Ambidextrous Intellectual Capital in the scientific research: An empirical analysis on university spin-offs

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Abstract
This work aims at analyzing the level of awareness on the topic of planning and control by people with an apical role in research spin-offs, suggesting a framework to increase the survivability of spin-offs.
The universities take a strategic role as "knowledge incubators" to ensure competitive advantage through the use of their knowledge stock. In this scenario, research spin-offs contribute to the valorisation of intellectual capital in universities. However, Consorzio Netval's data highlighted that the percentage of spin-offs liquidated from 2000 to 2019 is approximately 72%.
The analysis of the literature shows many issues that spin-offs face; however, there is little research on another possible critical issue that this study aims to fill: the difficulties during the phases of research spin-offs' planning and control, especially in adequately balancing their short and long-term goals.
Thus, we submitted a questionnaire to a panel of experts to investigate their view of the management, planning and control systems. Results show a lack of attention to the application of these systems in spin-offs, while acknowledging awareness of their importance.
On the basis of these findings, we propose a framework to increase the survivability of research spin-offs, overcoming their main issues. Our framework relies on the application of ambidextrous intellectual capital to spin-offs, considered a valuable solution, given that it combines the attention to the future, typical of spin-offs and start-ups, with the attention to the present, necessary to go beyond the pre-seed phase.

Keywords: spin-off, intellectual capital, ambidexterity, innovation, planning and control; university

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1. Introduction

The universities take a strategic role as "knowledge incubators" to ensure competitive advantage through the use of their knowledge stock (Stewart and Ruckdeschel, 1998) and research spin-offs contribute to the valorisation of the intellectual capital (IC) in universities.

IC is defined by Stewart (1997) as *"intellectual material, knowledge, experience, intellectual property, information…that can be put to use to create wealth"*. It is composed of human capital, relational capital and structural capital (Stewart, 1997). Human capital incorporates individual potential and capabilities to provide problem-solving and produces knowledge that generates innovation, relational capital is the set of relationships established between the company and its stakeholders, while structural capital represents all the codified and non-codified knowledge owned by the company (Trequattrini, 2008).

IC can be considered a strategic asset in light of its contribution to i) innovation as the main source of competitive advantage; ii) the knowledge and knowledge-based economy; iii) the network society; and iv) the information technology and information society (Petty and Guthrie, 2000; Lombardi and Schimperna; 2021). Additionally, in the current context of growing uncertainty and complexity, the ambidextrous IC, an evolution of IC, is becoming increasingly relevant to every type of organization (Mubarik *et al*., 2019). It allows the combination of the characteristics of companies focused on leveraging existing capabilities to generate profits and those focused on exploring new growth opportunities (O'Reilly and Tushman, 2004). Thus, it combines exploration and exploitation (Duncan, 1976). This generally allows to perform better and be more vigorous than non-ambidextrous organizations (Tushman and O'Reilly, 1996; Benner and Tushman, 2003). Particularly, ambidexterity enhances organisations' sustainable competitive advantage (Turner *et al*., 2015) and improves organisational performance (Junni *et al.*, 2013; Turner *et al*., 2015) through increased efficiency in the execution of normal activities (exploitation), and the simultaneous ability to adapt to change by exploring new opportunities (exploration) (Presenza and Petruzzelli, 2019).

In this perspective, entrepreneurial universities are intermediaries that manage and enhance local IC, enable the growth of learning regions (Trequattrini *et al.,* 2018 b) and, through the creation of spin-offs, achieve economic and social benefits (Etzkowitz, 2003; Guerrero and Urbano, 2012; Shah and Pahnke, 2014; Mok, 2015).

However, analyzing Consorzio Netval's data, it is observable that the percentage of spin-offs liquidated from 2000 to 2019 is very significant: approximately 72% (excluding spin-offs with not available information). Particularly, spin-offs are more future-oriented than present-oriented, leading to an extremely low survival with high failure and closure rates, mainly in the first years. According to Wennberg et al. (2011), research spin-offs have lower survival and slower sales growth even than corporate spin-offs. However, some planning and control tools could allow these two aspects – future and present orientation – to coexist.

Planning and control are essential to define and implement the strategy of companies and verify compliance with objectives and the criteria of efficacy and efficiency (Marasca *et al.,* 2013; Lombardi *et al.,* 2021a). Research spin-offs are knowledge-intensive organizations (KIOs) (Habersam and Piber, 2003; Elia *et al.,* 2017) and their success is highly dependent on the continuous and effective management of their IC (Hormiga *et al.,* 2011). In this scenario, planning and control should be based on knowledge planning and implementation (Muchmore *et al.,* 2018). These tools should support both knowledge creation and sharing, with elements of adaptive and generative systems (Herremans and Isaac, 2005).

