

**KNOWLEDGE INTEGRATION AND ENTREPRENEURIAL INNOVATION,
A MULTIMETHOD APPROACH**

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STATEMENT OF ORIGINALITY

I certify that the intellectual content of this thesis is the product of my own work and that all the assistance received in preparing this thesis and sources have been acknowledged. This thesis has not been submitted for any degree or other purposes.

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PUBLICATIONS RELATED TO THE THESIS

The following sections draw on content presented or close to being presented at conferences, submitted, or close to being submitted to peer-reviewed journals. In all research outputs, I designed the study, collected, and analysed the data, and wrote the manuscript. Co-authors acted as mentors, orienting me throughout the theorizing process and helping me with the content and flow of my argumentations. Authorship is by order of contribution.

CHAPTER TWO (SYSTEMATIC LITERATURE REVIEW)

Preliminary versions of this article were presented in the following instances or included in the following publications:

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I hereby confirm that I received confirmation to include the published material by the corresponding authors. I further certify that this thesis has not been submitted for any degree or other purposes. The intellectual content of this thesis is the product of my own work. All assistance received in preparing this thesis and sources has been acknowledged.

As the primary supervisor for the candidature upon which this thesis is based, I can confirm that the authorship attribution statements above are correct.

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ABSTRACT

This thesis examines the role of knowledge as a precursor to innovation in the context of entrepreneurial post-entry conditions. Particularly this dissertation aims to clarify how entrepreneurial firms organize knowledge to achieve innovation, including the role of founders in the development of firm knowledge. To do so, this research uses a multimethodological approach, including a systematic literature review, a qualitative and a quantitative study. Besides underscoring the importance of adopting a process perspective to understand knowledge in entrepreneurship, this thesis findings include the identification of novel integration strategies and the factors determining such strategies. Moreover, this thesis provides a refined conceptualization of knowledge integration mechanisms, its founder-related antecedents and relationship with innovation. Consequently, this thesis contributes to a deeper understanding of the relationship between knowledge, entrepreneurship, and innovation in small firms. It offers insights into the role of founders, the integration of knowledge, and the pathways to innovation. By adopting a process perspective and exploring internal dynamics, this research advances the knowledge-based view of the firm and contributes to the broader applicability of knowledge perspectives in entrepreneurship.

Keywords: Entrepreneurship, knowledge, knowledge integration mechanisms, innovation.

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CHAPTER ONE

INTRODUCTION

1. Preface

I started my doctoral journey a few years after I had decided to move away from architecture and gradually transfer my skills to other areas. Back then, I was working as a leading architect at an innovation centre for timber construction, aiming to incorporate university-level research and new technologies into the lagging world of construction by promoting the use of timber in high-rise building projects. In a country like Chile, where seismic activity is a continuous concern and concrete structures are the standard, designing with timber was not only problematic from a regulatory perspective but it was also contended culturally. Developing social housing with community participation often involved adjusting the design to make the houses look *less like made out of timber* and *more like made out of stone*. Finding structural engineers specialized in high-rise timber construction was challenging. Convincing the local councils was a full-time job. And the list goes on. Soon we realized that we had to change the way we took on design briefings by incorporating stakeholders early in the process and start applying what non-designers call *design thinking*. Sharing the design process, taking decisions together, discussing alternatives with our non-designer partners, to name a few. Facilitating those meetings made me realize, for the first time, how natural it was for designers to integrate knowledge and how *unnatural* it could become for some. What I did not know then (or at least was not aware of) is that each person in the room held different pieces of knowledge, like a puzzle that needed to come together to reach a common understanding. Integration was key. Not long after, I was able to apply my observations into broader contexts, as I took a class on *organizational learning* lead by Professor Linda Argote at Carnegie Mellon University. This class introduced me to the world of knowledge management. Then I realized that regardless of size, organisations need to integrate knowledge, leverage the skills and expertise of its members, incorporate new learnings, and reach common understandings, especially when confronted with new challenges such as innovation. But *how* did they do it? (assuming they were not designers, of course!).

Keeping these experiences in mind, this thesis is an attempt to unravel the processes involved in knowledge integration in a learning-intensive context, entrepreneurship. Considering the constraints of the entrepreneurial activity, the question of *how* becomes even more puzzling and new questions emerge such as whether integration is always achieved and

to which implications for innovation. Regarding knowledge, this thesis implicitly advocates for a broader understanding of knowledge in firms, by moving away from theoretical streams that label specific types of firms as knowledge-intensive or examine knowledge in highly technological sectors. Considering knowledge as the outcome of learning (Argote & Miron-Spektor, 2011), every person and every organization capable of learning, can potentially be a holder of knowledge.

2. Motivation

The conceptualization of the relationship between knowledge and innovation in an entrepreneurial context, has involved the distinction between the knowledge acquired before the creation of a new venture such as the human capital of the entrepreneur, and the knowledge developed throughout the entrepreneurial process, such as the experience gained after undergoing critical events (Cope, 2011; Cope & Watts, 2000). Nonetheless, post-entry conditions entail a distinctive complexity whereby knowledge can be developed and stored at the individual level, at the firm level or both. For example, entrepreneurs might choose between keeping their learnings for themselves or sharing them by introducing firm-level improvements. Adding to this complexity, post-entry conditions often involve the management of knowledge across individuals, either inside the firm boundaries or in interaction with external sources (Alexander McKelvie, Wiklund, & Brattström, 2017). Yet, the entrepreneurship literature has predominantly conceptualized knowledge at the level of the entrepreneur prior to the start of the entrepreneurial process.

Firm-level knowledge must be integrated formally or informally to support growth by enabling knowledge application, learning, and innovation (Macpherson & Holt, 2007). Consequently, the integration of knowledge may involve practices oriented toward the dissemination of knowledge beyond individual boundaries to enable its utilization at the organizational level. Accordingly, firm-level knowledge entails both knowledge and knowledge-related practices. Specifically, firm-level knowledge that supports innovation must fulfill a double role by ensuring sufficient flexibility to enable openness and creativity in exploratory phases and providing consistency to leverage expertise in commercial exploitative phases (Cagliano & Spina, 2002). Formally actioned, the management of knowledge involves the identification of relevant knowledge and the implementation of “related processes of creation, organization, diffusion, use, and exploitation (Santoro, Thrassou, Bresciani, & Giudice, 2019)”. Building on these theorizations, this dissertation posits a conceptualization of firm-level knowledge along two dimensions; the knowledge that the ventures possess, and the

practices oriented at knowledge reconfiguration, transfer, and retention. Critical to this proposition is the idea that knowledge is a malleable resource, as it transforms over time (Brown & Duguid, 2001). As pointed out by Barley, Treem, and Kuhn (2017) there are significant differences across knowledge management frameworks as they convey different conceptualizations of knowledge. Accordingly, the distinctive characteristics of entrepreneurial knowledge should encompass a correspondent framework. Since firm-level knowledge requires organization, structuring, or integration to sustain innovation over time, I argue that specific decisions around knowledge must take place to achieve this goal. For example, which forms of knowledge and knowledge processes ensure the attainment of innovation in different entrepreneurial settings? How do entrepreneurs make these choices and to which consequences? Does the sole possession of knowledge and the implementation of processes lead to firm-level knowledge and innovation?

3. Research design and methodology

To address these issues, this thesis has aimed at examining firm-level knowledge in the context of entrepreneurship and its impact on innovation. As the main contribution, this thesis aims to advance the understanding of entrepreneurship knowledge at the firm level. A firm-level conceptualization of knowledge entails the examination of organizational perspectives, as firm-level knowledge needs to be organized and structured to enable firm-level outcomes (Macpherson & Holt, 2007). Given that the entrepreneurial context is characterized by economic and human capital resource scarcity (Rowe, 2001) and high employee rotation (Agarwal, Gambardella, & Olson, 2016); an understanding of post-entry knowledge may help explain differences in ventures' output that are not covered by existing frameworks.

Specifically, the overarching question of this thesis is: *How is knowledge organized in entrepreneurial firms, and what are the effects on the innovation outcome?* The first part, "How is knowledge organized in entrepreneurial ventures?" points at identifying and understanding the ways knowledge is embedded and promoted during the entrepreneurial process, focusing on differences and similarities among firms from different backgrounds. To aim at the identification of novel conceptualizations, this question is addressed through a qualitative study. The second part "(...) what are the effects in the innovation outcome?" aims at measuring the impact of implementing different knowledge approaches for innovation and therefore is tackled through a quantitative study. Underlying these questions, lies the assumption that the way knowledge is organized in entrepreneurial ventures differ from those of established firms, and therefore the concepts may be revised, and the frameworks refined or changed. Yet, to confront

these initial assumptions, I have started this project by investigating existing conceptualizations of knowledge in entrepreneurial settings toward innovation. Therefore, with the aim of clarifying, organizing, and conceptualizing different views of knowledge and its relationship to innovation, this thesis incorporates a systematic literature review. This review seeks to isolate firm-level conceptualizations of knowledge and incorporate views from different theoretical streams.

All in all, this thesis subscribes to a multimethod approach as a comprehensive method. Accordingly, the thesis adheres to the understanding of multimethod research as defined by Bazeley (2006): “Multimethod research is when different approaches or methods are used in parallel or sequence but are not integrated until inferences are being made”. A multiple methodology has been posed as a valuable tool at several levels of the research process, however, this study follows Edmondson and McManus (2007) rationale under the concept of “methodological fit” as a way to achieve consistency between the different components of this dissertation. This perspective highlights the state of prior knowledge around the intended phenomenon of study as a critical determinant of the research strategy selected. In general terms, this framework suggests that in fields where knowledge is in early development, the questions will be more open-ended, and thus the requirement of methods aimed at understanding and elaborating constructs will be needed. Conversely, in fields where knowledge is more robust, questions are more likely to be specific and aimed at explanatory theory building, thus methods that utilize existent constructs are more appropriate. Building on these principles, I suggest this thesis is situated in an *intermediate theoretical state*, which according to Edmondson and McManus (2007) occurs when a combination of existing frameworks are combined with novel concepts or constructs. In this case, prior conceptualizations of knowledge find new significance or give rise to new constructs in the light of the entrepreneurial context; therefore, a multi-method approach is appropriate for a study that draws on conceptual openness from qualitative data and hypothesis testing from quantitative data.

For the purpose of this thesis, the selection of a multimethod approach responds to the aim of i) synthesizing previous conceptualizations that are situated within the same research scope ii) confronting existing theoretical frameworks assessing their applicability to the entrepreneurial context through a qualitative study and, iii) applying suitable constructs and measure the effect of knowledge management in entrepreneurial venture innovation through quantitative methods. As a result, a multimethod approach has allowed the generation of three independent studies with independent research questions, findings, and contributions.

Moreover, the multi-method approach allowed the examination of the topic of study from different angles, reaching complementing views. In addition, a multiphase design (Creswell & Plano Clark, 2011) allowed the emerging findings and questions to strengthen the following phase and the thesis as a whole.

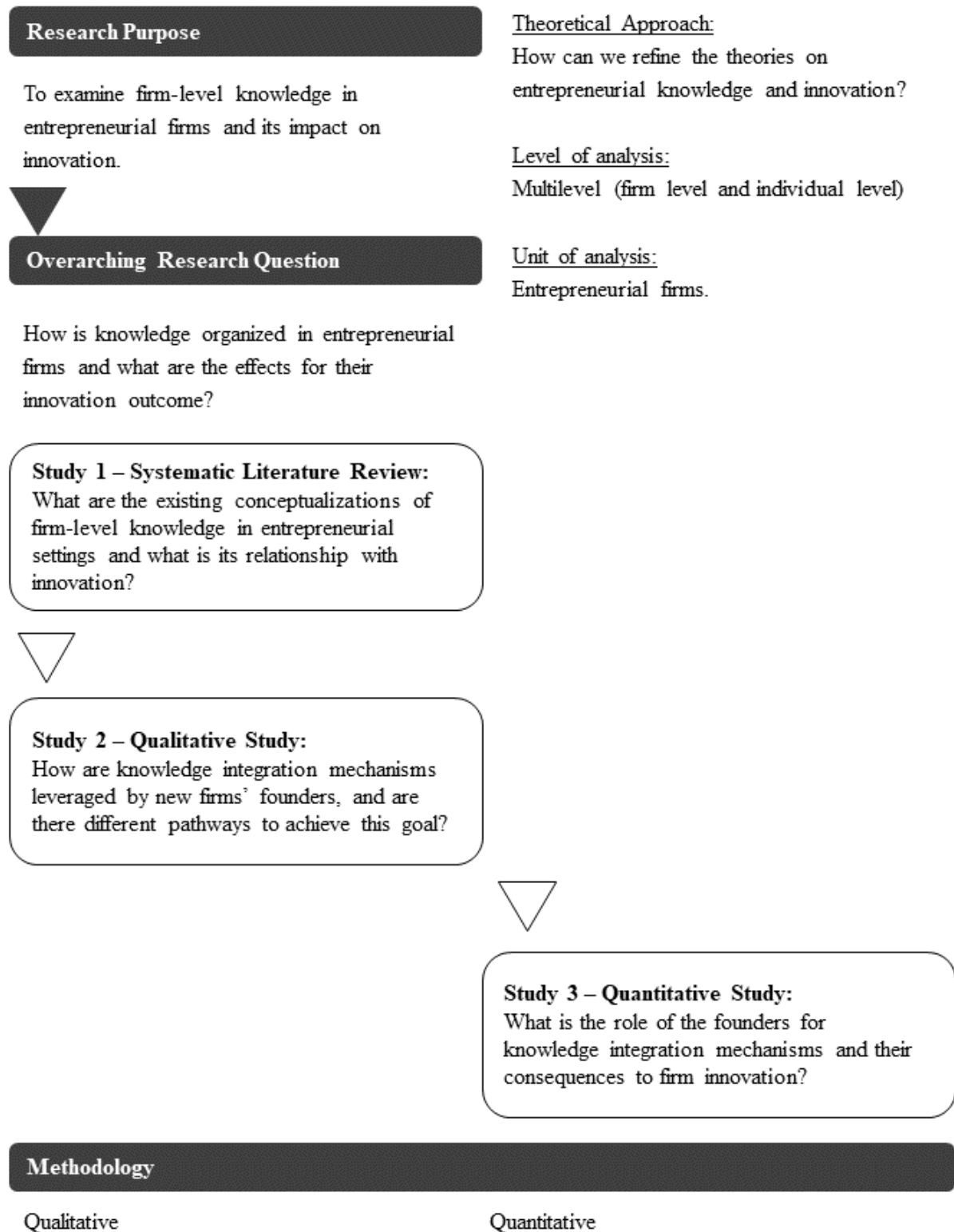
A summary of the studies included in this thesis is provided below:

- First, a *systematic literature review* (Study 1, Chapter Two) was conducted to organize previous findings around the conceptualization of entrepreneurial firm-level knowledge and its relationship with innovation.
- Second, a *qualitative study* (Study 2, Chapter Three) aims at examining knowledge integration in entrepreneurial ventures by characterizing different mechanisms and identifying its antecedents. Further, this study investigates the firm-level consequences of adopting different strategies, by elaborating four distinctive archetypes.
- Lastly, a *quantitative study* (Study 3, Chapter Four) was conducted aimed at testing the constructs identified in the precedent study and examining its relation with firm innovation. Correspondingly, this study aims to explain the variation in the innovation outcome of ventures.

Aligned with the purpose to submit a Thesis with Publications ¹, each study has been developed as an academic article and has been formatted accordingly. Moreover, each study uses an independent sample and a distinctive methodology. All three studies were conducted between June 2020 and December 2022. The sample for both empirical studies include ventures associated with start-up communities from the region of New South Wales in Australia. The reasons for targeting this group in specific responds to i) the intention to examine ventures for which innovation is a key aspect of their venture model ii) sample ventures that have just surpassed the initial development stage considering they may have a stronger need to back up their collective knowledge, and iii) ensure transferability of findings from Study 2 to Study 3, as both focused on ventures from the same population. A summary of studies included in this dissertation is described below. Further description of each of these studies is provided in the following section, and a summary of the research design rationale is shown in **Figure 1**.

¹ According to The University of Sydney “Thesis and examination of higher degrees by research Policy 2015”.

Figure 1: Overview of research design



4. Summary of Studies

Study 1: Systematic Literature Review

Study 1 aims at organizing prior research conducted around the concept of knowledge in entrepreneurship from an organizational perspective for innovation. As highlighted in the contributions, knowledge and entrepreneurship have been predominantly addressed from other theoretical lenses. Moreover, there is a lack of clarity around the concept of entrepreneurial knowledge at the venture level as most studies have mostly focused on the individual level. Consequently, this review addresses the following question: What do we know about entrepreneurial venture knowledge and innovation? In doing so this review provides a broader scope of the concept of entrepreneurial knowledge by organizing its findings across four conceptual dimensions: knowledge sources, knowledge repositories, knowledge processes, and knowledge outcomes. Further, the review offers a map of existing constructs and their interrelationships and elaborates on an extensive research agenda to continue the refinement of these propositions. The review includes 95 empirical studies –using qualitative, quantitative studies, and mixed methodologies– that contain the keywords “entrepreneurship”, “knowledge” and “innovation”.

Study 1 offer the following contributions. First, this study identifies, organize, and summarize prior research focusing on knowledge at the entrepreneurial venture level, particularly when innovation has been explained. This effort provides a synthesis of entrepreneurial innovation from the perspective of knowledge enabling a distinction between the aspects that have been previously studied and relevant gaps in the literature. Second, the study emphasizes single-level research (venture-level variables in relation to venture-level outcomes) compared to multi-level research (individual-level variables in relation to venture-level outcomes) within the entrepreneurship domain and particularly regarding innovation from a knowledge perspective. Third, this study brings an organizational lens to review the entrepreneurship literature by using a conceptualization of knowledge across dimensions that have been applied in other literatures (particularly on the concept of knowledge repositories) in the context of innovation. Consequently, this study outlines and synthesizes the evidence of knowledge involved in entrepreneurial innovation. More importantly, this study underscores the role of knowledge integration as a critical mechanism that sits in between external and internal dynamics, including the development of firm-level structures that can help sustain knowledge and innovation over time.

Study 2: Qualitative Study

Drawing on the findings from the systematic literature review, which highlighted the role of knowledge processes on the attainment of innovation, and particularly the importance of knowledge integration to the development of firm-level knowledge, the second study included in this thesis examines knowledge integration using an exploratory approach. Correspondingly, a qualitative study was conducted with the purpose of testing and refining existing theories regarding knowledge integration in the context of entrepreneurial ventures. Accordingly, the overall question of the study is: How are knowledge integration mechanisms leveraged by new firms' founders, and are there different pathways to achieve this goal? Aiming for generalizability this study adopts the abductive grounded theory method (Richardson & Kramer, 2006; Timmermans & Tavory, 2012) as a tool to achieve theoretical replicability. Furthermore, this study uses Hak and Dul (2009) recommendations for cross-case pattern search, emphasizing the idea that "multiple cases are needed for the test of new propositions" which resulted in the identification of four emergent venture archetypes.

The data for the study was collected through semi-structured interviews with members of 22 Australian ventures from different industries, recorded, transcribed, and coded using NVivo. Following the abductive theory methodology, the analysis incorporates deductive, inductive, and abductive steps. For example, to accommodate for the emergence of unbiased dimensions and constructs, the data collected was initially contrasted with existing theoretical constructs identified in the literature review (deductive codes). Depending on the fit between these frameworks and new data, uncategorized data allowed for the generation of new codes (inductive coding). Further, by cross comparing the similarities and differences between the codes across cases (ventures), the analysis included the generation of new plausible relationships which resulted in the identification of venture archetypes (abductive coding). Through these steps, the study intends to identify new ways to characterize and categorize knowledge integration in entrepreneurial contexts. The key findings of this study are the identification of multi-level antecedents of knowledge integration in entrepreneurial firms that can enable or hamper the occurrence of two distinctive mechanisms (systematization and coordination of knowledge), and the emergence of four distinctive archetypes that represent different pathways to knowledge integration.

Study 3: Quantitative Study

Drawing on the new conceptualizations obtained in Study 2 resulting from inductive steps, Study 3 quantitatively measures the role of founders in the implementation of knowledge

integration mechanisms and their consequences to innovation. Consequently, the data collected in Study 2 served as a base to develop measures for knowledge integration antecedents, and to adapt existing scales to measure knowledge integration mechanisms. In particular, this study aimed at explaining differences in the innovation output of new firms related to the type of integration mechanism pursued and their founder-related antecedents. The data was collected through a self-administered questionnaire responded to by 149 founders and employees of ventures from New South Wales in Australia. The data was analyzed using Structural Equation Modelling (SEM). This statistical method was selected for its suitability to analyze different relationships and nest the data in different random ways. Further, SEM allows the analysis and comparison of different theoretical models, thus incorporating different causal propositions. Lastly, by using SEM the study aims to achieve a higher level of generalizability and therefore, more robust results.

5. Contributions

Although each of the studies included in this thesis has specific contributions detailed in their corresponding sections, the compiled work offers the following contributions to existent theory:

- i) Extend the research focusing on knowledge and entrepreneurship by examining the effect of firm-level knowledge during the entrepreneurial process. As emphasized in the literature, knowledge is critical for entrepreneurial success and innovation, however, it has predominantly been studied from the perspective of the individual, associated with human capital and the experience obtained through the entrepreneurial process. Moreover, literature focusing on entrepreneurial learning has largely characterized entrepreneurial activity as a learning process posing that the ability of entrepreneurs to capitalize on their learning outcomes is a determinant of entrepreneurial success, survival, and innovation performance. Building on these theories and the evidence suggesting that individual knowledge can only explain a portion of entrepreneurial performance, the main proposition of this thesis is that knowledge must be conceptualized and integrated at the level of the firm to obtain performance benefits. To do so, this thesis incorporates conceptualizations from entrepreneurship and organizational perspectives, suggesting a broader scope to characterize knowledge in the entrepreneurial context. Given the relevance of knowledge in supporting the delivery of innovation and taking a stance on

innovation as a natural outcome of entrepreneurship, this thesis investigates the effect of venture-level knowledge on entrepreneurial innovation.

- ii) Examine the different forms that knowledge takes in entrepreneurial firms, especially inside the firm boundaries. Specifically, this thesis distinguishes and highlights multiple ways to account for knowledge, including external sources, internal repositories, distinctive mechanisms, and an array of firm-level outcomes, proposing an integrative framework to seize them together. In doing so, this work underscores overlooked elements of entrepreneurial activity that can also be examined under the lens of knowledge. For example, entrepreneurial culture or the role of prototypes as carriers of collective wisdom, are potential new avenues to broaden the scope of knowledge theorizations. Further, an integrative framework can help to connect long-standing conceptualizations stemming from views focusing on the input and output of economic resources, with organizational views that focus on the internal processes, firm-level benefits, and the conditions that sustain knowledge within firms. Moreover, by looking at this broader picture, it becomes easier to recognize the complexity of entrepreneurial activity which has to deal with intensive external and internal knowledge dynamics. In sum, an intersection between entrepreneurship and organizational theory is still in its infancy and this project aims to contribute to the advance of this effort along with outlining potential opportunities for future research.
- iii) Given the dynamic nature of entrepreneurship compared to established firms this thesis highlights and characterizes such differences concerning knowledge in an innovative context. As emphasized in the literature, entrepreneurship is characterized by continuous learning, high employee rotation, high flexibility, low levels of formalization, opportunistic behavior, high degree of collaboration and networking –among others. Despite these distinctive complexities, the appraisal of knowledge in entrepreneurial contexts has predominantly followed more traditional theorizations such as human capital in technology-driven innovation contexts. Although those conceptualizations have been fruitful to explain the use of knowledge in specific types of ventures, this thesis suggests that there is ample room to advance in new ways to characterize knowledge in broader entrepreneurial settings. Thereby, the present thesis contributes to this aim by introducing new constructs (antecedents of knowledge integration mechanisms), new theoretical models (awareness, dependency, and enablers framework), and emergent venture

archetypes stemming from distinctive pathways to knowledge integration in ventures. Beyond the need for further research to consolidate these findings, this thesis provides empirical evidence of a high level of variation in the way entrepreneurs promote and embed knowledge for collective use.

- iv) Lastly, this thesis helps to advance the understanding of entrepreneurial innovation. Following the meta-framework presented by Dean A. Shepherd, Wennberg, Suddaby, and Wiklund (2019) that organizes entrepreneurship research according to their explained variables (DV's), this project is aimed at explaining innovation as a firm-level outcome. In particular, this thesis tackles several points highlighted as future research opportunities in the abovementioned review, such as distinguishing between innovation input, output, and performance. Along the same line, this thesis clarifies the role of distinctive mechanisms of knowledge integration in the innovation output of entrepreneurial ventures.

Finally, at a practical level, the identification of effective strategies for successful innovative entrepreneurship could inform organizations and policies oriented toward the guidance and resource optimization of ventures. Currently, most education entrepreneurship programs do not offer a knowledge management approach despite the well-known recognition of knowledge as a critical resource for entrepreneurial firms. Further, this study also extends the perspective of knowledge management to entrepreneurial ventures regardless of their industry, as it can be argued that all entrepreneurial ventures possess valuable knowledge that will serve as a driver of survival, growth, and innovation over time.

