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Navigating the valley of death: Open innovation strategies for start-up survival

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ABSTRACT

Objective: The objective of the article is to showcase the utilisation of open innovation in new technology-based firms (NTBFs) from the perspective of entrepreneurs who have successfully survived the crossing of the valley of death. We examined the interplay of open innovation (OI), and the entrepreneurial background (*i.e.* human capital, entrepreneurial education) to identify success factors in crossing the valley of death.

Research Design & Methods: The research was qualitative and based on interviews conducted with founders of ten start-ups based in Madrid, Spain. To process the information obtained in a more objective manner, we utilised three R codes for qualitative data analysis. Subsequently, we employed word clouds to condense the interviews and ascertain the most significant variables related to the success of the ventures and OI.

Findings: There were several recurring components among the entrepreneurs that have enabled them to successfully cross the valley of death. During the early stages, the entrepreneurship background becomes apparent, enabling them to implement their ideas based on the experience and knowledge acquired. In the subsequent stage, the emergence of family support for entrepreneurship facilitates access to initial financing beyond one's own savings invested. Therefore, it appears that human capital and access to informal sources of finance are more critical for entrepreneurial success than open innovation.

Implications & Recommendations: Despite the fact that open innovation facilitates the acquisition of new knowledge from a theoretical standpoint, our results suggest that prioritising entrepreneurs' human capital and ensuring access to financing are more crucial in overcoming the valley of death, by optimizing the efforts of various stakeholders.

Contribution & Value Added: The article offers a comprehensive understanding of the survival process of non-traditional business enterprises (NTBFs) and categorises three distinct variables that contribute to comprehending the significance of external and internal factors to which entrepreneurs are exposed.

Article type: research article

Keywords: open innovation; start-up; entrepreneur; social support; professional experience

JEL codes: O36, M13, L26

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INTRODUCTION

The establishment of novel enterprises significantly contributes to economic progress (Holcombe, 2007; Schumpeter, 1934). It is achieved primarily by utilising innovative concepts to develop commercially viable products (Beckman *et al.*, 2012) consequently reducing unemployment rates and fostering economic growth (Morales-Alonso *et al.*, 2016).

Beginning with the differentiation between two modalities of entrepreneurship: necessity entrepreneurship, which emerges in response to economic crises or unemployment; and opportunity entrepreneur-ship, which evolves by capitalizing on favourable conditions for new business creation

(Cantillon, 1755; Peterson & Valliere, 2008), we established a foundational framework to comprehend the motivations and context that propel entrepreneurial activity in diverse economic landscapes.

New technology-related firms that exhibit attributes such as scalability, replicability, and a highly profitable business model are commonly referred to as start-ups (Blank & Dorf, 2020). These ventures often offer products or services with high uncertainty (Ries, 2017), leading to a high attrition rate within the first year of operation for most of them (Dahl & Reichstein, 2007). This can largely be attributed to the numerous obstacles they encounter during their initial stages of operation, particularly when they are relatively new and inexperienced.

Ultimately, there exists a valley of death that start-ups must overcome during the initial stages of their existence (Morales-Alonso *et al.*, 2020). These hurdles include barriers to entry, limited resources, lack of market familiarity, and financial constraints (de Jong & Freel, 2010; Eftekhari & Bogers, 2015; Gruber & Henkel, 2006; Radas & Božić, 2009). Therefore, an alternative approach to addressing these challenges would involve implementing open innovation (OI) practices within the organisation, thereby enabling them to overcome the initial shortcomings (Bogers, 2011).

However, the capacity to depend on external actors is somewhat interlinked with the presence of human capital within the company. Specifically, the education received by the entrepreneur and their professional background impacts entrepreneurial success (Morales-Alonso *et al.*, 2022).

In recent times, the related scientific literature has placed greater emphasis on new firms utilising OI (Remneland Wikhamn & Styhre, 2019) enabling companies to leverage external ideas that have not been fully exploited within a specific industry. According to Chesbrough (2003), companies continue to integrate their own discoveries with existing or emerging technologies. Furthermore, there is evidence of a strong correlation between the phenomenon of start-ups and OI (Spender *et al.*, 2017) and an increased likelihood of success (Gupta & Rubalcaba, 2022).

For this reason, this research showcases the utilisation of open innovation in new technology-based firms (NTBFs) from the perspective of entrepreneurs who have successfully survived the crossing of the valley of death. We examined the interplay of OI and the entrepreneurial background (*i.e.* human capital, entrepreneurial education) to identify success factors in crossing the valley of death, contributing to boosting the survival process of non-traditional business enterprises (NTBFs) and categorises three distinct variables that contribute to comprehending the significance of external and internal factors to which entrepreneurs are exposed. Hence, the research question was 'How do entrepreneurial background (human capital) and the existence of financial and social support for entrepreneurship help to overcome the valley of death in technological new ventures?'

Consequently, we developed this article aiming to understand the varied interests of start-up founders and their relationship with OI. It also seeks to comprehend their interaction with the stakeholders involved in the project. The article consists of five sections. The initial section 'Introduction' will examine the context and underscores the study's significance. The second section will encompass a comprehensive literature review, enabling us to grasp the fundamental concepts essential for formulating the proposed hypotheses. The third section will elucidate the methodology employed in this document. The fourth section will present the most significant findings and discussions arising from the research. Finally, the concluding chapter is presented.