For these reasons, this work aims to analyze the level of awareness on the topic of planning and control by people with an apical role in research spin-offs, suggesting some solutions to overcome the main issues that these organizations are facing, especially in the pre-seed phase.

In light of these considerations, we carried out a qualitative analysis (Hair Jr. *et al*., 2003) according to an ambidextrous perspective and based on a quadruple approach. In the first step of the analysis, we used Scopus to find relevant documents related to planning and management control of spin-offs and we classified them according to their contribution to the three components of IC. In the second step, we developed a set of four descriptors per component, while, in the third step, we created a questionnaire with a Likert scale submitted to a panel of experts with senior roles in research spin-offs to understand their level of awareness, in terms of knowledge of the relevance of these tools, and application on the topic of planning and control.

Lastly, in the fourth step, we analyzed the findings of the questionnaire, and we carried out a framework composed of relevant indicators to be considered to overcome the main issues spin-offs are facing.

The remainder of the article is structured as follows: Section 2 provides the literature review, Section 3 describes the research method, Section 4 highlights the main findings and the related discussion, and Section 5 carries out conclusions.

2. Literature review

2.1 Research spin-offs and ambidextrous IC

The universities can be considered "knowledge incubators", essential to ensure competitive advantage using their knowledge stock (Stewart and Ruckdeschel, 1998; Elia *et al*., 2017; Trequattrini *et al*., 2018a). In this perspective, universities play also a fundamental institutional role in national innovation systems (Sanchez and Elena, 2006; Todericiu and Serban, 2015), allowing the achievement of the following goals: knowledge production through scientific research, diffusion of knowledge asset through teaching activity (Leitner and Warden, 2004; Sanchez *et al.,* 2009; Veltri *et al*., 2014; Secundo *et al.,* 2016; Schimperna *et al.*, 2021a), research results' enhancement, and achievement of economic and social benefits thanks to the creation of spin-offs (Etzkowitz, 2003; Guerrero and Urbano, 2012; Shah and Pahnke, 2014; Mok, 2015).

Additionally, according to Trequattrini *et al.* (2018 b), entrepreneurial universities can be considered intermediaries that manage and enhance local IC and allow the learning region growth. Indeed, links between professors and company representatives have already emerged in the last century, generally in the form of contracts, conventions, donations, consultancies, and other types of commercialization of scientists' intellectual products. Today, the current phase of academic entrepreneurship development is characterized by the institutionalization of innovative tools, that allow universities and firms to have a strong leadership role in their respective contexts (Trequattrini *et al*., 2008), and by the development of new technologies (Schimperna *et al.*, 2021b; Lombardi *et al.*, 2021a; Russo *et al.*, 2022; Nappo *et al.*, 2023).

In this scenario, research spin-offs are assuming an increasingly important role (Lazzeri and Piccaluga, 2012). Research spin-offs are knowledge-intensive organisations (Habersam and Piber, 2003; Elia et al., 2017), involved in the knowledge creation and knowledge transfer of universities (Rothaermel et al., 2007). In this perspective, their success in the market is highly dependent on the continuous and effective management of their IC (Hormiga et al. 2011).

IC is defined as *"intellectual material, knowledge, experience, intellectual property, information…that can be put to use to create wealth"* (Stewart, 1997), and can lead to competitive advantage (Stewart and Ruckdeschel, 1998; Kamukana, 2013; Yaasen *et al*., 2016). It is composed of human capital, relational capital and structural capital (Becker, 1964; Lev and Schwartz, 1971; Nonaka, 1994; Stewart, 1997; Lombardi *et al.*, 2021b). Human capital

incorporates individual potential and capabilities to provide problem-solving and produces knowledge that generates innovation (Pennings *et al.,* 1998). In universities, it refers to the intangible value of individual competencies, as the expertise, knowledge and experiences of researchers, professors, technical and administrative staff, and students' competencies (Leitner *et al.,* 2014; Secundo *et al.,* 2016; Pradana *et al*., 2020).