CHAPTER TWO

MISSING LINKS IN KNOWLEDGE-BASED ENTREPRENEURSHIP AND INNOVATION RESEARCH: A MAP AND AGENDA

ABSTRACT

Knowledge is a core construct in entrepreneurship theorizing and it has been broadly related to firm innovation. However, entrepreneurship research has often conceptualized knowledge in a relatively static way referring to the knowledge and experiences of the founder entrepreneurs. This review uses a process perspective to synthesize multiple views on knowledge, thus providing a more dynamic conceptualization to strengthen our understanding of the knowledge–innovation link in entrepreneurial firms. Consequently, we review the entrepreneurship knowledge-based research with a focus on knowledge processes in relation to innovation, including the exploration, transfer, and integration of existing knowledge. We conduct a systematic literature review analyzing 95 empirical studies published over the past three decades. We map the key concepts related to the sources, repositories, processes and outcomes of knowledge, and their interrelationships, to identify opportunities for future research that could strengthen the integration of this literature.

Keywords: Entrepreneurship, innovation, knowledge, process, review

1. Introduction

A process perspective on entrepreneurship has multiple implications for entrepreneurship research theorizing (Davidsson & Gruenhagen, 2021). From the perspective of knowledge –a key resource for entrepreneurship and innovation (Acs & Audretsch, 1988; Nooteboom, 1994; Vossen, 1998)– a process perspective implies the understanding of knowledge as a changing outcome that stems from the experiences and learning of the entrepreneurs and their teams (Argote & Miron-Spektor, 2011). Since knowledge has been widely recognized as an antecedent of innovation (Acs, Audretsch, & Lehmann, 2013; Carlsson, Acs, Audretsch, & Braunerhjelm, 2009), a deficient understanding of knowledge may lead to an incomplete conceptualization of the knowledge-innovation link in the entrepreneurial context. Moreover, as entrepreneurship necessarily involves the interplay between the founding entrepreneur and her team (Nicolai J. Foss, Klein, Kor, & Mahoney, 2008), knowledge needs to be understood as a changing outcome from the experiences and learning at the level of the firm.

Contrasting this view, entrepreneurship theorizing has often conceptualized knowledge in a relatively static way referring to the knowledge and experiences of the founders at a certain point in time (Agarwal & Shah, 2014; Link & Ruhm, 2011). This is surprising given that knowledge involves new knowledge that needs to be shared, transferred, integrated, and stored and many of these processes involve more participants than just a founder entrepreneur. In fact, such knowledge processes allow employees to learn and develop new skills for the benefit of themselves and the organization (Zahra, Neubaum, & Hayton, 2019, p. 167) and provide the seeds for ongoing and sustained innovation. While there are studies emphasizing a more dynamic and firm-level conceptualization of knowledge (P. T. Bryant, 2014; Honig & Hopp, 2019) this literature is fragmented. Consequently, the motivation of this study is to integrate the research on knowledge and innovation at the level of the entrepreneurial firm in a way that captures the richness of the process perspective. By doing so, we aim at providing a more holistic understanding of this literature, its current challenges, and future opportunities.

To address this issue, we conduct a systematic literature review (Tranfield, Denyer, & Smart, 2003) to identify gaps and areas that require future research and to develop a framework of how knowledge affects innovation in entrepreneurial firms. There are a few considerations to our review. First, a firm-level conceptualization of entrepreneurship implies that entrepreneurial firms involve a certain type of organization (Alvarez & Barney, 2004; Burton,

Colombo, Rossi-Lamastra, & Wasserman, 2019; Teece, 2014). Therefore, we believe that prior theorizations stemming from organizational perspectives can provide suitable constructs to review this literature. Consequently, a process perspective of firm-level knowledge requires the inclusion of two key constructs: *knowledge processes*, as the processes and sub-processes aimed at the utilization and dissemination of knowledge in firms (Crossan, Lane, & White, 1999), and *knowledge repositories* as the firm-embedded knowledge that can result from the interplay of such processes (Argote & Ingram, 2000). In contrast, a non-process perspective of knowledge has long-established two additional constructs: *knowledge sources*, as the knowledge assets that are associated to a specific context (Srinivasan, Choo, Narayanan, Sarkar, & Tenhiälä, 2021), and *knowledge outcomes*, as the products of knowledge that can be leveraged by firms to survive and grow, such as innovation (Quintane, Mitch Casselman, Sebastian Reiche, & Nylund, 2011). We believe that both perspectives can be integrated to provide a broader picture of knowledge in firms. Thus, our proposition includes the four conceptualizations abovementioned, as dimensions of knowledge that enables a more holistic depiction of knowledge as a changing resource. While prior reviews on this literature have included some of these conceptualizations (Guckenbiehl, Corral de Zubieta, & Lindsay, 2021) or have focused specifically on processes (Lumpkin & Lichtenstein, 2005; Zahra, Sapienza, & Davidsson, 2006a), we have not found previous reviews that includes the concept of knowledge repositories or that reconciles process and non-process views. Since learning implies the generation of knowledge as a continuum, we believe both elements are needed to better understand the knowledge phenomena at the firm level.

Our findings are disseminated in two ways. First, we offer a map of the literature that highlights the areas that have been most and least examined. Furthermore, the review map emphasizes the array and role of three groups of processes, namely, exploration, transfer, and integration of knowledge, as mediating mechanisms between sources, repositories, and outcomes of knowledge. Particularly, and although the literature has predominantly focused on transfer processes, the map has revealed the pivotal role of knowledge integration in bridging the intersection between knowledge sources and firm-level knowledge repositories. In addition, while processes aimed at the scan and exploration of new knowledge are quintessential for entrepreneurial firms, our map suggest that the three groups of processes must be closely intertwined to sustain innovation. Second, our findings elaborate on the gaps and future research opportunities which are described in an extensive agenda organized across the four knowledge conceptualizations and their interrelationships.

We thereby provide two contributions. First, we call for a process perspective on knowledge-based entrepreneurship. Going beyond a relatively static view allows a focus on knowledge processes, such as the creation of new knowledge, the retrieval of existing knowledge, and the transfer of knowledge, and their links to innovation (Argote & Guo, 2016). Moreover, a process perspective emphasizing knowledge processes allows the conceptualization of reverse processes, thus looking at knowledge not only as an antecedent of innovation but also as an outcome of innovation. Further, emphasizing knowledge processes at the level of the firm helps understand how founders, the management team and employees interact with each other to create unique knowledge that cannot be easily transferred to other organizations. Second, focusing on knowledge at the level of the firm necessarily conceptualizes it at the intersection of two literature streams: entrepreneurship, and organizational perspectives. Taken separately, organizational views tend to emphasize knowledge as an endogenous phenomenon (Levitt & March, 1988; Tsoukas & Vladimirou, 2001; Zander & Kogut, 1995), whereas entrepreneurship emphasizes it as an exogenous one (Acs, Braunerhjelm, Audretsch, & Carlsson, 2009; Ganco, 2013). Yet, as our review suggests, the intersection of both theorizations reveals that knowledge in entrepreneurial firms occurs as both endogenous and exogenous phenomena, and therefore, it adds a unique complexity to the entrepreneurial process, compared to non-entrepreneurial ones. For example, entrepreneurs must choose between leveraging ongoing learnings to introduce organizational improvements, or just using it to improve decision-making at the managerial level. At the same time, entrepreneurs must choose between consistently sourcing knowledge from external parties or just at the times when it is needed. Further, entrepreneurs must introduce innovations that are a result of the combination of resources and actions implemented both externally and internally. Thereby, we extend previous conceptualizations and findings to achieve what Zahra and Newey (2009) described as *borrowing and extending* theory building.

2. A process perspective of knowledge: sources, processes, repositories, and outcomes.

A key challenge to synthesize the knowledge–innovation link from a process perspective is the inclusion of different knowledge conceptualizations without generating theoretical overlaps. An important consideration to this aim, is the differentiation between the knowledge perspective (Grant, 1996) and the capabilities perspective (Teece, Pisano, & Shuen, 1997). While both views underscore knowledge as a key resource for firm success and innovation, a capability perspective emphasizes what firms *can do* with knowledge, which is not the specific focus of this review. In contrast, as we aim at examining the empirical evidence

of knowledge as a driver of innovation, we do not explicitly seek for literature drawing on dynamic capabilities such as absorptive capacity (Cohen & Levinthal, 1990). Furthermore, the dynamic capabilities perspective in the context of entrepreneurship has been examined in seminal reviews (Zahra, Sapienza, & Davidsson, 2006b). Nevertheless, this consideration does not exclude articles drawing from different theoretical approaches, including the capabilities perspective.

Correspondingly, we address this issue by using four constructs that can accommodate multiple perspectives and guide the whole review process: knowledge sources, knowledge processes, knowledge repositories and knowledge outcomes. We borrow such concepts from seminal knowledge-based articles from different streams, including management, innovation and organizational learning (see **Table I**) and use them as a *coding frame* (Gibbs, 2007) to guide our analysis. A coding frame poses a critical distinction between a conceptual and a theoretical framework (Camp, 2001) which we explain in detail in our methodology section. Hence, we deliberately avoid applying existing theoretical frameworks (such as organizational learning frameworks) as our motivation is to incorporate multiple perspectives on the existing research related to the entrepreneurship knowledge–innovation link, not to develop a theory of entrepreneurial learning. Alternatively, as we analyse the interrelations between concepts, we develop a map of the literature that conveys the complexity of generating knowledge-driven innovation in entrepreneurial firms. A key consideration to the selection of such constructs is the incorporation of knowledge repositories as a key conceptualization of firm-level knowledge (Argote & Miron-Spektor, 2011). While the entrepreneurship literature often emphasizes the importance of external knowledge, there is vast evidence that the entrepreneurial process involves learning (Dahlin, Chuang, & Roulet, 2018; Wang & Chugh, 2014), and thus, we believe that the entrepreneurial process can involve the generation of firm-level knowledge as an outcome of learning. Through our map, we suggest that entrepreneurship provides a more challenging scenario to the management of knowledge than in established firms, given the need to curate and integrate knowledge from external sources, along with the generation of firm-level repositories for sustained performance in innovation.

Table 1: Conceptual Framework

Knowledge Dimension	Key Contribution	Author
Knowledge Sources	Definition of knowledge source as “the extent to which an organization prefers to develop new knowledge internally versus the extent to which it is more likely to seek inspiration in ideas developed externally (pp. 361)”.	Dibella et al. (1996)
	Implications of knowledge source’s breadth on innovation.	Leiponen and Helfat (2010)
	Implications of knowledge sources across boundaries on innovation.	Roper and Arvanitis (2012)
Knowledge Processes	Identification of the knowledge processes involved in organizational learning for firm renewal over time. The framework proposed includes individual, group, and organizational process levels: 1) Intuiting (individual) 2) Interpreting (group) 3) Integrating (group) 4) Institutionalizing (organization)	Crossan et al. (1999)
	Identification of the knowledge processes involved in firm innovation, which differentiation is determined by the radicalness of the innovation generated: 1) Syntactic transfer 2) Semantic translation 3) Pragmatic transformation	Carlile (2004)
	Identification of the knowledge processes involved in organizational learning from task performance: 1) Knowledge Transfer 2) Knowledge Creation 3) Knowledge Retention	Argote and Miron-Spektor (2011)
	Conceptualization of transactive memory as group-level knowledge structure that supports behavior	Wegner (1987)
Knowledge Repositories	Conceptualization of organizational memory as a firm-level knowledge structure that supports behavior and performance	Walsh and Ungson (1991)
	Identification of knowledge repositories in firms as structures that support knowledge transfer and enable learning across sub-units.	Argote and Ingram (2000)
Knowledge Outcomes	Conceptualization of the knowledge processes that lead to innovation in firms.	Nonaka (1994)
	Examination of knowledge attributes and knowledge processes leading to innovation in firms.	Galunic and Rodan (1998)
	Conceptualization of innovation as an outcome of knowledge.	Quintane et al. (2011)

3. Method

3.1 Identification of Articles

Following the recommendations of Tranfield et al. (2003) and Andreas Rauch (2019) for systematic literature reviews, we conducted searches in June 2020 using Boolean operators in three different scientific databases: Web of Science, ABI/Inform and ECONLIT. We did not set a starting date. With the aim of conducting an unbiased search as recommended by Tranfield et al. (2003, p. 215), we included unpublished studies such as Conference proceedings and book chapters². We used the same keyword combinations on each database generating a total of nine searches that contained the words “entrepreneur*”, “knowledge” and “innovation” either in the title, abstract or keywords. Additionally, we replaced the word “entrepreneur*” with the terms “venture”, “start-up” and “startup” in consecutive searches to include similar approaches. We used Boolean operators to extend the search to similar terms related to entrepreneurship such as “entrepreneurial”. We also used the operator “NEAR/5” between the words “knowledge” and “entrepreneur*/venture/start-up” to ensure that the term “knowledge” was included as a concept and did not refer to the existing literature. We developed a list of citations in an additive way by eliminating duplicates from previous searches before adding them to our final database. The search process resulted in a total of 793 studies including journal articles, conference proceedings and book sections by June 26, 2020.

3.2 Selection of Articles

We followed a selection protocol composed of inclusion and exclusion criteria. First, we included only empirical studies as the aim of our review was to synthesize the scientific evidence established in the field. Further, we included all article types (e.g., journal articles, conference proceedings, and book chapters) and all research designs including qualitative, quantitative, and mixed-methods studies. Thus, we conducted an integrative review, allowing us to triangulate findings across different methods, to identify patterns across studies and to develop a map of the relationships between concepts (Rousseau, Manning, & Denyer, 2008).

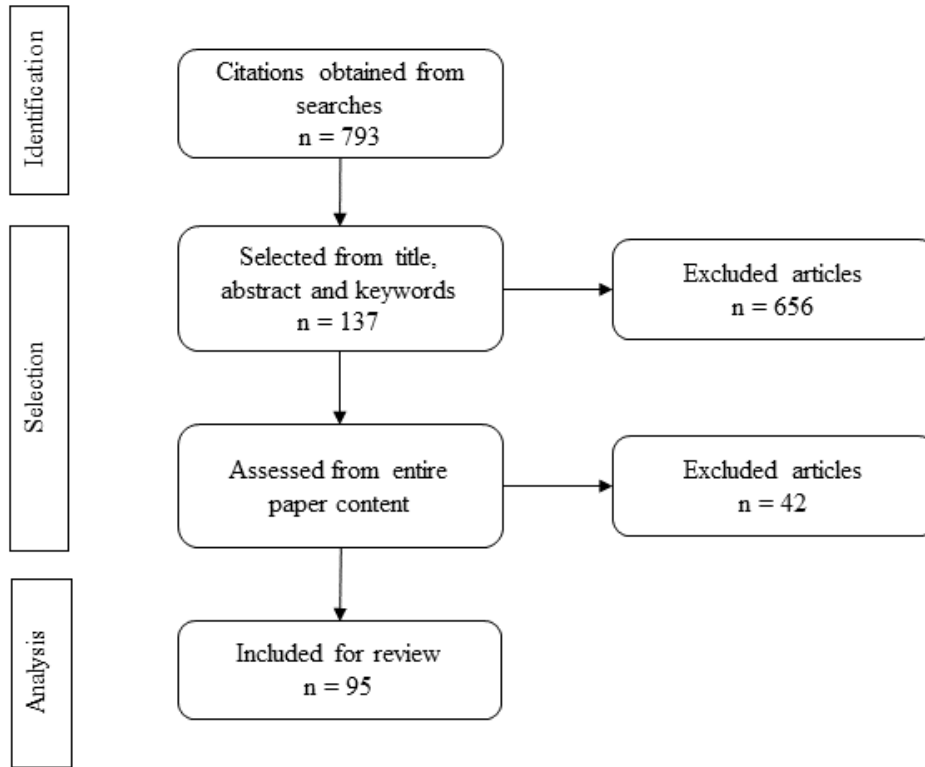
² According to Tranfield et al. (2003), “Searches should not only be conducted in published journals and listed in bibliographic databases, but also comprise unpublished studies, conference proceedings, industry trials, the Internet and even personal requests to known investigators”. However, while I have adopted a holistic approach for the purpose of this doctoral dissertation, I acknowledge the limitations of this perspective in the case of submitting this work to journal publication. Therefore, this criterion might be revised in further development stages.

As a second criteria, we included only studies that examined firm-level knowledge and innovation in entrepreneurial firms as a unit of analysis. By entrepreneurial firms, we considered a combination of entrepreneurial behavior (Shane & Venkataraman, 2000) and organizational status (Audretsch, Kuratko, & Link, 2015). For example, the studies included primarily examined new ventures, start-ups, and SMEs. Conversely, we excluded studies that focused on other levels of analysis. For example, we excluded all studies that focused on the entrepreneur at an individual level, such as studies that focused solely on entrepreneurs' cognition, experience and human capital. We also excluded studies that offered macro-level conceptualizations or examined multi-level relationships, for example, between firm-level and regional-level constructs, mostly found in papers from economic streams. In addition, as we target entrepreneurial firm-level knowledge we excluded studies focusing on corporate entrepreneurship, family businesses and institutional venturing. We excluded studies centred on corporate entrepreneurship because in those ventures the management of knowledge resources is generally associated with the resources and processes used by the parent company, and therefore we considered those findings might distort the overall dataset. Similarly, family businesses have distinct dynamics in which knowledge resources and processes transfer through generations and so their findings might vary significantly from studies on independent firms. In the same way, institutional entrepreneurship has access to specific knowledge resources and processes that focus on specific goals that are beyond the entrepreneurial activity.

As a third criteria and, to achieve a higher understanding of knowledge during entrepreneurial activity, we excluded papers that examined pre-entry or post-exit conditions. For example, we excluded articles about pre-entry conditions as predictors of future performance unless they provided evidence of knowledge during the entrepreneurial activity.

Following these criteria, we reduced the number of articles from 793 to 95 through two iterative inclusion–exclusion rounds. During the first round we considered the information available in the title, abstract and keywords. This round resulted in a preliminary dataset of 137 articles. We then read the entire paper and excluded 42 more studies using the same criteria described above, obtaining a final dataset of 95 articles for review published between 1994 and 2020. The whole process is illustrated in **Figure 2**. A supplementary list of all references of studies included in this review can be reviewed in **Appendix 1**.

Figure 2: Identification and selection of studies



Description of articles included in the review

Publication Type	Journal articles (85), Book Sections (3), Conference Papers (7)
Methodology	Quantitative (66), Qualitative (21), Mixed Methods (8)
Publication date range	1994–2020 (64 published 2015–2020)
Sample Type	New Ventures (46), SMEs (38), Start-ups (10), Other (1)
Number of articles incl.	95

3.3 Analysis

To conduct the analysis we developed a coding frame, defined as “a structured list of codes and the rules for their application” (Gibbs, 2007, p. 39). A coding frame differs from a theoretical framework, as it uses concepts grounded in the existing literature that are not necessarily interrelated (Camp, 2001), but are pertinent to the research question and can be used to organize and analyse a heterogenous data set (Miles, Huberman, & Saldaña, 2014). Our coding frame is based on the distinction of four conceptualizations of knowledge: 1) knowledge sources, 2) knowledge processes, 3) knowledge repositories, and 4) knowledge outcomes. For each group, we have identified key prior contributions and authors, as shown in **Table 1**. Although these concepts have been used in many literatures including the entrepreneurship field, we developed the coding frame guided by articles from organizational perspectives,

strategic management, and innovation streams to avoid theoretical bias. We used the coding frame to identify key contributions across our included articles using NVivo. For example, to identify sources of knowledge we searched for findings that indicated a recognition of the knowledge context and its implications for innovation, generally but not always associated with resources located outside the firm boundaries (Dibella, Nevis, & Gould, 1996; Leiponen & Helfat, 2010; Roper & Arvanitis, 2012). To identify knowledge processes, we primarily followed organizational conceptualizations as processes and sub-processes related to the use of knowledge for multiple strategic aims (Argote & Miron-Spektor, 2011; Carlile, 2004; Crossan et al., 1999). To identify knowledge repositories, we searched for firm-level structures where knowledge is embedded (Argote & Ingram, 2000; Walsh & Ungson, 1991; Wegner, 1987). Lastly, to identify knowledge outcomes, we followed prior propositions of innovation as a knowledge outcome and its implications in firms (Galunic & Rodan, 1998; Nonaka, 1994; Quintane et al., 2011). In addition, we coded each article according to the methodology and sample type.

Further, we analysed the content within each group to seek similarities and patterns which resulted in the identification of concepts as illustrated in **Table 2** and **Table 3**. There are two important considerations. First, not all studies analyse concepts at the same level and thus we opted not to aggregate the results within each group. For example, within the knowledge sources dimension, we found articles that focused on broad-level constructs such as “external knowledge” (Karagouni & Caloghirou, 2013; N. K. Kim & Ahn, 2020; Larraneta, Zahra, & Gonzalez, 2012; Nason, Wiklund, McKelvie, Hitt, & Yu, 2019; Ritala, Henttonen, Salojarvi, Sainio, & Saarenketo, 2013; Taheri, Ye, & van Geenhuizen, 2018) while other studies investigated more specific types or sub-types of external knowledge such as “market knowledge” or “customer knowledge” (Bettiol, De Marchi, & Di Maria, 2016; A. McKelvie, Wiklund, & Brattstrom, 2018; E. Shu, 2017; L. Z. Song, Di Benedetto, & Song, 2010; Tolstoy, 2009). Second, most studies we reviewed assessed more than one construct, and therefore the sum of articles identified per construct set is greater than the total number of articles.

Table 2: Identification of predominant constructs (highlighted terms correspond to concepts examined in 10+ studies)

Initial Codes	Constructs	Sub-constructs
Knowledge Sources	External Knowledge	External Knowledge (6 studies)
		Explicit Knowledge (2 studies)
		Tacit Knowledge (3 studies)
		Technological Knowledge (2 studies)
		Market Knowledge (7 studies)
	Congenital Knowledge	Customers (3 studies)
		Partners (4 studies)
		Human Capital
		Founder's Team HC (21 studies)
		Employee HC (3 studies)
Knowledge Repositories	Internal Knowledge	Social Capital (13 studies)
		Family Ties (1 study)
		Friends Ties (1 study)
		Business Ties (4 studies)
		Political Ties (1 study)
	Patents	Patents (11 studies)
Knowledge Processes	Knowledge Transfer	Routines (15 studies)
		Tools (6 studies)
		Prototypes (2 studies)
		Culture (2 studies)
	Knowledge Integration	Knowledge Acquisition (15 studies)
		Knowledge Sharing (6 studies)
		Knowledge Spillover (6 studies)
		Knowledge Transfer (6 studies)
	Knowledge Scanning and Exploration	Knowledge Creation (7 studies)
		Knowledge Application (3 studies)
		Knowledge Integration (2 studies)
		Knowledge Retention (0 studies)
Knowledge Outcomes	Innovation Performance	Knowledge Search (8 studies)
		Networking (17 studies)
		Collaboration (11 studies)
		Cooperation (3 studies)
		Firm Innovation (20 studies)
	Innovation Capacity	Product Innovation (10 studies)
		Innovation Performance (6 studies)
		Innovation Radicalness (2 studies)
		Disruptive Innovation (3 studies)
		Firm Innovativeness (10 studies)
		Likelihood of Innovation (2 studies)
		Innovation Competences (4 studies)

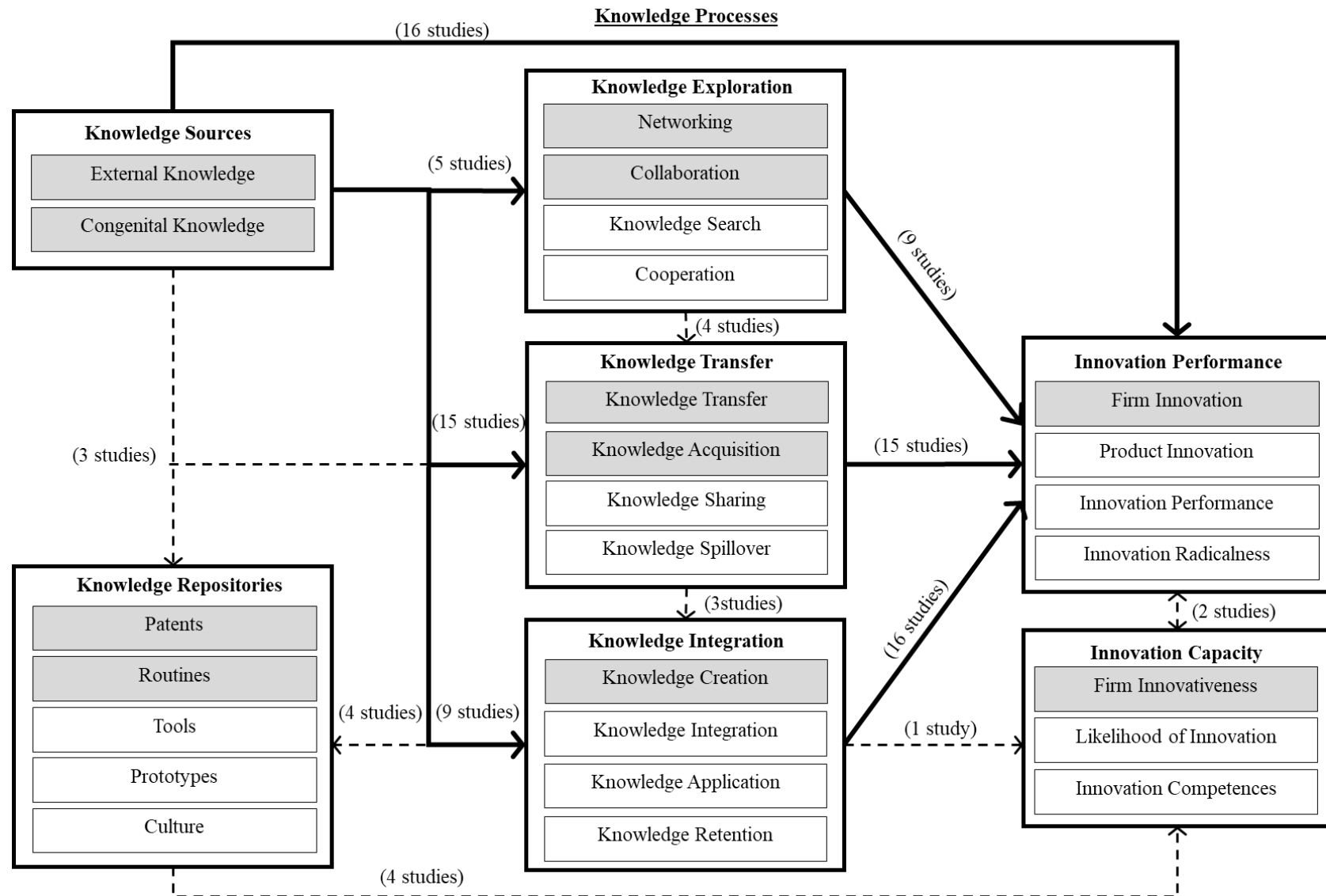
Table 3: Summary of dimensions, concepts and constructs