LITERATURE REVIEW AND HYPOTHESES DEVELOPMENT

Open Innovation and Entrepreneurial Ecosystems

Start-ups have emerged as the cornerstone of prosperity and constitute a pivotal innovation policy initiative in both advanced and developing economies (Ferràs-Hérnandez *et al.*, 2021). This is due to the theoretical and empirical evidence indicating their impact on reducing unemployment (Audretsch *et al.*, 2001) and enhancing gross domestic product (GDP) (Gomes & Ferreira, 2022). Such behaviour may not be decisive when attempting to extrapolate a cyclical trend or apply it to diverse contexts. However, it proves to be effective over the long term (Carree *et al.*, 2002). Particularly during periods of economic downturn, as this is the greatest demand for the creation of enterprises (Congregado *et*

al., 2010). This also contributes to the reduction of gender disparities, as an increasing number of start-ups are founded by women or have female members on their founding teams (Modaffari *et al.*, 2023).

To foster innovation and technological advancement, businesses must actively engage with their surroundings (Janssen *et al.*, 2014). In the realm of OI, organisations employ two primary methodologies: inbound OI, which involves the internal utilization of external knowledge from partners, customers, suppliers, or universities, and outbound OI, which focuses on harnessing external ideas or expertise for solutions beyond the confines of the organization (Chesbrough *et al.*, 2006). Moreover, Gassmann and Enkel (2004) introduced a third process called co-innovation, wherein companies seek to merge the entry and exit points by means of collaborations, alliances, or joint ventures.

In this context, OI emerges as a crucial instrument for the strategic advancement of knowledge (Modaffari *et al.*, 2023) by incorporating key stakeholders such as academic institutions, support platforms, other start-ups, and customers (Pakura, 2020). New entrepreneurs are transforming entrepreneurship into action (Makai & Dory, 2023) though evidence of greater market influence by innovative companies compared to others is rare (Audretsch, 1995). According to Chesbrough, OI is the next step in the classical treatment of innovation, which he calls closed innovation. To put it differently, the notion that a company must develop its own technology and guard it with utmost care despite not utilising it has been abandoned. Companies like P&G have a policy of releasing ideas that are not effective for three years or more to be taken advantage of by other players in the market, even direct competitors. This is done with the safeguard of maintaining intellectual property (Chesbrough, 2009; 2015).

In the literature, the most studied relationship between OI and entrepreneurship is the initial one, in which the benefits companies receive are from their ecosystems (Remneland Wikhamn & Styhre, 2019). In the research, we worked with new technology-based firms (NTBF) that design products for an unmet market or need and are committed to technology. In the initial phase of a start-up, the availability of information is limited (Sanasi *et al.*, 2023) and some entrepreneurs make errors in defining the value proposition, which can lead to future difficulties (Sus *et al.*, 2020).

Open innovation is a fundamental component in start-ups management. These improve their opportunities for innovation, competitiveness, and survival by opening to collaborations with stakeholders and strategic partners (Iglesias-Sánchez *et al.*, 2022). This OI approach not only has a significant impact on the success of start-ups, but it can also be facilitated by the appropriate partner selection (Fernandes & Castela, 2019) and a well-defined entrepreneurial model (Joseph *et al.*, 2021). It has been documented that individuals who engage in collaborative environments, such as science parks, exhibit superior performance in comparison to those who do not participate in such settings (Ramírez-Alesón & Fernández-Olmos, 2018). This finding emphasizes the importance of interactions and synergies facilitated by coexistence in specialized environments, pointing to a positive relationship between collaboration in science parks and improved performance of NTBFs. Based on this literature, we proposed our first proposition:

P1: In an NTBF, OI comes mainly from clients and universities or research centres.

Open innovation extends beyond the establishment of partnerships with large corporations and accelerators, as it has the potential to enhance the competitiveness of start-ups through the establishment of partnerships with small and medium-sized enterprises (Bereczki, 2019). The literature on OI has undergone a transformation from its initial focus on large enterprises to a more contemporary context of expanding digital enterprises (Al Sharif *et al.*, 2022). This emergence demonstrates the versatility and significance of operational intelligence in the context of diverse factors influencing business dynamics (Cavallo *et al.*, 2019). The implementation of OI not only has a significant impact on firms' strategic management, but also highlights its significance in the strategic development of knowledge (Modaffari *et al.*, 2023; Santoso *et al.*, 2020). The rapid adoption of novel technologies such as 3D printing or artificial intelligence is facilitating the creation of novel business models (Block *et al.*, 2017) by facilitating more efficient and timely access to existing knowledge and, according to the creation of knowledge (Wurth *et al.*, 2022).

