

A performance measurement system for academic entrepreneurship: a case study

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Summary

Purpose – This paper aims at proposing a performance measurement system (PMS) for academic entrepreneurship.

Design/methodology/approach – The PMS has been developed through action research carried out within an Italian higher education and research centre on the basis of the literature background, focus groups and interviews.

Findings – The study presents a new PMS based on an input–output model for academic entrepreneurship. As a result, a multidimensional framework for measuring technology entrepreneurship is proposed together with a set of key performance indicators (KPIs) to assess the “third mission” of universities. The application of the framework allows demonstration of its validity in public settings.

Research limitations/implications – Because the research was conducted in a specific organisation, the possibility of generalizing the results to similar institutions is a key issue. Hence, it is important to distinguish between what is general in scope and what is case-specific.

Practical implications – This study contributes to the extant literature on performance measurement of entrepreneurship process within research and higher education institutes that is traditionally focussed at the firm level. From a practitioner perspective, the model can be used both by universities which are interested in measuring their entrepreneurial capital and by other stakeholders who are interested in evaluating the value generation performances of universities. Implications for the society are clarified as well.

Social implications – As for the society, the proposed model allows evaluation of the university's pivotal role in the social and economic development of the region where it is located, especially in terms of new employments and new technology-intensive firms.

Originality/value – The PMS is developed according to a process-oriented perspective of the academic entrepreneurship by identifying, for each step, a set of KPIs to meet the information needs of different stakeholders. The proposed PMS allows monitoring each phase of the technology entrepreneurship and managing the results in terms of social and economic impact developed. Contributions in PMS and intellectual capital literature are identified.

Keywords Performance measurement, Intellectual capital, Action research, Entrepreneurial university, Academic entrepreneurship

Paper type Research paper

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1. Introduction

Although education and research have traditionally been the universities' main missions, this has gradually evolved with the emergence of new perspectives on their role in the system of knowledge production and valorisation (EU, 2005). According to Fairweather (1990), academic institutions, by appearing to respond to social needs and to contribute to economic development, can enhance their public image, taking a key role in leading regional and national innovation systems (Martin and Etzkowitz, 2001). This entrepreneurial behaviour characterising the third university's mission opens the possibility for many higher education institutions to get a broader source of funding, thus operating as an entrepreneurial university (Etzkowitz, 1983). Many definitions of entrepreneurial university

exist. Some studies (Wright *et al.*, 2007; Rothaermel *et al.*, 2007; Gibb *et al.*, 2013) consider the entrepreneurial university as an *entrepreneurial organisation* with a key role within the innovation system, both as a human and a technology capital provider (Jaffe, 1989; Rosenberg and Nelson, 1994; Mowery *et al.*, 2001). Other studies (Oakey, 1995) consider the entrepreneurial university as a source of potential global start-ups, especially in high-tech sectors. In this meaning, the entrepreneurial university can influence significantly the regional development and economic growth by undertaking technology transfer processes and valorising the research and scientific results (Clark, 1998; Etzkowitz, 2004; Kirby, 2006; Lazzeroni and Piccaluga, 2003; Poh-Kam *et al.*, 2007). Thus, the entrepreneurial university model implements the academic entrepreneurship process which accomplishes the university's third mission (Etzkowitz, 1983; Rothaermel *et al.*, 2007; Gibb *et al.*, 2009). Actually, academic entrepreneurship includes large-scale science projects, contracted research, consulting, patenting/licensing, spin-off firms, external teaching, sales and testing (Klofsten and Jones-Evans, 2000).

