The Role of Academic Spin-Offs Facilitators in Navigation of the Early Growth Stage Critical Junctures

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***Abstract*—Academic spin-off facilitators support high-tech academic spin-offs and help them to navigate various barriers and critical junctures during their growth stages. In this article we draw on stage-gate models, the path-dependency, and resource based view to identify start-ups' resource needs as perceived by both facilitators and by entrepreneurs. Using qualitative data based on in-depth interviews with 18 academic spin-off facilitators and nine spin-off founders, from three technical universities in the Netherlands, we explore the critical junctures and key support activities. The results show that founders appreciate milestones and direct interface regarding business support, business plan development, and legal support during the early growth stages. In all stages, in particular during the later stages, founders appreciate different type of network support (e.g., start-up network and industry) and when facilitators act as intermediaries to guide them in the network. This helps spin-offs to gain credibility and reach out to the market. This article adds to current research on academic facilitators and in particular incubators by providing a more comprehensive explanation for the low usage of the incubator's resources. By matching key resources and support activities that can navigate particular critical junctures, we try to promote the successful transition from one stage to the other. Our findings offer significant implications, both theoretical and practical, for academic entrepreneurship literature.**

***Index Terms*—Academic spin-off (ASO), critical junctures, growth stages, stage-gate model.**

I. Introduction

ACADEMIC spin-offs (ASO) commercialize technology which is developed through university research [1]. ASO are a central pillar for the pursuit of new technologies [2] which reflect the increasing importance of research knowledge as a strategic resource that creates competitive advantage [3]. These start-ups are believed to be beneficial to local and national economies and social development [4]–[6]. However, they tend to remain relatively small and often fail to grow, due to the their academic origin, lack of resources, or network relationships suggesting that large numbers of spin-offs remain struggling with particular obstacles [7], or critical junctures [8]. Various facilitating organizations, such as universities, technology transfer offices (TTOs), science parks, development agencies, venture capital investors, and new business incubation centers help these new firms to start, grow, and accelerate by providing them with access to resources and network relationship [9].

Recent studies suggest that entrepreneurs and facilitators staff have different perceptions about the importance of the supports and resources [10], [11]. The extant literature provides various explanations for these differences in perceptions that primarily point at the incubator. Some of these studies show that incubators do not sufficiently consider the needs of entrepreneurs, which results in a mismatch between the resources provided by facilitators and the resources needed by start-ups [10], [12], [13]. Following this stream of research, we propose that in order to address these perception differences, it is important to know what are the ASO specific barriers and needs during the growth stages [8]. This will lead us to the first research question: 1) What are the main ASO critical junctures and how does the pattern of critical junctures change during the spin-offs growth stages? Next, it has not yet been explored which specific resources entrepreneurs undervalue. So our next question is: (2) What are the key support activities provided by university facilitators in different growth stages and do perceive as important?

Finally, we analyze the support activities, from a resource based view to better understand how unique resources that create sustainable competitive advantage (SCA) [14] are linked to the growth stages [15]–[18]. We follow the literature that has analyzed the new firm development in terms of a stage-gate approach, dividing the growth of spin-off into a number of stages separated by different junctures [8]. This time dimension is so important since entrepreneurs need to be able to assess and satisfy their resource requirements and support as accurately as possible if they meet key support at the right point in time [7]. We give a better understanding of the various facilitators and their key support activities to address the critical growth junctures of ASO by answering our last question: 3) How can facilitators match their support activities to particular critical junctures of ASO?

While a large amount of research has focused on the role of specific facilitators such as universities [19], [20], TTOs [18], [21], [22], faculty staff, and venture capital investors [23], a view

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on the concurrent role of multiple facilitators in accelerating ASO growth is absent. The nature of ASO growth is dynamic with various barriers [7], each requiring different resources, skills, and relationships, that may not be provided by a single facilitator, which calls for a more careful examination [7], [24]. This article takes a more holistic approach to analyze the role of facilitators during the growth stages of spin-off. Furthermore, the support available for ASO does not only vary across facilitators, but it may also vary across the stages of growth. Therefore, we investigated three universities and interviewed 18 representatives of prominent facilitators to find out what support activities they consider important for ASO at each growth stage. We also interviewed nine ASO founders and asked them what support activities they considered important given the challenges they were facing during their growth. The analysis of the critical junctures and the relevant support activities provides a practical guideline for facilitators and policy makers to help start-ups overcome their growth barriers. It also helps entrepreneurs to better understand their needs and time-bonded support related.

The rest of this article is organized as follows. Section II reviews the literature on the stage-gate models of ASO. Section III presents the methods used to collect and analyze the data Section IV presents the results in conjunction with our analysis. Finally, Section V concludes this article.

II. Theoretical Framework

Based on the resource-based view, firms need to access different resources and capabilities to reach to sustainable returns over time [25]. The set of unique resources will provide startups the ability to create value and SCA [14]. However, ASO are short in resources since they originate in a university and research setting, which is often less focused on business-related activities. Due to their academic origin they face particular challenges when acquiring and configuring resources for commercialization [20]. Using the resource-based view, barriers can emerge due to poor or nonavailability of key resources at times when spin-offs need these resources. Barriers may include shortage in management skills, shortage in market knowledge and marketing skills to access the market, and financial obstacles such as lack of cash flow and lack of investment capital [26]. While the resource-based view provides insight into the performance of ASO at one point in time [27], some authors have remarked that nonlinear stage-based models are suitable for understanding the growth of ASO and changes in resource needs over time [7], [28]. These models describe growth based on periods of evolution and revolution, and highlight typical challenges and critical junctures [7], which spin-offs have to overcome before they can continue to grow and mature [29]. Following the resource-based view, we investigate how facilitators can support and provide key resources for ASO to overcome growth challenges.