However, as start-ups engage in network structures (Dooly *et al.*, 2022), intellectual property-related challenges arise for an increasing number of companies of both public and private nature that

are partnering. The influence of OI is remarkable, especially when public-private companies are established (Godlewska-Majkowska *et al.*, 2023; Hahn *et al.*, 2019). The initial evaluation of NTBF's potential and viability is notably influenced by the alliances forged with corporations, investors, and the development of patents (Wessendorf *et al.*, 2019). Consequently, while exposure to open innovation (OI) in companies associated with scientific parks or local university institutions may not reach exceptional levels, it persists to a greater extent compared to companies not affiliated with such entities (Lindelöf & Löfsten, 2004). Drawing upon this academic literature stream, we propose:

P2: Start-up incubators should try to impact beyond entrepreneurial education if they want to improve NTBFs' survivability.

Entrepreneurial Background

When evaluating entrepreneurship and its correlation with human capital, it is imperative to acknowledge that it has distinct metrics that differ based on the perspective employed. There are many different relationships between, *e.g.* entrepreneurs' origins, training (Acevedo *et al.*, 2007), personality (Krieger *et al.*, 2022), and early exposure (Morales-Alonso *et al.*, 2016; 2022). We may also analyse these relationships through their relationship with entrepreneurship ecosystems, such as innovation and digital knowledge (Di Vaio *et al.*, 2021) and technological turbulence (Li, 2012). However, there is still no consensus that human capital is key to the success of high-tech firms (Colombo & Grilli, 2010; Morales-Alonso *et al.*, 2023), there are many more factors.

Skill Variety and Entrepreneurial Human Capital

Human capital plays a critical role in the search for new business opportunities and this influence is growing stronger with experience in a specific sector and general education (Jang, 2019). Indeed, cognitive traits possess the ability to surpass demographic factors and human capital in the context of high-tech-based start-ups (Morales-Alonso *et al.*, 2022). Furthermore, when the complementary capabilities of the founders are combined, synergy emerges, resulting in enhanced profits (Colombo & Grilli, 2005).

The increasing number of academic entrepreneurs has led technical and university entities to adopt a more focused approach to training their students towards innovation (Dooly *et al.*, 2022). Together, these dynamics propel entrepreneurship and innovation in the business landscape, particularly among those students who have been exposed to entrepreneurial training (Lee *et al.*, 2019). In the context of NTBFs, the presence of PhDs in their teams has been a topic of interest, with significant evidence showing that investment programs prefer to derive their capital from those who have PhDs in their teams (Ferràs-Hérnandez *et al.*, 2021). Indeed, it aims to integrate scientists (Hahn *et al.*, 2019), researchers, publishers, and libraries to enhance the potential of start-ups (Gupta & Rubalcaba, 2022). This is because the amalgamation of technological knowledge, entrepreneurial education, and educational diversity are crucial factors for success (Bertin & Mavoori, 2022).

The literature has delineated the positive influence of various factors on the success of start-ups, including the entrepreneur's leadership, agility, technology orientation, sustainability, teamwork, motivation (Lago *et al.*, 2023), the ability to remain vigilant, acquired experience (Edigbo *et al.*, 2021), and risk-taking (Wadood *et al.*, 2022). Moreover, the presence of individuals possessing prior business expertise within the founding team is also associated with superior growth (Colombo & Grilli, 2005) and better financial outcomes (García-Cabrera *et al.*, 2021). Anchoring on this literature, we propose:

P3: For the survivability of a NTBF, professional experience is more important than education.

Financial Support for Entrepreneurship

In addition to the technological foundation and experience, the primary factors that determine a company's success include family support, which can be either economic or emotional (Ascarya & Rahmawati, 2018). It has been demonstrated that the financial or capital support that the family provides at the onset of entrepreneurial activities has a greater impact than the emotional support (Gao *et al.*, 2021), thereby ensuring that entrepreneurs find their initial access to business capital through family financing (Marliati, 2020).

The configuration of network structures emerges as a crucial factor in the development of start-ups (Dooly *et al.*, 2022). Moreover, the implementation of OI significantly enhances the managerial prospects of these start-ups by emphasising the significance of involving stakeholders in attaining innovation, fostering competitiveness, and ensuring survival (Iglesias-Sánchez *et al.*, 2022). There are at least four OI models that allow for the interaction of different agents with start-ups, such as corporate accelerators, external platforms, consortia or alliances, and the direct business approach (Boni & Joseph, 2019). Despite their positive impact on collaboration and innovation, they also create a dilemma and conflict around the claim of intellectual property within these networks. Despite these challenges, there is a growing trend in the association of public-private companies (Dooly *et al.*, 2022).

The aim of collaboration between educational institutions and start-ups is to achieve sustainability by facilitating access to technology that would otherwise be inaccessible. Several start-ups, particularly NTBFs, seek collaboration with university incubators, particularly in the hopes of obtaining resources through tax incentives and incubator support (Jirapong *et al.*, 2021; Ziakis *et al.*, 2022). This is because access to educational institutions will enable entrepreneurs to make decisions based on data and not on unreliable intuitions (Gupta & Rubalcaba, 2022).

Nonetheless, this type of collaboration is less prevalent in emerging enterprises with a social focus, as public programs tend to invest in start-ups that specialise in big data management or artificial intelligence (Eiteneyer *et al.*, 2019). Furthermore, the competitiveness of a start-up is not solely contingent on the environment in which it operates, but also influenced by the characteristics of its managers, knowledge management, absorptive capacity, and participatory capacity (Salimi *et al.*, 2023). The most realistic options that entrepreneurs have to obtain financial resources during their initial stage include their own savings, business angels or their close circle composed of family, friends, and fools (FFF) (Hamilton, 2001). In the case of companies that are just starting their activities, FFF (as an informal finance source) provides financial support in most cases (Ramachandran & Ramnarayan, 1993). These results in terms of funding sources for entrepreneurship led us to our next proposition:

P4: The initial survivability of NTBFs depends mainly on the availability of funding from informal sources.