Despite the increasing interest in looking for solutions to develop entrepreneurial behaviour within higher education institutions, universities lack specific information and tools to monitor and evaluate the overall entrepreneurial performances (Wright *et al.*, 2004). Academic entrepreneurship needs an overall evaluation that goes beyond the specific aspects such as the financial returns to a given intellectual property portfolio; to consider wider social and economic benefits such as the diffusion of knowledge, the creation of intangible assets behind the new venture process and the contribution to employment for social, cultural and economic development. Thereby, a system devoted to measure the overall academic entrepreneurship should contemplate the different views and expectations of every involved stakeholders, by considering both the strategic dimension (e.g. data and information concerning the development of university policies and strategies for medium- and long-term planning) and the operational dimension (e.g. data and information concerning the development of joint initiatives and programmes) (Agostino *et al.*, 2012). This implies focussing on management and development strategies of key intangible assets of universities, and consistently redesigning their processes and instruments (Arena *et al.*, 2009). In such a way, the resulting performance measurement system (PMS) of academic entrepreneurship would represent a valuable support in assessing the value-generation process of universities and, thus, defining the limited and reduced public budget for financing research (Arena and Arnaboldi, 2013).

Framed in these premises, this paper aims at investigating which PMS can be developed to capture an extensive and systemic view of academic entrepreneurship process within universities.

The article is structured into five main sections: after a background focussed on a review of the most relevant approaches about the PMS and academic entrepreneurship, the research design is presented with the details on methodology, data collection and analysis. Then, the model of the proposed PMS to assess the technology entrepreneurship performance is presented, together with an application. Discussion of the model and its implications conclude the paper, along with some final remarks and avenues for further research.

2. Background

Extant literature defines *academic or university entrepreneurship* adopting different perspectives. According to Rothaermel *et al.* (2007), it refers to activities and assets of an entrepreneurial university such as technology transfer, university licensing, science parks, incubators, university spin-offs and other processes aimed to implement the third mission of the university. Other authors interpreted the academic entrepreneurship as businesses started by academia as university spin-offs (Shane, 2004; Wright *et al.*, 2004). More detailed taxonomies include the *research-based entrepreneurship* (Goel and Grimpe, 2011) or businesses started on the basis of academic research and technology. Moreover, academic entrepreneurship is defined as a practice performed with the intention to transfer

knowledge between the university and the external environment to produce economic and social values both for external actors and for members of the academia (Cantaragiu, 2012).

The strategic perspective of measuring *academic entrepreneurship performance* as essential elements to activate the dialogue inside universities and between their environment and society has been highlighted by many researchers (Taylor and Massy, 1996; Dolence and Norris, 1999). In this perspective, PMSs reveal a very useful and powerful tool. They are complex tools adopted by private and public organisations to engage policy and manage organisational change, which also greatly enhances transparency of organisations (De Bruijn, 2002). Performance management and performance measurement have been often used synonymously in the literature because they are closely related concepts. But it is important to distinguish between the two processes: while performance management is viewed more broadly as a tool that seeks to improve the performance of an organisation (Aguinis, 2009), performance measurement focusses more narrowly on the metrics and key performance indicators (KPIs) used to determine how an organisation is performing and to quantify both the efficiency and effectiveness of actions to each the targeted goals (Neely *et al.*, 1995).

The university system is a specific area of the public services where this approach is needed (Esposito *et al.*, 2013) and where there is a growing interest in PMS (Broadbent and Laughlin, 2009) for a lot of reasons, including:

- the usage of strategic performance indicators can improve public efficiency and effectiveness by increasing the accountability and improving decision-making processes of public administrators (Cavalluzzo and Ittner, 2004);
- the availability of data and information on the university performance satisfies the stakeholders' need for information transparency (Corcoles *et al.*, 2011), and can be used as criteria to regulate competition among teachers, researchers and students (Sanchez *et al.*, 2009);
- the increasing cooperation between university and firms has resulted in the demand for similar processes of evaluation for both players (Secundo *et al.*, 2010);
- the need for searching funding is associated with the pressure of demonstrating the ability of generating research outputs that provide a positive value for the wider society (Senker, 2001; Coccia, 2004), as well as to contribute to the early stages of the innovation process within the national innovation system (Senker, 2001; Leitner and Warden, 2004); and
- the use of new companies' creation as strategy to exploit university inventions (Di Gregorio and Shane, 2003) calls for universities to set up an effective performance dashboard for attracting established industrial firms and investors, and thus supporting the creation of academic or corporate spin-offs (Rosenberg and Nelson, 1994).

