi-disciplines, the book may be useful for both academic research and practical management.