Knowledge Sources	
External Knowledge	<i>Technological knowledge</i> is often measured in the form of patents and licenses but also as published content, or codified knowledge. <i>Market knowledge</i> includes business-specific knowledge such as knowledge from customers, suppliers, competitors, and partners.
Congenital Knowledge	<i>Human capital</i>: Two common operationalizations to assess human capital are based on knowledge characteristics and knowledge content. Knowledge characteristics are associated with the depth and breadth of knowledge. Knowledge content distinguishes between general human capital or technical knowledge and experience acquired through formal education, and specific human capital, related to managerial and entrepreneurial knowledge. <i>Social capital</i> corresponds to social relations possessed by members of entrepreneurial ventures, enabling firms to access knowledge that would not otherwise be available (W. Tsai & Ghoshal, 1998). Research on this area has examined social capital characteristics such as depth and breadth, and distinguished between relevant sub-types, related to family, friends, business, and political ties.
Knowledge Repositories	
Patents	Patents refer to rights to commercially exploit inventions or other forms of intellectual property created or acquired by individuals or organizations, which have formally completed a patenting awarding process. Thus, this excludes trademarks, registered designs, and copyrights unless these have formally obtained an invention patent.
Routines	Routines correspond to coordinated activities between different members of an organization to perform tasks more efficiently.
Digital Tools	Tools are information systems that support conducting tasks, increasing the speed of knowledge transfer within and across organizations (Argote & Ingram, 2000).
Prototypes	Knowledge can be embedded in new products or services, as a result of collaboration between individuals, between external sources of information and individuals, tools or other repositories and leveraged at the organizational level for the use of the whole firm (Argote & Ingram, 2000).
Culture	Knowledge can be embedded in the organizational culture, modelling the values and practices that guide the actions of its members (Dana, Korot, & Tovstiga, 2005).
Knowledge Processes	
Knowledge Transfer	<i>Knowledge transfer</i> is a process by which knowledge is transmitted from one party to another enabling learning by the recipient from the transmitter's experience. Knowledge transfer can occur internally or externally to the firm's boundaries. Following this definition, several processes enable the conducting of knowledge between entities, and accordingly, we have incorporated the findings around the constructs of knowledge acquisition, knowledge sharing and knowledge spillovers in this category.

	<u>Knowledge acquisition</u>: What distinguishes knowledge acquisition from a generic construct of knowledge transfer seems to be the strategic intention of the firm to incorporate new knowledge for specific purposes. <u>Knowledge sharing</u>: Knowledge sharing refers to the exchange of knowledge in which both parties act as senders and recipients (Ipe, 2003). <u>Knowledge spillovers</u>: Knowledge spillovers are flows of knowledge from an originating firm to a recipient firm by which the receiver obtains a benefit (Yang et al., 2010).
Knowledge Integration	<u>Knowledge integration</u> includes all knowledge-related processes oriented towards the fusion or combination of different knowledge sources inside the firm (Lin & Chen, 2006). <u>Knowledge creation</u> refers to the generation of new knowledge created either internally or in conjunction with external partners, deriving knowledge conducive to commercialization or to organizational improvement. <u>Knowledge application and knowledge exploitation</u> are related terms that refer to the utilization of knowledge collected for specific purposes within the firm, often creating goods or improving processes. <u>Knowledge retention</u> refers to the act to store knowledge purposively for future uses.
Knowledge Exploration	<u>Knowledge search and networking</u> are activities that may lead to the acquisition of knowledge sources located outside the firm boundaries or to the acquisition of social capital. Knowledge search is a unilateral activity that involves the purposive scanning of knowledge that may be relevant for the new firm. <u>Collaboration</u> and <u>cooperation</u> are related to formal agreements between two parties to engage in knowledge transfer for mutual benefit. Often collaboration has been used to refer to agreements in which there is a shared objective that is usually associated with a timeframe and a financial goal, while cooperation has been mostly associated with asymmetrical or more open-ended arrangements.
Knowledge Outcomes	
Innovation Performance	Includes firm innovation, product innovation, innovation performance, disruptive innovation and radicalness of innovation.
Innovation Capacity	Refers to the skills and capabilities to achieve innovation including innovativeness, innovation capacity and likelihood of innovation.

Lastly, we coded the relationships established across concepts and then integrated the results in a map shown in **Figure 4**. Following (Habersang, Küberling-Jost, Reihlen, & Seckler, 2019) we distinguished between unidirectional and reciprocal relationships, illustrated with arrows in the figure. Further, based on the number of studies that established relationships between the concepts, we use strong lines to represent a higher volume of research, and dashed lines to represent less examined relationships.

Figure 3: Review Map (bold arrows and highlighted constructs denote predominance of research, dashed lines denote scarcity of



4. Findings

Our analysis yielded results across two areas: 1) predominant constructs and sub-constructs within conceptual dimensions (knowledge sources, knowledge repositories, knowledge processes and knowledge outcomes), as detailed in **Table 2** and **Table 3**, and 2) relationships between constructs, which enabled us to elaborate a conceptual map illustrated in **Figure 4**. Correspondingly, first we briefly describe the concepts identified, elaborating further on those that have received less attention in previous reviews. Particularly, we describe in more depth the concepts derived from the application of an organizational perspective, namely, knowledge processes and knowledge repositories, compared to those more extensively discussed such as knowledge sources and knowledge outcomes. Second, we describe the relationships identified between constructs and explain the review map.

4.1 Knowledge Sources

Studies focusing on knowledge sources emphasize knowledge as a static resource that is either external to the firm, or is congenital to the firm, as a required pre-existing asset (see **Table 3**). External knowledge needs to be acquired or integrated and is often examined according to its specific content, such as *technological knowledge* (often measured in the form of patents, licenses, and published content) and *market knowledge* (business-specific knowledge such as knowledge from customers, suppliers, competitors and partners). While technological knowledge is often acquired through economic transactions and therefore may only be available to certain firms, market knowledge seems easier to attain, even at early development stages. For example, market knowledge can be sourced through consumers (Balan & Ionita, 2011), competitors, industry fairs, conventions, government policies and agencies (Tassis, Tassi, Zois, Souchla, & Maroulas, 2017). External knowledge can be further characterized based on its nature, for example, some studies distinguish between explicit and tacit types of knowledge (Jin, Shu, & Zhou, 2019; Lee, Tsai, & Lee, 2011; Sousa-Ginel, Franco-Leal, & Camelo-Ordaz, 2017). Although technological and market knowledge can be either explicit or tacit, a dominant approach considers technological knowledge as an explicit source and market knowledge as a tacit one (Garcia-Cabrera, Garcia-Soto, & Nieves, 2020; Lee et al., 2011; R. Ma & Huang, 2016; Siegel & Renko, 2012). Across all perspectives, market knowledge as a tacit source was the most examined construct of external knowledge at the level of the firm.

Congenital knowledge refers to the sources of knowledge that belong to the firm at the time of its conception (Yli-Renko, Denoo, & Janakiraman, 2020). This group of studies

includes *human and social capital* perspectives to account for firm-level knowledge. Although both human and social capital can continue changing and growing post-entry, we found that a prevailing view portrays them as inputs rather than outputs of knowledge. Human capital, defined as knowledge and skills pertaining to individuals (Unger, Rauch, Frese, & Rosenbusch, 2011), provides firms with learning capabilities that equip them to better absorb new knowledge (Bettiol et al., 2016; Protogerou, Caloghirou, & Vonortas, 2017; Talebi & Tajeddin, 2011), increase their orientation towards collaboration with research institutions (Taheri et al., 2018; Tassis et al., 2017), improve their R&D activity (Jang, Hadley, & Lee, 2019), and facilitate product differentiation (L. Z. Song et al., 2010). Social capital corresponds to social relations between individuals that enable firms to access knowledge that would not otherwise be available (W. Tsai & Ghoshal, 1998) and may help overcome the difficulties derived from a resource-scarce context. The literature reviewed identified different types of social capital, particularly those related to the links between entrepreneurs and external knowledge sources. For example, while family ties enable entrepreneurs to access general business knowledge, friends can provide customer knowledge in the form of feedback (Burstrom, Harri, & Wilson, 2018) and political ties may grant early access to emergent industry or market policy which might be critical for entrepreneurial firms in highly regulated markets or economies that have frequent policy change (Shan & Lu, 2020). Across these views, research on social capital suggests two main issues for the entrepreneurial domain. First, social capital may be more relevant in certain stages of business development, particularly at the beginning when there are no formal systems in place to manage knowledge (Ladib, 2015). Second, social capital enables the acquisition of specific types of external knowledge and therefore the social ties possessed by the firm may influence its access to relevant information located outside the firm boundaries (Bai, Lind, & Johanson, 2016; Jiang, Wang, & Jiang, 2019; Khan, Lew, & Sinkovics, 2015; Shan & Lu, 2020).

4.2 Knowledge Repositories

Knowledge repositories are receptacles of knowledge after the firm has been created. While repositories of knowledge can take any form, our findings suggest a distinction between patents, digital tools, routines, prototypes, and culture. *Patents* can convey new knowledge owned by the firm. Although patents can be an outcome of internal activity associated with entrepreneurially-oriented firms (Jiang et al., 2019; Li, Liu, Wang, Li, & Guo, 2009), they are more likely to be found in firms operating in highly dynamic markets or in ventures undertaking open innovation strategies with high risks of spillovers (N. K. Kim & Ahn, 2020). Thus, one

of the shortcomings of accounting for patents as a proxy of knowledge in firms is that patents may only be relevant in some industries.

Routines correspond to coordinated activities between different members of an organization to perform tasks more efficiently (Argote & Guo, 2016). As such, routines can encompass procedural knowledge gained through coordinated experience, supporting ongoing operational processes. Unfortunately, most studies reviewed, cite routines to support hypotheses or as part of higher-order constructs without observing them directly. For example, studies build on the notion of routines as rigid structures based on prior research on established firms (C. L. Shu, Liu, Gao, & Shanley, 2014) or cite routines as an example of internal knowledge generation (A. McKelvie et al., 2018). Routines carry knowledge that is firm-specific and can be adapted to integrate new learning and information. Modification of organizational routines can signal those dynamics and, thus, routines have been studied as a result of learning processes, flows of knowledge and adaptation to environmental changes. In entrepreneurship research, routines have been described from two contrasting angles. On the one hand, there are approaches that build on the assumption that routines are rigid structures that constrain organizational change (X. F. Ma, Zhou, & Fan, 2015), are built over time and, therefore, are associated with more mature stages of business development (Burstrom et al., 2018). Often, studies in this tradition associate a higher level of organizational flexibility with an absence of routines. On the other hand, there are studies that pose that routines provide a template to which new knowledge can be incorporated (Sousa-Ginel et al., 2017). In particular, these studies emphasize the role of learning routines prior to interaction with external partners (Burns, Acar, & Datta, 2011; R. Guo, L. Cai, & Y. Fei, 2019; J. Y. Lin, 2017).

Digital tools might store firm-specific knowledge or may provide a space for social interaction and collaboration. Tools as enablers of knowledge in entrepreneurial firms have been examined as a space where social interaction takes place (Baskaran, 2018) and as an instrument for knowledge exchange and collaboration (Oliva & Kotabe, 2019). In our set of studies, we did not find any studies distinguishing between different types of digital tools and their implications for entrepreneurial outcomes.

Prior organizational conceptualizations have included *products and services* as knowledge repositories as they convey knowledge that has previously been integrated and modified (Argote, McEvily, & Reagans, 2003; Hansen, 1999). However, this approach may overlap with other theorizations, as new products and services can also be considered as knowledge outcomes, particularly innovation (Dolfsma & van der Panne, 2008). To avoid this confusion, we have included the concept of *prototypes* as preliminary forms of products or

services that have not yet progressed to commercialization phases. Prototypes can also include primary forms of business plans, operational processes, or other explicit forms of knowledge, and can be elaborated in a physical or digital format (Oliva & Kotabe, 2019). Seen this way, prototypes are important instruments to test knowledge integration as organizational structures evolve. The capability to generate prototypes as part of the concept of knowledge conversion has been studied by Sousa-Ginel et al. (2017) on a sample of Spanish ventures arising from academic research. Some of the findings include that a higher number of interactions between the venture and external partners does not influence the capacity to generate prototypes but rather the network size does. This may suggest that prototyping involves incorporating specific knowledge from different sources rather than iterating a solution with a particular partner.

Lastly, some attributes of *organizational culture*, have been found surprisingly similar among entrepreneurial ventures across different locations (Dana et al., 2005). Using a diverse sample, Wu, Lin, and Chen (2013) also reported that the innovation capabilities that lead to firm performance of 393 firms from different countries and industries are determined by both external and internal openness. By internal openness the authors referred to an organizational culture that includes practices of inter-disciplinary collaboration and knowledge sharing, as well as the awareness of team members' expertise within an organization. Specifically, Wu et al. (2013) study suggests that internal openness significantly influences the firm's absorptive capacity which further improves the innovation capability and firm performance.

4.3 Knowledge Processes

We found multiple firm-level processes related to knowledge in entrepreneurial firms. Following existing conceptualizations, we organize these processes into three groups: (1) knowledge exploration, (2) knowledge transfer, and (3) knowledge integration.

Knowledge Exploration

This category was composed of processes oriented towards the scanning, identification, and exploration of new knowledge. Within this group we have included knowledge search, networking, collaboration, and cooperation, as our studies particularly examined these processes. *Knowledge search* involves the purposive scanning of knowledge that may be relevant for the new firm. Knowledge search can be influenced by company size (Ritala et al., 2013), team diversity (Hayton & Zahra, 2005), and interpretation of environmental threats (J. J. Liu, Chen, & Kittilaksanawong, 2013). Because knowledge search is a strategic action (Ritala et al., 2013; E. Shu, 2017) firms that actively search for knowledge may be engaged in explorative or exploitative knowledge search strategies (Rui & Lyytinen, 2019), or engaged in

open innovation models (Karagouni, 2015). In contrast, *networking* is seen as an activity conducive to the generation and maintenance of social capital (Vasileiadou, Missler-Behr, & Ullrich, 2011), knowledge acquisition and opportunity recognition (G. Song, Min, Lee, & Seo, 2017). While *collaboration and cooperation* may occur both at the inter-organizational and intra-organizational level, often collaboration has been used to refer to agreements in which there is a clear objective with a timeframe and a financial goal. Examples of collaborative arrangements are alliances, joint ventures, partnerships between firms or technology licensing arrangements which could lead to knowledge transfer, knowledge sharing, knowledge spillovers or creation of new knowledge. Although in some cases the terms collaboration and cooperation have been used interchangeably (Grochowski, Warschat, & Dasher, 2016; McGee & Dowling, 1994; Ribeiro-Soriano, Benavides-Espinosa, & Mohedano-Suanes, 2013), in most cases cooperation is used when the parties have voluntarily agreed to interact with each other for independent goals, or when the objective is less specific or altruistic. Examples are cooperation between small scale enterprises and research institutions, or between firms and suppliers. Cooperative arrangements are likely to involve knowledge exchange (Karagouni, 2018; Ribeiro-Soriano et al., 2013).

Knowledge Transfer

As a generic construct, knowledge transfer refers to the transmission of knowledge, both at the inter and intra-organizational level (Argote & Ingram, 2000). Across the studies reviewed, a predominant approach addresses knowledge transfer as an inter-organizational phenomenon, focusing on external–internal transmission of knowledge in collaborative arrangements such as joint ventures, alliances, or academic spin-offs. Knowledge transfer in the entrepreneurial context might involve other simultaneous processes leading to commercialization, as external knowledge changes entrepreneurs' views on their own competencies, strategic focus and management of knowledge resources (Lockett, Cave, Kerr, & Robinson, 2009). At the intra-organizational level, knowledge transfer can occur between entrepreneurs and employees, among associates, from senior to junior members or between individuals with complementary capabilities through instances such as mentoring, meetings, discussions or presentations (Balan & Ionita, 2011). Other findings have emphasized factors associated with knowledge transfer success, such as the role of organizational similarity (Oxley & Wada, 2009). Moving on to more specific forms of knowledge transfer, we identified three sub-processes: knowledge acquisition, knowledge sharing, and knowledge spillovers. *Knowledge acquisition* often refers to the attainment of knowledge from external sources to

inside firms. From the studies reviewed, there are two predominant ways to account for knowledge acquisition. The first is limited to the acquisition of technological knowledge and is operationalized through patent citations, licenses or contracts of technological agreements. For example, a study examining knowledge acquisition and innovation performance based on a sample of US joint ventures examined patent citations for a period of 6 years after the alliance had been established as a proxy for knowledge acquisition (C. Chen, Lin, Lin, & Hsiao, 2017). A second way to measure knowledge acquisition includes both technological and market knowledge and it is often operationalized through a survey. For example, a study on knowledge acquisition and entrepreneurial alertness based on a sample of 138 Chinese suppliers used a Likert-scale survey to assess the extent of both technical and market knowledge acquired from a key customer (R. Ma & Huang, 2016). Another specific form of knowledge transfer corresponds to the sharing of knowledge. *Knowledge sharing* refers to the exchange of knowledge in which both parties act as senders and recipients (Ipe, 2003). Knowledge sharing has mostly been observed across entities who hold a similar status such as work peers or ventures using the same co-working space, excluding direct competitors. Because entrepreneurial firms often have flexible organizational structures, they are an ideal environment for knowledge sharing. For example, a high level of knowledge sharing is correlated with a lower organizational structure complexity (Burns et al., 2011). Additionally, knowledge sharing is positively related to entrepreneurial orientation (Li et al., 2009; Vafaei-Zadeh, Hanifah, Foroughi, & Salamzadeh, 2019). In line with these findings and based on interviews with start-up founders in Japan, Laitinen and Senoo (2017) observed that most entrepreneurs considered that incentivizing knowledge sharing within their ventures was unnecessary, arguing that working collaboratively was critical for the business operation. In contrast, knowledge sharing with external partners may be motivated by personal purposes, such as satisfaction derived from helping others or reciprocity in exchange of information, or by business purposes, in the hope it will lead to the development of business ties to collect specific knowledge (Allen, Gloor, Colladon, Woerner, & Raz, 2016). Further, knowledge sharing may be facilitated by the implementation of pre-established knowledge-sharing routines (J. Y. Lin, 2017).

Lastly, we find that the spillover of knowledge can be another form of knowledge transfer. Entrepreneurial firms can benefit from knowledge spillovers from external companies. A common case occurs when workers from established firms leave to start their own businesses and carry with them organizational knowledge from their previous institutions such as social capital (Lowe, Williams, Shaw, & Cudworth, 2012). Similarly, ventures engaged in open

innovation strategies have been found to profit from external spillovers, increasing innovation performance but decreasing innovation radicalness (Nason et al., 2019). Therefore, entrepreneurial firms that engage in R&D activities with external partners must gauge the permeability of the firm's boundaries in order to prevent drawbacks from knowledge spillovers. In the context of alliances, it has been observed that knowledge spillovers between partners are higher when the perception of knowledge protection between partners is also high (C. L. Shu et al., 2014).

Knowledge Integration

Knowledge integration processes include all knowledge-related processes oriented towards the fusion or combination of different knowledge sources inside the firm (B.-W. Lin & Chen, 2006). Because the concept of knowledge integration encompasses a broad range of processes, we include in this category the processes of *knowledge creation*, *knowledge application* and *knowledge retention*. As an overarching construct, the measuring of knowledge integration varies. For example, while one study distinguished between coordinated and systemic integration of knowledge measured through a differentiation between socialization and formalization practices (R. Guo et al., 2019), another study proposed a distinction between the knowledge aimed at exploration versus the knowledge aimed at exploitation (Rui & Lyytinen, 2019). Moving into more specific forms of knowledge integration, we found the most cited one was knowledge creation, as entrepreneurial firms seem especially suited to such processes (Jiang et al., 2019; M. T. Tsai & Li, 2007). From the studies focusing on knowledge creation, two studies used the measure proposed by Nonaka (1994) which includes four sub-processes: socialization, externalization, combination and internalization (Alshanty & Emeagwali, 2019; M. T. Tsai & Li, 2007), three studies measured knowledge creation through the assessment of its outcome (Jiang et al., 2019; A. McKelvie et al., 2018; Tolstoy, 2009), and one study used a mixed assessment of outcomes and other processes such as knowledge transfer, acquisition and exploitation of knowledge (Zacca, Dayan, & Ahrens, 2015). Less cited variants of knowledge integration are *knowledge application* and *knowledge exploitation*. However, a differentiation between those two lacks consistency across the studies reviewed and requires further examination. Lastly, *knowledge retention* as a purposeful aim of storing knowledge for future uses can also be considered as a form of integration of knowledge in firms. Despite its potential relevance, we did not find any study that rigorously examined knowledge retention or knowledge storage, however the study by Oliva and Kotabe (2019)

identified the action of resistance to documentation as one relevant barrier to knowledge management in start-ups.

Knowledge Outcomes

The studies reviewed cite several forms of innovation as consequences of knowledge in entrepreneurial firms. We make a distinction between the studies associating knowledge and related processes with *performance* measures such as firm and product innovation, innovation performance, disruptive innovation and radicalness of the innovation attained, and the studies aimed at conceptualizing innovation as a *capability* such as innovativeness, innovation capacity and likelihood of innovation. In general terms, performance measures are aimed at the quantification and/or qualification of innovation outputs given determined inputs, whereas innovation capabilities refer mostly to innovation as a behavior that is conducive to operational benefits. The latter can be measured by examining the frequency of certain behaviors, such as creative thinking, or by assessing the skills needed to innovate, regardless of contingent factors. While the first approach may fall short at clarifying whether the commitment to innovation is sustained over time, the second approach may fail at demonstrating if those capacities are in fact translated into market-valued innovation, and thus support short and long-term survival.

4.4 Review Map

The map shown in **Figure 4** provides a synthesis of concepts and their interrelations derived from our analysis. Broadly, concepts and arrows outlined with thick, continuous lines represent concepts and relationships that are more predominant in the literature (more than five studies). Conversely, concepts and arrows demarcated with dashed lines represent less examined areas that can offer opportunities for further research (four or less studies). At the centre of the map are knowledge processes. Because innovation involves both existing and new knowledge, knowledge processes facilitated the effects of knowledge sources through knowledge transfer, integration, retention, and exploration. The map generated emphasizes the importance of knowledge processes as a critical link between knowledge of any type. We have distinguished three main groups of processes, but the literature has placed a different emphasis on each of them. For example, those processes aimed at the scanning and exploration of knowledge along with transfer processes such as acquisition and sharing have been actively examined in entrepreneurial contexts. In most cases, these processes have been investigated in relation to knowledge sources rather than to firm-level repositories. Integration processes have been mostly examined from the perspective of knowledge creation, either through internal R&D investment or in collaboration with external partners.