A. Stages in the Evolution of an ASO: Critical Junctures

Stage-gate models provide insight into how the challenges, strategies and structures of a company change with the stages that the company growth [30]–[32]. Research on growth stages of ASO has highlighted the lack of relevant human capital, venture capital funding, network contacts, and research-based technology [7], [33], [34].

Stage-gate models of ASO typically refer to Vohora *et al*. [8], who investigated the challenges that separate their growth stages, suggest the following classification of five broad growth stages: research; opportunity framing; preorganization; reorientation; and sustainable returns [8]. Between each two stages, Vohora *et al*. [8] identified barriers which they refer to as critical junctures, respectively: opportunity recognition, entrepreneurial commitment, credibility, and sustainability. Before the spin-off can proceed to the next stage, it needs to overcome this critical juncture [28], [35]. Opportunity recognition is the first critical juncture and refers to the ability to recognize the need of an unfulfilled market and requires the spin-off to acquire the capabilities to identify opportunities [18]. "Without developing, acquiring or accessing the capability to combine scientific knowledge with a commercially feasible offering that satisfies an unfulfilled market need, academic scientists [will] not be able to proceed towards commercializing their technologies" [8]. Entrepreneurial commitment is the second critical juncture and refers to the ability to recognize the skills required to establish, and manage the spin-off. At this point in their growth trajectory, spin-offs need an entrepreneurial champion who has the skills, knowledge, and commitment to start the new company [18]. "The critical juncture of entrepreneurial commitment arises due to the conflict between the need for a committed venture champion to develop the ASO and the inability to find an individual with the necessary entrepreneurial capabilities" [8]. Credibility is the third critical juncture and refers to the ability to recognize that the spin-off needs to gain sufficient credibility to access and acquire the key resources (funding and staffing) to start to function [8]. Finding investors is a key challenge for most new ventures [8], [36], [37]. ASO often hit this challenge at the point between prototype development and production and sales [23]. Sustainability is the fourth critical juncture and refers to the ability to recognize that the spin-off needs to develop entrepreneurial competencies that enable them to reconfigure deficiencies from earlier stages into resource strengths, capabilities, competencies, and social capital [8], [18]. Following these five stages of growth and four critical junctures, we focus on identifying the first three critical junctures up to the so-called credibility juncture of a startup to launch their business.

Academic facilitators such as university officials, TTOs, and incubators can play an important role in signaling, building, and acquiring entrepreneurial resources for start-ups in need of specific resources, managerial skills and organizational systems [20], [38]. They facilitate commercialization and entrepreneurship [39]. Researchers have identified various types of support activities, such as infrastructural business, and financial support, which are considered important to address the critical junctures [1], [18], [40], [41].

B. Stages in the Evolution of an ASO: Key Support Activities and Actors

The literature distinguishes between five support categories from different facilitators. First, infrastructural support refers to the provision of office and laboratory space, equipment, and shared services often in one building or in buildings in close proximity. Infrastructure support such as office space [42] as well as laboratories and equipment [43] are critical to business incubation [44]–[46]. University incubators and science parks

usually provide this type of support to start-ups. In fact, the incubator acts as a mediator or a direct supplier of resources without substantial costs [47]. It can also bring together start-ups which find themselves in a similar situation, and can thus stimulate and help each other and act as positive peer role models.

Second, financial support includes seed capital, direct or indirect funding, and venture capital [38], [42], [48]. Proving adequate financing is one of the principal and most difficult tasks an ASO needs to achieve [8], [41], [49]. Difficulties in accessing private financing at this initial phase usually cause ASO to try to obtain their seed fund through university or government institutions that provide financial resources to ASO at reduced cost in conditions of uncertainty [23]. Government institutions have also tried to operate financing systems for start-ups through a variety of public instruments [23], [50]. Wright *et al*. [23] identify several European countries that have developed government initiatives directed at financing high-technology ASO at their initial stage of growth such as Biopartners in the Netherlands, however, most studies indicate at the role of venture capitalists during the later stages [51].

Third, network support includes access to a network of professional contacts. Incubators can provide resources directly or indirectly through the incubator's networks [52]. These networks include business people, industry, other start-ups, clients, and big companies. This can reduce the cost of searching for partners [53] and is beneficial in terms of references, endorsement, and recognition. Facilitators can assist ASO to acquire managerial and commercial competences through consultancy, training, mentoring, and transfer of experiences [41], [54].

Fourth, business support includes activities such as mentoring, coaching, and counseling [46], business plan development, and personal training [42]. This is the most common types of support facilitators' offer is a business support [18], [20]. Business support is critical during the early growth stages of ASO. A well-written business plan, in particular, is crucial to help generate interest among potential investors [55]. ASO have difficulty accessing funding because, in the first place, their founding teams usually lack the competencies required to design an attractive business plan for investors [23], [56]. TTOs usually offer training and experience in preparing business plans [57], [58]. University incubators can also provide advisory and training services in the entrepreneurial capacities that are essential at this initial stage [27]. Administrators of science parks run training courses and offer advisory services to help ASO develop capabilities such as knowing how to identify and satisfy evolving customer needs in dynamic markets and how to select effective future markets [59]. Finally, legal support includes activities such as developing clear rules and procedures governing the exploitation of university technology [54] and providing access to professional business services for arranging and managing specific advice on IP regulation.