Relational capital is the set of relationships established between the company and its stakeholders (Prahalad and Ramaswamy, 2000; Dorrego *et al.*, 2013; Hayaeian *et al*., 2021; Weqar *et al*., 2021); particularly, in universities, it can be considered as the whole of intangible resources capable of generating value linked to the university's internal and external relations. It includes relations with public and private partners, position and image in (social) networks, the brand, involvement of industry in training activities, collaborations with international research centres, networking with professors, international exchange of students, international recognition of the universities, and attractiveness (Leitner *et al.,* 2014; Secundo *et al.,* 2016).

Structural capital represents all the codified and non-codified knowledge owned by the company (Bontis, 1998; Trequattrini, 2008). Its main components in universities are the databases, the research projects, the research infrastructure, the research and education processes and routines, the university culture, image and reputation (Leitner *et al.,* 2014; Secundo *et al.,* 2016).

Today, the ambidextrous IC, an evolution of IC, is becoming increasingly relevant in companies. It links exploration and exploitation (Duncan, 1976) and generally allows to perform better and be more vigorous in business than non-ambidextrous organizations (Tushman and O'Reilly, 1996; Benner and Tushman, 2003). There is agreement that an organization faces a balance between properly exploiting existing skills and exploring new opportunities by aligning its functions (Junni *et al.,* 2013; Baškarada *et al.,* 2016; Alänge and Steiber, 2018; Mubarik *et al.,* 2019).

IC enhances business value through knowledge resources (Rehman et al., 2021; Ahamad *et al*., 2022; Karasneh, 2022) and allows to promote business competitiveness by creating ambidextrous innovation (Mahmood and Mubarik, 2020; Mubarik *et al*., 2019). Ambidextrous innovation is the simultaneous implementation by a company of both exploratory and exploitative innovation (Lin and Chang, 2015). The first one is the disruption of existing knowledge and technologies, the discovery of new designs, methods and processes, the creation of new products or services, and the development of new markets. The second improves and updates designs, methods and processes based on existing knowledge and technologies to further reduce costs and improve product or service quality (Lin and Chen, 2015). In this perspective,

knowledge sharing influences ambidextrous innovation (Zhang *et al*., 2022).

Thus, IC is the basis of ambidexterity (Simsek, 2009; Dezi *et al*., 2019). Through specific combinations of IC components, it is possible to support the acquisition, transfer and integration of the knowledge required for ambidexterity (Kang and Snell, 2009). In particular, by improving IC (e.g. business processes, human capital and relationships), ambidexterity can be achieved (Bontis, 1998; Mubarik *et al*., 2019). It is through human capital, structural capital and relational capital that an organization achieves a balance between exploitation and exploration of opportunities (Subramaniam and Youndt, 2005; Kang and Snell, 2009; Swart and Kinnie, 2010).

In this scenario, the ambidextrous IC allows to enhance organisations' sustainable competitive advantage (Turner *et al*., 2015) and improve organisational performance (Junni *et al*., 2013; Turner *et al*., 2015) through an increased efficiency in the execution of normal activities (exploitation), and the concurrent ability of exploring new opportunities (exploration) to adapt to change (Presenza and Petruzzelli, 2019). This leads ambidextrous organizations to have the ability both to compete in the current marketplace through efficiency, cost, and dynamic innovation and to develop new products and services for new and emerging markets through speed, flexibility, and experimentation (Tushman and O'Reilly, 1996).

Usually, these two profiles have different characteristics (Liang *et al*., 2024). Specifically, in an exploitative business, profit is the strategic aim, the critical tasks are operations, efficiency, and incremental innovation, the skills required are mostly operational, the structure is formal and mechanistic, and the controls and rewards concern margins and productiveness. Moreover, in such an environment there is authoritative and top-down leadership, and it is imbued with a culture of efficiency, low risk, quality, and customer-oriented (O'Reilly and Tushman, 2004; Kearns, 2007). Conversely, in an exploratory business, the strategic intent is represented by innovation and growth, adaptability, new product research, and breakthrough innovation are the main critical tasks, there is the need for entrepreneurial skills, the structure is adaptive, and the controls and rewards are related to milestones and growth (Raisch and Tushman, 2016; Jia, 2018). In addition, the leadership is visionary and involved, and the culture is geared toward flexibility, experimentation, speed, and risk-taking (O'Reilly and Tushman, 2004).

Thus, by achieving organizational ambidexterity through the tool of ambidextrous IC, it is possible to manage the two opposing perspectives together, overcoming the limitations of either view (Pasamar *et al*., 2015; Chen, 2017; Armenia *et al*., 2024). In the literature, limitations of an unambidextrous enterprise, based only on exploration or only on exploitation,

emerge (Joensuu-Salo and Viljamaa, 2024). In particular, exploration alone can lead to failure, neglect of improvement and adaptation of existing routines, and failure to benefit from economies of scale (March, 1991; Levinthal and March, 1993; Güttel and Konlechner, 2009).