Our review map indicates that the entrepreneurship research has strongly focused on knowledge from a resource perspective as an antecedent of innovation in firms. Following macro-level approaches aimed at understanding new venture creation, innovation and competitiveness, this research has elicited important contributions, particularly by emphasizing an input–output approach, where external knowledge plays a critical role. For example, the literature has thoroughly examined the acquisition of external knowledge or the creation of new knowledge in partnership with external entities, to generate innovation. Similarly, the literature has investigated how exploration processes such as knowledge search and networking affects innovation. In most cases, these relationships have been examined unidirectionally (knowledge to innovation), finding strong positive associations. For example, external knowledge from research institutions facilitates disruptive innovation (C. Chen et al., 2017) and market knowledge such as international business knowledge is positively associated with innovation performance (Bai et al., 2016). However, a closer examination of external sources suggests that not all types may be equally beneficial. For example, external knowledge that is tacit leads to innovation while explicit knowledge does not (Garcia-Cabrera et al., 2020). In addition, while explicit knowledge such as patents may be associated with opportunity recognition which can lead to innovation, certain sectors, such as biotechnology, may file patents before commercialization stages (Siegel & Renko, 2012), and therefore patents as a signal of innovation can be equivocal. Lastly, some sources of external knowledge have been found negatively related to venture innovation under certain conditions, such as customer knowledge when market dynamism is high (A. McKelvie et al., 2018). Regarding congenital knowledge, a similar association between human and social capital with innovation has been emphasized in the literature, with a shared distinction between knowledge base and innovation type. For example, human or social capital that is highly specialized and narrow in scope is associated with exploitative or incremental innovation (Hayton & Zahra, 2005; Hormiga & Desiderio Juan, 2016), while human or social capital that is broad facilitates explorative or more radical innovation (J. J. Liu et al., 2013; Protogerou et al., 2017).

We also note that knowledge can be stored in repositories to sustain innovation over time. The map offers a refined proposition on the link between knowledge and innovation in an entrepreneurial context, where processes mediate between sources and repositories to generate innovation. Considering that processes can be seen as strategic actions, we believe the implications of such decisions can be key to sustain innovation performance over time. Further, the map allows the recognition of underdeveloped areas that we discuss in the following section.

5. Future research agenda

5.1 Future Research on Knowledge Sources and Innovation

Entrepreneurship research has heavily focused on knowledge as an antecedent of innovation in firms. Opportunities for future research include (1) the outsourcing or reliance on external knowledge, (2) the knowledge embedded in employees, and (3) the negative side of social capital.

Within the stream of studies focusing on external knowledge we find there is an opportunity to explore external knowledge that temporarily becomes internal, such as knowledge from freelancers, consultants, contractors, incubators, and mentors. There are many different variants of these types of activities discussed in the literature on larger firm context, such as outsourcing and offshoring of knowledge related activities (Bustinza, Molina, & Gutierrez-Gutierrez, 2010; Ernst, 2000). Such activities might be highly attractive for many entrepreneurial ventures who are often resource constrained and have limited access to knowledge from highly skilled employees. Moreover, such activities provide the flexibility often associated with entrepreneurship. However, there might be many disadvantages as well, as outsourced knowledge might reduce tacit knowledge in the firm and hinder knowledge retention (Levallet & Chan, 2019). Therefore, future research might study which type of knowledge outsourcing might be efficient for entrepreneurs and also when the outsourcing of knowledge is beneficial and when knowledge is better created and maintained in the firm.

In addition, while we found three studies examining the role of the knowledge of entrepreneurial employees, we believe this topic could expand the understanding of knowledge in entrepreneurial firms and is highly undeveloped. In the context of entrepreneurship, the founder or founder team determines decision making and thus affects organizational learning and knowledge creation in the firm (Balan & Ionita, 2011), and there is evidence that such decisions are effective (A. Rauch, Frese, & Utsch, 2005). Moreover, there is ample evidence that employees matter in innovation processes in management research (B.-W. Lin & Chen, 2006; McEvily & Chakravarthy, 2002; Spencer, 2003) and they matter in entrepreneurial contexts as well (Y. Zhou, Hong, & Liu, 2013). It would be interesting to know how knowledge affects innovation in entrepreneurial firms. For example, is the effect of knowledge an imprint that supports innovation right from the start? Is it more effective to develop knowledge internally or to hire key employees to increase the knowledge stock? Is firm-level knowledge becoming increasingly important during the life cycle of the firm?

Regarding social capital, we find that most studies build on the assumption that social ties are beneficial for innovation since they allow firms to obtain knowledge that is not readily

available. However, often this view examines social ties at a point in time, ignoring the possibility that networks may develop and change strategically depending on the knowledge required to address uncertainty and innovation (Elfring & Hulsink, 2007; Engel, Kaandorp, & Elfring, 2017). In addition, there might be situations where social bonds are counteractive as knowledge obtained might be deficient, distorted or bad-intentioned but rooted in mutual trust (Levin & Cross, 2004). In particular, strong relationships might reduce external pressure to innovate and to see better ways of doing things. Thus, there might be a dark side of social capital inhibiting innovation processes (Anderson & Jap, 2005). Moreover, social capital and networking has been conceptualized at the level of the entrepreneur assuming that tie formation is goal directed, purposeful and driven by the entrepreneur (Elfring & Hulsink, 2007). However, particularly in highly uncertain environments that are typical for knowledge intensive industries, networking becomes less goal oriented and instrumental as desired ties are difficult to identify (Engel et al., 2017). As a consequence, networks become more means driven and depend on self-selected stakeholders (Hulsink & Elfring, 2019). As such, connections in the firm become important as some key employees have valuable relationships with potential collaborators of the firm.

5.2 Future Research on Knowledge Repositories

Recent entrepreneurship research has started looking at knowledge embedded in the organizational context either in tangible or intangible forms. Tangible forms of knowledge are observed in patents, tools or prototypes. Intangible forms of knowledge include routines and culture. We find that this space, traditionally occupied by studies focusing on patents as an indication of knowledge, has gradually moved towards research focusing on routines, tools, and prototypes. This approach poses several challenges and opportunities.

In general, it would be interesting to understand how knowledge repositories affect firm outcomes as more formalized knowledge might reduce flexibility and quick decision making. For example, on routines in the entrepreneurial context, literature does not agree on whether routines facilitate or hamper entrepreneurship and when. Considering the mixed findings on the implications of routines on innovation, more research is needed to clarify the role of these structures and the contextual characteristics that facilitate innovation through the entrepreneurial process. Moreover, as knowledge repositories are a result of learning processes, their capacity to stimulate innovation can vary across different developmental stages or across different learning capabilities. For example, it has been suggested that specific types of routines, such as learning routines, can be critical to incorporate new knowledge but a stronger

body of evidence is needed to support this idea. There is also an apparent lack of consensus on whether routines are developed over time or just modified from primary to more mature forms.

Overall, we see a promising future for research on how entrepreneurial firms choose to store their knowledge in a way that can be collectively accessed. For example, even though founders apparently highly value the use of digital tools and prototypes (Oliva, Couto, Santos, & Bresciani, 2019), we do not know the implications of storing knowledge in such ways or the specific outcomes. In the case of tools, while there are a few studies on the use of online platforms for interaction and collaboration, many other technological advances in the knowledge dimension have emerged in recent years that could be examined such as Internet of Things, AI, robotics or programming coding scripts just to name a few. Lastly, embedding knowledge in the organizational culture by purposively establishing practices and values that align with those of the founders seems to resonate greatly with the entrepreneurial context and could bring interesting findings. In sum, an examination of knowledge repositories in ventures may reveal strategic decisions associated with potential advantages or disadvantages of embedding knowledge in certain ways. For instance, a comparison between firms that choose to embed knowledge in organizational systems and those firms which rely mostly on individuals could suggest some implications of these decisions.

5.3 Future Research on Knowledge Processes

There has been considerable scholarly attention to knowledge processes in the entrepreneurship literature but there also remains much to be learned, specifically on (1) knowledge integration, (2) knowledge retention, 3) knowledge processes as strategic decisions, (4) conceptualization, differentiation and consistency of knowledge process operationalization and measures, and 5) interaction between knowledge processes.

First, the review denotes that a majority of the research conducted around processes has focused on processes that involve interaction with external stakeholders, such as knowledge scanning and exploration (knowledge search, networking, collaboration and cooperation), and knowledge transfer (knowledge sharing, knowledge acquisition and knowledge spillovers). Most of these studies are mainly concerned with how entrepreneurs assess, obtain, and transform external knowledge to generate internal benefits. Consequently, we know less about the processes associated with knowledge integration, and particularly around application and retention of knowledge. For example, almost no attention has been given to the integration processes that may help develop organizational structures where knowledge is embedded and stored to support sustained performance, and particularly innovation over time.

Second, it is surprising that knowledge retention has not been studied in the entrepreneurship literature on knowledge and innovation because organizational knowledge needs to be retained and passed on, otherwise it can be lost, for example, when key employees resign or move to other firms or when firms do not use this knowledge regularly. Knowledge retention may even become more important as innovations become increasingly complex in a dynamic environment. Retained knowledge influences the acquisition of new knowledge and thus affects organizational learning and transfer. In entrepreneurship research, knowledge retention is usually just a cognitive construct, assuming that it is inherent in the memory of the entrepreneur. Notably, this knowledge needs to be accessible to the employees. In the literature we see a propensity to assume that new knowledge is integrated to improve and transform the firm as it grows, while the notion of storing of relevant knowledge is mostly ignored. There are ample opportunities to study how retention takes place in the entrepreneurship process. For example, when ventures scale up to operate in new markets by establishing overseas teams, they may need to guide their new members through the main lessons already acquired to avoid repeating mistakes in the future.

Third, knowledge processes can be seen as strategic decisions. We see an opportunity to examine knowledge processes as strategic decisions carried out by entrepreneurial firms enabling a deeper understanding of the rationale and implications of those decisions. Because knowledge processes involve an action that leads to a specific outcome, we believe that entrepreneurs might have a preconceived idea of which processes to pursue and for which purposes. Conversely, a mismatch between action and outcome might have negative implications for firm performance. Following prior findings on the implications of different processes on firm performance, there are various levels of risk associated with each of them. Particularly in the context of innovation, ventures may struggle to prevent knowledge spillovers while promoting collaboration and knowledge sharing (Michelino, Cammarano, Lamberti, & Caputo, 2017). However, even firm knowledge spillovers have been observed as intentional practices, leading to benefits such as early investment attraction (Park, Shin, & Choy, 2020). Similarly, interaction with external actors has the same challenges. Thus, we believe entrepreneurial firms might gauge the advantages and disadvantages before engaging in any of these activities, particularly external versus internal collaboration.

Fourth, we see an opportunity to advance in the differentiation across existing conceptualizations of knowledge processes and implications for entrepreneurial activity. Our review found some overlap across knowledge process conceptualizations, specifically a lack of hierarchical classification of knowledge transfer and knowledge integration sub-types. For

example, the concept of knowledge transfer is relatively broad as it is not associated with a specific purpose. In contrast, the concepts of knowledge acquisition, sharing and spillover have clearer implications in firms, and therefore research on them poses a distinctive theoretical advance. While preparing this review, we noted other scholars have started to identify and tackle these issues, specifically the concepts of knowledge integration, and the distinction between collaboration and cooperation (Castañer & Oliveira, 2020; Zahra et al., 2019). Similarly, we noted research focusing on collaboration and cooperation may assume the occurrence of knowledge flow processes, such as knowledge transfer, acquisition or sharing, and wondered whether it would be more appropriate in these cases to use existing concepts or explain further how those concepts differ. The confusion around these terms also permeates the corresponding constructs and measures. For example, we observed that the concept of knowledge acquisition has been used to refer to the obtaining of knowledge without the mediation of financial transactions, in which case any new knowledge incorporated in firms may be treated as knowledge acquired. We believe this undermines research focusing on more specific actions and the implications and generates unnecessary confusion.

Finally, we see an opportunity for future research on the interrelation between knowledge processes. In most of the studies reviewed, knowledge processes are examined in isolation or directly related to innovation. However, we have less evidence of the sequence of processes and how these may be mutually affected. For example, we have found several studies that support the relevance of transferring external knowledge to generate innovation, including knowledge acquisition and knowledge sharing (Burns et al., 2011; C. J. Chen, Lin, Lin, & Hsiao, 2020; Jang et al., 2019). At the same time, the integration of knowledge through knowledge creation and application has also been highlighted as critical for innovation (J. Chen, Zhu, & Zhang, 2017; R. Guo et al., 2019; Zacca et al., 2015). However, the literature does not make a clear distinction about the implications of these processes, as the mere acquisition of knowledge has been associated with innovation directly. This prompts the question of whether integration is needed and to what extent and conversely, where is knowledge transferred and embedded if not integrated? We believe this domain may benefit from longitudinal studies that provide an in-depth understanding of transfer processes, particularly through learning and vicarious learning such as knowledge transfer from mentors, advisors, board members or temporary employees.

5.3 Future Research on Knowledge Inter-Relationships

A few recent studies have investigated knowledge resources and processes at the same time (Roper & Hewitt-Dundas, 2015; Rupietta & Backes-Gellner, 2019; Sung & Choi, 2018; van Wijk, Jansen, Van Den Bosch, & Volberda, 2012). This is important as these concepts are not independent from each other. While we recognize that more research is required on the relationships between each sub-element of the knowledge–innovation process, we highlight some specific relationships to show how future research can contribute to our understanding of the knowledge–innovation relationship in entrepreneurship research.

First, and possibly due to the dominance of a resource perspective, entrepreneurship research has looked predominantly at how knowledge affects innovation. Future research needs to highlight how innovation affects the sources of knowledge. A hypothesis could be that entrepreneurs exploit those innovations that provide the best learning potential to them and their firms and, thus, the opportunity to acquire unique knowledge resources (Haynie, Shepherd, & McMullen, 2009). Innovations that allow firms to learn and develop new knowledge might be attractive as they allow firms to develop and maintain a sustained competitive advantage. Thus, the tacitness of experience-based knowledge developed in the firm provides unique new sources of innovation. In addition, there might be reciprocal effects between knowledge sources and innovation as well as potential upward spirals of reinforcing processes in entrepreneurial firms. Thus, prior knowledge is associated with future innovation, which is, in turn, associated with subsequent knowledge.

In addition, it can be attractive to exploit the relationship between existing knowledge resources and innovations that imply productivity, efficiency, cost, and experience. Specifically, exploiting innovation requires learning and knowledge that focuses on endurance and existing trajectories (Wenke, Zapkau, & Schwens, 2021). Focusing on endurance requires different structures and processes in the firm compared to focusing on newness and change (Koryak, Lockett, Hayton, Nicolaou, & Mole, 2018). Some of these structures may have already been imprinted from the inception of the firm (Baron & Hannan, 2003; DeSantola & Gulati, 2017). While the imprinting literature argues that such effects are possibly initiated at the time of the firm formation when individual agency was high, our map in **Figure 4** suggests that knowledge repositories help to ensure that knowledge is stored, available and not lost in the innovation process. Such knowledge processes may help to address imprinting effects that diminish a firm's ability to exploit existing knowledge in order to enhance the innovation output of the firm. There are two key questions that could be tackled by research in this area. The first is how do entrepreneurial firms not only innovate but sustain innovation-driven

behavior across growth and scaling stages (D. Shepherd & Patzelt, 2021). The second is the reclaiming and adaptation of the conceptualization of organizational memory in an entrepreneurial context. Moving beyond team-level and networking perspectives such as transactive memory systems (Dai, Roundy, Chok, Ding, & Byun, 2016), investigating how entrepreneurial firms carry out processes for the retention, forgetting and discarding of knowledge and how these processes support long-term innovation could extend the scope of research based on knowledge theories and offer a deeper understanding of how innovation-led performance is attained.

Third, there are ample opportunities to look more specifically at how knowledge processes interact with knowledge sources, repositories, and innovation outcomes. For example, future research could investigate how knowledge is affected by the way in which knowledge is shared and connected in a firm. For example, do people know where information is located (e.g., digital tools, culture) and who possesses the knowledge required for innovation? Some knowledge processes may need to be implemented to make sure that any knowledge that diminishes the ability to create new knowledge required for innovation can be unlearned. Additionally, are different knowledge processes required for different types of innovation?

Fourth, we did not find much literature on knowledge and its relationships to processes in the external environment. However, knowledge by definition relies on experiences and the experiences differ in different contexts and situations (Tsoukas & Vladimirou, 2001). Thus, the environment is an antecedent of knowledge sources. At the same time, the environment might function as a moderator affecting the interrelationships between knowledge processes and innovation. For example, a resource constrained environment may not easily provide knowledge sources to a firm, for example due to difficulties recruiting knowledgeable human capital. Therefore, knowledge processes and measures to develop new knowledge internally may be critical for innovative firms operating in a resource constrained environment. Finally, there are reciprocal effects between entrepreneurs and their environment, for example between knowledge spillovers as enablers of recognition and exploitation of opportunities and economic growth enabled by the entrepreneurial activity (Acs et al., 2013).

6. Concluding remarks

The domain of entrepreneurship has repeatedly recognized the critical role of knowledge in the entrepreneurial process. Surprisingly, the study of entrepreneurs' knowledge has led to results of little practical significance. In fact, there are several meta-analyses showing

that the effect sizes of entrepreneurs' individual knowledge are small. For example, Rauch and Saeed (2021) aggregated six meta-analyses on entrepreneurs' human capital and reported an average effect size of $r = .019$. We aimed to contribute to the discussion about the importance of knowledge and entrepreneurship by moving away from an individual-level conceptualization of knowledge to a firm-level conceptualization, summarizing the literature that is available at this level of analysis, developing a conceptual map and discussing areas for future research. We believe that conceptualizing knowledge at the level of the entrepreneurial firm is timely. For example, technological developments such as digitalization, process automation, and artificial intelligence move knowledge away from the individual. Moreover, there are global trends that call for emphasizing knowledge in entrepreneurial firms. About 15 years ago, the World Bank called for a knowledge-based economy emphasizing innovation and institutions that stimulate entrepreneurship (Bank, 2007). The intersection between knowledge, entrepreneurship and innovation is not only relevant on the political agenda but is also reflected by the huge number of studies that have recently addressed this topic. For example, Piñeiro-Chousa, López-Cabarcos, Romero-Castro, and Pérez-Pico (2020) identified 424 studies published between 2015 to 2019, although many of them were at the individual level. Technological advancement and the importance of innovation is one of the megatrends that will decide how we live in the future (Hajkowicz, 2015). We hope that our research agenda inspires scholars to study and understand the role of entrepreneurship in these trends.

CHAPTER THREE

ENABLERS AND BARRIERS OF KNOWLEDGE INTEGRATION IN NEW FIRMS: FOUR EMERGING ARCHETYPES.

ABSTRACT

Knowledge integration has been defined as a multi-level organizational capability through which firms combine knowledge to generate firm-level benefits such as innovation. Therefore, knowledge integration is critical for new firms. While knowledge integration occurs through contrasting mechanisms, namely, systematization and coordination of knowledge, prior research has supported the idea that both types are needed to sustain innovation. Yet, systematization and coordination practices have different aims and require different resources and therefore we argue that new firm's founders may choose these mechanisms in distinctive ways leading to differentiated firm-outcomes. Consequently, we formulate the following question: How are knowledge integration mechanisms leveraged by new firms' founders and are there any differences in the way these are configured? We tackle this question through an exploratory qualitative study oriented towards theory generation using abductive grounded theory method. Our findings emphasize important variations in the way venture-level integration is achieved and include the identification of multilevel enablers and barriers associated to knowledge integration mechanisms, and the identification of four distinct firm archetypes. Our study contributes to the knowledge-based entrepreneurship research by suggesting antecedents of knowledge integration in new firms. Further, our study contributes to the literature focusing on venture archetypes stemming from knowledge-based perspectives.

Keywords: entrepreneurship, knowledge integration, venture archetypes, resource dependence

1. Introduction

Knowledge integration is key for innovation and thus for entrepreneurial ventures (Amankwah-Amoah & Adomako, 2021; Salunke, Weerawardena, & McColl-Kennedy, 2019; K.-H. Tsai, Liao, & Hsu, 2015; K. Z. Zhou & Li, 2012). Regardless, the extant literature suggests that innovation stemming from knowledge integration can deem particularly challenging for new firms. For example, knowledge integration has been largely associated to firm-level capabilities (Zahra et al., 2019) which may be difficult to attain in a limited timeframe and with few resources (Alvarez & Busenitz, 2001). Accordingly, one might expect that knowledge integration might only become important once firms grow and mature (Crossan et al., 1999; De Boer, Van Den Bosch, & Volberda, 1999). Moreover, while knowledge integration is a firm-level capability (Zahra et al., 2019), its occurrence can be a result of multi-level contributions (Alegre & Chiva, 2008; Argote & Guo, 2016). Yet, often new firms hold knowledge in individuals and founder entrepreneurs (Schulz, 2001; Wegner, 1987) and we do not know precisely when and how firm knowledge integration occurs, if at all. Further, knowledge integration is enabled by two contrasting mechanisms: while knowledge systematization enables integration through knowledge codification and storing in firm-level systems, knowledge coordination does it through the share of knowledge via social interaction and collaboration (Jansen, Tempelaar, van den Bosch, & Volberda, 2009; Zahra et al., 2019). Since systematization and coordination of knowledge have distinctive aims and require different resources and capabilities, it can be argued that the selection and implementation of one strategy over the other may lead to advantages or disadvantages in the capacity of firms to innovate.

Considering the above, we believe that new firm's founders may have a key role in navigating these difficulties. Moreover, since early management decisions can have long term consequences (Baron, Hannan, & Burton, 1999) we believe that the selection and implementation of knowledge integration mechanisms can be determinant in the way knowledge is structured (Macpherson & Holt, 2007) and thus affect the capacity of new firms to innovate. Following existing theorizations, founders are the key decision makers of new firms and their influence can have firm-level effects (Beckman & Burton, 2008). For example, founders who choose to predominantly integrate knowledge by systematization can generate a constrained environment that hampers creativity and affect certain types of innovation (García-Muiña, Pelechano-Barahona, & Navas-López, 2009). Conversely, founders who choose to predominantly integrate knowledge by coordination can generate an environment that prevents knowledge from being sustained over time (Levallet & Chan, 2019). Furthermore, we believe

that the attainment of firm-wide integration is complex, and therefore not all new firms may be able to achieve it, which may affect innovation. With all the above, we pose the following question: How are knowledge integration mechanisms leveraged by new firms' founders and are there any differences in the way these are configured?

We address this question through an exploratory qualitative study aimed at theory generation using the abductive grounded theory method. We use data collected from interviews with founders and employees from 22 new Australian firms. We conduct deductive steps to distinguish between two main mechanisms of knowledge integration, which we detail and refine further for contextual pertinency. In addition, we perform inductive analysis to identify enablers and barriers to the selection and implementation of knowledge integration mechanisms. Lastly, we use abductive analysis to generate venture archetypes based on the interrelation of the concepts identified.

Our findings, grounded in multilevel concepts, emphasize variances in the way knowledge is integrated in new firms. This allows us to theorise different venture archetypes that derived from it. Consequently, our findings are organised across three areas: first, we provide a description of knowledge integration mechanisms in the context of new firms. Second, we explain the concepts identified as enablers and barriers to the selection and implementation of each of these strategies. Importantly, we suggest one individual-level enabler (knowledge awareness), one firm-level enabler (organizational enablers) and one firm-level barrier (firm dependence on the founders). Third, we synthesize different combinations of mechanisms, enablers, and barriers into four empirically grounded archetypes, namely, *founder-driven*, *shared organizations*, *shared in silos* and *standardized organizations*. These archetypes depict a range of arrangements related to knowledge integration, including two extreme types (knowledge fully integrated and knowledge not integrated) and two hybrid types (where knowledge is partially integrated).

We offer three contributions. We contribute to the knowledge-based view entrepreneurship literature in two ways. First, by identifying the enablers and barriers associated to knowledge integration mechanisms in new firms. These are related to the recognition of knowledge (awareness) leveraged by new firms, specific organisational characteristics that facilitate the integration of knowledge, and the dependence of the firm on the founders to access knowledge and innovation. By doing so, we add to the literature focusing on antecedents of knowledge integration (Koch, 2011; Luca & Atuahene-Gima, 2007; W. Tsai, 2002; K. Z. Zhou & Li, 2012) by explaining how individual views can determine the selection of different firm-integration mechanisms. Second, by disentangling the relationship between

the founder and their firm regarding the integration of knowledge. Particularly, our study suggest that the implementation of integration mechanisms not always guarantee firm-level access to knowledge and innovation which could be detrimental for the capacity of new firms to innovate. Although these are preliminary findings, more research on this topic can more deeply investigate whether this phenomenon is associated with control mechanisms at the micro level, as posed by resource-dependency theories (Drees & Heugens, 2013; Hillman, Withers, & Collins, 2009). Third, by elaborating on venture archetypes based on different arrangements of knowledge integration at the firm level, we contribute to the literature on new firm archetypes from the perspective of knowledge. Although these findings are emergent, we believe our study offers a preliminary understanding of knowledge integration in new firms by suggesting that integration may concur in different ways. By doing this we offer an alternative approach that contrasts with existing views that have treated firm-level integration as a process applicable to firms in the same way (Amankwah-Amoah & Adomako, 2021; Y. J. Kim, Song, Sambamurthy, & Lee, 2012; Salunke et al., 2019).