These reasons highlight that there is a widespread dispute about which measures are more suitable in assessing the performance of *academic entrepreneurship*, and, at present, this debate is still open. Relatively few contributions have dealt with a similar issue: some consider the issue of R&D performance measurement in the public sector (Coccia, 2004; Leitner and Warden, 2004); some other the intellectual capital management issue in universities (OEU, 2006; Secundo *et al.*, 2010; Seemann *et al.*, 2000; Bontis, 1998; Leitner and Warden, 2004). This last research stream is strictly connected with the second generation of PMS that moved from the measurement of financial resources (*first generation of PMS*) towards the measurement of intangible resources (or intellectual capital) that "you cannot see nor touch nor buy or sell" (Fried and Orellana, 2006). Although the intellectual capital concept was first developed as a framework to analyse the contributions of intellectual resources in for-profit enterprises, it was soon adopted by public and non-for-profit organisations, such as universities and research centres (Mouritsen *et al.*,

2004; Kong and Prior, 2008; Ramirez, 2010). In the past decade, some applications for adopting intellectual capital approach in “research-intensive” and “technology-intensive” companies, as well as in universities have been developed (Leitner, 2005; Sanchez *et al.*, 2009; Veltri *et al.*, 2012; Secundo *et al.*, 2010; Ramirez, 2010). In addition, the European Commission (EU, 2006) proposed the document “RICARDIS – Reporting Intellectual Capital to Augment Research, Development and Innovation in SMEs” in which intellectual capital reporting was highlighted as being paramount in the knowledge economy. Another interesting initiative is the “Intellectual Capital Report 1999-2004” by the Austrian Research Centers, which has become the mandatory foundation for intellectual capital reporting in Austrian universities (Leitner, 2005). Later, the Observatory of European Universities (OEU, 2006), within the PRIME Network of Excellence, proposed the “Intellectual Capital Report for Universities” which has been used from some universities and research centres to develop a report for describing their intellectual assets and knowledge flows.

Finally, a third generation of PMS has been defined to link it to the effectiveness of organisational practices, moving from a pure instrumental focus to a critical, reflexive assessment in practice (Fried and Orellana, 2006).

Despite this, the literature typically suggests that public sector applications of PMS are limited and often have only limited success, primarily due to the lack of focus on the process of managing the implementation of performance measurement (Goh, 2012). Besides, the application of a PMS to monitor and assess the technology entrepreneurship performance of universities is still not so widely diffused, setting the motivation for this work.

3. Research design

Framed in the above premises, the main goals of this study is to develop a model of PMS for measuring the academic entrepreneurship performance of a higher education and research centre, and to propose a set of KPIs useful to monitor and orient the strategic setting according to the third mission aim. The research context is the Euro-Mediterranean Incubator (hereafter EMI) of e-Business Management, a research and higher education centre operating at the University of Salento (Italy).

3.1 Methodology

The study carried out in this paper has been done by adopting the action research methodology (Susman and Evered, 1978). This methodology has been selected because it aims to contribute both to the practical concerns of people in an immediate problematic situation and to the goals of social science by joint collaboration with the members of the system to evolve towards a desirable direction, stressing the importance of co-learning as a primary aspect of the research process. According to the literature, action research is conceived as a cyclical process articulated in five phases:

1. diagnosing (identification or definition of the problem);
2. action planning (alternative actions to solve the problem);
3. action taking (selection and execution of a possible action);
4. evaluating (the consequence of the action); and
5. specifying learning (identification of findings).

The five phases are contextualised into a social system (i.e. a group, an organisation, a network of actors or a community) in which the members face problems to be solved (Trist, 1977).

In this study, action research has been applied to face the problem of a PMS definition for the EMI, by following a two-cycle process. Within both cycles, the authors of the paper acted as participant researchers by taking part to all the phases. Cycle I is synthetically described in Table I.