Instead, exploitation alone can lead to obsolescence and a stable but suboptimal equilibrium (March, 1991; Levinthal and March, 1993). From this perspective, it becomes critical for companies to have capabilities, strategies, and structures that allow for ambidextrous short- and long-term balance as a competitive capability (Birkinshaw and Gupta, 2013). Thus, ambidextrous IC is a critical factor for short- and long-term success, bringing superior performance (O'Reilly III and Tushman, 2013; Zhang *et al*., 2021) and sustainable competitive advantage (Huang *et al*., 2021; Park *et al*., 2019).

2.2. The main features of research spin-offs

Research spin-offs originate by budding from a university or Public Research Organisation (PRO), in which a group of researchers forms an entrepreneurial core to exploit skills and research results gained within the home institution (Conti *et al.,* 2011). In research spin-offs, knowledge is the main resource, together with financial funding and instrumental assets (Di Berardino, 2013). According to Conti *et al*., 2011, there is not a unique definition of research spin-off. However, it is possible to identify the following characterizing elements:

- founding membership: it must always include at least one person with relevant experience in public research;
- intellectual property (IP) rights: partners can start the business activity to enhance their knowledge, regardless of the presence of IP rights or a patent (or several patents) on which the business idea is based;
- business sector: spin-off companies are often started in fields where barriers to entry are quite low;
- motivations of the founding partners: among them, there are the involvement of the young people they work with, the enhancement of their skills by performing, providing job opportunities for PhDs, establishing a "virtuous circle" that attracts promising young researchers to their laboratories (Helm and Mauroner, 2007; Lam, 2011). These motivations generally lead to little appetite for growth and risk. The opposite situation occurs when "unstructured" young people, perhaps together with some professors, actually aspire to set up an enterprise to make it their main professional activity;

- industrial partner: the participation in the share capital of other organizations greatly affects the business model of the spin-off;
- the nature of the technology that influences the definition of the spin-off business model: from this perspective, each spin-off has a certain degree of innovation linked to the technologies employed. Therefore, it is necessary to assess the temporal distance between the moment of invention and the moment when the market will be able to absorb the proposed innovation to a significant extent;
- the presence of a financial partner: it is relevant, given that a key element for the success of all start-ups is access to finance (Giakoumelou *et al.,* 2023). In addition, lenders and investors assess also management control systems (Davila *et al*., 2015).

Research spin-offs contribute to the valorisation of the IC in universities. In universities, intangible assets and IC represent the largest percentage of assets (Sánchez *et al*., 2009; Secundo *et al*., 2010; Ramírez Corcóles *et al*., 2011) and, through research spin-offs, these assets are valorized. In this scenario, technology transfer and investment in innovation take place and research spin-offs become the operational arm of the university in the local economy, providing economic benefits and creating IC.

The main outputs of IC creation are: i) the development of hi-tech skills for employees (perspective of human capital); ii) the creation and improvement of networks (perspective of relational capital); and, iii) the development of patents and research projects (perspective of structural capital). In turn, these benefits stimulate a scientific atmosphere that, in a virtuous circle, leads to new innovative ideas, research and businesses (Mariani *et al.,* 2018).

In this scenario, planning and control are pivotal in KIOs. Particularly, they are essential for defining and implementing the strategy and verifying compliance with objectives and criteria for effectiveness and efficiency (Marasca *et al*., 2013; Lombardi *et al*., 2021a). In the context of KIOs, planning and control should be based on knowledge planning and implementation (Muchmore *et al*., 2018). These tools, indeed, should support both the creation and sharing of knowledge, with elements of adaptive and generative systems (Herremans and Isaac, 2005). Particularly, an adaptive system is characterized by learning through a self-organizing process (Gell-Mann, 1994; Kauffman, 1993). Instead, a generative system is based on learning associated with radical innovations that would improve firm performance (Kang *et al*., 2007).

However, the analysis of the literature pointed out difficulties during the phases of research spin-offs' planning and control and in adequately balancing spin-offs' short and long-term goals; particularly, Iacobucci et *al.* (2010) show

that two managerial issues impact on transforming the initial idea into a sustainable business in the market: (i) the imbalance of the founding partner team toward purely technological skills instead of managerial and organizational skills; and (ii) the lack of clarity in the definition of entrepreneurial orientation.