2. Background

Prior research emphasizes knowledge integration as an antecedent of innovation in new firms (Chang, Tsai, Fu, Chen, & De Peng, 2016; De Boer et al., 1999; Koch, 2011; B.-W. Lin & Chen, 2006). Considering that innovation has been defined as a context-dependent phenomenon (Rosenbusch, Brinckmann, & Bausch, 2011), it can be argued that the use of different knowledge integration mechanisms may facilitate innovation in different settings. In line with these arguments, further research supports the idea that firms pursuing innovation need to implement a combination of knowledge integration mechanisms (Runping Guo, Li Cai, & Yupeng Fei, 2019; Guo, Lv, Wang, Chaudhry, & Chaudhry, 2020). Specifically, prior studies have distinguished between two contrasting knowledge integration mechanisms: 1) coordination, the processes oriented at knowledge exchange through social interaction, and 2) systematisation, the processes aimed at the storage, documentation and visibility of information and knowledge (Runping Guo et al., 2019). Although prior studies have used different terms to refer to these groups of mechanisms—for example, informal and formal mechanisms (Jansen et al., 2009), processes and structures (K.-H. Tsai et al., 2015), socialisation and formalisation (Briel, Schneider, & Lowry, 2019; Zahra et al., 2019), knowledge dissemination or storage (Alegre, Sengupta, & Lapiedra, 2011), and knowledge share and knowledge acquisition (K. Z. Zhou & Li, 2012)—they all contend a difference between integrating knowledge through interactions and integrating knowledge through systems. Considering that both coordination

and systematisation of knowledge have their own difficulties and require different resources, entrepreneurial ventures may be more prone to implement one type over the other depending on the resources they have at hand (Guo et al., 2020; Sarasvathy, 2001). Given that key knowledge integration mechanisms differ significantly, an inclination to either one may result in a more “coordinated” or “systematised” venture that may affect its ability to innovate. Because knowledge integration and firm formation can occur simultaneously, we believe that knowledge integration mechanisms can greatly affect the way the organisation is shaped from the very beginning. Furthermore, the propensity towards one or the other strategy may be derived from the founder’s own experience, values, or beliefs. For example, literature focusing on imprinted founding characteristics have emphasised that the founding team’s prior experience can influence the organisational trajectory in the long term (P. T. Bryant, 2014; Hsu & Lim, 2014). Consequently, we believe that, in the context of entrepreneurship, knowledge integration must be examined as a multi-level phenomenon. Given that new firms are started by individuals who possess knowledge and experience (Dencker, Gruber, & Shah, 2009), understanding how this knowledge is transferred and integrated at the firm-level can add a new perspective on how innovation is achieved and sustained over time from individual knowledge contributions.

However, the empirical literature in entrepreneurship has predominantly studied knowledge integration at one single level of analysis, often at the individual or firm level. Broadly, at the individual level, research has mostly focused on antecedents such as learning processes (Pisano, 1994), human capital (Chang et al., 2016), and social capital (Yli-Renko, Autio, & Sapienza, 2001). At the firm level, research has distinguished between antecedents such as organisational capabilities (Briel et al., 2019; Chirico & Salvato, 2008) and consequences such as operational benefits (Bahlmann, 2016; Chang et al., 2016; Runping Guo et al., 2019; Jansen et al., 2009; Y. J. Kim et al., 2012; Mehta & Mehta, 2018; K.-H. Tsai et al., 2015). In such studies, knowledge is often aggregated at the firm level, without examining whether integration occurs at other levels simultaneously. Only, a few multi-level studies have drawn links across macro-level perspectives, for example, between firm-level integration and market’s dynamism (K. Z. Zhou & Li, 2012). Extending these multi-level studies, research needs to incorporate individual and organisational perspectives of firm-level knowledge integration (Casson, 2005). While there is no evidence of how firm-level integration is achieved, it is suggested that entrepreneurial firms that attain venture-wide integration are more likely to survive employee turnover and can better leverage pre-entry human capital due to the embedding of organisational resources that can withstand employee rotation (Argote & Guo,

2016; Chirico & Salvato, 2008; Gardner, Gino, & Staats, 2012). Finally, knowledge integration varies across firms (Zahra et al., 2019), and this variation needs to be covered by a theory of knowledge integration in new firms.

3. Methodology

To examine knowledge integration in the context of new firms and to allow for the generation of new ideas, we adopt an exploratory qualitative approach (Corbin & Strauss, 2008). Specifically, we employ the abductive grounded theory (Rahmani & Leifels, 2018; Richardson & Kramer, 2006; Timmermans & Tavory, 2012) as a way to build new theoretical propositions based on findings that confront existing research. Grounded theory was initially posed as a purely inductive method aimed at the discovery of emerging patterns in observed data (Glaser & Strauss, 1967); however, critical views have questioned its feasibility, arguing that the formulation of research inquiries are inevitably supported by pre-existing knowledge. In response to these concerns, refined variants of the method have arisen (A. Bryant, 2019). For example, Strauss and Corbin (1997) propose a structured process that integrates inductive and deductive steps iteratively, and Charmaz (2014) describes a constructivist approach that accounts for the researcher's background and context. In a similar vein, Timmermans and Tavory (2012) pose that integrating deductive and inductive analysis enables an abductive conceptualisation of data by generating plausible explanations that connect both existing and new ideas. Hence, by identifying and incorporating existing concepts of knowledge, particularly knowledge integration mechanisms of coordinating and systematising as a preliminary framework to extract new data, we adopt an abductive approach.

3.1 Data Sources

Consistent with grounded theory aimed at generalisation by providing evidence of research synthesis, we followed a purposeful sampling strategy consisting of a combination of criterion and maximum variation sampling (Suri, 2011). First, we established preliminary inclusion and exclusion criteria to select firms for our study. In doing so, we included firms that self-identified as ventures, including young and small firms. We included ventures that had been operating for at least one year, as knowledge integration as an organisational process develops over time (Zahra et al., 2019). Following previous conceptualisations of young firms, we established a cut-off firm age of 12 years (Rosenbusch et al., 2011). We included all team sizes, as long as the entrepreneur had at least one other collaborator, as we wanted to examine the integration of different sources of knowledge, including among individuals. Second, to achieve maximum variation within our sampling scope, we included firms from different

industries and with different aims, including manufacture, services, ICT and social enterprises. By recruiting ventures of different characteristics, we aimed at gathering contrasting cases that may lead to the collection of rich and diverse data. Third, we followed theoretical sampling in the data collection stages by adjusting the number of interviews to the emergence or absence of new insights (Corbin & Strauss, 2015). As a result of our sampling strategy, we conducted 22 interviews with 28 members of Australian ventures, as detailed in **Table 4**.

3.2 Data Collection

Over a 7-month period from January to July of 2021, we carried out one-off interviews with members of our selected firms, including founders and employees. To recruit our participants, we posted an invitation to participate in the study in different public-access entrepreneurial forums. The invitation to participate included a link to a short survey where we completed a check of our inclusion criteria. We sent group invitations to the eligible ventures' contact information they had specified in the survey, encouraging them to pass the invitation on to the rest of their members. From a total of 29 invitations, we obtained 22 positive responses from ventures to conduct interviews. Over the 22 interviews conducted, six were carried out with two participants, either one founder and one employee or two co-founders, reaching a total of 28 participants.

Table 4: Overview of interviews

Interview No.	Industry	Firm Size	Firm Age	Participant (s)
1	Financial Services	11	7	Founder
2	Healthcare	2	3	Founder
3	Social Enterprise	2	3	Founder, Employee
4	ICT	10	10	Founder, Employee
5	Transportation	6	2	Founder, Employee
6	Consulting	10	10	Founder
7	ICT	6	3	Founder
8	ICT	4	2	Founder
9	Social Enterprise	2	3	Founder
10	Marketing	5	2	Founder
11	Financial Services	15	3	Employee
12	Social Enterprise	2	2	Founder
13	Manufacturing	3	2	Founder
14	Transportation	8	3	Founder
15	Human Resources	5	1	Founder, Co-Founder
16	Education	4	1	Founder
17	Financial Services	7	1.5	Founder
18	Education	7	1.5	Founder
19	Healthcare	5	3	Founder
20	Entertainment	6	2.5	Founder
21	Hardware Automation	5	1	Founder, Employee
22	Energy	10	1	Founder, Employee

3.3 Interview Procedure

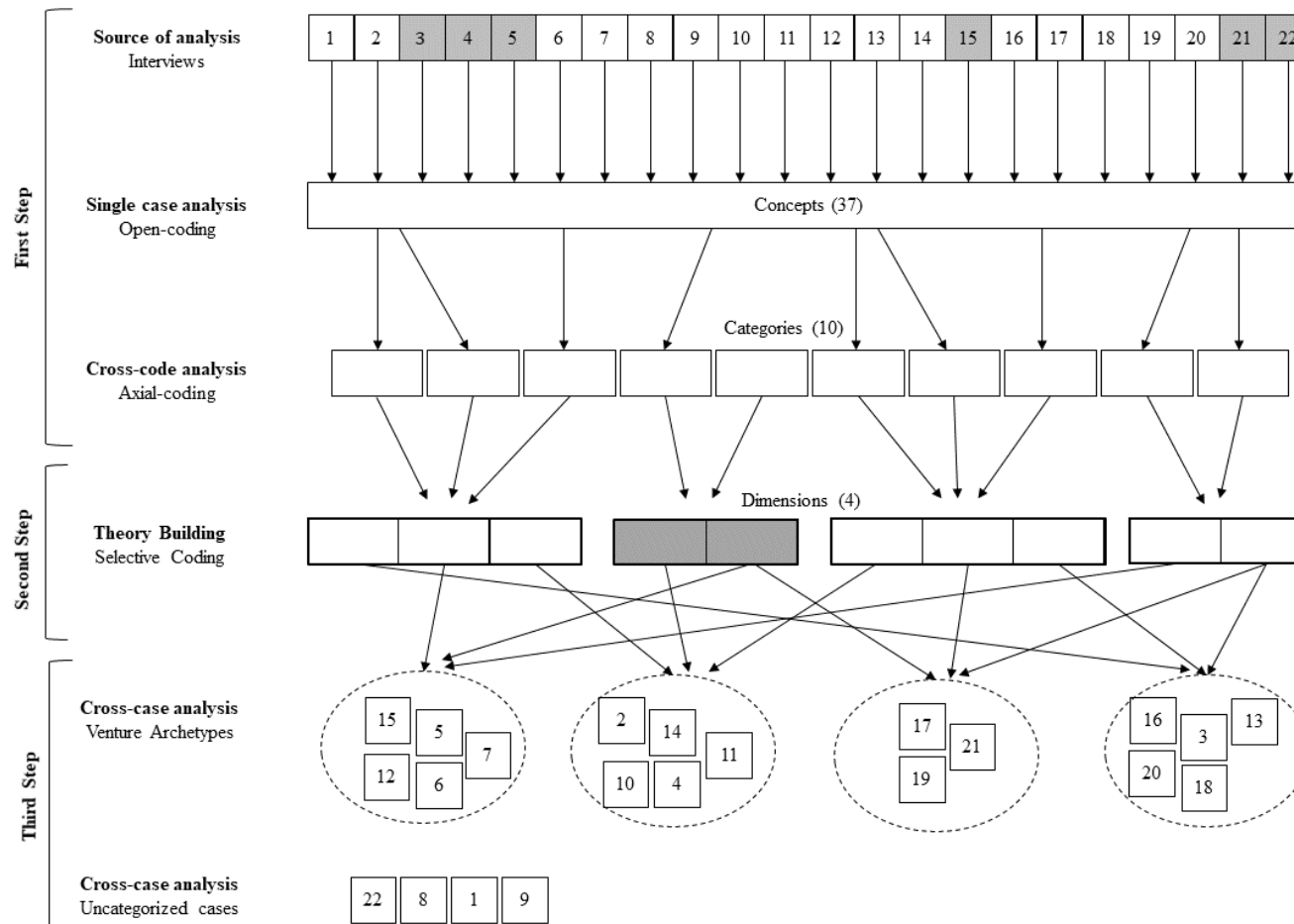
While group interviews represented a small percentage of the whole sample, we used them to increase data validity through the participants' spontaneous interactions, as group interviews "based on existing networks are likely to be more representative of people's actual daily interactions" (Hollander, 2004, p. 628). Consistent with the exploratory aim of the study, we followed a semi-structured protocol consisting of three main questions and a varying number of secondary questions depending on the answers provided. We focused our enquiries on entrepreneurial behaviour rather than entrepreneurial beliefs to minimise interpretive manipulation of the data in subsequent stages. We started our interviews by asking participants to summarise their venture journey, focusing on how they went from an idea to a business. This question led to different sub-topics such as the resources, people, and entities involved in the business development process, as well as the nature of the business opportunity, including its innovation radicalness. To assess knowledge integration, we used situational questions (Oostrom, Melchers, Ingold, & Kleinmann, 2016) across two dimensions—systemic and coordinated integration—following existent theoretical propositions (Runping Guo et al., 2019; Jansen, Van Den Bosch, & Volberda, 2005). For that purpose, we encouraged our participants to use their own definitions and understandings of the term "knowledge", avoiding the reliance on academic terminology. Situational questions have been identified as accurate predictors of human behaviour in work-related contexts (Klehe & Latham, 2006; Oostrom et al., 2016) and are a useful tool to simulate and contextualise the participant's real environment. To explore systemic integration, we asked our participants to imagine a situation where the whole team, including founders, had to be replaced by new members without notice. In that scenario, we asked them to comment on how they thought the new team would manage to continue the work they had been doing for the last few weeks. This question elicited responses of "where" knowledge was embedded, "what" this venture's knowledge was, and to what extent this information was available and accessible to new members. To assess coordinated integration, we asked participants to imagine a situation where a new skilled member would join the venture for a limited period of time while the business continued with its normal operations and activities. In this case, we asked them to describe what would they normally do to use or assess all the knowledge available. This scenario prompted responses focused on socialisation practices and coordination dynamics, such as the description of meetings and their frequency, existing induction and recruitment protocols, aspects of the venture's culture and other established organisational activities. All interviews were conducted via videoconference, recorded and transcribed for analysis.

3.4 Data Analysis

Following recommendations from grounded theory scholars, we started analysing the data as we collected it, allowing for comparison and refinement between codes and comparison with existing theoretical conceptualisations. We conducted the analysis in three iterative steps using NVivo as illustrated in **Figure 5**. First, we coded, structured, and aggregated the data following the systematic approach proposed by Gioia, Corley, and Hamilton (2013) to ensure the validity of inductive concept development and of our propositions. We started by conducting open coding on the entire content of each interview transcript, including additional information such as the venture industry, the number of the venture's members and the firm age, gathered in the selection survey. By connecting this information to each interview transcript, we generated basic cases. In addition, we produced notes or "memos" as we went along with the collection and analysis of the data to keep track of emerging insights derived from the comparison between codes and cases. We started to observe code saturation at around 15 interviews (Hennink, Kaiser, & Marconi, 2016). We conducted axial coding by subsuming codes into larger categories, thereby creating a preliminary structure of first- and second-order concepts. We continued with iterative steps of open and axial coding until we reached data saturation at around 20 interviews. Then we started conducting selective coding by aggregating categories³, revising and consolidating the data structure into first-order concepts, second-order themes and aggregated dimensions, as illustrated in **Table 5**. We used deductive codes for only one dimension—knowledge integration—in accordance with our research question. Further, in the analysis, we incorporated two deductive second-order codes: coordinated knowledge integration and systemic knowledge integration, as our data appeared to fit well into those existing theoretical conceptualisations. The following remaining codes were generated inductively: knowledge awareness as an individual-level knowledge integration enabler, organizational knowledge integration enablers and firm's dependence on their founders to access knowledge and innovation, as a firm-level barrier.

³ For additional information on the coding rationale refer to the Appendix 2.

Figure 4: Overview of the Analysis

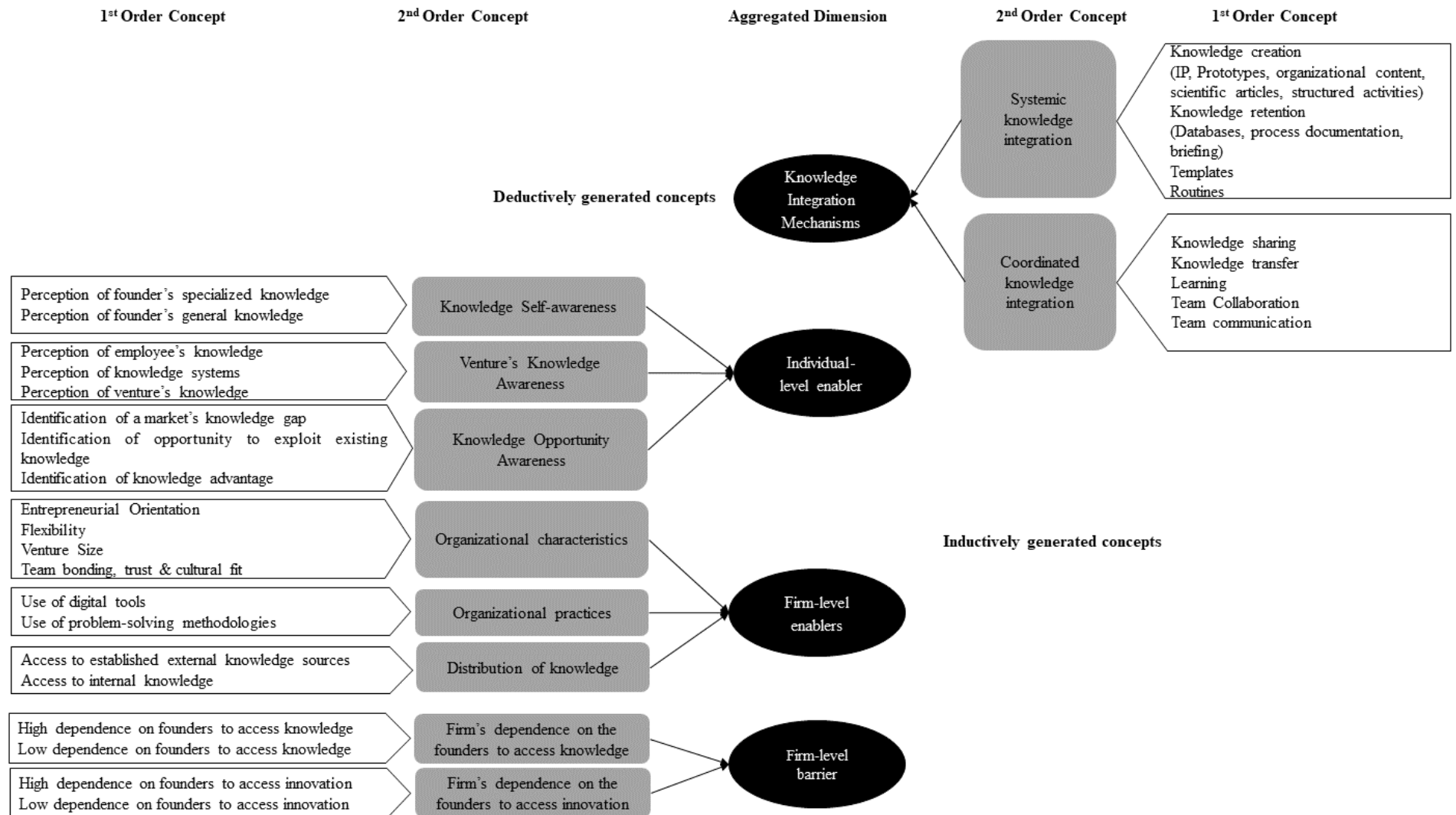


Notes:

Interviews: Highlighted squares correspond to group interviews

Theory Building: Highlighted dimension correspond to knowledge Integrated mechanisms

Table 5: Data Structure



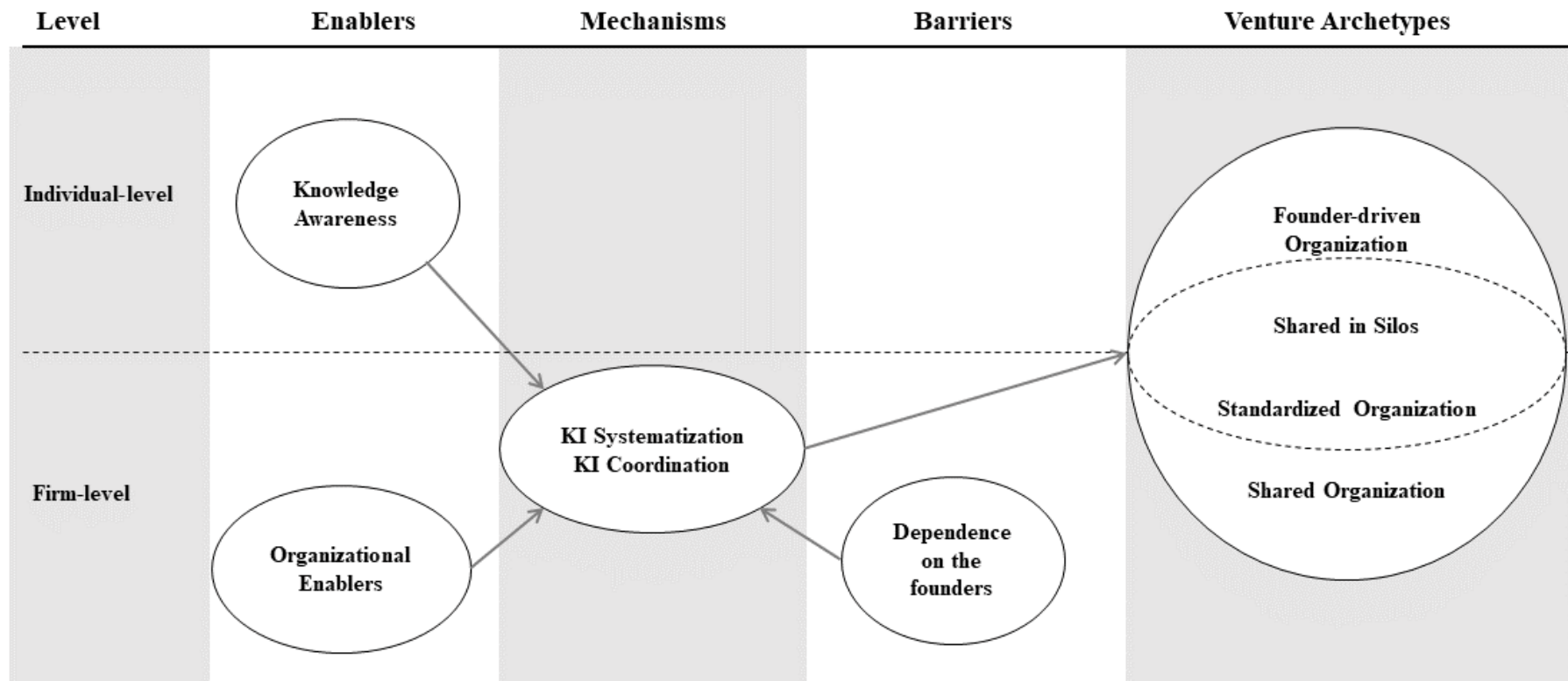
Second, we coded each interview seeking evidence of relationships between our concepts. Following similar analytical approaches, we distinguished between unidirectional and reciprocal relationships (Habersang et al., 2019). We coded unidirectional relationships as relationships between codes that follow a sequential (causal) logic, that is, when the participant provided an explanation of an issue by citing another. For example, in the excerpt *“It’s critical to have systems and processes in place to leverage other people’s knowledge so that it is not just in my own head”*, it can be inferred that this participant-founder’s knowledge awareness motivates systematic knowledge integration. In contrast, we coded reciprocal relationships when we found concepts that were interrelated but had no identifiable causal direction. For example, in the excerpt *“We have meetings internally, very open discussions. Everyone has the right to speak their mind on what they’re doing”*, it can be deducted that team communication and team bonding are mutually entwined. We compared, triangulated, and aggregated all relationships. As a result, we further grouped the concepts into 1) knowledge integration mechanisms, 2) knowledge integration enablers and 3) knowledge integration barriers.

As a final step, we compared codes between cases seeking cross-case similarities and differences as illustrated in. Following prior research with similar aims (Bronstein & Reihlen, 2014), we generated a cross-tabulation table (**Table 6**) using NVivo to compare all ventures interviewed in relation to the categories of codes generated. Since interviews differed significantly in the amount of time spent on one topic or another depending on the participant’s responses, we opted to compare our cases based on coding presence (Yes/No) instead of coding frequency. We sought patterns of similarity in relation to our coding dimensions, starting by examining similarities in knowledge integration codes. However, we only began to observe patterns when we grouped ventures together that had similar coding structures at the barriers dimension. We then identified four coding patterns from which we abductively generated archetypes by examining similarities and differences in the remaining categories. In addition, we identified a group of ventures that did not fit into the established archetypes nor follow a distinguishable pattern. As our yielded archetypes are elaborated upon the concepts and relationships described in the previous steps, we consolidate our findings in a model shown in **Figure 6**. We describe and discuss this group of ventures in the findings and discussion sections respectively.