Table I The action research methodology (cycle I)

Research phase	Description	Technique	Output
Diagnosing	Researchers stimulate EMI personnel to participate and debate about the needs and expectations from a PMS	Literature review, meetings and focus groups	Shared meaning of the role of PMS into the EMI; main needs and requirements for the PMS
Action planning	Researchers and EMI personnel meet and discuss to identify key people and data sources useful for designing the PMS	Literature review, meetings and interviews	Main processes and data collection tools for the PMS definition and design
Action taking	Researchers perform interviews and organize meetings with the EMI people to analyse data, documents and build the PMS model with the first set of indicators	Meetings, interviews and document analysis	PMS model and KPIs
Evaluating	Researchers present the PMS model and KPIs, and collect feedbacks	Plenary meetings	Feedbacks on the PMS model and KPIs
Specifying learning	Researchers analyse the process used, discuss the collected feedbacks and suggestions and ask some details to the EMI key people to better understand and interpret them	Internal meetings and interviews	Analysis, interpretation and discussion of collected feedbacks and insights to activate the Cycle II

Cycle II follows cycle I, by executing and covering the five phases of action research, with the difference that while in cycle I, the process is mainly exploratory with an intense activity of listening and collaboration; in cycle II, the process is more focussed on finalising and tuning the PMS model with its KPIs. For this purpose, new data sources have been included, meetings have become more frequent and often involved people who were wise and perfectly aligned to the status of the activities.

The execution of both cycles of action research in a climate of commitment and collaboration allowed to identify and describe a series of facts happening inside the organisation which support the importance to have a PMS.

3.2 Data collection and analysis

Data collection has been carried out using a heterogeneous plurality of instruments, specifically focus groups, semi-structured interviews and formal documentation. Such pluralism is coherent both with the theoretical framework and with the differentiated nature of the information required by the action research method (Susman and Evered, 1978).

Initially, two focus groups were held to define and share a common understanding of the PMS and to identify the main needs and requirements; the first involved the scientific and administrative directors of the research center, whereas the other involved six research project coordinators. This close contact with administrative and research staff allowed understanding of the main requirements of the PMS.

Focus groups were animated by the researchers who prepared a list of issues related to the importance of PMS adoption from higher education institutes which are projected towards the third mission and interested in wide spreading of the entrepreneurial spirit. The issues were categorised in two groups:

1. one for the focus group with the scientific and administrative directors; and
2. one for the focus group with the project coordinators.

This choice was made to ensure that relevant aspects and expectations from both groups were considered. Discussion about the two groups of issues allowed each participant researcher to take notes and produce a report which was then analysed textually to highlight the main concepts related to the PMS role, design and KPIs.

After this, interviews have been undertaken involving 23 people involved on entrepreneurial development processes and programmes, selected according to the level of involvement within university–industry research collaborations and by also ensuring diversity in their backgrounds (specifically, seven members of the academic faculty, eight staff members in the area of contracting and technology transfer and eight managers from companies involved in R&D collaborations with the university). The choice to involve different groups of people was made to ensure that multiple goals and perspectives of PMS were considered. The interviews were conducted through a questionnaire containing mainly open questions addressed to understand the university organisation and its entrepreneurial characteristics, the strategic vision and mission, the dynamics of the academic entrepreneurship process and the indicators related to the main characteristics of the entrepreneurial university (Clark, 2004; EC–OECD, 2012). Moreover, through the interviews, the selected people were involved to provide detailed information about the processes and the dimensions characterizing the PMS, including the set of KPIs considered. Responses from the interviewees were recorded and then grouped together according to similarity. A number of interviewees declared the need for basic performance indicators to measure the success of entrepreneurship development, considering both tangible and intangible aspects (Johanson *et al.*, 2001).

Finally, the third data source was the annual reports and the strategic plans of the EMI, related to the years 2005, 2008 and 2011. Reading and analysis of this type of documentation were carried out to obtain two main results:

1. from one side, to understand what EMI did in the past to measure its performance; and
2. from the other side, to extract the value of the final set of KPI considered for the proposed PMS.