Since start-ups do not have unlimited means to fill all resource gaps simultaneously, they need to prioritize which resources to develop first [15], [60]. Following, the resource-based view the focus is how firms obtain the necessary resources [25], [61], a process that Sirmon *et al.* [15] refer to as "structuring" of the resource base. To successfully structure their resource base, firms continuously assess the resources in their possession, the resources they need to achieve their goals (reaching to the next growth stages), and the subsequent resource "gaps" that need to be addressed [60], here critical junctures. Therefore, in order for facilitators to adequately address the resource gaps of spin-offs, a fit between the key support offerings of different facilitators and the resource needs of ASO when navigating specific junctures is needed [14], which is addressed in this article.

III. Method

A. Research Design

A case study method, as a qualitative research type [62] is considered for this study to understand complex social phenomena and when existing theories are inadequate or incomplete [63]. Given our objective to understand the role of various facilitators, we conducted multiple case studies within three different university contexts [63]. A multiple case study generally provides a stronger base for theory building than single case studies do [64], [65] and it offers a richer theoretical framework and is more robust to compare findings across cases [63]. We used multiple informants in order to mitigate subjective bias and to create a richer result [66]. Nine comparable case studies of spin-offs were developed based on interviews with the founders and 18 representatives of university facilitators that contributed to the start-ups. The cases were across three technical university campuses in the Netherlands: Eindhoven University of Technology (TUE), Wageningen University and Research Center (WUR), and Delft University of Technology (TUD). We selected these technical universities because each university has a well-developed institutional infrastructure supporting roughly eight to ten new ASO each year, through a formalized and explicit support program. However, most of these Dutch spin-offs remain relatively small, more than three-third of the spin-offs employed less than five persons (64.9%) [7]. This picture matches the general trend in the EU that university spin-off firms remain small sized, i.e., 80% of the survivors after 6 years employ less than ten persons [67]. Triangulation was incorporated through using several data sources. Secondary data from universities were collected through documentary sources such as annual reports, and web pages to identify the universities facilitating activities and support programs. Primary data from each university were collected through visits, conversations, and interviews.

B. Data Collection

We gathered data from multiple sources, including both semi-structured interviews ($n = 9$) with CEOs and/or high level executives of nine spin-offs, and semi-structured interviews ($n = 18$) with university facilitators. We interviewed both entrepreneurs and facilitators to explore differences in perceptions regarding the support activities that facilitators provide and the real needs of start-ups. In cooperation with incubator directors, we identified three successful spin-off cases at each university campus, based on the definition of ASO that concern university research as a technological basis, and university researchers played key roles in the initiation and development of the spin-off [68]. In addition, to capture a range of market and industry

TABLE I
CHARACTERISTICS OF ACADEMIC SPIN-OFFS

	Case 1- WUR	Case 2- WUR	Case 3-WUR	Case 4-TUD	Case 5-TUD	Case 6-TUD	Case 7-TUE	Case 8- TUE	Case 9-TUE
Founding date	2006	2008	2010	2005	2010	2010	2005	2007	2010
Founder(s)	2 university researchers	2 university graduates	1 PhD graduate	1 university graduate 1 professor	2 university researchers	2 university researchers	2 university researchers	1 PhD graduate	1 university graduate and 1 professor
No. of employees	14	3	3	60	2	2	2	2	4
Growth Stage	Sustainable return	Re-orientation	Pre-organization	Sustainable return	Opportunity recognition	Pre-organization	Re-orientation	Sustainable return	Pre-organization
Industrial sector	Biotechnology	Information technology	Clean technology	Clean technology	Clean technology	Information technology	Information technology	Medical technology	Medical technology
Product	Fruit maturity testing	Online screening video camera	Plant electricity	Fast charging electric vehicle	Solar panels	Digital distance solutions for disabilities	Architectural acoustics	Digital diagnostic test	Pregnancy monitoring machine

contexts, we included spin-offs from three disciplines: information technology, clean technology, and medical/bio-technology. Most spin-offs occur within these industries [50]. Therefore, we selected successful cases to better picture the contribution of facilitators in navigating the early growth junctures of the spin-offs. This approach of purposive sampling is typically used in qualitative research to identify and select the information-rich cases for the most proper utilization of available resources [69], [70]. To disclose the role key of facilitators, we started interviewing incubator managers involved in the spin-off. Following a snowballing technique [71], we identified other facilitators that were actively involved in the start of the spin-off and interviewed them accordingly to ensure a detailed case description of facilitator involvement in the spin-off. Among the facilitators we interviewed were IP managers, incubator directors, TTO managers, science park directors, and other facilitators.

The interviews followed a process approach that allowed us to develop a chronological overview of the growth of each spin-off and helped us to decipher the intent and motivation of the various actions and actors involved in the spin-offs development process. In our preliminary analysis, we identified the current stage the spin-off was in and the junctures it had passed. The interviews were semi-structured based on a narrative approach [72], which combined a structured agenda with the flexibility of asking additional questions. The interviewer kept interruptions to a minimum and invited the facilitators to describe their involvement in a course of time during the spin-offs development process from its inception to the present. This interviewing technique is aimed at gaining a better understanding of the actual events, avoiding personal views and theoretical perspectives to dominate data collection [1]. After informing and inviting potential participants by e-mail, two researchers visited the participants to conduct face-to-face interviews in their professional environments. We deliberately started with an open question to enable participants to express their views in their own words. Miller *et al*. [66] reported that this leads to higher accuracy in retrospective reports.