Table 6: Cross-case analysis and archetype generation

Coding Presence / Archetypes			Standardized organization					Shared organization					Shared in Silos			Founder-driven					Uncategorized			
Dimension	Category	Concepts	15	5	7	12	6	14	11	10	4	2	17	21	19	16	20	3	13	18	9	22	8	1
Knowledge Integration Mechanisms	Coordinated Integration	Knowledge Sharing	•	•				•	•			•				•	•	•			•		•	
		Knowledge transfer		•			•		•	•			•						•			•		•
		Learning			•		•			•	•	•		•	•				•				•	•
		Team Collaboration		•					•			•		•	•							•	•	•
		Team Communication	•	•				•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
	Systemic Integration	Knowledge Creation		•	•		•		•			•		•		•			•	•		•		
		Knowledge Retention	•	•	•	•	•	•	•		•	•	•	•	•	•	•	•	•	•	•	•	•	•
		Routines	•	•																				
		Templates	•		•						•				•									•
Individual-level enabler: Knowledge Awareness	Founder's Knowledge Awareness	Perception of founder's general knowledge			•	•				•	•			•	•		•	•			•		•	•
		Perception of founder's specialized knowledge	•	•	•	•	•	•		•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
	Knowledge Opportunity Awareness	Identification of knowledge advantage			•									•				•					•	
		Identification of market's knowledge gap	•	•	•			•	•	•	•	•		•			•		•	•			•	•
		Identification of opp. to exploit existing knowledge		•													•				•			
	Venture's Knowledge Awareness	Employee knowledge	•	•	•	•	•	•	•				•	•	•	•	•	•	•	•	•	•	•	•
		Perception of knowledge systems: Negative		•								•		•	•		•	•	•	•			•	•
		Perception of knowledge systems: Positive	•	•				•		•	•					•	•	•	•	•	•		•	•
		Venture's knowledge perception	•	•				•						•			•				•			•
Firm-level Knowledge Enablers	Distribution of knowledge	Access to established external knowledge	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
		Access to Internal Knowledge					•	•					•	•	•		•	•	•	•		•	•	•
	Organizational Enablers	Entrepreneurial Orientation	•				•	•										•					•	•
		Flexibility	•	•				•	•	•	•	•	•	•	•	•	•	•	•	•	•		•	•
		Team Bonding, Trust & Cultural Fit					•			•	•			•			•	•					•	•
		Venture Size					•			•	•	•											•	•
	Organizational Practices	Use of Digital Tools	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•		•	•
		Use of problem-solving methodologies	•	•			•	•			•	•	•	•	•	•	•					•		•
Firm-level Knowledge Barriers	Firm's dependence on the founders to access innovation	High level of dependence	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•			
		Low level of dependence						•	•	•	•	•	•	•	•	•								
	Firm's dependence on the founders to access knowledge	High level of dependence					•	•					•	•	•	•	•	•	•	•	•			
		Low level of dependence	•	•	•	•	•	•	•	•	•	•	•									•		

Figure 5: Theoretical Model



4 Findings

Consistent with existing theoretical propositions (Runping Guo et al., 2019; Jansen et al., 2009), we found evidence of knowledge integration across two main mechanisms: coordinated knowledge integration and systematic knowledge integration. We refer to mechanisms as the differentiating strategies, methods or processes involved in knowledge integration as identified in prior research (De Boer et al., 1999; Zahra et al., 2019). Interestingly, the number of ventures and codes associated with each of these categories was very similar, which suggests that new firms “coordinate” as much as “systematise” their knowledge. By embedding knowledge into formal systems, ventures generate horizontal linkages to exchange knowledge across differentiated units. Consequently, within the systematic integration dimension, we found the following practices: knowledge retention, knowledge creation, routines and the use of templates. Regarding coordinated integration of knowledge, we identified five main categories: knowledge sharing, knowledge transfer, learning, team collaboration and team communication. We provide contextual description of these mechanisms in **Table 7**.

Drawing on our iterative analysis, our study indicates that there are variations in the way knowledge is integrated in new firms. Based on the examination of relationships among the concepts yielded by this research, we organise our findings in two subsections. First, we identify, describe, and explain enablers and barriers of knowledge integration in new firms across two distinct mechanisms, namely systematic and coordinated integration. We identify knowledge integration enablers as the factors associated with the adoption of knowledge integration mechanisms and knowledge integration barriers as the factors found associated with the absence or scarcity of knowledge integration. We summarize these concepts in

Table 8. Lastly, we identify, elaborate, and explain four venture archetypes stemming from the combination of mechanisms, enablers and barriers found across our cases.

Table 7: Knowledge integration mechanisms in the context of new firms

SYSTEMATIC INTEGRATION OF KNOWLEDGE IN CONTEXT	
Knowledge retention	Deemed critical for business assessment and planning, knowledge retention was cited by 81% of firms surveyed across two themes: process documentation and briefing and possession of databases. Process documentation includes: - The documentation of external knowledge (i.e.: information related to customers, suppliers and advisors) - The documentation of internal processes and activities (i.e.: meeting briefings, product development roadmaps) Databases includes: - day-to-day repositories - archival repositories (i.e.: sales history and customer records)
Knowledge creation	Cited by 45% of firms surveyed in the following forms: - Prototypes - Patents, - Organisational content such as assessments, workshops, activities and legal documents. - Scientific papers derived from technological research.
Use of templates	Cited by 27% of firms surveyed, we found that often founder(s) were responsible for the creation of templates the use of templates involves: - Both the documentation of a process and the creation of new knowledge. - The identification of relevant knowledge that structures a specific process while allowing for flexibility to adjust to new use-cases. - A way to ensure that the sustenance of specific knowledge will prevail over time (knowledge consistency). - A way to facilitate internal cohesion within their teams.
Routines	Only 9% of firms surveyed referred to routines as a structured sequence of tasks conducive to a specific outcome.
COORDINATED INTEGRATION OF KNOWLEDGE IN CONTEXT	
Team communication	Cited by 77% of firms surveyed, as the fastest way to exchange information and coordinate different tasks within the team. Communication among team members include: - Verbal communication within founders or managers, team members and one-on-one meetings. - Written communication (i.e.: software-based forums, chat groups or topic-organized digital channels). Communication effectiveness was associated to communication frequency and periodicity in a verbal format even if they had multiple written communication channels as it facilitated spontaneous interaction and socialization needed, for example, in brainstorming sessions.

Knowledge transfer	Cited by 68% of firms surveyed, knowledge transfer included: - Transfer of knowledge among co-founders, seemingly more likely in earlier stages of business development. - Transfer of knowledge from founders to employees (directly through interaction) - Transfer of knowledge between employees (i.e.: through handover of roles) - Transfer of firm-level knowledge to new employees (through induction processes)
Knowledge sharing	Cited by 36% of firms surveyed, knowledge sharing was more prominent in teams where synchronous collaboration occurred and included: - Informal verbal exchanges of information - Digitally enabled knowledge sharing
Team collaboration	Cited by 36% of firms surveyed, team collaboration referred to the interdependence of team members to achieve a common goal, including: - Synchronous collaboration—often when team members have similar skills. - Asynchronous collaboration, when different skills are applied separately in consecutive steps.
Learning	Cited by 36% of firms surveyed, coordinated learning instances included formalized team meetings to reflect on failure experiences.

Table 8: Enablers and Barriers of Knowledge Integration Mechanisms

INDIVIDUAL-LEVEL ENABLER: KNOWLEDGE AWARENESS		
Knowledge Awareness	Founders' knowledge self-awareness	Founders interviewed demonstrated different degrees of awareness of their own knowledge, including: - General knowledge, cited by 77% of firms' founders surveyed as the possession or lack thereof (i.e.: through formal education or technical training) - Specific knowledge cited by 50% of firms' founders surveyed as the possession of (i.e.: prior managerial, entrepreneurial, or industry-specific experience).
	Founders' awareness of their firm's knowledge	Founders interviewed expressed different degrees of awareness of their firms' knowledge, including: - Awareness of the knowledge of their employees, mainly related to general knowledge and skills, as founders often recruit employees that can perform specific tasks. Recruitment of employees without the possession of general knowledge was also cited, as interns or mentees that can assist founders and gradually take over specific tasks.

	- Awareness of the firm's knowledge systems expressed through positive or negative perceptions of the firm's information systems. - Awareness of the knowledge of their firms as a whole, referred to the general state of knowledge of the venture compared to others.
Founders' awareness of the knowledge related to the business opportunity pursued	Founders interviewed expressed varying perceptions of knowledge related to the business opportunity that prompted the creation of their ventures, including: - The identification of a market knowledge gap (i.e., when there is a need to create new knowledge to solve an existing problem in a specific market), was cited by 59% of firms' founders. - The identification of an opportunity to exploit existing knowledge, cited by 18% of firms' founders (i.e.: by applying knowledge into a different market or leveraging specific technology) - The identification of a knowledge advantage (i.e., when the founder has realised, he or she possess specific knowledge that could be advantageous in a specific market) was cited by 18% of firms' founders
FIRM-LEVEL ENABLERS	
Organizational Enablers	Specific organisational characteristics were cited in 77% of the interviews conducted including: - Entrepreneurial orientation, cited in 22% of interviews was associated to innovation as "having a mindset of agility and always looking for opportunities to innovate", resilience and self-motivation to work in a determined industry - Flexibility, cited in 68% of interviews (i.e.: flexibility of roles and flexibility of work arrangements) - Team bonding, trust and cultural fit, were cited in association to coordinated mechanisms. - Team size, particularly small team size, was cited in 22% of interviews in association to coordination mechanisms.
	Organisational practices were cited in 86% of the interviews conducted and include: - Problem-solving methodologies to structure outcome-driven processes such as project management and innovation (i.e.: use of formal frameworks such as <i>Agile</i>, <i>Lean Canvas</i> or <i>McKinsey's Final Plan</i> or informal processes such as customer discovery or go-market strategies).

		- The use of digital tools Digital supporting systematic integration (i.e.: by providing a shared space to store and update knowledge) and coordinated integration (i.e.: by facilitating communication and collaboration).
	Knowledge distribution	Cited by knowledge distribution as the concentration of knowledge in relation to the venture's members (Rulke & Galaskiewicz, 2000), including: - Established access to external holders of knowledge (i.e.: advisory board members, key customers, suppliers or other frequent collaborators). - Established access to internal holders of knowledge (i.e.: extent to which founders grant employees access to the firm's integrated knowledge)
FIRM-LEVEL BARRIERS		
Firm's dependence on the founders	Firm's dependence on the founders to access knowledge	A high firm's dependence on the founders to access knowledge occurs when firm-level knowledge is concentrated and controlled by the entrepreneur, either because it is not integrated at this level, because it is not uniformly distributed, or because the founders possess specific knowledge that is difficult to access, such as social networks.
	Firm's dependence on the founders to access innovation	A high firm's dependence on the founders to access innovation occurs when innovation is predominantly carried out by the entrepreneurs, either because employees do not have access to the full extent of the venture's knowledge or because they have restricted roles in this process.

4.1 Individual level enabler of knowledge integration: Knowledge Awareness

As an individual-level enabler of knowledge integration we identified the founder's awareness of knowledge as a key factor influencing the type and extent of mechanism employed. Knowledge awareness has been referred to as "an individual's state of being informed and having perceived information about others' knowledge" (Engelmann, Dehler, Bodemer, & Buder, 2009). We found differences in the way venture members refer to and perceive knowledge across three distinct areas: the knowledge pertaining to the founders (self-knowledge awareness), the knowledge pertaining to the venture, and the knowledge related to the business opportunity exploited. Overall, we found knowledge awareness mostly related to systematic knowledge integration. Particularly, we observed that entrepreneurs who demonstrated high levels of knowledge self-awareness, specifically about technical knowledge obtained through formal education, were more likely to document, structure and store their knowledge in formal systems. Conversely, entrepreneurs who identified deficiencies in their firm's knowledge systems often associated them with the absence of formalization about their own specific knowledge such as contacts' information and social relationships, which was not available to other members of their teams. The founder's knowledge awareness about their own ventures and particularly about their employee's knowledge, was found to influence decisions such as who gets access to which information and when, as founders need to match each employee's skills with the knowledge needed to complete specific tasks. Awareness about the venture's knowledge systems was also associated with decisions around accessibility to knowledge, as often a negative perception of knowledge systems was used as a justification for a more restricted distribution of internal knowledge. Interestingly, we did not find any relevant associations between knowledge opportunity awareness and the rest of our concepts, being the only theme unlinked among our data. We presume the type of knowledge opportunity that motivates venture creation may have some implications for knowledge integration, but that area would require further research.

4.2 Firm level enablers of knowledge integration: Organizational characteristics, practices, and distribution of knowledge

We found three groups of knowledge integration enablers at the firm level: organisational characteristics, organisational practices, and knowledge distribution. Organisational characteristics included entrepreneurial orientation, flexibility, team bonding, trust and cultural fit, and team size as important factors that facilitate knowledge integration in ventures. Organisational practices included problem-solving methodologies and the use of

digital tools as enablers of knowledge integration. We suggest that these methodologies may help entrepreneurs identify, structure, and organise relevant knowledge through manageable steps so they can better adjust to unexpected scenarios. Knowledge distribution can be understood as the concentration of knowledge across the venture's members (Rulke & Galaskiewicz, 2000) including access to external and internal holders of knowledge. We identified several reasons for which founders restrict their employees' access to knowledge. Arguably, the most common reason is to protect firm-specific knowledge from spilling outside the venture, especially if the firm possesses patents or has engaged in non-disclosure agreements with other partners or clients. Another justification given by our respondents was to improve employees' performance by providing them only with the information they need to complete their tasks. In addition, respondents justified restrictions in knowledge distribution to facilitate the process of navigation and identification of relevant information. In some of these cases, a negative perception or a lack of formal knowledge systems may be accompanying these decisions. Sometimes, founders underestimated the amount of knowledge an employee would require completing their tasks, in which case, the distribution needed to be adjusted. We also found that restricting the access to internal knowledge not only affected knowledge that had been integrated systematically, but also affected the knowledge that was integrated through coordination.

4.3 Firm level barriers of knowledge integration: Firm's dependence on the founders

We identify the two firm-level barriers to knowledge integration: the firm's dependence on the founders to access knowledge and the firm's dependence on the founders to access innovation. The first occurs when knowledge is concentrated and controlled by the entrepreneur, either because it is not integrated at the firm level or because it is not uniformly distributed. We found varying degrees of knowledge dependence that we organised in two groups: high and low dependence on the founders to access knowledge. In a few cases, we found that even when knowledge was well integrated and distributed, there were specific areas of knowledge that would still be dependent on the entrepreneurs such as network contacts, stakeholders and social ties.

Similarly, we identify the firm's dependence on the founders to access innovation as a firm-level barrier to knowledge integration. This occurs when innovation is predominantly carried out by the entrepreneurs, either because employees do not have access to the full extent of the venture's knowledge or because they have restricted roles in this process. As we found varying degrees of firm's dependence on the founders to access innovation across our

participants, we distinguish between high and low firm's dependence on the founders to access innovation. In addition, we found that, in some cases, innovation was carried out by the founders with the active involvement of external partners such as members of an advisory board, customers or close collaborators, in which case the dependence on the founder diminished.

Concerning the relationship between integration mechanisms and firm's dependence on their founders, we found that systematic knowledge integration can counteract the dependency to access knowledge but not innovation. Conversely, we found that coordinated knowledge integration can counteract both. For example, a venture that has formal systems to integrate its knowledge may have a lower risk of relying on their founders to access knowledge, as the information has been supported in firm-level systems. Yet, this may not translate into disseminated innovation resulting from collaboration among members. In turn, a venture that consistently coordinates knowledge ensures less dependency on the entrepreneur to access knowledge while facilitating interaction and participation in the innovation process. Lastly, we found that knowledge dependence is related to innovation dependence, as founders who concentrated most of the venture's knowledge were more likely to lead and control the innovation activities.

Lastly, we did not find evidence of a link between the firm's age and its level of dependence with their founders, thus we suggest that entrepreneurs may choose to embed knowledge at different levels for different reasons. Although our study did not examine the rationale behind these strategies, we found support to propose that knowledge-related challenges, such as fear of spillovers, may explain a hesitancy of founders to integrate knowledge or restrict its access, in varying extents. However, innovation dependency poses a more entangled puzzle, as founders from firms with a high level of dependence related to innovation, seemed inclined to dominate the innovation process for other reasons such as strategic alignment or to provide a holistic perspective of the business problem.

4.4 Venture Archetypes stemming from knowledge integration strategies.

Through the inductive analysis based on the cross-case comparison summarized in **Table 6**, we identified four distinct venture archetypes stemming from different combinations of mechanisms, enablers and barriers: a) Founder-driven organisations, b) Shared organisations, c) Standardised organisations, and d) Shared in silos organisations, as illustrated in Figure 2. From these types, the former two correspond to extreme cases with either absence

of knowledge integration or full extent of it, whereas the two latter correspond to intermediate cases where knowledge integration is partially pursued.

Founder-driven organisation. This archetype is characterised by the minimum extent or absence of knowledge integration at the firm level. Consequently, neither systematic nor coordinated mechanisms of integration can be observable with ease. Specifically, we found little evidence of coordinated integration other than team communication and rudimentary forms of systematic integration usually related to unstructured storage of data and the creation of specific knowledge. From the group of knowledge enablers, the most relevant for this type was organisational characteristics, specifically flexibility. Likely, to compensate for the lack of organizational structure, team members and working arrangements need to remain flexible to maintain this firm afloat. Concerning other firm attributes, we found examples of this type in different firm ages, however most of them were relatively young (<3 Years) and had relatively small teams (between 2-7). Regarding individual-level enablers, particularly founders' knowledge awareness, we did not find a consistent parameter of knowledge self-awareness or specific awareness of the knowledge related to the business opportunity exploited. In turn, we did find this type associated with awareness of knowledge concerning the firm, particularly regarding the knowledge of their employees. Based on our observations, in this type of firms the founder has a one-to-one relation with each employee or collaborator, whom has specific tasks and goals to fulfill, and specific knowledge needs and requirements. Aligned with this arrangement, the founder-driven organisation often showcase a negative perception of the firm's knowledge systems. Concerning firm-level barriers, we find this type of firms relying strongly on the founders to access both knowledge and innovation which can be closely linked to its inability to integrate knowledge at the firm level.

Shared organisation. This archetype is characterised by a maximum extent of knowledge integration at the firm level. Concerning knowledge integration mechanisms, this type of firm was the one that presented more evidence of coordinated integration in all sub-categories and particularly around knowledge sharing, transfer, and learning, across all archetypes. However, we did not find a specific pattern of systematic knowledge integration. Regarding firm-level enablers this type seems to benefit mostly from organisational characteristics such as flexibility, venture size but particularly from team bonding, trust, and cultural fit. Concerning other firm attributes, all our cases grouped in this category corresponded to ventures that have been operating for three years or more, and most of them (4 out of 5 ventures) had teams larger than five members. Regarding individual-level enablers, we did not find specific associations of founder knowledge awareness or venture knowledge

awareness to this type, but surprisingly, all ventures grouped in this category presented high levels of awareness concerning the knowledge related to the business opportunity exploited, more specifically, around the recognition of a market's knowledge gap. In other words, shared organizations showcased highly motivated teams that worked cohesively and coordinately to develop a solution where knowledge-led innovation was critical for its success. In relation to firm-level barriers, this type of firm shows a low dependence on the founders to access knowledge and innovation which facilitate the integration of knowledge at the firm-level.

Standardised organisation. This type of firm is characterized by a high extent of knowledge integration and rely primarily on systematic over coordinated integration mechanisms. This type of firm showcased a variety of systematization strategies, especially related to knowledge retention through data storing practices, the documentation of processes, the creation and utilization of templates, and, notably, the implementation of routines (which were not found in any other archetype). Regarding firm-level enablers, this type seems to benefit mostly from access to established external partners and the use of digital tools. In relation to firm attributes, we found a variety of ventures within this category, from very small and young firms (less than 2-years-old and two members) to larger and more mature ventures (10-years-old, ten members). Regarding individual-level enablers, we found this type associated with a high level of founder's knowledge awareness, particularly of technical knowledge acquired through formal education. Consistent with our findings related to the systematization of knowledge, we found this type associated to positive perceptions of the firm's knowledge systems. Concerning firm-level barriers, we find this type of firms barely reliant on their founders to access knowledge, likely due to the existence of robust and updated knowledge systems. However, we find this type of firms highly reliant on their founders to access innovation, with founders controlling the innovation process by leveraging their own ideas or by restricting the tasks associated to the development of new ideas to specific firm members and collaborators. Some clues on the rationale behind these decisions given by the founders interviewed in our study, were for example, that the complexity of the problems tackled by innovation was not understood by all team members, not related to their roles either, so the founders would lead the process and identify the relevant knowledge and relevant skills needed to carry it on. Alternatively, based on our observations, this type of firms is primarily concerned with performance (for example through knowledge exploitation) and only secondarily concerned with innovation through knowledge exploration.

Shared in silos. This type of firms are characterized by presenting intermediate to low extents of knowledge integration at the firm level and rely primarily on coordinated over

systematic integration mechanisms. This archetype is distinguished by having members with highly specialised roles conforming a team with complementary skills. Regarding knowledge integration mechanisms, coordinated integration was found to be important for this type, particularly in relation to collaboration, team communication and learning, while systematic integration was mostly focused on basic knowledge retention, such as the maintenance of updated databases. Regarding firm-level enablers, this type of firms emphasizes the implementation of organisational practices such as problem-solving methodologies and the use of digital tools, and an internal distribution of knowledge that grants its access across the firm. For this group of firms, we did not find a clear pattern of age, but they all had at least five members. In relation to individual-level enablers, we found this type associated with a high level of founders' knowledge awareness, specifically around technical knowledge, and employee knowledge. Concerning firm-level barriers, this type of firms showcases a high level of reliance on their members instead of on their founders to access knowledge which is generally sorted through socialization and interaction mechanisms. Moreover, as each member hold specific knowledge and information, we find that firm-level of knowledge integration was partially attained but did not seem problematic. Alternatively, these firms show an interdependency among its members to generate innovation which translates in highly collaborative teams where innovation is achieved through firm-wide participation.

Aside from the identification of the archetypes described above, we found four ventures that did not fit in any of our previous categories, nor did they conform to a new one. The ventures included in this group ranged from newly formed (1-year-old) to mature firms (>7-years-old) and with a diversity of team sizes (from 2 to 10 members). As illustrated in Figure 2, the main reason we could not fit them into our established patterns was that the analysis did not retrieve data on resource dependence dynamics. We discuss this issue in the limitations section of this paper.

5 Discussion

Although knowledge integration in entrepreneurial contexts has not been absent from prior empirical examinations, we believe that entrepreneurship poses distinct challenges to the integration of knowledge, thus the implications for theory and practice are not fully unfolded. Complementing existing theorising that examines external and inter-organisational dynamics (Briel et al., 2019; B.-W. Lin & Chen, 2006; K. Z. Zhou & Li, 2012), we examine intra-organisational behaviour to offer a contrasting view on this issue. In line with prior propositions, we found that knowledge in ventures can be integrated in different ways.

However, more importantly, our findings suggest that those differences are influenced by a combination of individual and firm-level factors such as entrepreneurial awareness of knowledge, organisational characteristics, organisational practices, and knowledge distribution. Furthermore, our analysis reveals that the absence of knowledge integration at the firm level can be associated to firm-level barriers, such as the dependence of firms on their founders to access knowledge and innovation. We discuss the implications of our findings for theory and practice, limitations, in the following sections.

5.1 Knowledge integration enablers in new firms, towards a multi-level understanding of knowledge in ventures

Bridging existing concepts of knowledge at the macro and the micro level (Zahra et al., 2019), our findings offer a novel understanding of knowledge integration in ventures by outlining how the individual's views and decisions, along with organisational characteristics and practices, can influence knowledge integration mechanisms. At the individual level, the notion of "awareness" sits at the centre of the entrepreneurship debate, specifically supporting concepts of entrepreneurship as a discovery (Kirzner, 1997; Venkataraman, 1997) rather than a creation of new opportunities (Schumpeter, 1934). Entrepreneurial alertness, for its part, is a similar concept, just more closely associated with the ability to identify, judge, evaluate and make decisions on external situations such as opportunities (Gaglio & Katz, 2001; Tang, Kacmar, & Busenitz, 2012). Focusing on knowledge, our findings expand on these propositions by suggesting that knowledge is identified, appraised, evaluated and judged by entrepreneurs at different levels, and that, according to those perceptions, entrepreneurs make decisions that have firm-level implications. Our concept of the founder's knowledge awareness includes three sub-categories: knowledge self-awareness, venture's knowledge awareness and knowledge opportunity awareness. Concerning knowledge self-awareness and venture's knowledge awareness, our analysis offers a step further towards a multi-level understanding of knowledge integration in ventures by suggesting that entrepreneurs may be focusing on their own knowledge, the knowledge of their employees or the knowledge of the venture as a whole to sustain the firm's knowledge structure. Although more research is needed to understand the link between knowledge opportunity awareness and knowledge integration mechanisms, our findings resonate with studies that have started to draw this connection (Guo et al., 2020) and with studies that have examined opportunity identification and entrepreneurial knowledge (Ucbasaran, Westhead, & Wright, 2008).

Several relationships were identified between knowledge enablers and the remaining concepts. For example, some organisational characteristics were found to be related to coordinated integration. The most prominent, team bonding and trust, was found to have a reciprocal relationship with knowledge share. This is supported by previous findings that emphasise the importance of trust for knowledge transfer (Levin & Cross, 2004). Similarly, venture size was often cited by participants as a facilitator of team communication. Regarding organisational practices, we found that the use of digital tools significantly supported systematic and coordinated integration. For example, digital tools proved to be essential to enable communication, collaboration, learning and sharing of knowledge, while facilitating knowledge retention. Notably, all ventures interviewed had members working in different geographical locations, so digitalisation was key. However, we did not find associations between the use of problem-solving methodologies and other concepts of our analysis. Regarding knowledge distribution, we found that access to established external sources of knowledge and access to internal knowledge was associated with both low knowledge dependence and low innovation dependence. For example, when ventures had a board of advisors that met regularly, we noted that entrepreneurs were less reliant on their own knowledge and included external partners in the innovation process. Similarly, ventures from entrepreneurs who granted employees more access to knowledge seemed less reliant on the founder's knowledge, and the innovation process appeared more inclusive.