4. Findings: a model of PMS to assess the academic entrepreneurship

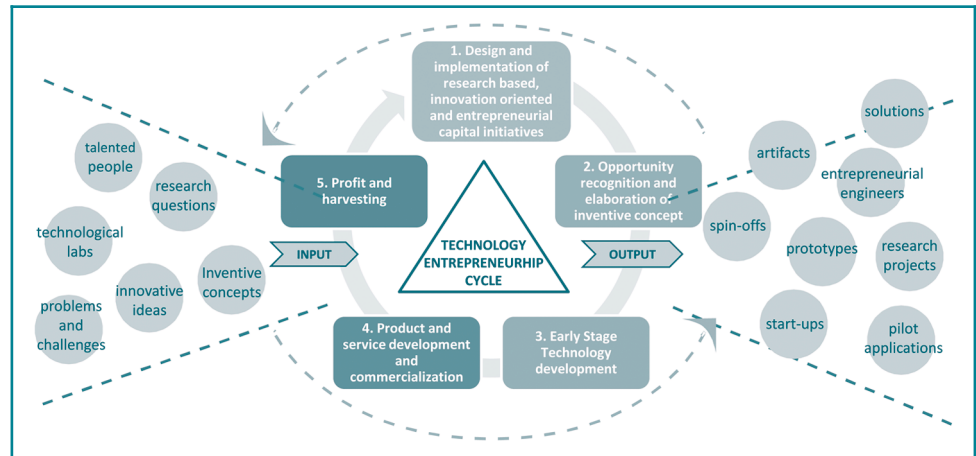
Through the integration of the findings from the literature studies on measuring performance with the research results extracted from the data collection and analysis phases, a process-based model has been developed to measure the performance of academic entrepreneurship in those universities and higher education systems which are moving towards the third mission.

The model, inspired to the knowledge triangle vision (education + research + innovation) represents a performance measurement tool based on an input–output logic and which considers tangible and intangible aspects. The “input” component includes talented people, research projects, R&D laboratories, innovative ideas and inventive concepts, problems and challenges. The “output” component is represented by the results generated to sustain the social and economic development, such as spin-offs and start-ups, prototypes and systems, new research projects, pilot applications and new professional profiles with entrepreneurial capacity. The input is transformed into output by leveraging on the five stages supporting the “invention–innovation–commercialisation” process. Figure 1 provides the conceptual model representing the academic entrepreneurship process on the basis of the proposed PMS.

By balancing the static view (resources) and the dynamic view (processes and activities), the model can nurture and make sustainable and repeatable the technology entrepreneurship process within a university. For each of the five stages, a set of KPIs has been associated, thus allowing to derive a performance measurement tool for monitoring the entire technology entrepreneurship process (OECD, 2009). The KPIs adopted in this tool fulfil the criteria specified into the Paxis Project (EU, 2005):

- *specific focus on relevant aspects of the academic entrepreneurship process, informing about the obtained results and added value, as well as about the inputs,*

Figure 1 A process-based model for academic entrepreneurship performance



organisational features, resources and working processes that have been used to obtain the results;

- *usefulness for different purposes and audiences*, allowing trend analysis and comparison, as well as including indicators for external stakeholders to allow the dialogue with them;
- *adequate levels of breakdown*, permitting further investigation to discover cause–effect correlations, thus providing a more effective support in decision-making processes; and
- *highlighting the contribution of universities to the economic development* (Rasmussen and Borch, 2010), by fulfilling the triple mission of teaching, research and innovation.

The tool includes “smart” indicators, i.e. *specific, measurable, achievable, realistic and timed* (Philbin, 2008), which complement the measures used to evaluate the intellectual capital of universities and research centres (Secundo *et al.*, 2010), thus allowing to assess the academic entrepreneurship performance (OECD, 2009; Nadim and Hoffman, 2008).

Table II illustrates the set of indicators proposed. The KPIs of Stages 1 and 2 represent the input of the technology entrepreneurship development model; the KPIs of Stage 3 give information about the situation of the early-stage technology development initiatives. The KPIs of Stage 4 measure the results in terms of technology entrepreneurship process. Finally, the KPIs of Stage 5 provide valuable insights to evaluate the overall socio-economic impact of the entrepreneurial performance of the university according to the third mission aim.