Social Ties for Entrepreneurship

According to empirical research, it has been demonstrated that the training of entrepreneurs, along with the management of their budgets and the mitigation of any negative experiences they may have encountered in the past, have a significant impact on the degree of future expansion that start-ups can achieve (Ireta Sanchez, 2023). Moreover, it is important to understand the needs of customers and their levels of satisfaction when purchasing a product or service (Khaliq *et al.*, 2022). If we are referring to social relationships, entrepreneurs must possess a high level of social intelligence in order to maintain relationships with interest groups (Ingram *et al.*, 2019). Another form of social assistance that aids in the advancement of enterprises is the exposure to entrepreneurial activities that they have received during their academic years. When they are at an advanced stage, this exposure can provide them with access to incubators that connect them to venture capital investors or financing entities (Hoang *et al.*, 2022) because, when entrepreneurs perceive their project to be risky, they avoid taking on loans with uncertain interests (Liu & Yang, 2023) or an incentive that makes them feel in danger with their novel knowledge property (Lin *et al.*, 2023). Hence, we propose:

P5: Founders of NTBFs give the greatest importance to industry knowledge and independence.

RESEARCH METHODOLOGY

Sample Choice

The research centred on the collection of data pertaining to the NTBFs of the Autonomous Community of Madrid. While the concept of an NTBF is not universalised and is used in different ways (Autio, 1994; Bollinger *et al.*, 1983; Storey & Tether, 1998), for this investigation, we decided to employ Autio's con-

cept, which asserts that NTBFs are novel, relatively small, based on solid scientific and technological foundations, and also contribute to the generation of employment and innovation (Autio, 2008).

To establish communication with the NTBFs, Universidad Politécnica de Madrid partnered with the Madri+d Foundation, which provided access to the founders or co-founders of companies with highly technological operations. We sent a preliminary questionnaire to 500 companies, of which 7% responded. The filter inquiry inquired about the degree of satisfaction (ranging from 1 to 5) pertaining to the technological knowledge acquired through the foundation. To ensure the sample's representativeness, we selected eight companies that indicated a low level of satisfaction (1 or 2), and eight that indicated a high satisfaction level (4 or 5) in a completely random manner. Once we obtained a list of the 16 companies eligible for the interview, we contacted them.

To conduct the necessary interviews, it was imperative to conduct four rounds from June 29 to July 4, 2018. During this period, we contacted. only 10 founders or co-founders of the NTBFs, resulting in a response rate of 62.50%. Figure 1 depicts the summary of the process for gathering the information. The interview protocol consisted of six carefully crafted inquiries designed to explore the hypotheses outlined in the research. We interviewed ten entrepreneurs and meticulously recorded their responses and transcribed them to facilitate thorough analysis.

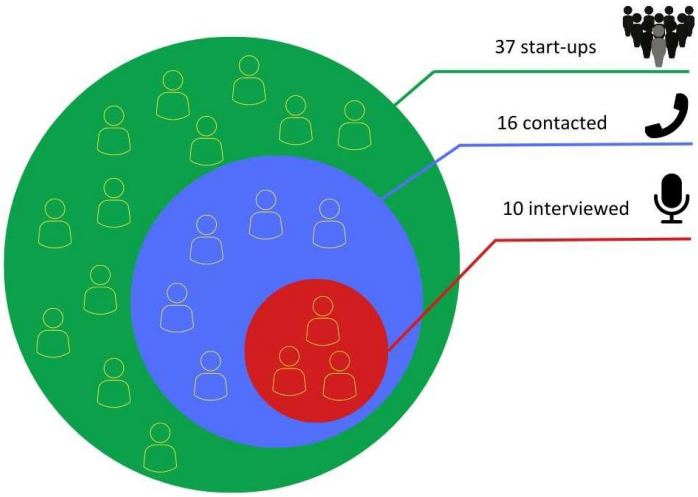

Figure 1. Selected sample and data collected
Source: own elaboration.

Descriptive Sample Analysis

The oldest company surveyed commenced its operations in 2005, while the most recent company was established in 2014 spanning various industries including Information and communication, factory, professional, scientific and technical activities, administrative and support service activities, financial and insurance activities, human health and social work activities, wholesale and retail sales of engine parts, vehicles, and motorcycles and professional, scientific and technical activities. The distribution of companies based on their number of employees was as follows: six companies had fewer than nine employees, while four had more than nine but fewer than 49 employees, reaffirming their status as small enterprises.

Data Analysis Method

To analyse the data gathered from the interviews, the statistical software R for Qualitative Data Analysis (RQDA) was utilised, offering a unified platform for analysing both qualitative and quantitative variables (Huang, 2014). Furthermore, given the exploratory analysis, we generated a Word Cloud for each inquiry, facilitating the visualisation of the most salient topics among the interviewed entrepreneurs. Moreover, we employed the information conglomerate to define the recurring variables and identify the primary connections among the responses obtained during the interviews.