5.2 Knowledge integration barriers in new firms: the dependence on their founders

Prior research drawing on resource dependence theory has distinguished resource dependence based on specific human capital on key entrepreneurs (Arthurs, Busenitz, Hoskisson, & Johnson, 2009), on key employees (K. Liu & Arthurs, 2019), and on key stakeholders such as key customers (Yli-Renko et al., 2020). Knowledge dependence of ventures has also been studied from the perspective of external links driven from inter-organisational director connections (Howard, Withers, & Tihanyi, 2017). Resource dependencies on specific individuals have been found to restrict venture autonomy, which in turn affects firm performance (Drees & Heugens, 2013). Conversely, resource interdependence based on human capital complementarity has been linked to improved firm performance (Ethiraj & Garg, 2012). In line with previous findings, our study adds to the research focusing on new firm's dependencies by highlighting potential shortcomings associated with the dependence of the firm on their founders to access knowledge and innovation. Particularly, our findings suggest that this reliance may entail negative implications at the firm level, such as

the inability to achieve knowledge integration. In doing so, we add to the research on resource dependency theory by providing evidence of intra-organisational dependencies on key members (Arthurs et al., 2009; K. Liu & Arthurs, 2019). In line with key findings in this domain, our study suggests that such dependencies, particularly innovation dependence, can be compensated by establishing inter-organisational arrangements (Drees & Heugens, 2013). For example, our analysis indicates that innovation dependence diminishes when the venture has a formal external counterpart, such as an advisory board or established clients.

5.3 Archetypes, Variations in Knowledge Integration and Potential Implications for Innovation in Ventures

Our study adds to the research focusing on entrepreneurial archetypes (Angel, Jenkins, & Stephens, 2018; Bronstein & Reihlen, 2014; Gartner, 2008; Habersang et al., 2019). As such, our study suggests that different types of firms may arise from the interrelation between the processes of firm formation and knowledge integration mechanisms. Broadly, our analysis suggests that differences are associated with the extent to which knowledge is recognised, shared, systematised, and distributed within firms, where the entrepreneur plays a pivotal role as knowledge and innovation manager. Although more research is needed to clarify the specific implications of these variations to performance outcomes, we believe that different venture archetypes may develop different capabilities over time. For example, knowledge integration can create path dependencies that could affect the firm's ability to adapt (P. T. Bryant, 2014). As more rigid knowledge structures have been associated with growth and more flexible knowledge structures have been linked to innovation (Macpherson & Holt, 2007), knowledge that is integrated in certain ways at the beginning may determine the firm's ability to grow or innovate or do both simultaneously.

In addition to the above, the variations in knowledge integration reflected in different types of firms could be further investigated through the lens of the Upper Echelons Theory (Hambrick, 2007). This theoretical perspective can be especially relevant to the understanding of founder-driven ventures, where the influence of the entrepreneur on the decisions regarding the management of knowledge is considerable. While more research is needed to establish how the background, values, cognitive biases and other individual characteristics can influence the strategic decisions regarding the integration of knowledge in ventures, our findings suggest that founder-driven ventures are more vulnerable organisational structures as their actions and outcomes can be highly tied to the perceptions and decisions of their founders.

5.4 Limitations

This study has some limitations. The first and most important one is the exclusion of external integration mechanisms due to our focus on intra-organisational dynamics. For example, we did not examine socialisation mechanisms associated with external networking or collaboration with other organisations. Research focusing on external mechanisms and entrepreneurship has established a strong association between organisational capabilities and macro-level dynamics (Briel et al., 2019; Runping Guo et al., 2019). Complementing those views, we aimed to offer a micro level understanding of knowledge integration in ventures. By doing so, we are cognisant that an important part of entrepreneurial knowledge conceptualisation is excluded from our theoretical propositions; however, we think this allows us to offer an alternative perspective on entrepreneurial knowledge integration and a broader look into the interrelation between the entrepreneur and their developing venture. Secondly, we acknowledge the limitations derived from using interviews as a primary source of data and that most of our participants were founders. To reduce the bias created by these concerns, we conducted very open conversations with our participants, adding several follow-up questions depending on each participant's responses. We used situational questions to allow our respondents to elaborate freely on the topics presented, which generated a wide range of interview content. Furthermore, we analysed and synthesised the data by aggregating it into similar concepts through cross-pattern identification. As a third limitation, we note that our sample included relatively small ventures (≤ 15 employees), and therefore, our findings must be applied with caution to firms that are significantly larger. Lastly, regarding the group of ventures that did not fit into our archetype categories (seen as “uncategorised” in **Table 6**), we note the difficulties of extracting insights around resource dependency from managers as a unique source of data collection. Looking back at our interviews, we note those inconclusive results may be caused by the caution or dissent in disclosing sensitive information from the managerial perspective.

6 Conclusion

Our analysis indicates that there are differences in the way knowledge is integrated in ventures. We explain those differences across two areas generated through deductive, inductive, and abductive steps: the enablers and barriers of knowledge integration mechanisms, and the venture archetypes associated with them. This study offers several potential contributions to research on entrepreneurship, knowledge, and innovation. First, through a qualitative examination of knowledge integration in ventures, the study demonstrates that both

socialisation and formalisation practices are implemented by new firms and identifies the factors that facilitate and hamper the selection and implementation of such mechanisms. By doing so, we offer an alternative approach to propositions that links knowledge integration to more mature stages of firm development. While literature on knowledge integration in entrepreneurial firms exists (Macpherson & Holt, 2007; Zahra et al., 2006a), we see an opportunity to advance the understanding of the implications of knowledge at the firm level, particularly how knowledge is articulated and structured, and to what extent the flexibility or rigidity arising from those initial arrangements can facilitate or undermine the known advantages of knowledge. For example, our findings on knowledge enablers and particularly the identification of organisational practices (such as the use of problem-solving methodologies) can be further investigated as tools to structure knowledge from different sources in contexts of high uncertainty such as entrepreneurial activity. Similarly, we suggest that the use of prototypes, as opposed to templates, for knowledge integration can be observed as early indications of different approaches to knowledge sharing, collaboration, knowledge distribution and potentially resource dependencies. Therefore, more research in this domain could bring greater clarity to these issues. Secondly, we contribute to the entrepreneurship literature focusing on knowledge, by developing a model that integrates multi-level conceptualizations by explaining how entrepreneurs' views and firm attributes can lead to differentiated firm types. Third, we identify venture archetypes conveying different levels of formalisation and socialisation practices for knowledge integration. While our study offers a preliminary approach, more research around archetypes linked to knowledge structuring can contend with or refine our findings. For example, future research could investigate whether differences in knowledge integration may be associated with the venture focusing on innovation or performance independently.

CHAPTER FOUR

A SYSTEMATIC PATH TO INNOVATION? THE ROLE OF FOUNDERS IN THE KNOWLEDGE INTEGRATION OF SMALL FIRMS

ABSTRACT

Knowledge integration is critical for innovation and entrepreneurship. We thus seek to unravel the role of founders in the implementation of knowledge integration mechanisms, including knowledge coordination and knowledge systematization. We do so by investigating two antecedents of integration mechanisms: the knowledge awareness of the founder and the firm dependence on its founders to access knowledge and innovation. We use data collected through an online questionnaire, including 149 ventures from different sectors based in the region of New South Wales, Australia. We analyse the data using structural equation modelling (SEM). Our findings emphasize the role of knowledge awareness in systematic knowledge integration to achieve innovation in the context of small firms. Further, our study underscores the role of coordinated knowledge integration as an indirect pathway to innovation through systematic knowledge integration. By highlighting the role of knowledge systematization in small firms we contribute to the literature on knowledge integration in an entrepreneurial context. Furthermore, by identifying significant factors related to the role of founders in the integration of knowledge, we contribute to the entrepreneurship literature that focuses on knowledge-based perspectives.

Keywords: Entrepreneurship, knowledge integration mechanisms, innovation, knowledge awareness, knowledge dependence.

1. Introduction

Knowledge-based approaches have emphasized knowledge as a core resource and conceptualized firms as *knowledge integration institutions* (Grant, 1996). Accordingly, the main purpose of firms is the application of knowledge for the creation of value, a goal that is only achievable through the combination of different types of knowledge broadly distinguished between explicit and tacit types. Correspondingly, knowledge integration involves the mechanisms suited to articulate both strands, for example by embedding explicit knowledge into systems, or by coordinating tacit knowledge across individuals. Furthermore, knowledge integration has been deemed critical for firm innovation, including in entrepreneurial firms (Amankwah-Amoah & Adomako, 2021; Salunke et al., 2019).

Nonetheless, knowledge is context-dependent (Argote & Miron-Spektor, 2011; Brown & Duguid, 2001; Tsoukas & Vladimirou, 2001) and therefore most studies focusing on knowledge processes such as knowledge integration, have examined the conditions upon which these processes can grant firm-level benefits (Chang et al., 2016; Koch, 2011; K.-H. Tsai et al., 2015). Accordingly, the entrepreneurial activity offers a unique context for the integration of knowledge, a resource that may be both scarce and critical for firm existence (Acs et al., 2013; Dolmans, Burg, Reymen, & Romme, 2014). Furthermore, the entrepreneurship literature has characterized new firms' outcomes as heavily influenced by its founders, for example, the founders' knowledge (Dencker et al., 2009), capabilities (Teece, 2016), beliefs (Cliff, Jennings, & Greenwood, 2006), or decision making (Dean A Shepherd, Williams, & Patzelt, 2015). Considering the above, this paper aims at examining the role of founders in the knowledge integration of their firms, by exploring founder-related antecedents of knowledge integration mechanisms and their subsequent effect on innovation.

Previous research has depicted founders as critical knowledge holders (Colombo & Grilli, 2005; Dencker et al., 2009; Unger et al., 2011). However, integrating this knowledge in the firm can create several difficulties. For example, founders who hold highly specialized knowledge may need to ascertain whether to transfer those skills to employees by direct interaction, by creating manuals and procedures, or by keeping this knowledge to themselves. Similarly, founders may need to assess their employees' knowledge and choose the mechanisms to make those resources available to the rest of the firm members. In addition, previous research building on a resource-based perspective has pointed at the difficulties of managing knowledge within an entrepreneurial context. For example, new and small firms have few resources available (Baker & Nelson, 2005), may require a more flexible allocation

of tasks (Fisher, Kotha, & Lahiri, 2016; Zolin, Kuckertz, & Kautonen, 2011), and may have asynchronous work arrangements (Montoya-Weiss, Massey, & Song, 2001). These challenges place a pressing demand for knowledge integration to the founders of new and small firms.

While the literature on entrepreneurship and knowledge integration has concentrated on the identification of firm-level antecedents and consequences (Runping Guo et al., 2019; Y. J. Kim et al., 2012; Salunke et al., 2019), more focused research is needed to understand the role of founders in the adoption of knowledge integration mechanisms and their subsequent effect on innovation. We believe that the distinction between formal and informal mechanisms can be key to understand these relationships, specifically by examining founder-related antecedents for the application of knowledge integration mechanisms. For example, formal and informal mechanisms require different resources and capabilities to be implemented (Chang et al., 2016; Chirico & Salvato, 2008), may suit specific types of knowledge (Jensen, Johnson, Lorenz, & Lundvall, 2007), and may lead to different organizational arrangements, which can, in turn, affect innovation. Further, the new firm's founders may choose to integrate knowledge based on their own beliefs, past experiences, needs, aims, and resources (Cliff et al., 2006). Therefore, we believe that new firms' founders may be confronted with important challenges when pursuing innovation by leveraging knowledge integration mechanisms. Lastly, the entrepreneurship research has placed a special emphasis on the role of informal knowledge integration mechanisms such as networking, collaboration, and social interaction (Briel et al., 2019; Hulsink & Elfring, 2019; Sorenson, Rivkin, & Fleming, 2006), thus overlooking the role of formal mechanisms which are generally associated with established firms. Consequently, an improved understanding of the role of knowledge integration mechanisms in the context of entrepreneurship, and the factors associated with their occurrence may advance current theorizations and help entrepreneurs navigate these challenges in a more efficient way.

To examine the role of founders in the knowledge integration of new firms, we focus on two antecedents: the *knowledge awareness of the founder*, as the extent to which founders identify and appraise firm knowledge, and the *firm's dependence on its founders*, as the extent to which the firm relies on the founder to access knowledge and innovation (Tabilo & Rauch, 2022). Consequently, we investigate the interrelation between these founder-related antecedents, systematic and coordinated knowledge integration mechanisms, and its effect on innovation, through a quantitative study using structural equation modelling (SEM) to analyse data collected from 149 Australian ventures from different sectors.

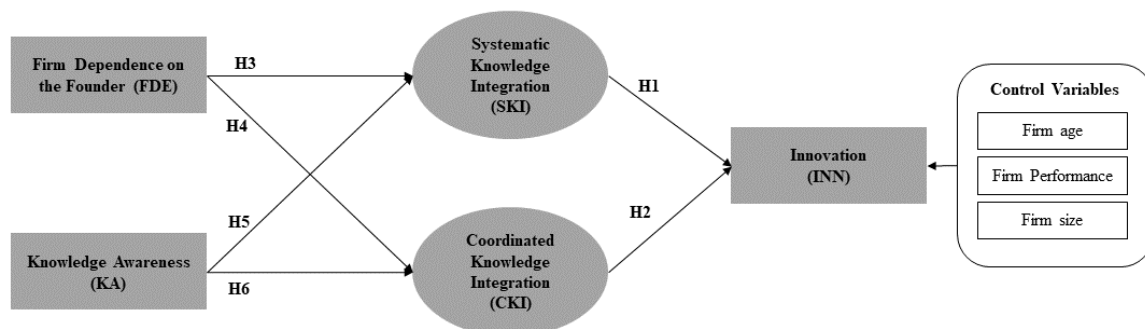
Our findings underscore the role of the founder's knowledge awareness which is found positively associated with knowledge integration mechanisms leading to innovation,

particularly systematic knowledge integration. In addition, we find that coordinated integration facilitates systematic knowledge integration which in turn leads to innovation. These findings contribute to the knowledge-based view of new firms. First, by looking at the role of founders in knowledge integration and its effect on firm-level outcomes such as innovation, we bridge the understanding between micro and macro-level perspectives (Zahra et al., 2019). We do so by offering a nuanced view on the role of founders suggesting that the founder's identification and appraisal of knowledge can be sufficient to action distinctive knowledge integration mechanisms, conducive to innovation. Second, by looking at and comparing different knowledge integration mechanisms concurrently, we refine existing conceptualizations of knowledge integration concerning innovation. Specifically, by highlighting the importance of systematic knowledge integration, our study contends a seemingly large number of studies focusing on coordination mechanisms, and their effect on innovation in the context of new and small firms. Moreover, in line with conceptualizations advocating for the complementarity of both types of mechanisms (Jansen et al., 2009), we provide a refined conceptualization of the relationship between them in the context of small firms. Third, we contribute to the literature focusing on innovation in new and small firms – a context where founders have a larger impact compared to larger firms (Andries & Czarnitzki, 2014).

2. Background

In the following, we elaborate on the role of founders in knowledge integration mechanisms and their subsequent link with innovation. We discuss these concepts and generate hypotheses that are illustrated in **Figure 7**.

Figure 6: Conceptual Model and Hypotheses



2.1 Knowledge integration mechanisms and innovation

Knowledge integration – the firm-level capability to create and recombine knowledge through formal and informal mechanisms (Zahra et al., 2019) – is important for firm-level

outcomes such as innovation (Barley et al., 2017; Koch, 2011; K.-H. Tsai et al., 2015), which in turn is key for entrepreneurship (Colombelli, Krafft, & Vivarelli, 2016; Minola, Hahn, & Cassia, 2019; Protogerou et al., 2017). The literature discusses two mechanisms of how knowledge is integrated at the level of the firm: formal or systematic mechanisms refer to the encoding, embedding, and storage of knowledge in systems that are accessible to the whole organization, and, informal or coordinated mechanisms focus on the exchange of knowledge through social interaction (Briel et al., 2019; Runping Guo et al., 2019; K. Z. Zhou & Li, 2012).

Systematic Knowledge Integration

The integration of knowledge through systematization involves the practices aimed at the encoding, organizing, and storing of knowledge in formal systems (Runping Guo et al., 2019; K.-H. Tsai et al., 2015; Zahra et al., 2019; K. Z. Zhou & Li, 2012). While knowledge systematization has been found beneficial for activities that require consistency over time, for example, operational processes (Kah-Hin & Nebus, 2012), knowledge systematization has also been posed as a firm constraint (Macpherson & Holt, 2007). Nonetheless, in some specific contexts, knowledge systematization can support learning and decision-making toward change. For example, the systematization of knowledge through codification can enable vicarious learning from complex and heterogenous experiences (Echajari & Thomas, 2015), therefore, knowledge systematization may be especially relevant to the integration of knowledge in interdisciplinary teams. In addition, the extent to which knowledge is systematized within a firm appears relevant, as higher levels of knowledge codification can hinder decision inertia and change in the context of post-acquisition integration, compared to lower levels of codification (Castellaneta, Valentini, & Zollo, 2018).

Coordinated Knowledge Integration

The integration of knowledge through knowledge coordination includes practices oriented toward the transfer and creation of knowledge via social interaction (Runping Guo et al., 2019; K.-H. Tsai et al., 2015; Zahra et al., 2019; K. Z. Zhou & Li, 2012). As suggested in the literature, the coordination of knowledge is a key ingredient for innovation (Dingler & Enkel, 2016). Since innovation involves the combination of existing knowledge (Collins & Smith, 2006), the aim at share, transferring, and exchange of knowledge through social interaction facilitates this process (Tödtling, Lehner, & Kaufmann, 2009). Specifically, knowledge coordination can support the absorptive capacity of firms (Jansen et al., 2005), enabling them to leverage external knowledge resources, such as social capital (Moreira,

Markus, & Laursen, 2018). In addition, knowledge coordination can facilitate the leverage of internal knowledge, for example through knowledge sharing, however, this relies on team-level factors such as trust (Rauniar, Rawski, Morgan, & Mishra, 2019), un-hierarchical structures and the existence of informal lateral ties among team members (W. Tsai, 2002).

While prior research on knowledge integration mechanisms in the context of new firms, has mostly focused on coordination processes (Briel et al., 2019; Salunke et al., 2019), existing theorizations point to the complementarity of systematization and coordination of knowledge to achieve innovation (Jansen et al., 2009; López-Nicolás & Meroño-Cerdán, 2011).

Since the systematization of knowledge can facilitate the storing, codification, organization, and management of firm-level knowledge, we hypothesize that:

Hypothesis 1: Systematic knowledge integration positively affects innovation in new firms.

Further, since the coordination of knowledge through social interaction can involve the transfer of tacit knowledge, which is difficult to articulate and access, we hypothesize that:

Hypothesis 2: Coordinated knowledge integration positively affects innovation in new firms.

2.2 Founder-related antecedents of knowledge integration mechanisms

There is an extensive discussion in the literature about the antecedents of knowledge integration (Zahra et al., 2019). At the individual level, existing theorizations have relied on resource-based theories, including human and social capital approaches (Bahlmann, 2016; Chang et al., 2016; Zhang, Wang, & Zhao, 2021), and capabilities, such as managerial, leadership, and decision-making capacity (Caridi-Zahavi, Carmeli, & Arazy, 2016; Guo et al., 2020). Correspondingly, the entrepreneurship literature drawing from knowledge-based view approaches has underscored two key roles of founders regarding knowledge in new firms. First, founders are depicted as key knowledge holders within their firms (Kato, Okamuro, & Honjo, 2015; Protogerou et al., 2017; Unger et al., 2011). Second, founders are the key decision-makers within their firms (Dean A Shepherd et al., 2015), including decisions about the management of resources such as knowledge (Sirmon & Hitt, 2003; Sirmon, Hitt, Ireland, & Gilbert, 2011). Playing this double role around knowledge can lead founders to encounter many difficulties, for example, gauging between integrating their own knowledge at the firm level, or, keeping the knowledge of others to themselves. In the context of new and small firms, these actions can determine the extent of control that founders have over the firm resources. Alternatively, knowledge decision-making may require specific capabilities or understandings

that go beyond formal education and experience, for example choosing an effective integration mechanism to achieve a firm-level purpose such as innovation.

Considering these views and based on the findings of a precedent study (See Chapter Three), we introduce two plausible antecedents of knowledge integration mechanisms related to the role of founders. First, drawing from scholarly views of entrepreneurs as key knowledge holders, we argue that the concentration of knowledge on the firm's founders can lead to knowledge dependence, which in turn, may hinder the integration of knowledge at the firm level. Second, drawing from research underscoring the role of founders as decision-makers, and extending views linking the perception of resources with managerial actions (Dolmans et al., 2014; Voss, Sirdeshmukh, & Voss, 2008), we argue that the founder's knowledge awareness can facilitate the recognition and assessment of different types of knowledge, leading to the implementation of knowledge integration mechanisms. We elaborate on these concepts in the following.

Knowledge dependence

While the integration of knowledge through systems or practices has been generally found beneficial for firms, the sole implementation of these mechanisms may not suffice to grant firm-wide access to knowledge and innovation. Prior studies have examined the *knowledge dependence* of the firm on key individuals (Howard et al., 2017; K. Liu & Arthurs, 2019), however, as salient reviews suggest, the literature on this domain has predominantly explained the dependence of firms from its external environment, using a resource perspective (Drees & Heugens, 2013; Hillman et al., 2009). Yet, a potential dependence of firms upon their founders can also lead to control mechanisms over the use and access to knowledge and innovation which may reduce their ability to innovate through knowledge. Furthermore, the reliance of knowledge on key individuals appears contrary to the idea of firm-level integration, which aims at the combination of knowledge from multiple sources with its consequent firm-wide knowledge appropriability (Toh & Ahuja, 2022). This idea extends to both knowledge integration mechanisms. For example, a firm that has robust knowledge systems, where information is frequently codified, stored, and updated, might be less likely to rely on its founders to access knowledge and innovation. In the same way, a firm that coordinates knowledge frequently, by transferring and sharing knowledge across members through social interaction, might be able to distribute knowledge across its members, reducing its reliance on individual knowledge. In both cases, the knowledge held by the founders might be embedded in systems or transferred across individuals.

Consequently, we hypothesize that:

Hypothesis 3: The dependence of the firm on its founders to access knowledge and innovation can negatively affect systematic knowledge integration in new firms.

Hypothesis 4: The dependence of the firm on its founders to access knowledge and innovation can negatively affect coordinated knowledge integration in new firms.

Knowledge Awareness

At the individual level, we propose that the *knowledge awareness* of the founder regarding their knowledge and the knowledge of others (Engelmann et al., 2009) can affect the extent to which knowledge is systematized or coordinated in young firms. Being aware of knowledge involves the recognition and assessment of knowledge in the firm, for example, being able to identify whether the firm possesses unique knowledge compared to its competitors, whether its members including themselves possess highly technical or general knowledge, or whether the firm aims at creating, exploiting, or transferring knowledge in the market where it operates. Our preliminary study (See Chapter Three) suggested that knowledge awareness could influence the founder's decisions on how to integrate knowledge. For example, founders who were highly aware of technical knowledge were more inclined to codify and store their knowledge in formal systems and organize knowledge through structured material such as templates and forms. In those cases, the recognition and appraisal of valuable knowledge, motivated founders to preserve knowledge in a way that can be used iteratively and reliably over time. This response was observed upon the recognition of knowledge from different sources and at different levels, for example when the valuable knowledge was held by the founder, by key employees, or by external advisors, and also when the knowledge was collectively assembled.

Similarly, founders who were highly aware of knowledge were also prone to coordinate knowledge frequently. In this case, the recognition and appraisal of valuable knowledge that is contingent (for example, the knowledge generated throughout projects) motivated founders to establish instances for the transfer, sharing, and exchange of knowledge such as regular meetings, mentorship practices, and social events.

Based on those findings, we hypothesize that:

Hypothesis 5: The knowledge awareness of the founder positively affects systematic knowledge integration in new firms.

Hypothesis 6: The knowledge awareness of the founder positively affects coordinated knowledge integration in new firms.

3. Method

3.1 Sample

The sample corresponds to 149 ventures operating in the state of New South Wales, Australia. The data was collected through a self-administered questionnaire distributed to ventures from different sectors, that have been operating for less than 10 years and were composed of at least 2 members. The questionnaire was distributed via email to 2,088 ventures, corresponding to the total number of listings found at the following public databases (NSW Start-up hub, Crunchbase) by July 2022. From that group, 657 invitations were returned undelivered due to different situations for example because of companies ceasing to operate. Correspondingly, a total of 1.431 invitations were successfully delivered. The data collection process resulted in 225 submitted questionnaires from which 149 corresponded to complete responses that were included in the analysis, representing a response rate of 10.4%.

The firm profiles and respondent profiles can be seen in detail in **Table 9**. The sample is varied across industries (31.4% technology sector, 68.6% spread out around 25 other sectors) and corresponds mostly to young firms (4.2 Years on average) and small firms (15.6 employees on average). Furthermore, 59% of the firms declared to be in the initial stages of development (pre-seed, seed, and early stage).