With reference to the KPIs of each stage listed in Table II, some considerations can be done:

- Stage 1 – entrepreneurial capital development initiatives: this area includes KPIs related to those initiatives realised in education and research contexts where technology entrepreneurship is incubated.
- Stage 2 – opportunity recognition and elaboration of inventive concepts: this area refers to the KPIs for evaluating and assessing the technological feasibility and the market acceptability of the business ideas, thus identifying and monitoring those initiatives that can become the early main inputs of the entrepreneurial process.
- Stage 3 – early-stage technology development: this area presents the KPIs to evaluate the state of the potential valuable items, including the development of business plans, the implementation of prototypes and applications and the foundation of spin-offs and start-ups.
- Stage 4 – product and service development and commercialisation: this area contains the KPIs to evaluate the launch on the market of new technology-intensive products and services.

Table II The KPIs of the academic entrepreneurship performance measurement model

Stage 1. Entrepreneurial capital development initiatives

Average years of experience of research personnel
Number of international publications
Number of PhD students
Number of master's students
Number of students involved in training programmes for industrial research
Number of entrepreneurial education programmes launched
Number of local companies involved in research and education activities
Number of international companies involved in research and education activities
Number of research institutions involved in research and education activities
Number of governmental institutions involved in research and education activities
Number of R&D projects submitted for financing
Per cent of success in project financing
Average budget for R&D project
Number of researchers involved in the research activities
Per cent of international researchers on total research personnel

Stage 2. Opportunity recognition and elaboration of inventive concepts

Number of business concepts generated
Number of project proposals accepted by stakeholders to be jointly investigated and developed
Number of agreements signed with national stakeholders
Number of agreements signed with international stakeholders
Number of invitation to participate in research projects or public initiatives
Number of technological solutions or methodologies adopted by the involved stakeholders

Stage 3. Early-stage technology development

Number of business plan prepared
Number of requests for patents submitted
Number of patents incorporated into the new products/solutions developed
Number of prototypes developed
Number of real demonstrations performed (proofs of concept, installations)
Number and typology of stakeholders involved into the development of new prototypes
Number of meetings held with financial providers (public and private)
Number of financial operators who are investing in the new venture
Share held by financial investors
Number of spin-offs and start-ups launched
Number of people hired by the new generated venture
Number of people hired by the involved stakeholders

Stage 4. Product and service development and commercialization

Number of products and services developed
Number of collaborations and partnerships signed for developing new products/services
Number of collaborations and partnerships signed for commercialising new products/services
Number of patent extensions submitted
Number of new products or services launched as a commercial offerings
Number of customers adopting the new products or services
Level of customer satisfaction related to the new products or services launched
Number and typology of users participating in innovating the new products or services
Duration of the customers have been involved

Stage 5. Profit and harvesting

Market share and turnover of the new generated companies
Per cent of revenues generated by new developed products/services on total revenues
Number and geography of targeted markets
Total number of new jobs have been created
Per cent of export increment
Per cent of increment of local gross domestic product
Number of financial rounds performed
Level of financial rounds performed (founders, family, friends (FFF), business angels (BA), venture capitalists (VC), private equity (PE), initial public offering (IPO))

- Stage 5 – profit and harvesting: this area presents KPIs to evaluate the business and social value created by the entrepreneurial opportunities, respectively, measured by indicators related to the market share and turnover of the new generated companies and by new jobs created.

5. An application of the proposed PMS

To assess the validity of the proposed PMS, a first application to the EMI case is presented here, taking in consideration the indicators of the first three stages illustrated in Table II (indicators included in Stages 4 and 5 have been excluded from the application because they cannot be valorised within the case analysed). Considering that in 2005, the EMI completed its start-up phase, two years have been considered as “milestones” to measure the results: 2008 (as the intermediate year after the completion of the start-up phase of EMI) and 2011 (most recent data available); the variation 2011/2008 has been also calculated. The discussion of indicators listed in Tables III, IV and V highlights the most significant insights.

Concerning the metrics related to Stage 1, the increase of 50 per cent of students involved in training programmes for industrial research represents an important achievement in the perspective of creating human capital potentially capable to activate entrepreneurial processes. This important result is further supported by the increase of a number of national and international companies involved in the research and education activities (respectively +57 per cent and +100 per cent), and of governmental institutions (+250 per cent). As a consequence, the number of international scientific publication also increased (+253 per cent), even if the number of researchers involved into the research activities decreased (–30 per cent). This last data must be interpreted positively because some of the researchers were hired by the newly created spin-offs or by the companies involved in the research projects. Definitely, results in Table III highlight the multi-perspective nature of the entrepreneurial capital development initiatives, by considering the aspects related to the human capital, the educational activities, the research initiatives, the institutional involvement and the international dimension.