RESULTS AND DISCUSSION

This section presents findings derived from an in-depth analysis of three codes in RQDA, strategically used to explore central themes of innovation, entrepreneurship, and support networks. We also used Word Cloud maps to visually represent interview data, highlighting key topics such as university collaboration, business strategies, and connections with stakeholders. The following discussion will examine each hypothesis to understand the impact of OI components on overcoming challenges in business development such as crossing the valley of death.

Entrepreneurs emphasized innovation as crucial for their ventures, often using it to develop business ideas. While universities were seen as catalysts, some entrepreneurs felt they lacked expected technical support. Interpersonal relationships and soft skills, previously undervalued, emerged as vital for business expansion.

The first inquiry, 'Can you describe your start-up idea and your experience facilitating its development?' aimed to explore knowledge sources and compare OI practices. It delved into idea generation, opportunities identified at the start, and potential modifications over time.

Figure 2 illustrates entrepreneurs' interactions with external agents. Most acknowledged customers' influence on product development. Nearly half collaborated with universities, while a small percentage worked with corporations or research centres. However, 30% reported no external collaboration, underscoring the importance of diverse assistance in venture expansion.

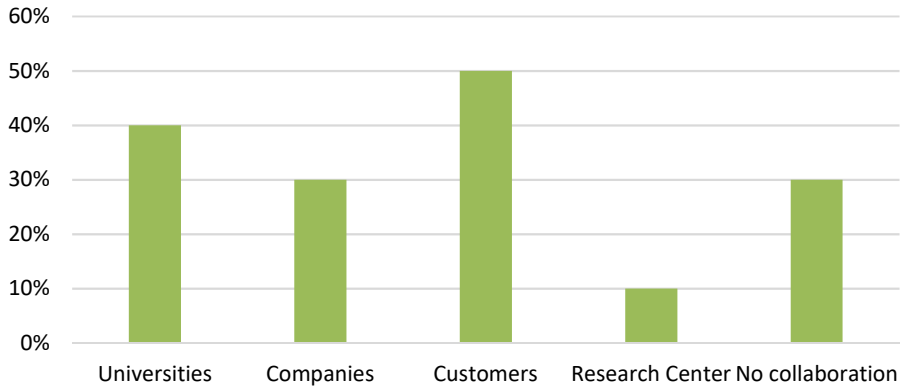

Figure 2. Links developed by firms
Source: own elaboration (*n* = 10).

Furthermore, we noted an increase in sales as companies effectively communicated with diverse stakeholders. Initially, companies showed reluctance to embrace OI but became more receptive over time, engaging with stakeholders such as customers, larger businesses, research centres, and public institutions as they progressed through the development stages.

When the gathered responses of the companies to the initial inquiry (Figure 3) highlighted prominent variables such as 'idea,' 'university,' 'business,' and 'knowledge,' with 'customers' being less prominent. We can attribute this to the focus of the initial question on formulating concepts rather than subsequent business evolution. To better understand the impact of OI on high-tech start-ups, three subquestions were formulated (Figure 4).

> *Question 1.1 Have you had any other considerable interactions with other actors? (*e.g. *universities, suppliers, customers, private research institutions, government or public authority).*

Given that the initial funding predominantly stemmed from personal savings or familial loans, as explored further in hypothesis 4, we could deduce that the initial growth of the surveyed start-ups remained uninfluenced by external factors. In more exceptional cases, some entrepreneurs asserted that the operational methodology they had devised proved adequate to sustain continued expansion, even in the presence of additional investment income.

Question 1.2 What benefits and challenges are related to the involvement of these actors in the innovation process?

In the case of companies that received support from entities affiliated with the Madri+d Foundation, they opted to highlight the progress of innovation within their ventures. This strategy allowed them to attract a broad clientele and bolster the sustainability of their ventures. Moreover, they endeavoured to bridge the divide between invention and innovation, aiming to market their products consistently in the marketplace.

Question 1.3 Which competencies did you acquire from these actors that you did not have?

The cohort of entrepreneurs acknowledging the benefits of leveraging their network of contacts to involve various stakeholders in their development process also identified a shortfall in their business management information systems. This inadequacy could be addressed by harnessing the expertise and experience of these newcomers.

In alignment with Hypothesis 1, positing that OI predominantly stems from customers and universities or research centres, the word cloud underscores the substantial contributions of 'university' and 'knowledge' in shaping these entrepreneurial ventures. This nuanced comprehension partially corroborates the initial hypothesis, revealing a correlation between business concepts that are enriched through external collaborations such as clients and academic institutions to a greater extent, albeit with a lower involvement with research centres.

Figure 3. Word cloud: Question 1
Source: own elaboration.

Figure 4. Word cloud: Question 1.1, 1.2 y 1.3
Source: own elaboration.