Table I provides a description of each case and its main characteristics. Because our interviews involved asking the spin-offs founders to draw on their memory, and to recall and reflect on the action in the course of time, challenges and support they received during their growth, we included only spin-offs that had been established in the last decade. We asked each founder to explain the spinoff's biographic history in the periods of time. As their stories evolve, we identified how they moved on at different stages by passing different stage junctures [73].

Then the audio-recorded interviews were transcribed for detailed analysis. The interviews were structured as follows. We first asked entrepreneurs to explain the spin-off's biographic history. We asked the university facilitators questions on two issues: 1) the growth process and the critical junctures that ASO encounter during the early growth stages, and 2) the support they provided to the spin-offs to overcome their critical junctures. Then, we asked the ASO founders questions on the two issues: 1) the spin-offs development process and the critical junctures they had experienced during the early growth stages, and 2) the support they had received from facilitators to overcome these critical junctures. The information from three facilitators in three universities gives us a broad picture of all the barriers that spin-offs face during their growth and the supports that they provide. However, we validated the information by asking founders to rank the main critical junctures and key support activities which were extracted from interviews by the facilitators on a seven-point Likert scale.

C. Data Analysis

To explore differences in perceived resource needs, a distinction was made between data coming from entrepreneurs and data coming from facilitators. The data on open questions were

TABLE II
IMPORTANT GROWTH JUNCTURES AS PERCEIVED BY ENTREPRENEURS AND FACILITATORS

Critical junctures	Challenges mentioned (family codes)	Facilitators (n=18) (#Times mentioned)	Founders (n=9) (#Times mentioned)
Opportunity recognition	Inability to arrange IP protection	6	4
	Inability to think commercially	5	6
	Inability to write business plan	4	7
	Lack of industry network	2	5
		#: 17	
Entrepreneurial commitment	Lack of entrepreneurial skills	9	5
	Inability to find market application	5	5
	Lack of role model	3	2
	Lack of entrepreneurial capability	3	4
Credibility	Inability to attract finance	18	5
	Lack of a well-balanced managerial team	5	5
	Lack of legitimacy	5	4

analyzed using thematic coding [74]. Atlas.ti, a software package for content analysis, was used to facilitate the systematic combined interpretation of the interviewees' wide-ranging statements in the transcribed interviews following two approaches. In generating codes we used both themes identified through the literature review and themes induced by the researchers in examining the interviews. First, we assigned codes to text fragments using a bottom-up approach, i.e., without strong *a priori* assumption. This approach allowed us to move back and forth between the transcribed interviews [75] and to identify themes and codes in order to arrive at a more accurate inductive and explorative analysis. We tried to refine the codes into themes to generate a set of axial (family) codes by reducing the open codes further [74]. This is known as conventional content analysis [76]. Second, we adopted a more top-down approach, known as directed content analysis [76], in which we related our codes to the academic literature. This aided both simplification, through reduction to dominant categories, and also the complication through an expansion and reconceptualization of the data [77]. To derive systematic explanations for the processes we observed, we identified observations that matched theoretical concepts in an interactive process [1]. For example, we were able to relate all answers to five support activities found in the literature. The following example illustrates how this sequential approach works: a respondent might say "Usually when we visit clients, we go together to make better deals." We coded this text fragment as "LINK TO CLIENTS." This might be a code that was used for similar content in another interview, or a new code, when the opinion expressed has not yet been voiced by anybody else in the sample. Next, we reduced the data by combining several codes into "family codes," similar to econometric factors, representing codes that are related at a more generic level. Building on the example above, we combined the "LINK TO CLIENTS" code and the "LINK TO BUSINESS PEOPLE" to form an overarching "NETWORK SUPPORT" code. In other words, we assigned the same code to multiple quotes in various data sources, and then group these codes into broader family codes. Note that any code was assigned to one interviewee only once to prevent interviewees who voiced a very strong opinion from having a disproportionate influence on the overall results. The data were processed by two people in order to fully understand and thoroughly analyze each case and maximize external validity.

IV. RESULTS

The facilitators we interviewed disclosed the critical junctures during the growth stages of the spin-offs and the important support activities they provide during the growth stages. We grouped facilitators statements based on the "family codes" of conceptually similar challenges and support. Then, we validated these elements with the ASO founders.

Tables II and III give an overview of the junctures and support activities identified in the theory section. Based on conceptual similarity, these activities are grouped together into families to form five main types of support: infrastructural, financial, network, business, and legal support (see Table III). Given our relatively large interview sample, the purpose of the numbers is to provide an overview of key support activities and critical junctures mentioned by entrepreneurs and facilitators. We will rely on the qualitative insights obtained through interviews. In this part, we turn our focus to the key support activities and actors that can best help ASO navigate specific critical junctures during the transition from one growth stage to the next stage.

The interview data revealed the concepts that explain the key support activities to navigate specific junctures, which is outlined with interview quotes. Only three of the spin-offs in our study had reached the sustainable returns. Therefore, we

TABLE III
SUPPORT ACTIVITIES AND NEEDS AS PERCEIVED BY ENTREPRENEURS AND FACILITATORS

Main types of support	Most mentioned supports (family codes)	Facilitators (n=18) (#Times mentioned)	Founders (n=9) (#Times mentioned)
Infrastructural support	Accommodation	6	7
	Office space	4	4
	Lab space	4	3
Business support	Coaching	8	4
	Education and training	8	4
	Developing business plan	5	8
Network support	Link to business people	8	9
	Link to industry network	6	9
	Link to other start-ups	5	9
	Link to clients	4	4
	Link to big companies	3	3
Financial support	Attract finance by linking to investors	18	7
	Provide seed funds	10	9
Legal support	Collaboration agreement	5	6
	Arranging and managing IP	5	5

mainly analyze the first three critical junctures. These three junctures seem to be important for an empirical analysis of spin-offs after their founding since the credibility juncture refers to the establishment of transactions with potential customers and to accessing resources from suppliers and (key) financers like venture capitalists [7].