This could contribute to Consorzio Netval's findings that highlighted a very significant percentage of spin-offs liquidated from 2000 to 2019, approximately 72%. The most common issues they face are also attributable to i) intrinsic difficulties in the development of new technologies and competencies (Oakey *et al.,* 1996); ii) organizational and managerial factors (Stoneman, 1995; Hall and Rosenberg, 2010); and iii) factors linked to the context in which they are located (Breznitz *et al*., 2008; Baldini, 2010; Rasmussen *et al.,* 2011); iv) access to finance (Giakoumelou *et al.,* 2023).

Additionally, the literature provides only few articles on the topics of planning and management control of spin-offs and the need for a well-defined framework to address the main issues spin-offs have to face emerged.

In light of the previous considerations, we selected the following two research questions:

RQ1: What is the level of awareness on the topic of planning tools and practices and control by people with an apical role in research spin-offs?

RQ2: What are the main indicators spin-offs should consider to adequately address the stages of planning and management control, in the perspective of the ambidextrous IC?

3. Research method

Our research relies on a qualitative method (Bell *et al*., 2022), considered the best solution to answer our research questions. Particularly, *"A qualitative research approach is the most appropriate and indeed the only way to achieve some research objectives. Situations in which qualitative research is likely to be the preferred method include 1) which little known about a research problem or opportunity, 2) where previous research only partially or incompletely explains the research question, 3) when current knowledge involves subconscious, psychological, or cultural material that is not accessible using survey and experiments, and 4) if the primary purpose of the research is to propose new ideas and hypotheses that can eventually be tested with quantitative research"* (Hair Jr. *et al*., 2003, p. 276). In light of this, we applied a qualitative method based on a quadruple approach, developed in the following stages: i) identification; ii) selection; iii) exploratory analysis; and iv) development of the framework. The framework by Mahmood *et al.*

(2021) provided the basis for the development of our methodology and the questionnaire. This framework was developed for start-ups; thus, we modified and removed some points to adapt it to the characteristics of research spin-offs and IC in spin-offs.

In the first step of the research ("identification"), we analyzed the literature to identify the dimensions and sub-dimensions of IC. Particularly, we used Scopus as the database to find relevant documents to understand the main themes related to planning and management control of spin-offs. We did a lot of research, always without any time limit, in order to have the widest possible view of this perspective. Specifically, by searching for "management control AND start-up*", limiting the search field to "Business, Management and Accounting" and selecting only English research articles, we found 199 documents. Applying the same filters, but searching for "planning AND start-up*", we found 510 documents. Narrowing the research field to spin-offs, we retrieved only 60 articles related to "planning and spin-off*" and 23 related to "management control and spin-off*". However, no one addresses the issues of closure of spin-offs and the absence of management control systems. Then, we reclassified these articles according to their contribution to the IC components as follows: 24 were associated with human capital, 31 with relational capital, and 28 with structural capital. This classification is the basis for the next step, as it provides us with the key elements of the three components of IC according to the literature.

Table 1 - Descriptors per component

IC component	Descriptor
Human capital	i) experiences and competencies of the decision-making body;
	ii) employees' skills and abilities;
	iii) gender diversity;
	iv) creativity.
Structural capital	i) intellectual property rights;
	ii) databases;
	iii) procedures;
	iv) research and development.
Relational capital	i) stakeholder relations;
	ii) strategic alliance with incubators or companies;
	iii) collaboration with universities;
	iv) management reputation.

Source: our elaboration

Starting from the analysis of the articles classified according to the IC components, we developed a set of four descriptors per component (second step – "selection"), as described in Table 1. These descriptors represent the main characteristics of each IC component, as emerged from the literature classification, and are the basis for understanding on which aspects an ambidextrous intellectual capital-based planning and control tool should be based.

In the third step of the research ("explorative analysis"), each descriptor was articulated through 2 or 4 questions to develop a questionnaire with a 5-point Likert scale (Likert, 1932) (See Appendix A for the questions – www.sidrea.it/ambidextrous-intellectual-capital). Additionally, the questionnaire was developed from the perspective of ambidextrous IC, taking it a step further than the literature. Particularly, this means that the assertions were constructed considering both exploitation and exploration. The questionnaire was submitted to a panel of experts with senior roles in research spin-offs to understand the level of awareness and application on the topic of planning and control, with both the perspectives of exploration and exploitation, by people with an apical role in research spin-offs.