Regarding question 2, which addresses the degree of satisfaction with technological learning provided by the Madri+d Foundation, it was subdivided into three sub-questions to explore entrepreneurs' perceptions of the role of incubators in their business development, spanning from the initial conceptualization of the idea to achieving self-sustainability. Noteworthy, to ensure the sample's representativeness, companies with varying levels of satisfaction were included, thereby enabling balanced responses

regarding the performance of an entrepreneurship support entity. This methodological approach enhances the accuracy and comprehensiveness of the outcomes obtained, facilitating a deeper understanding of the impact of incubators on the entrepreneurial journey of the analysed enterprises.

Q2.1 What services have you used from the foundation?

Q2.2 Can you describe what are the negatives (or positives) you noticed about the services? Are there positives (or negatives)?

Q2.3 After you had used the foundation's services, how did you continue on your path grow? And now?

Based on the gathered data, entrepreneurs expressed a notable reliance on their internal development of knowledge to manage and operate their enterprises, rather than placing significant reliance on external institutions. However, they acknowledged the value added by incubators, which provide ongoing support and tools such as mentorship and marketing strategies. This discovery suggests that entrepreneurs are increasingly embracing autonomy and internal drive, while also recognising the specific resources that incubators can offer in key areas for growth and entrepreneurial advancement. This aspect is relevant for incubators to consider as they enhance their support procedures and strive to foster greater engagement among entrepreneurs who rely on incubation processes, thereby facilitating their access to anticipated resources.

The interviews revealed that entrepreneurs benefiting from the services offered by the Madri+d Foundation exclusively expressed positive perceptions. Several participants emphasized the valuable assistance provided in acquiring essential tools and establishing strategic connections, significantly facilitating the acceleration of their business growth processes. On the other hand, those three who did not use the foundation's services or whose satisfaction level was assessed as low (2 or 1) chose not to express their opinion on the matter. This response pattern underscores the positive correlation between the effective utilization of services provided by the Madri+d Foundation and favourable perceptions among entrepreneurs regarding the positive impact on their respective development processes.

Among the array of services provided by the foundation, mentorship and networking opportunities were the most commonly utilized, as affirmed by 90% of the participating companies. Despite the lack of adverse outcomes, respondents indicated that they acquired substantial knowledge that propelled the advancement of their companies. This analysis underscores the effectiveness of the mentorship and networking initiatives offered by the incubator and their beneficial impact on the growth and progression of the participating enterprises.

To propose an incubation strategy, we conducted a thorough analysis of word clouds to identify primary concerns overlooked by the incubators. Figure 5 vividly illustrates that participants unanimously stressed the necessity for investment capital, whether from foundations or investors, to improve their products, increase production levels, and ultimately solidify the stability of their ventures. This finding underscores the importance of concentrating on targeted strategies for securing funding as a critical element in the development of enhancements for incubators.

In other words, entrepreneurs' expectations suggest that the incubator's responsibilities should not be solely confined to providing courses on soft skills or mentoring for business development, supporting the second hypothesis that implies incubators should go beyond offering basic skills to enhance the survival probability for a start-up. Entrepreneurs anticipate incubators to establish direct connections with potential investors for their business concepts. The issue of funding has emerged as a significant concern for new entrepreneurs in the high-tech sector, as they are aware that implementing their business concepts requires substantial initial capital and the resulting returns may take months or even years to materialize. This approach highlights the need for incubators to broaden their responsibilities beyond conventional training, emphasizing the importance of establishing direct connections with funding sources to address the specific requirements and financial challenges faced by high-tech entrepreneurs.

With regards to the third hypothesis, the testimonials provided by entrepreneurs who have experienced a favourable outcome from the Madri+d Foundation provide pertinent insights. Entrepreneurs have mentioned that the favourable impact was not solely reflected in the enhancement of business skills and

the enhancement of accessible projects, but also the enhancement of financial skills and the acquisition of seed capital through contests and competitions. Thus, we formulated the following question:

Q3 Which competencies did you acquire from these services that you did not have?

Figure 5. Word Cloud: Questions 2.1, 2.2 y 2.3
Source: own elaboration.

This finding suggests that within the framework of incubation offered by the Madri+d Foundation, hands-on experience and active participation in contests and competitions play a pivotal role in entrepreneurs' success. While education may offer theoretical foundations, the practical application of business skills and involvement in specific entrepreneurial activities emerge as the determining factors in the perceived positive impact.

This comparative approach highlights the synergy between education and professional experience, indicating that both components are fundamental and interact synergistically to achieve entrepreneurial success. The hypothesis favouring professional experience does not negate the significance of education but rather emphasizes the necessity for a balanced amalgamation of both dimensions to have a significant impact on entrepreneurial advancement.

A significant proportion of entrepreneurs emphasized the importance of acquiring training in business skills, particularly those with backgrounds in engineering fields that did not include these subjects in their initial education (75%). Nonetheless, it is imperative to emphasize that numerous individuals have highlighted that one of the primary advantages of achieving entrepreneurial success stems from the prior experience they acquired before establishing their ventures. Despite incorporating business skills through additional training, prior experience has been identified as a distinct factor that significantly contributed to the successful accomplishment of their organizations.

Upon examination of the word cloud corresponding to Question 3 (Figure 6), we discerned a distinct consensus among all entrepreneurs who expressed their involvement in previous projects. These projects provided them with the opportunity to enhance their entrepreneurial abilities, which were further bolstered through the training provided by incubators, should they choose to avail themselves of these educational opportunities. This finding highlights the coherence in the experiences of entrepreneurs, accentuating the importance of previous projects as a basis for the development of entrepreneurial skills. This fully supports the third hypothesis, which states that experience is more important than academic knowledge. These skills were further enhanced through incubation programs, enriching their entrepreneurial experience.