A. Analysis of Key Support Activities in Navigating Critical Junctures

1) Key Support in Navigating Opportunity Recognition Juncture:

a) Challenges regarding opportunity recognition: Based on the interview with 18 facilitators, we identified 17 distinct quotes relating to 4 challenges of opportunity recognition juncture which were inability to arrange IP protection, inability to think commercially, inability to write business plan, and lack of industry network. Founders validate these challenges in particular the inability of spin-offs to think commercially, to write a business plan, and their lack of an industry network as the main challenges. Most challenging was writing the business plan as one of the facilitators claimed: *"Every single academic spin-off that I meet, without exception, has great trouble drawing up a business plan. They don't have a clue what should be in it."* Besides, one founder voiced this disparity in valuation as follows: "*I had to ask for advice, from [the] university incubator, on writing a business plan, and especially on the financial part, I'm a biologist, so that is what I have no knowledge of writing business plan"*. Inability to think commercially can also be linked to Inability to write business plan.

b) Facilitators support in navigating opportunity recognition: Facilitators play a significant role in the early growth stages of spin-offs by providing business support in terms of helping them to develop their business plan and to shape their business by providing market-oriented advice. According to an incubator director: *"…We have a look at the proposition or plan, we comment on things that are not developed very well. I give some help and advice to come to a viable business plan…*." The largest majority of founders appreciated help in developing their business plan. Founders appreciate practical help with developing their business plan through incubators and business developers in very beginning. One of the founder pointed out: *"The university incubator coached us in writing a business plan and finding the right market and developing standard documents.* Concerning network support they strongly valued being at university incubator to do network with other start-ups. As the other facilitator claims "…What we do is put them in touch with business people, business minds…" and lab facilities mainly for prototyping their product." *…being located at incubator combined with the equipment and the lab facilities that the university provided, was super critical in the early stages*". As the other founder claims: *"…being located at incubator that combined with the equipment and the lab facilities that the university provided, was super critical in the early stages."* Considering the lack of industry network as a barrier, spin-off founders stated how helpful it was to meet other business people and expand their network in order to develop their business opportunity. All founders greatly valued the network support to get access to people in industry.

Facilitators provide legal advice to start-ups on how to valuate and protect intellectual property, because they know how to

manage patents and other intellectual property rights. A TTO-manager: "*Almost all new ideas will be patented by the university and should be reported to the TTO. The vast patent base is screened and the ones with a high potential are selected.*" Inability to arrange IP protection was confirmed by some founders as they appreciated the legal support they received in terms of intellectual property protection and management (see Table III). All founders appreciated the financial support from facilitators, providing seed funding during early growth stage and support in terms of IP protection. For example, a founder mentioned that the university TTOs pay for the spin-off's patent as an indirect loan, to later become shareholder in the company: "*They offered us facilities in the first years and a kind of preferred partnership… The university sold us the patents and provided part of the start-up capital*."

2) Key support in Navigating Entrepreneurial Commitment Juncture:

a) Challenges regarding to entrepreneurial commitment: The second critical juncture is the lack of entrepreneurial commitment. There were 28 quotes related to 8 challenges, with lack of entrepreneurial skills and capability, the inability to find market applications, and the absence of a role model, as the most frequently mentioned ones (see Table II). For example one of the facilitator mentioned: *"I would say the biggest problem is too few entrepreneurial skills to actually find clients, to make that first sale."* Founders stress the lack of entrepreneurial capabilities, and the inability to find a market application, as the main challenges. One of the founder pointed out: "*to develop a product for a market which was not there was really difficult.*"

b) Facilitators support in navigating the entrepreneurial commitment: To navigate this juncture, facilitators support spin-offs by providing network support by bringing together spin-offs and by stimulating knowledge transfer and experience sharing was much appreciated by founders. This support was valued by all spin-offs founders as they appreciated network support to realize close contacts with other spin-offs, allowing them to share common infrastructure and to advance networks for sharing knowledge and providing mutual help.

University incubators claim to enhance founders' skills by providing education and training programs in accordance with founders' personal needs. As the director of an incubator explained: *"We have a kind of personal development program. … So we started a peer review group, just like they do in hospitals where doctors get together every two weeks to discuss a case."* Facilitators also connect entrepreneurs with coaches, serial entrepreneurs who have created, developed and sold spin-offs before. As a university business developer put it: "*…We just offer them a platform with all kinds of programs … they can be assigned a coach, who is always a serial entrepreneur*." Facilitators deliberately house various spin-offs together, as one of the facilitators mentioned: "*I think it's most important for the start-ups that they're here together, in this building. We house all kinds of companies from start-ups to booming businesses*." Or, other facilitator put it, "*we establish a network among the university's spin-off companies. …. The network is useful for information sharing, but also for members' to prepare a joint presentation to the market*." Founders also appreciate all the early clients that facilitators provide to them as one founder claims: "*At the early stage, finding clients through the incubator was critical for us. And some of these early contacts are still our customers*."