After recognition of the university's spin-offs on the website and Netval and checking this with the designated office of the university, to make sure no spin-offs were excluded, the Aida database was used to find information on the people in senior positions of these spin-offs. Thus, we submitted our questionnaire to 52 people, representing 91% of people involved in research spin-offs of the University of Cassino and Southern Lazio. In this university there are 10 spin-offs operating in different sectors: electronic processing of accounting data (1 spin-off); computer programming activities (1 spin-off); research and experimental development on social science and humanities (2 spin-offs); integrated engineering planning services (1 spin-off); manufacture of batteries and accumulators (1 spin-off); manufacture of electrical and non-electrical domestic equipment (1 spin-off); manufacture of electricity distribution and control apparatus (1 spin-off); engineering office services (1 spin-off); other entrepreneurial consulting services and administration-management and company planning consultancy (1 spin-off). Additionally, 6 spin-offs are small-sized, 3 are medium-sized and 1 large-sized.

The people involved in these spin-offs have different backgrounds: there are graduates in economics, business, law, humanities, and engineering subjects. Focusing on the positions held, some are full professors, some associates, some researchers, some technical-administrative staff, and others are external experts from the university, while age ranges from approximately 30 years to approximately 65 years. In this way, the results were not affected

by variables related to background, role, and age. Their specific characteristics are described in the following Table 2.

Table 2 - Main characteristics of the panel of experts

Aspect	Characteristic	Number of people
Role in spin-off	Chairman of the board	5
	Vice Chairman of the Board	3
	Member of the Board	16
	Sole Administrator	4
	Shareholder	23
	CEO	1
Age	≤30	3
	31-45	19
	46-55	14
	56-70	15
	≥71	1
Gender	Man	35
	Women	17

Source: our elaboration based on the Aida database

Subsequently, the findings of the questionnaire were analysed and allowed us to answer our research questions, understanding: i) the level of awareness on the topic of planning and control by people that have an apical role in research spin-offs; and ii) the main indicators spin-offs should consider to adequately address the stages of planning and management control (see Section 4). Particularly, the answers were analyzed to understand whether planning and control indicators developed from an ambidextrous perspective can be effective tools, according to the experts. Their answers showed whether i) they find planning and control developed from an ambidextrous perspective useful; and ii) they agree with ambidextrous IC planning and control statements. The framework was developed considering the descriptors and indicators derived from questions that received 50% + 1 of the answers with 5/5 (“strongly agree”) and 4/5 (“agree”). This resulted in a framework based on ambidextrously IC descriptors and indicators that enable the planning and control phase shared by experts. Our framework broadens the framework by Mahmood *et al.* (2021) by identifying indicators that allow measurement of ambidextrous IC and improve planning and control in a KIO.

4. Findings and discussion

The results showed a broad participation in the questionnaire. Particularly, the response rate was 82.69%. After the analysis of the answers, we considered suitable for the framework only those questions that received a score of 5/5 and 4/5 in 50% + 1 of the cases. Conversely, the item was excluded, as it did not represent a significant aspect to be considered according to the expert panel. When analyzing the answers, a positive value was given to the item with a score of 5/5 or 4/5. In the case of scores of 3/5, 2/5, and 1/5, a negative value was given to the answer. More in detail, 24 answers (80%) had scores of 4/5 or 5/5 and 6 answers (20%) had scores of 3/5, 2/5 or 1/5.

The first step of the analysis of the questionnaire was based on the human capital, and we found that people with an apical role in research spin-offs consider experiences and competencies of the decision-making body essential for both exploitation (in the present, in which efficiency, costs and dynamic innovation are crucial) and exploration (in the future, in which speed, flexibility and experimentation are crucial).

The answers pointed out the relevance of employees' skills and abilities for both the exploitation of the current opportunities and the exploration of future ones. Focusing on the role of gender diversity, there is not a unique trend of answers: for someone, it is very relevant, for others, there is not a significant impact. Specifically, for 60% (percentage consisting of those who gave a score of 5/5 or 4/5) of respondents, having gender diversity (for both senior management and/or employees) plays an important role in exploring and exploiting at the same time. For the others, gender diversity is not an impactful issue for achieving organizational ambidexterity. Additionally, for 70% (percentage consisting of those who gave a score of 3/5, 2/5, and 1/5), gender diversity is not related to cost reduction.

Focusing on the questions related to the "creativity" descriptor, 72% stated that the creativity of top management is important for the commercialization of innovation, while 52% stated that the creativity of top management is not relevant.