To analyse this part of the research, we proposed three different for the progression of an emerging company towards maturity. The 0-period 'existence' is commonly referred to as the start-up stage, wherein entrepreneurs are faced with limited resources and capabilities, leading them to rely on their own resources to accomplish their tasks. Next was Period 1 'survival,' the stage of market openness, at which performance, and management of technological and financial knowledge become critical factors. It is at this point that the use of OI becomes more relevant. In Period 2 'success,' start-ups are on the path to maturity with consolidated ideas, growing and maturing, escaping the dreaded Valley of Death, and becoming sustainable over time.

Table 1 depicts the source of financial funds procured by companies during each aforementioned stage. During the initial phase of the start-up process, a majority of companies utilised their own resources, augmented by funds from family or acquaintances. During the initial period, certain enter-

prises commenced acquiring funds from a diverse range of financing sources, including both public and private ones. During the second period, the majority of companies expressed a more clarified comprehension of the necessity to raise additional funding to sustain their expansion.

Figure 6. Word Cloud: Questions 3
Source: own elaboration.

Table 1. Funding sources

Codification	Period 0	Period 1	Period 2
1	Personal	N/a	N/a
2	Personal	Personal and public sources	Personal and public sources
3	Personal	N/a	Personal
4	Personal	Personal and public sources	Personal and public sources
5	Personal and public sources	Private sources	Personal and public sources
6	Personal	Personal	Personal
7	Personal	Private sources	N/a
8	Personal	Personal	Personal and public sources
9	Personal	Personal	Personal and public sources
10	Personal	Personal and public sources	Personal and public sources

Source: own study (*n* = 10).

To gain a more comprehensive understanding of the present perception of entrepreneurs who have successfully consolidated their technological organisations, we conducted an analysis of the word cloud of their responses (Figure 7) from Q4 'Was it necessary to raise funds to support your business? If so, can you describe how you collected them and what is the composition (%) of the firm's ownership structure? (*e.g.* entrepreneurs and co-founders, friends and family, crowd equity investors, professional investors or other).' The significance attributed to capital primarily from family and the public sector, through contests or awards that promoted their ideas is particularly noteworthy. In certain instances, incubators played a pivotal role in facilitating access to these financial resources. Despite the importance of investors in capital raising, a minority of respondents expressed reluctance to seek financial assistance from individuals outside their immediate circle (FFF), even after consolidating their enterprises. This analysis supports the fourth hypothesis completely, which proposes that the first financial supports of successful entrepreneurs were supported by FFF from the beginning, because we also found that entrepreneurs obtained some financial sources from the public sector.

When asked about the most valuable advice entrepreneurs could offer to individuals embarking on the exciting journey of entrepreneurship, as illustrated in Figure 8, the most frequently mentioned phrase was 'always begin,' obtained from Q5 'If you could, what would be the three pieces of advice you would give to a new, young entrepreneur?'

Furthermore, additional responses included recommendations to adequately prepare for and execute all tasks, acquire knowledge during the initial year, and be ready to confront various obstacles. As entrepreneurship continues to evolve, they suggested securing a stable and traditional occupation, as it may experience slow growth. They also advised focusing on acquiring market knowledge to max-

imise competitive advantages and survival prospects in the valley of death. Consequently, the fifth hypothesis was fully supported, as entrepreneurs based their success on the specialised knowledge they had acquired about the market in which they operate and prefer economic freedom that keeps them away from debt, especially with banks.

Figure 7. Word Cloud: Question 4
Source: own elaboration.

Figure 8. Word cloud: Question 5
Source: own elaboration.

DISCUSSION

We aimed to analyse the relevance of IO by drawing insights from successful entrepreneurs who have navigated the challenging period known as the valley of death, thus creating a safer journey map for future entrepreneurs aiming to establish high-tech businesses (Figure 9). Due to the intrinsic nature of the Internet of Things, the analysis focused on entrepreneurs' stakeholders and their interactions, thereby facilitating start-up survival. Three distinct components have been identified.

The first component identified was the entrepreneurs' background (emphasizing human capital) and their sustained relationships with stakeholders, laying the groundwork for entrepreneurial activities. These findings are in line with Elston and Audretsch's (2011) assertion that human capital is among the most crucial resources for technology-related start-ups. The second concept aligns with Neyens *et al.* (2010) and Iglesias-Sánchez *et al.* (2022), who argue that entrepreneurial innovation is bolstered by formed alliances.

The second component for advancing along our journey map encompasses incubators and the entrepreneurship skills refined during incubation processes. In agreement with Lamperti *et al.* (2023), Jirapong *et al.* (2021), and Ziakis *et al.* (2022), we assert that business incubators play a pivotal role in facilitating entrepreneurs' access to economic and knowledge resources.