3) Key Support in Navigating Credibility Juncture:

a) Challenges related to credibility: Considering the credibility juncture, facilitators as well as founders mentioned the inability to attract funding from investors especially from facilitator's view, lack of legitimacy, and the lack of a well-balanced managerial team as the spin-offs main challenges. This juncture is mentioned most often, with 37 quotes relating to 9 challenges that belong to this family. The main challenge was the company's inability to attract finance from investors. One facilitator stated: *"… They couldn't convince investors to put up the money and there was an inability to attract finance in the second and third round going from prototyping to mass production…"* Another facilitator stated: *They are unable to achieve a balanced managerial and scientific team…"*

Founders referred to their failure to attract funding from investors, as much as to their lack of a well-balanced managerial team. "*Finding a well-balanced team was a challenge in the beginning, two people left at the same time and took us time to replace them ….* " As one founder explained: "*It became a problem that we lacked commercial experience just around the same time that we were running out of initial funding.*" Other founder mentioned: "*So we were not able to appoint a commercial manager, a commercial person when it was really needed."*

b) Facilitators support in navigating credibility juncture: Facilitators help spin-offs to contact with external financiers, potential customers, and investors who want proof of market, proof of concepts, and the credentials of the entrepreneurs they invest in. In this respect, facilitators play a key role by building networks and attracting finance from investors, such as business angel networks and venture capitalists. A university facilitator, previously active as venture capitalist, elaborated: "*In my network I have contacts with informal investors, with banks… Sometimes I accompany someone while they negotiate a deal with an investor or the bank…*" This support will give them access to resources beyond their financial capacity and helped them to enhance their credibility. Spin-off founders we interviewed emphasized that their initial lack of legitimacy was later compensated through university support, especially for companies located in incubators. Being located in the incubator helped to gain external legitimacy and to further expand in industry in getting access to venture capitalist networks. As one founder explained "*Being located at the university gives us credibility and helps us to grow our network*." Founders also mentioned that collaboration agreement provides credibility and access to external resources.

4) Summary of Findings: To navigate the opportunity recognition juncture, founders appreciate infrastructure support in terms of lab facilities mainly for prototyping their product and business support to develop their business plan. They also valued linkages with industry as well as financial and legal support in terms of seed funding and IP protection. For raising the entrepreneurial commitment, founders appreciate infrastructure support in terms of being located at incubators and the network support in linking spin-offs together. Founders also perceived these links as very important in order to find a market

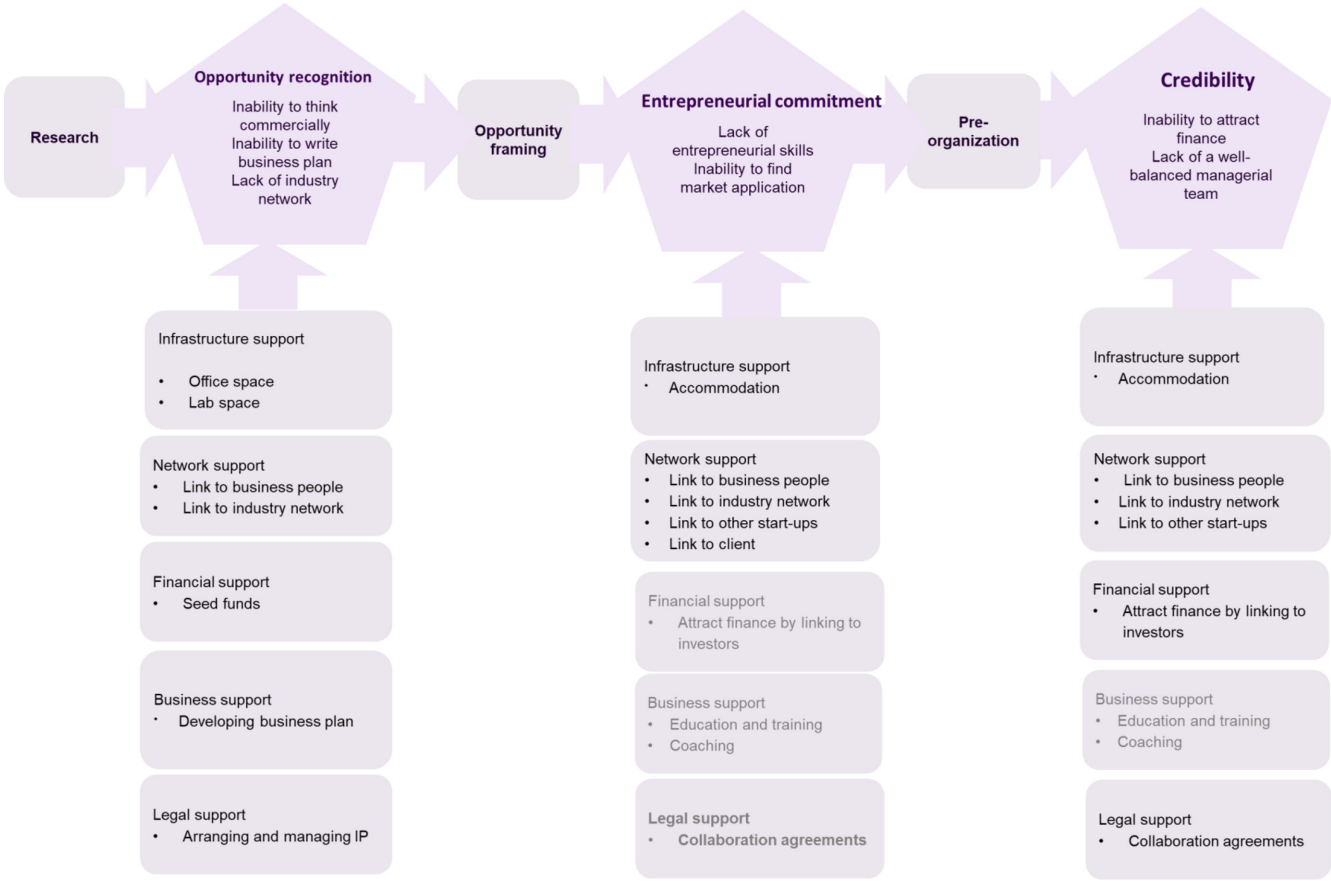

Fig. 1. Key support activities in navigating the growth stage critical junctures.