Moving to the structural capital, 78% highlighted that intellectual property rights and research and development allow exploitation through cost reduction, and 81% stated that intellectual property rights and research and development allow exploration through the commercialization of innovative products and services. Instead, intellectual property rights and research and development appear not relevant for adopting innovative work processes (73%). Focusing on databases and procedures, we did not find a unique trend: database and procedures (68% and 65% respectively) do not allow a reduction of operative

costs, even if they could impact on the possibilities of exploitation and exploration, through a comprehensive view of the state-of-the-art of technologies on which the business idea is based, enhancing the firm performance.

With regard to relational capital, 70% highlighted that stakeholder relations and collaboration with universities have a relevant role in exploitation and exploration. Additionally, 80% stated that strategic alliances with incubators or companies mainly support innovative processes. Lastly, management reputation enhances the commercialization of products and services that are completely new to the organization (75% of respondents), exploiting existing opportunities (72% of respondents) and adopting innovative work processes (86% of respondents). Instead, it would appear irrelevant to reduce operating costs (59% of respondents).

Thus, these results are aligned with previous literature, showing a high awareness of the importance of ambidextrous managerial control systems in spin-offs. However, the literature highlights a lack of attention to their application (Feldman and Klofsten, 2000), leading to the high percentage of spin-offs liquidated as suggested by Consorzio Netval's data. To overcome these issues, in our view, the application of the framework of ambidextrous IC (Mahmood *et al.*, 2021) to spin-offs can be a valuable solution, given that it combines the attention to the future, typical of spin-offs and start-ups, with the attention to the present, necessary to go beyond the pre-seed phase. Indeed, this organizational ambidexterity is an organizational capability that allows an organization to explore new opportunities through innovation, while effectively exploiting the current opportunities (Stewart, 1998; Raisch and Birkinshaw, 2008; Jansen *et al.*, 2012; O'Reilly III and Tushman, 2015; Pasamar *et al.*, 2015; Jurksiene and Pundziene, 2016). Thus, moving from the IC to the ambidextrous IC, exploration and exploitation activities can be effectively balanced (Harris, 2000; Asiaei *et al.*, 2018; Mubarik *et al.*, 2019; Mahmood and Mubarik, 2020). In light of the literature review and the results of the questionnaire, we think that the following framework of planning and control in the research spin-offs based on ambidextrous IC can increase the survivability of spin-offs. Our framework, divided according to the IC component, is composed of descriptors (developed from the literature review) and proposed indicators (developed from the answers received to the questionnaire), that allow the effective implementation of ambidextrous IC in research spin-offs and planning their improvement.

Human capital descriptors and related indicators developed are the following (Tab. 3):

Table 3 - Human capital framework

IC component	Descriptors	Proposed indicators
Human capital	i) experiences and competencies of the decision-making body; ii) employees' skills and abilities; iii) gender diversity; iv) creativity.	i) average age of management;
		ii) the number of managerial experiences;
		iii) the number of training courses activated for employees;
		iv) diversity in corporate management;
		v) diversity among employees;
		vi) the number of innovative projects financed.

Source: our elaboration

Focusing on relational capital, we developed the following descriptors and indicators, as shown in Table 4:

Table 4 - Relational capital framework

IC component	Descriptors	Proposed indicators
Relational capital	i) stakeholder relations; ii) strategic alliance with incubators or companies; iii) collaboration with universities; iv) management reputation.	i) the number of contracts, facilitations and agreements concluded with public and private entities;
		ii) the number of projects carried out with the support of incubators or other entities (venture capital);
		iv) existence of contracts and agreements with universities or research centres;
		v) the number of publications or research activities carried out on the subject of the spin-off.

Source: our elaboration

Moving to structural capital descriptors and indicators, we defined the following (Tab. 5):

Table 5 - Structural capital framework

IC component	Descriptors	Proposed indicators
Structural capital	i) intellectual property rights; ii) databases; iii) procedures; iv) research and development.	i) revenues from the strategic use of intellectual property assets.
		ii) the number of databases purchased.
		iii) the number of certifications and/or organisational models.
		iv) amount of funding for research and development

Source: our elaboration

The success of KIOs, including research spin-offs, is highly dependent on the continuous and effective management of their IC (Hormiga et al. 2011). Thus, the suggested dashboard, derived from the set of these indicators, can help to understand which elements of IC to consider and develop to carry out better planning and control, both in the exploitation and exploration perspective, thereby also enriching the existing literature on the topic.