Finally, the third component for navigating the death valley describes the initial access to financing, sourced from friends, family, and fools. This finding corroborates Gao *et al.* (2021), Marliati (2020), and Gbadegeshin *et al.* (2022), who suggest that FFFs play a crucial role in surviving the death

valley during the company's initial years. They enable avoidance of bank interest rates and allow NTBFs. to focus on the challenges in their developmental stage.

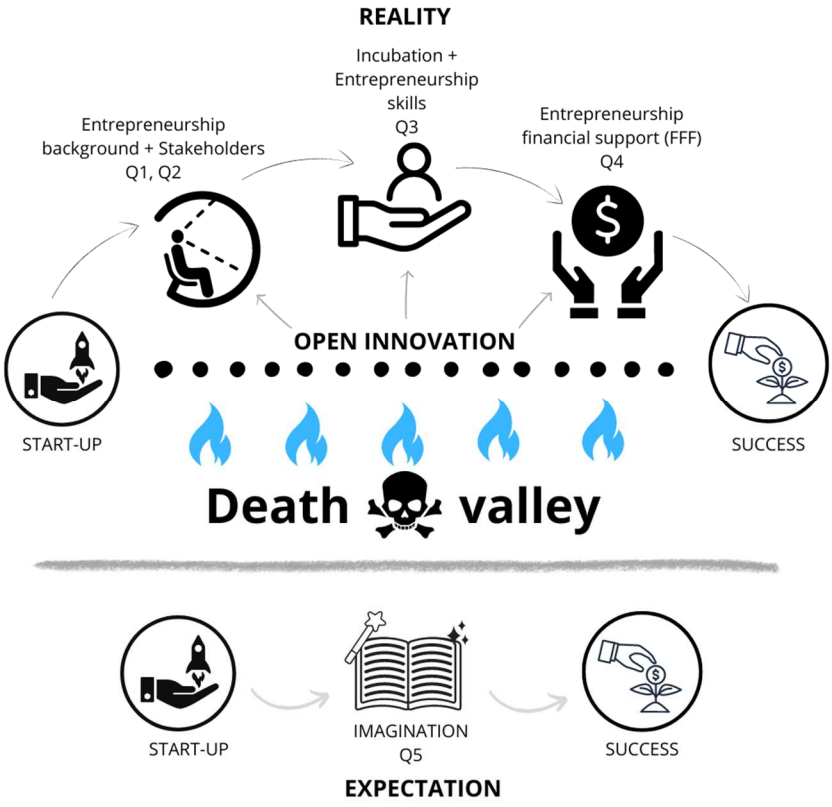

Figure 9. The valley of death journey map
Source: own elaboration.

CONCLUSIONS

In the present study, we examined the significance of open innovation (OI) for new technology-based firms (NTBFs) through empirical research involving ten companies incubated within the Madri+d ecosystem in Madrid, Spain. The findings provided full support for four out of the five hypotheses posited and partial support for one. This indicates that, for navigating the valley of death, the possession of human capital and access to informal sources of funding appear to be more crucial than OI itself.

From the hypotheses entirely supported by the findings, we concluded that:

1. Incubators should not merely focus on imparting entrepreneurship skills and business modelling knowledge but also go further by fostering networking and facilitating access to funding sources and potential clients (H2);
2. Despite NTBFs being highly specialised, contrary to expectations, professional experience remains the indispensable factor for survival over education (H3);
3. Initial financial support available to entrepreneurs relies on their family, friends, and fools (FFF) network and personal savings (H4);
4. One of the primary sources of motivation for entrepreneurs is the opportunity to actively contribute to industry knowledge development and achieve work independence.

From the hypothesis that was not fully supported (H1), it can be concluded that while open innovation is important for a company's development, it takes a backseat in the early stages of entrepreneurship, which prioritises survival through the 'Valley of Death' and emphasise activities conducive to establishing a stable market position. At this juncture, universities emerge as critical partners, primarily assuming the role of incubators providing access to business information to enhance the likelihood of surviving the valley of death.

Regarding the implications of the study for the academic community, we underscored the importance of examining and understanding the factors determining entrepreneurs' perception of openness in the early stages of their companies' development. Specifically, our study on NTBFs suggests that OI may be less critical for start-ups than the scientific community might presume, especially, in comparison to human capital and access to informal funding sources. This insight enriches existing literature on OI and provides valuable information for future research endeavours.

For managers, entrepreneurs, and other professionals, the results underscore the strategic relevance of focusing efforts on points identified as critical for surviving the valley of death, such as possessing adequate human capital and accessing informal funding sources.

Regarding implications for public entities involved in entrepreneurship, including incubators, it is suggested to promote policies supporting the training and ongoing support provided by these entities. This aims to enhance entrepreneurs' human capital and facilitate their access to funding sources. In particular, we highlighted the importance of exploring avenues to facilitate access to external funding as emerging companies progress through their developmental stages. The positive perception of incubators as resources for capacity building underscores their crucial role in developing essential entrepreneurial skills. Collaboration with incubators may be considered an effective means to nurture entrepreneurial talent and strengthen knowledge bases in the business domain.

Lastly, the study acknowledges the presence of limitations, such as focusing on a specific context (Spain) and reliance on highly specialized data. These limitations underscore the need to avoid generalizing results and encourage exploring multiple contexts in future research on entrepreneurship and OI.

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Conflict of Interest

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