application and early clients. In addressing the credibility junctures, founders appreciate the linkages to the people and being located with other start-ups. Founders appreciate the legitimacy they gain by locating at university, connecting to other linkages to enhance their credibility. They also value different legal support in terms of collaboration agreement and financial support in terms of attracting their access to venture capitalists enhancing ASO's legitimacy and credibility. Overall, the founders considered problems related to writing a business plan, the lack of an industry network, and the inability to find market applications more important than facilitators, whereas facilitators found the inability to raise funds more problematic. Regarding to the support activities, the largest perceptual differences between facilitators and founders concern network support. All spin-off founders ranked the connection to business people, industry networks, and other start-ups as important throughout the growth stage in contrast to merely one-third of the facilitators. They ranked support in terms of attract finance by linking to investors as important. Fig. 1 summarized the key support activities in navigating the growth stage critical junctures.

V. Conclusion

This article provided new scientific insights into the entrepreneurship process with the aim to clarify the role of key facilitators and the key support activities to help ASO to navigate critical junctures and to facilitate transition from one stage to another. Prior studies primarily pointed at the low quality of the incubator's resources and at a mismatch between the start-up's needs and the incubator's supply of resources [10], [12]. While we confirmed these findings, this article identified an additional mismatch: a mismatch between the needs that spin-offs have and the support activities offer during growth stages. We thereby respond to calls for research on incubation practices [59], [78]. While a large amount of research exists on the role of specific facilitators, little research has taken a more holistic approach to analyze the role of multiple facilitators during the different stages of spin-off growth. This article developed an analytical framework based on the literature of stage-based models and the resource-based view that enabled us to first investigate the specific knowledge or resource gaps in different stages (critical junctures during start-ups' growth stages). Finally, we investigated the role of facilitators in matching the key support activities in navigating specific critical juncture to facilitate their transition toward the next growth stage. In line with prior studies [7], [18], [79], our cases also identified different growth stages and junctures and suggested that the university facilitators' support was highly influential for early growth development. We contribute to these studies by matching key support activities from specific facilitators to specific critical juncture. Specifically, we investigated the experiences of both spin-off founders and facilitators and identified the key support activities that are essential to overcome certain critical junctures. In this way, we have added new, useful empirical insights to the relatively few studies that

take both founders and facilitators into account regarding the critical junctures and key support activities.

In order to navigate the opportunity recognition juncture, founders appreciate infrastructure support in terms of lab facilities mainly for prototyping their product and business support in terms of developing their business plan through incubators and business developers. They valued the different industry links provided by incubators in the very beginning and financial as well as legal support in terms of seed funding and IP protection through TTOs.

During the entrepreneurial commitment juncture, founders claim that they lack entrepreneurial skills and they are not able to find the market application. Some previous study [26] found that technological entrepreneurs have a "technology push" view of invention, emphasizing technological development while underestimating the importance of satisfying a market need and creating a viable business model. It was surprising that the spin-offs founders in our cases were well-informed about this issue and considered that as real challenge they have. In order to navigate entrepreneurial commitment juncture, founders appreciate infrastructure support in terms of being located at incubators and the network support in linking spin-offs together to realize close contacts with other spin-offs, allowing them to share common infrastructure and to advance networks for sharing knowledge and providing mutual help. Founders also perceived these links very important in order to find a market application and early clients. Surprisingly, very few number appreciate the support activities in terms of coaching and training, whereas studies show that introduction to coaches and professional trainers help spin-offs to meet their strategic development goals such as finding market application and increasing their commitment to develop their ventures [41], [80] and to navigate the juncture of entrepreneurial commitment [8], [81]. However, in this stage, founders appreciate the network support to bring them in contact with other spin-off founders. This increases their entrepreneurial skills and motivates them to be committed to the venture [44], [82]. Therefore, facilitators helped spin-offs navigating entrepreneurial commitment juncture by helping them connecting to other start-ups.

Considering the credibility juncture, facilitator regarded the inability to attract funding from investors, and the lack of a well-balanced managerial team the main challenges. In addressing the credibility junctures, founders appreciate the linkages to the people and being located with other start-ups. Founders appreciate the legitimacy they gained by locating at university, connecting to other linkages to enhance their credibility. They also value different legal support in terms of collaboration agreement as well as financial support in terms of attracting and improving their access to venture capitalists enhancing ASO's legitimacy and credibility. Financial support by linking them to venture capitalists was appreciated by spin-offs, since it gave them access to resources beyond their financial capacity and helped them to enhance their credibility next to the networks. This is in line with studies indicating that limited network hinders ASO to gain credibility and accessing to a second round of funding [8], [28], [34]. Network building by facilitators leads to greater credibility [38], [54], [83], and better access to financial resources, complementary assets, and sources of knowledge [84]. Some founders have stated that affiliation with the university helps them build the necessary networks and credibility, legitimacy, and reputation, making it easier for them to access an external resource which helps them to overcome the credibility juncture. This is in line with the previous literature that state that the brand name, prestige, and reputation of the university from which the ASO is spun off may act as an endorsement of the business project, facilitating its funding [85]–[87]. Universities, TTOs, and incubators help spin-offs navigating credibility juncture by helping them expand their network and linking them to the venture capitalists. By introducing spin-offs to financial experts and venture capitalists, or encouraging them to hire a serial entrepreneur, facilitators can help spin-offs to raise additional funding needed to reach the point where they overcome the final critical juncture of sustainability. This will help them to compete with market actors [7], [19], [88]. However, founders appreciate facilitators as intermediaries, linking spin-offs to venture capitalists and experienced entrepreneurs to develop expertise and expand the spin-off's network.