In existing spin-offs, this framework should be used initially to monitor the level of ambidextrous IC achieved. Then, it could be used to plan how to improve the level of ambidextrous IC by setting new objectives for the next period. In new spin-offs, it should be used from the outset to plan in order to have an optimal combination of ambidextrous IC and subsequently to monitor and set new objectives. In a KIO, indeed, only planning and controlling the combination of IC to achieve ambidexterity makes it possible to survive the first few years. Thus, by giving attention to the presence of ambidextrous IC in all business processes, it is possible to improve business performance and, consequently, decrease the failure and closure rate (Turner *et al*., 2015; Presenza and Pretuzelli, 2019).

This planning and control tool could allow higher efficiency and survival rate since it combines short- and long-term goals. These indicators have been developed considering the characteristics of spin-offs and IC in research spin-offs and are applicable to all research spin-offs without specific conditions. Additionally, with appropriate adjustments, it is possible to generalize them to KIOs.

5. Conclusions

Entrepreneurial universities as intermediaries that manage and enhance local IC allow the learning region growth (Trequattrini *et al.* 2018b). Links between professors and company representatives have already emerged in the last century, in many forms of commercialization of scientists' intellectual products, such as contracts, conventions, and donations. Today, the current phase of academic entrepreneurship development is characterized by the institutionalization of innovative tools that allow universities and firms to have a strong leadership role in their respective contexts (Trequattrini *et al.,* 2008). In this scenario, research spin-offs are KIOs that contribute to the valorisation of IC in universities. Analyzing data about research spin-offs available on Netval, it is possible to note the high closure rate, approximately 72%, from 2000 to 2019, and the literature review shows a literature gap about this topic. Thus, our research aimed to answer the following two research questions: i) *What is the level of awareness on the topic of planning tools and practices and control by people with an apical role in research spin-offs?* and ii) *What are the main indicators spin-offs should consider to adequately address the stages of planning and management control, in the perspective of the ambidextrous IC?*

Focusing on RQ1, results show a high level of awareness of the importance of ambidexterity planning and control in spin-offs but a low application of planning and control methodologies. Moving to RQ2, on the basis of the answers received, we suggest a framework of planning and control composed of descriptors and indicators of ambidextrous IC to manage short and medium-long-term goals simultaneously.

Thus, these findings and the suggested framework provide insight into how the application of ambidextrous IC in planning and control can increase the survivability of spin-offs, thanks to the attention to both the future, typical of spin-offs and start-ups, and the present, necessary to go beyond the pre-seed phase. Skills to succeed in the present are different from those in the medium-long-term and being oriented to both the present and the future allows one to be competitive in the current marketplace, where efficiency, cost, and dynamic innovation are key assets, and to develop new products and services for new and emerging markets, where speed, flexibility, and experimentation are key elements (Tushman and O'Reilly, 1996).

This study confirms the crucial role of planning and control knowledge implementation in KIOs (Muchmore *et al*., 2018). Furthermore, we corroborated previous research (Tushman and O'Reilly, 1996; Benner and Tushman, 2003; Mahmood *et al*., 2021) on how in contexts where it is crucial to balance short-term and long-term objectives, and where intangible capital is the key corporate

resource, being able to develop ambidextrous IC (and thus planning and control) could be useful to increase the survival rate of spin-offs and combine short-term and long-term objectives. Additionally, our framework broadens the one by Mahmood *et al.* (2021), because, on one side, it is adapted to particular start-ups with a high closure rate, i.e. research spin-offs, and, on the other, it also provides indicators on the basis of which to plan and control IC in KIOs.

This research has several theoretical and practical implications. Particularly, in the theoretical perspective, it contributes to the literature on planning and control (Marasca *et al*., 2013; Muchmore *et al.,* 2018; *Lombardi et al.,* 2021a), on issues affecting spin-offs (Stoneman, 1995; Oakey *et al.,* 1996; Breznitz *et al*., 2008; Hall and Rosenberg 2010; Baldini, 2010; Iacobucci *et al*., 2010; Rasmussen *et al.,* 2011) and on the ambidextrous organization (Park et al., 2019; Huang *et al*., 2021; Mahmood *et al*., 2021; Zhang *et al*., 2021). Additionally, these results can be useful for academic researchers and practitioners. Specifically, this research provides them with a tool that could be useful for improving the survival rate of their research spin-offs. Furthermore, it provides a planning and control tool that can also be applied in other contexts characterised by the need to balance exploitation and exploration.

However, this research has a main limit due to the restricted sample that answered the questionnaire, limiting the possibility of generalising the results and investigating in detail any geographical differences. Overcoming this limitation will be the starting point for future research.

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