Concerning the metrics related to Stage 2, the increase of business concepts generated (from 1 to 4) can be considered as a valuable result. The other indicators support positively this assessment dimension: the growth of project proposals accepted by stakeholders to be jointly investigated and developed (+125 per cent), the increase of numbers of agreements signed with national and international stakeholders (+83 and +100 per cent, respectively), the rise of the invitations to participate in research projects or public initiatives (+60 per cent) and the increased number of technological solutions adopted by stakeholders (+167 per cent) contributes to develop and consolidate the network of

Table III KPIs related to stage 1

<i>Stage 1. Entrepreneurial capital development initiatives</i>	<i>2008</i>	<i>2011</i>	<i>Variation 2008/2011 (%)</i>
Average years of experience of research personnel	3	5	67
Number of international publications (journals and books)	19	67	253
Number of PhD students	16	5	–69
Number of master's students	23	0	–100
Number of students involved in training programmes for industrial research	20	30	50
Number of entrepreneurial education programmes launched	0	1	–
Number of national companies involved in research and education activities	7	11	57
Number of international companies involved in the research and education activities	2	4	100
Number of research institutions involved in the research and education activities	9	15	67
Number of governmental institutions involved in the research and education activities	2	7	250
Number of R&D projects submitted for financing	7	11	57
Per cent of success in project financing	96	80	–17
Total budget for R&D projects (M€)	5	2,3	–54
Number of researchers involved in the research activities	50	35	–30
Per cent of international researchers on total research personnel	35	10	–71

Table IV KPIs related to stage 2

<i>Stage 2. Opportunity recognition and elaboration of inventive concepts</i>	<i>2008</i>	<i>2011</i>	<i>Variation 2008/2011 (%)</i>
Number of business concepts generated	1	4	300
Number of project proposals accepted by stakeholders to be jointly investigated and developed	4	9	125
Number of agreements signed with national stakeholders	6	11	83
Number of agreements signed with international stakeholders	4	8	100
Number of invitation to participate in research projects or public initiatives	5	8	60
Number of technological solutions or methodologies adopted by the involved stakeholders	3	8	167

Table V KPIs related to stage 3

<i>Stage 3. Early-stage technology development</i>	<i>2008</i>	<i>2011</i>	<i>Variation 2008/2011 (%)</i>
Number of business plan prepared	1	4	300
Number of requests for patents submitted	0	0	–
Number of patents incorporated into the new products/solutions developed	0	0	–
Number of prototypes developed	9	15	67
Number of real demonstrations performed (proofs of concept, installations)	3	7	133
Number of stakeholders involved into the development of new prototypes	5	11	120
Number of meetings held with financial investors (public and private)	1	5	400
Number of financial operators who are investing in the new venture	0	0	–
Share held by financial investors	0	0	–
Number of spin-offs and start-ups launched	0	2	–
Number of people hired by the new generated venture	0	7	–
Number of people hired by the involved stakeholders	5	12	140

relationships with public and private stakeholders to identifying unexplored ideas and opportunities connected to market needs. This is aligned with the triple helix perspective to generate innovation and growth. Definitely, results in [Table IV](#) give a measure of the entrepreneurial potential of the outcomes generated by the education and research initiatives. Indeed, they refer to business concepts, project proposals, agreements or outputs in terms of technological solutions and methodologies that have already met the stakeholders' interest.

Concerning the metrics related to Stage 3, even if data are not completely available, the observable indicators provide promising results. First, there has been a consistent increase of business plans prepared (+300 per cent), of prototypes developed (+67 per cent), of real demonstrations performed (+133 per cent) and of meetings held with financial investors (+400 per cent). Consequently, the number of spin-offs and start-ups launched increased as well (from 0 to 2), along with an increase of people hired by the new generated ventures (from 0 to 7) and an increase of people hired by the companies or institutions involved into the research and education activities (+140 per cent). Definitely, results in [Table V](#) provide an indication about the degree of the entrepreneurial value embedded in the projects' outcomes, and ready to be exploited. Indeed, they provide information about the business plans that are ready to be implemented, the patents to be submitted for registration, the proofs of concept ready to be implemented, the presence of financial investors interested in financing start-ups and spin-offs and the people hired by new ventures or existing partners.