In general, in terms of support, the founders appreciate the business support activities in writing a business plan in the early stage. Also, whereas the facilitators see the connection to the venture capitalist to find founds for spin-offs as the most critical support, founders appreciate other linkages and being introduced into various networks. Therefore, based on our findings, facilitators can help spin-offs in the later stage juncture by linking them to venture capitalists and different business networks. It seems that is a point where facilitators should step back, because the spin-off bridges the gap between the university and the business world itself. Interestingly, we observed that founders appreciate early interaction effects of support activities on critical junctures more, whereas the facilitators focus more on the last stages of facilitating process, such as providing links to venture capitalists. It is important for facilitators to understand the facilitating process and the activities that will lead to the results. In fact supporting ASO in reaching to a viable business plan and several linkages throughout the process will not only help spin-offs in navigating opportunity recognition juncture, but also will increase the chances of obtaining financing from private investors to navigate credibility juncture [8], [56]. Similarly, supporting spin-off to formulate the commercial part of their plan and find early customer will help spin-offs to commercialize their products/services and increasing the value of the new venture in competitive markets [8], [89]. This is in line with the findings of current studies that market-related obstacles tend to be the most resistant over time whilst financial thresholds may be overcome fairly quickly [90]. In fact, comparing to other start-ups, highly innovative spinoffs could solve later junctures of the credibility and sustainable returns more quickly due to first-mover advantages [90].

This article expanded entrepreneurship research in several ways. First, the results were in line with studies discussing a mismatch between the incubator's supply and the start-up's demand for resources [10], [12], [13]. We proposed that in order to address these perception differences, it was important to know what were the ASO specific barriers and needs particularly during the growth stages. So it went beyond a static view of the role of facilitators responding to the call by Mian *et al*. [91] for more in-depth exploration of the incubation process and a contingency approach, where support should be tailored to specific

critical junctures. Second, while previous studies proved the overall positive impact of different types of support on spin-offs' development, few paid attention to the founders' experience and assessment of these support programs. This article therefore complements existing studies on entrepreneurship policy by focusing on entrepreneurs' experience and by contrasting them with facilitators' views. Third, we investigated how this key support was geared toward, and affected, specific critical junctures during the growth stages. This article contributes to a better understanding of how entrepreneurial processes interacted with and benefit from key support actors by investigating what were the key support in terms of resources or knowledge that different facilitators could provide to help ASO navigate specific juncture in specific stage of growth to gain SCA [14].

A. Managerial Implications

From an economic policy point of view, it would be wise to assess the effectiveness of startup support programs, especially given the increasingly large amount of public funding invested in these programs. All in all, our findings verify that incubators provide a resource rich environment [27]. This article suggests how facilitators can benefit more from their resources to foster spin-off growth by helping them to find their way through particular critical junctures. To improve the conditions for start-ups, scholars often advise policy makers to adapt their policies to the needs of start-ups by asking entrepreneurs what they perceive as the main factors constraining entrepreneurial activity [10], [92], [93]. As such our findings provide detailed insight into how facilitators can match their support portfolio to the needs and critical junctures that spin-offs face during their growth. Facilitators should know that founders appreciate different kind of network support through the growth stages.

Facilitators should be aware that support aimed at business plan writing, IP arrangement, seed funding, and network building are crucial ways to help spin-offs overcome the critical junctures of opportunity recognition and entrepreneurial commitment. During later stages of a spin-off's development, facilitators should switch to acting more as intermediaries between spin-offs, venture capitalists, in order to deal with the subsequent junctures of credibility and sustainability. If incubators only provide resources and guidance without addressing their real need in different stages, start-ups will likely fail as soon. Consequently, the incubator should be an environment where start-ups learn how to identify gaps in their resource base, and be able to autonomously acquire or develop these resources with incubators [10]. As start-ups mature and entrepreneurs eventually recognize the importance of business knowledge, incubators were found to take a laissez-faire approach [10]. This is also in line with Ferretti *et al*.'s [94] study that claims a proper strategy is "neither absent nor too present" is necessary for parent universities to support the sustainable development. Also founders should carefully reflect on their growth stages and resources needed when approaching facilitators in order to overcome the specific critical junctures.

B. Limitations and Future Research

Although this article sheds light on barriers to ASO growth and on the type of support that is important in overcoming this, we must draw attention to some limitations and possible future research. There is a widely recognized need to study the development of ASO [6], [20], [95], and we hope this article may function as a catalyst. This article has focused on explaining founder assessment of support programs based on the activities these programs provide. We did not take into account the background of the founders and how this might affect their assessment [41]. Future research could focus on how the prior experience of founders in terms of industry experience and education might influence the value they attach to the support activities of facilitators. Our samples are mainly early stage spin-offs, whereas future study can benefit from more established cases in the later growth stage to explore their real support needed then.

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