6. Discussion and conclusions

This paper aims at proposing a PMSs for a higher education and research centre engaged in developing academic entrepreneurship, and, thus, contributing to the achievement of the third mission of the university. Assessing academic entrepreneurship is strategically relevant, especially for universities moving towards the "entrepreneurial model", thus contributing to the economic and regional growth.

The PMS has been developed through an action research approach carried out within an Italian higher education and research centre operating since 2000 at the University of Salento (Italy). Based on literature and data collection, the PMS model with the key performance indicators was proposed for measuring academic entrepreneurship.

The model has been developed according to a process-oriented perspective, instead of a traditional knowledge domain perspective, thus encompassing all the steps of technology entrepreneurship development within a higher education and research centre. For each step, a set of KPIs has been identified to satisfy the information needs of different stakeholders (university board, students, public decision makers, investors, etc.). The novelty of the model is based on the integration of the intellectual capital perspective and technology entrepreneurship within universities and research centres, thus contributing to the extant literature on performance measurement which presents models, frameworks and methodologies for measuring entrepreneurship performances mostly focussed at the firm level.

The paper identifies implications for research and practice. At the research level, findings can be used to support the definition of a holistic PMS for universities integrating higher education, research and innovation through an entrepreneurial lens, thus contributing to support regional development and economic growth (Etzkowitz, 2004). This is in line with the third generation of PMS that allows a critical and reflexive assessment aimed at improving the overall organisational effectiveness (Fried and Orellana, 2006). In this endeavour, the model contributes to expand findings of the PMS literature in the public sector using an intellectual capital perspective for defining the strategic indicators of higher education and research centres engaged in the “third mission”.

From a practitioner point of view, the preliminary application of the model to an Italian case supports the research results presented in this paper, and provides universities and its stakeholders with the opportunities to measure the academic entrepreneurship level of higher education institutions and research centres. In such a way, universities can obtain precious information about which direction can be undertaken to redesign policies and strategies, to stimulate entrepreneurial behaviour and to foster new venture formation. Universities can also make a benchmarking by comparing themselves with other institutions, deriving precious insights to be more attractive. At the same time, stakeholders can receive objective data to evaluate if it is strategic and convenient for them to continue to invest resources in the collaborations with the analysed institute. Moreover, the five sections containing the overall set of KPIs can represent five strategic areas of skills characterizing new professional profiles capable to support the entrepreneurial university transformation process. Finally, the PMS can be used not only to measure the performances of academic entrepreneurship but also to assess the impact of actions (in terms of efficiency and effectiveness) on the stakeholders of the organisation whose performance is being measured (Bourne *et al.*, 2003). Definitely, the adoption of a PMS stimulates people to make positive improvements, activate learning and implement change (Goh, 2012). In particular, for policymakers, the model allows to improve the decision-making processes of public administrators and to set up new strategic directions to enhance resources allocation and international ranking of academia.

Finally, for the society, the model allows to evaluate the university’s pivotal role in the social and economic development of the region where it is located, especially in terms of new employments and new technology-intensive firms. The realisation of the right balance requires a responsible and competent leadership, mobilisation of all members of the university towards the common goal and collaboration with the relevant stakeholders.

Because the research was conducted in a specific organisation, the possibility of generalising the results to similar institutions is a key issue. Hence, it is important to

distinguish between what is general in scope and what is case specific (Agostino *et al.*, 2012). While the PMS model proposed aims to be general in scope, the set of indicators is case specific and reflects the characteristics of the research centre analysed, even though it could provide a source of inspiration for similar organisations.

Further research includes the analysis of the indicators of Stages 4 and 5 within the case analysed, and the application of the same PMS in other research context to evaluate the generalisation of the model.

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