Table 9: Firm Profiles and respondent characteristics

Firm characteristics	Mean / Range	Category	Percentage
Age (years)	4.2 / 0.5-14	0-5	77.2
		6-10	18.8
		11-14	4.0
Size (no. of full-time employees, incl. founders)	15.6 / 1-334	1-10	71.1
		11-100	26.2
		101-334	2.7
Number of founders	2 / 1-6	1	33.6
		2-3	57.7
		4-6	8.7
Business Stage		Pre-seed (1.3%) & Seed (20.8%)	23.4
		Early stage (36.9%) & Growth (34.9%)	70.6

	Expansion (scale) & Exit	6.0
Industry sector	Technology	31.4
	Other 25 industries (<10%)	68.6
Type of firm	For-profit	100
Respondent characteristics	Category	Percentage
Gender	Female	24.2
	Male	73.8
	Other	2.0
Role in the firm	Founder	91.9
	Full-time employee	6.0
	Part-time employee	2.1
Sample size: 149		

Table 10 summarizes the composition of firms regarding the role of their members, this is the number of founders, full-time, part-time, and freelance employees of each firm. Accordingly, most firms had more than one founder (66.4% between 2-10 founders) and a minimal number of part-time and freelance collaborators (between 0 and 1).

Table 10: Firm Composition by Role

Role	Mean/range	Category	Percentage
Founder(s)	2.05 / 1-6	1	33.6
		2-3	57.7
		4-6	8.7
Full-time employees	10.18 / 0-150	0-1	37.5
		2-10	40.3
		11-50	18.1
		50-150	4
Part-time employees	3.33 / 0-223	0-1	64.5
		2-10	32.8
		11-223	2.7
Freelancers	9.49 / 0-823	0-1	44.3
		2-10	19.7
		11-823	6

3.2 Measures

The measures included in the questionnaire were derived from the extant literature and others were self-developed based on our qualitative pilot study. To develop a questionnaire, we conducted the following preliminary steps: (1) the conduct of a preliminary qualitative study on a separate group of ventures to identify items to develop scales, (2) a draft of the survey was piloted on a separate group of 34 ventures to test the clarity and effectiveness of the questions included, (3) the inclusion of a detailed participant information sheet at the beginning of the survey to explain the project's purpose and method, (4) the inclusion of a consent form as a mandatory field to submit a response. A full list of questionnaire items is provided in **Appendix 3**.

An overview of the variables included is showcased in **Table 11**. The independent variables include (1) knowledge awareness, and (2) the firm's dependence on its founders to access knowledge and innovation. As mediating variables, we included the following knowledge integration mechanisms: (4) systematic knowledge integration, and (5) coordinated knowledge integration. As a dependent variable, we examined (6) firm innovation, through an index measure composed by the number of new products and services successfully introduced in the market over the last 12 months, and the number of products and services in development over the last 12 months. In addition, we included control variables such as firm age, firm size, and firm performance. The survey questions were measured using a five-point Likert scale (anchored from strongly disagree[^] (= 1) to strongly agree[^] (= 5)). Reliability measures and construct validity tests (using confirmatory factor analyses) were performed for all reflective measures. Cronbach's alpha results are also presented in **Table 13**.

Table 11: Overview of variables

Variable Type	Abb	Variable Name	Description
Independent Variable	KA	Knowledge Awareness	The extent to which individuals identify and appraise knowledge
	FDE	Firm's dependence on the founder	Perceived reliance on the founder to access knowledge and innovation
Mediating Variables	CKI	Coordinated Knowledge Integration	Informal practices aimed at capturing, interpreting, and synthesizing knowledge
	SKI	Systematic Knowledge Integration	Formal practices aimed at capturing, interpreting, and synthesizing knowledge

Dependent Variable	INN	Innovation	New to the market Innovation: Number of products or services that are new to the local market where the venture is operating
			Innovation in Development: Number of new products or services that the venture is currently working on; not introduced yet
Control Variables	AGE	Firm Age	Number of years that the firm has been operating
	SIZE	Firm Size	Number of venture's full-time employees, including founders
	PER	Firm Performance	Perceived performance against competitors across different areas

Independent variables

The measures for knowledge awareness and firms' dependence were self-developed based on our qualitative pilot study. We opted to develop formative over reflective measures as the items for each variable measured specific forms of each construct, therefore, conveying different degrees of the variable rather than complementing each other (Hulland, 1999). Specifically, we computed indices for these variables by adding the standardized items divided by the number of items as used in other studies (Andreas Rauch & Rijsdijk, 2013).

Correspondingly, *knowledge awareness (KA)* is a 7-item indexed measure developed upon responses about seven questions assessing: i) the awareness of knowledge related to the business opportunity pursued, ii) founders' knowledge self-awareness and ii) the awareness of the knowledge of the firm as a whole. The measure for *dependence of the firm on its founders (FDE)* was adapted from Skinner and Gultinan (1986), based on the data collected through interviews shown in Chapter Three. Correspondingly, this variable was assessed using a 4-item indexed measure containing responses from two areas, i) the reliance of the firm on their founders to access knowledge, and ii) the reliance of the firm on their founders to access innovation.

Mediation variables

To assess knowledge integration mechanisms—systematic knowledge integration (SKI) and coordinated knowledge integration (CKI), we adapted existent scales previously applied in the literature (De Boer et al., 1999; Runping Guo et al., 2019) based on the data collected through interviews and shown in Chapter Three. For systematic knowledge integration, the

Cronbach's alpha is 0.767, and the composite reliability is 0.853. For coordinated knowledge integration, the Cronbach's alpha is 0.875, and the composite reliability is 0.877.

Dependent variable

We measured innovation using recommendations from the "Oslo manual 2018: guidelines for collecting, reporting and using data on innovation" (2018). Particularly, we created an index measure combining the number of new products and services that were successfully introduced in the market (*new-to-the-market innovation*) and the *innovation in development* over the last 12 months. We opted for including innovation in development due to the characteristics of our targeted firms, particularly age. Innovation that is new to the market was assessed by the number of products or services that are new to the market where the firm is operating and introduced in the last 12 months. Innovation in development was assessed by the number of new products or services that the firm has been working on for the last 12 months.

Control variables

As control variables, we included firm age, firm size, and firm performance. Specifically, while young firms have been found more innovative compared to mature firms (Huergo & Jaumandreu, 2004) young firms may face more challenges leveraging knowledge to achieve innovation (Balasubramanian & Lee, 2008). Accordingly, we measured firm age as the number of years that the firm has been operating. Similarly, firm size can influence the innovation output of firms (Shefer & Frenkel, 2005) as large firms have more resources and capabilities at hand to leverage knowledge (Knott & Vieregger, 2020). As shown in Table 9 71.1% of our sample corresponded to firms of less than 10 employees, and 97.3% of our sample corresponded to firms of less than 100 employees. As a result, the data corresponding to firm size was not normally distributed but skewed and therefore, we tested firm size as a log-linear variable to depict the relationship between this control variable and innovation more accurately. We detail these tests on a separate reference in Appendix 4. Lastly, following existing operationalizations (Santoro et al., 2019; Wiklund & Shepherd, 2003) we captured firm performance by asking respondents to rate their firm's performance against their competitors across six areas: overall performance, sales growth, market share, profit growth, product and service quality and customer satisfaction using a five-point Likert scale from much lower (1) to much higher (5).

3.3 Analysis

Given that our hypotheses involve the examination of a series of interrelations between constructs, we use structural equation modelling (SEM) to test our propositions. SEM is a technique that allows the conduction of path analysis, this is, the conceptualization and estimation of “the magnitude and significance of hypothesized causal connections among a set of variables” (Stage, Carter, & Nora, 2004, p. 5). Because path analysis requires the examination of a model grounded in a theoretical framework, we believe this technique is well suited to assess the propositions included in our conceptual model. Importantly, while path analysis is not aimed at exploratory research, it allows the comparison between models that entail refined propositions of the relationship between variables, such as competing direct and indirect paths to the explained variables. More specifically, SEM was chosen above other techniques for the following reasons: i) it allows the inclusion of observed and unobserved variables, ii) it accounts for the measurement of error iii) it facilitates the depiction, assessment, and refinement of both theoretical conceptualizations and measures (Hulland, 1999). Correspondingly, the data was analysed in two steps. First, we run descriptive analyses and measurement validation using SPSS, version 28. Second, we employed AMOS 28 to conduct structural equation modelling to assess and estimate the structural model by testing the hypothesis proposed.

Measurement Validation

Regarding the assessment of the formative measures employed (Knowledge Awareness and Firm dependence on their founders) we adhere to most methodological approaches that underscore the difference between reflective and formative measures and the requirement of differentiated methodological treatments (George, 2011). As such, formative measures represent constructs that are *formed by* the aggregation of its multiple dimensions, regardless of whether these dimensions are or not correlated (George, 2011; Kenneth, 1989). Consequently, all dimensions need to be incorporated in order to represent the construct appropriately. Thus, the measurement validation process applied to reflective measures, does not apply to formative ones. Specifically, as posed by George (2011, p. 1299) “measures of internal consistency reliability such as Chronbach’s alpha are not valid indicators of reliability for a formative construct since it represents the extent to which the indicators represent a common underlying construct.”

To estimate the validity and reliability of the reflective measures, we conducted the following assessments. We conducted an exploratory factor analysis to assess the internal

reliability of our latent variables as summarized in **Table 12**, followed by a confirmatory factor analysis. **Table 13** shows the reliability of the scales employed in the study. First, we assessed Cronbach's alpha and composite reliability (CR) of the latent variables employed. Following existing theorizations for reliability measures, all our latent variable's alphas were above the recommended 0.70, the lowest being 0.767 pertaining to Systematic Knowledge Integration (SKI). Second, we assessed construct reliability (CR) measures, with all values above the recommended threshold of 0.70 (Hu & Bentler, 1999) with the lowest being 0.853 corresponding to systematic knowledge integration (SKI). Third, we assessed convergent validity by calculating the average variance extracted (AVE) which retrieved values above the recommended 0.5. Further, AVE values are lower than CR. Fourth, we assessed discriminant validity by calculating the maximum shared variance (MSV), which values are lower than AVE. All in all, we did not find problems related to the validity of the measures employed in the study.

Acknowledging potential issues derived from the use of data collected through single sources, we assessed the common method variance (CMV) present in the study. To do so, we conducted the following tests. First, we conducted Harman's one-factor test by reducing all the variables to a single factor constrained without rotation. As a result, we obtained a single factor explaining 33.81% of the total variance which is lower than the maximum of 50% recommended. Second, we conducted a common latent factor analysis (CLF) by estimating the common variance among all variables when a common latent variable is introduced. The result retrieved a common variance of 15.21% which is below the recommended threshold of 50%.

Table 12: Exploratory Factor Analysis (EFA)

	Rotated Component Matrix^a	
	Component	
	1	2
CKI_1	0.808	0.049
CKI_2	0.747	0.221
CKI_3	0.781	0.221
CKI_4	0.851	0.212
CKI_5	0.797	0.292
SKI_1	0.107	0.583
SKI_2	0.226	0.842

SKI_3	0.284	0.764
SKI_4	0.123	0.772
Extraction Method: Principal Component Analysis.		
Rotation Method: Varimax with Kaiser Normalization.		
a. Rotation converged in 3 iterations.		

Table 13: Scale validity and reliability measures

	Cronbach's alpha (> 0.70)	CR (> 0.70)	AVE (> 0.50)	MSV
Systematic Knowledge Integration (SKI)	0.767	0.853	0.681	0.556
Coordinated Knowledge Integration (CKI)	0.875	0.877	0.592	0.556

Regarding correlations between variables as shown in **Table 14**, we did not find high correlations between independent variables.

3.4 Results

To test our hypothesis, the study included the development of SEM models using SPSS AMOS version 28. We present the results of two models. Since our initial model (Model 1) retrieved goodness-of-fit indices that partially meet the recommended values, we developed an exploratory model (Model 2) to examine additional propositions of the relationship between variables. Thereby, this section describes the results obtained by *Model 1* and *Model 2*. A comparison of the indices obtained for both models is summarized in **Table 15**.

Table 14: Correlations between variables

				Correlations							
	Variable	Mean	St. Dev.	1	2	3	4	5	6	7	8
1.	KA- Knowledge Awareness	0.000	0.501	1.000							
2.	FDE- Firm dependence on founder	0.000	0.809	.314**	1.000						
3.	SKI- Systematic Knowledge Integration	4.001	0.708	.291**	-0.003	1.000					
4.	CKI- Coordinated Knowledge Integration	4.422	0.615	.189*	-0.033	.471**	1.000				
5.	INN- Innovation	0.000	0.926	.323**	.868**	0.018	-0.041	1.000			
6.	PER- Firm Performance	0.000	1.000	.218**	0.033	.165*	.210*	-0.030	1.000		
7.	AGE- Firm Age	0.000	1.000	0.078	0.038	0.042	-0.057	0.009	0.112	1.000	
8.	SIZ- Firm Size	0.190	1.155	0.097	-0.074	0.242**	0.175*	0.296**	.349**	.418**	1.000

** . Correlation is significant at the 0.01 level (2-tailed).

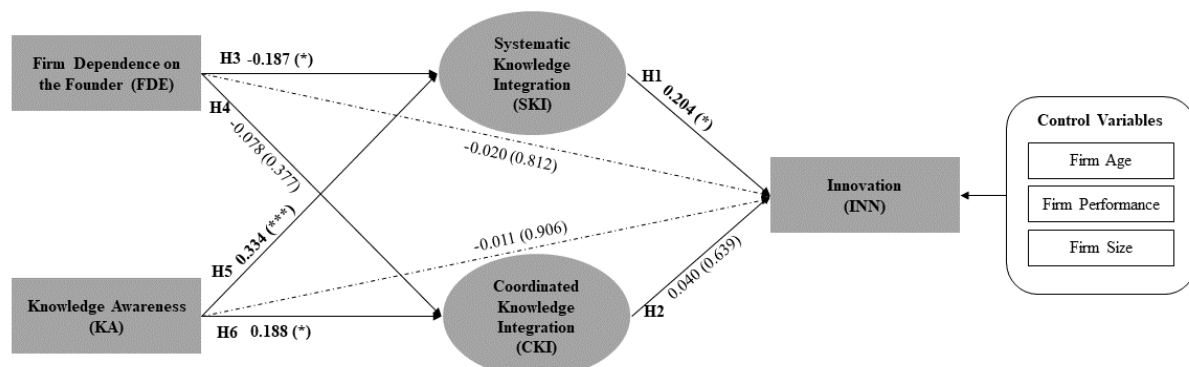
* . Correlation is significant at the 0.05 level (2-tailed).

Table 15: Summary of fit indices among models

Model Fit	Model 1	Model 2	Ref. values
Chi Square	123.334	94.966	
Degrees of freedom	67	66	
X2/ (df)	1.841	1.439	<3
CFI	0.919	0.959	>0.95
TLI	0.874	0.934	>0.95
RMSEA	0.075	0.054	<0.050
P-level	0.000	0.011	p>0.05
AIC	259.334	232.966	
SRMR	0.1152	0.0521	(~0)

Model 1

Figure 8 illustrated the results from Model 1. To assess Model 1, we used maximum likelihood estimation and fit indices as recommended in the literature (Hu & Bentler, 1999). Accordingly, we assessed Model 1 overall fit based on the chi-square (123.334), degrees of freedom (67), and Bollen-Stine p -value of 0.000. In addition, we assessed additional indices such as the root-mean-square error of approximation (RMSEA=0.075), Tucker-Lewis Index (TLI=0.874), and Comparative Fit Index (CFI=0.919). While these results suggest a sufficient fit overall, some indices were slightly below the recommended values including the p -value is significant, CFI and TLI is below the recommended value of 0.95, and RMSEA is above the recommended value of 0.050.

Figure 7: Model 1 Results

Regarding the hypotheses tested, the analysis suggested the following results. First, the analysis conducted indicates that systematic knowledge integration (SKI) has a positive and significant effect on innovation ($\beta=0.204$, $p=0.038$), therefore, H1 is supported. Yet, we did not

find a significant effect of coordinated knowledge integration (CKI) on innovation. Therefore, H2 is not supported. We find a significant negative effect of the dependence of the firm on its founders (FDE) on systematic knowledge integration (SKI) ($\beta=-0.187, p=0.041$), therefore H3 is supported. Further, while the effect of the dependence of the firm on its founders (FDE) on coordinated knowledge integration (CKI) is also negative, this effect was not significant and therefore H4 is not supported. Third, knowledge awareness (KA) has a positive and significant effect on systematic knowledge integration (SKI) ($\beta=0.334, p=0.000$) and therefore H5 is supported. In addition, we find a positive and significant relationship between knowledge awareness (KA) and coordinated knowledge integration (CKI) ($\beta=0.188, p=0.039$), consequently, H6 is also supported. In addition, we tested for control variables such as firm age, firm size, and firm performance but did not find a significant effect of the control variables on exogenous variables, including knowledge integration mechanisms and innovation (See Appendix 4).

Table 16 shows unstandardized direct, and indirect effects of Model 1. The analysis underlines a significant indirect effect of knowledge awareness on innovation mediated by systematic knowledge integration ($\beta=0.122, p=0.020$). In addition, the analysis retrieved a significant negative small indirect effect of the firm's dependence on the founder on innovation mediated by systematic knowledge integration ($\beta=-0.043, p=0.020$). No significant direct effects were found between knowledge awareness and innovation, neither between the firm's dependence on its founders and innovation.

While Model 1 retrieved most fit indices within acceptable ranges, we believe there are still unresolved issues that required further clarification. The literature (Briel et al., 2019; Dingler & Enkel, 2016) has highly emphasized the role of coordinated knowledge integration on innovation, which is not supported in our results in Model 1. To shed light on this issue, we proceeded to test an alternative model which is detailed in the following.

Table 16: Model 1, unstandardized direct, indirect and mediation effects

Model 1 - Relationship	Direct Effect	P-Value	Indirect Effect	Confidence Interval		P-Value	Conclusion
Knowledge Awareness >Systematic Knowledge Integration >Innovation	-0.011	0.906	0.122	Lower	0.017	0.020*	Full mediation
				Upper	0.387		
Knowledge Awareness> Coordinated Knowledge Integration >Innovation	-0.011	0.906	0.013	Lower	-0.021	0.356	No mediation
				Upper	0.086		

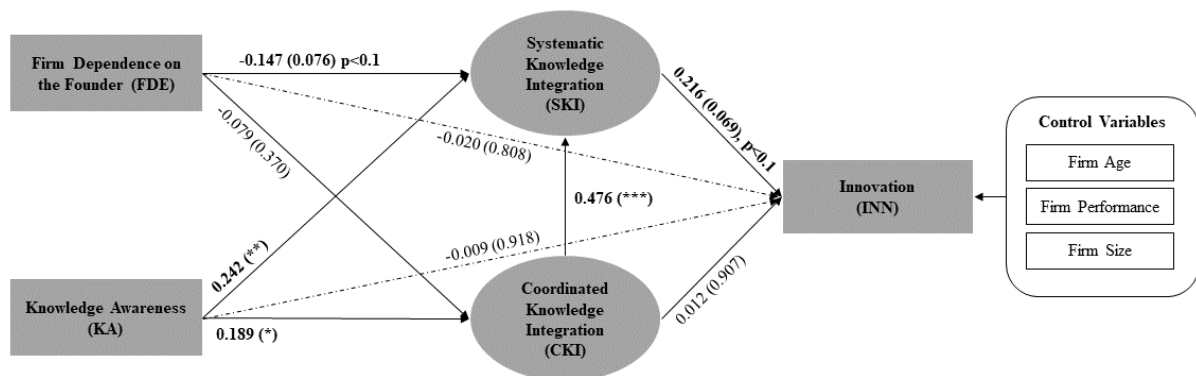
Firm's Dependence> Systematic Knowledge Integration >Innovation	-0.020	0.812	-0.043	Lower	-0.147	0.020*	Full mediation
				Upper	-0.006		
Firm's dependence >Coordinated Knowledge Integration >Innovation	-0.020	0.812	-0.003	Lower	-0.030	0.273	No mediation
				Upper	0.005		

Model 2

Model 2 aims at exploring alternative or additional explanations to the theoretical model proposed initially, complementing the findings retrieved by Model 1. To do so, we maintained the hypotheses supported in Model 1 and tested one new proposition among the variables that remained unlinked in the previous model. Specifically, we further examined the relationship between coordinated knowledge integration (CKI) and innovation by exploring an indirect path through the mediation of systematic knowledge integration (SKI).

To assess Model 2 (shown in **Figure 9**), we used the same parameters used to analyse the results of Model 1. Accordingly, we tested Model 2 and assessed its overall fit based on the chi-square (94.966), degrees of freedom (66), and Bollen-Stine *p*-value of 0.011. In addition, we assessed additional indices such as the root-mean-square error of approximation (RMSEA=0.052), Tucker-Lewis Index (TLI=0.934), and Comparative Fit Index (CFI=0.959). As suggested by these results, Model 2 exhibits improved goodness-of-fit indices than Model 1, including *p*-value, RMSEA, TLI, and CFI. Moreover, another suitable fit index for comparison is the Akaike Information Criteria (AIC) (Akaike, 1987), being the lowest value as an indication of a better fit. Accordingly, Model 2 presents a better AIC value (232. 966) than Model 1 as showcased in **Table 15**.

Figure 8: Model 2 Results



Regarding the initial hypotheses posed, the analysis suggested the following results. First, the analysis corroborates a positive and significant effect of systematic knowledge integration (SKI) on innovation ($\beta=0.216, p=0.069, p<0.1$), therefore, H2 is supported. Second, Model 2 finds a small significant negative effect of the firms' dependence on their founders (FDE) and systematic knowledge integration (SKI) ($\beta=-0.147, p=0.076, p<0.1$), therefore H3 is supported. In contrast the analysis did not retrieve a significant effect of the firms' dependence on their founders on coordinated knowledge integration (CKI) therefore H4 is not supported. Third, Model 2 confirms a positive and significant effect of knowledge awareness (KA) on coordinated knowledge integration (CKI) ($\beta=0.189, p=0.038$) and on systematic knowledge integration (SKI) ($\beta=0.242, p=0.006$) and therefore H5 and H6 are supported. Further, the coefficients and significance values of the abovementioned relationships retrieved similar values between Models 1 and 2.

The new relationship suggested by this model retrieved that, coordinated knowledge integration (CKI) has a positive and significant effect on systematic knowledge integration (SKI) ($\beta=0.476, p=0.000$) which suggest an indirect effect on innovation.

Table 17 summarizes the unstandardized direct, indirect, and mediation effects found in Model 2, underscoring a significant indirect effect of CKI on innovation, mediated by systematic knowledge integration (SKI). We discuss our results in the following section.

Table 17: Model 2, unstandardized direct, indirect, and mediation effects

Model 2 - Relationship	Direct Effect	P- Value	Indirect Effect	Confidence Interval		P- Value	Conclusion
Knowledge Awareness->Systematic Knowledge Integration->Innovation	-0.017	0.918	0.094	Lower	0.016	0.030 *	Full mediation
				Upper	0.300		
Knowledge Awareness->Coordinated Knowledge Integration->Innovation	-0.017	0.918	0.004	Lower	-0.036	0.760	No mediation
				Upper	0.051		
Firm's Dependence ->Systematic Knowledge Integration->Innovation	-0.023	0.808	-0.035	Lower	-0.121	0.035*	Full mediation
				Upper	-0.007		
Firm's Dependence ->Coordinated Knowledge Integration->Innovation	-0.023	0.808	-0.001	Lower	-0.019	0.570	No mediation
				Upper	0.008		
	0.012	0.907	0.147	Lower	0.033	0.024*	

Coordinated Knowledge Integration>Systematic Knowledge Integration >Innovation	Upper	0.364	Full mediation
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4. Discussion

Our findings provide an insightful understanding of the role of founders in the implementation of contrasting knowledge integration mechanisms and their consequences for innovation in young entrepreneurial firms. Particularly, our study underscores a seemingly overlooked path to innovation: the role of knowledge awareness in knowledge systematization to achieve innovation. While an extensive body of research has concentrated on socialization mechanisms for knowledge transfer, share, and innovation (Rupietta & Backes-Gellner, 2019; Spencer, 2003), our study suggests that these processes alone cannot grant the attainment of innovation in small and young firms relatively to previous studies in this area. The integration and further utilization of knowledge inside firms require broad access to knowledge which is key to enabling innovation (Sung & Choi, 2018). We discuss the findings around the role of knowledge integration mechanisms, the role of the founders' knowledge awareness and firms' dependence in the context of new and small firms, and the limitations of this study in the following.

Systematization versus coordination of knowledge: an unlikely path.

Despite extensive theorizations on the link between informal mechanisms of knowledge integration, particularly those aimed at social interaction, and innovation (W. Tsai & Ghoshal, 1998; Yli-Renko et al., 2001; Zhang et al., 2021), our results suggest that the systematization of knowledge may contend an even more critical role to achieve innovation in the context of small and young firms. Although somewhat surprising, our results can be seen as an indication of the role of embedding knowledge at the firm level in a way that is widely accessible to all members of the organization and that can be sustained over time. This might be especially important for young firms with a small number of members considering the likelihood of employees performing several roles (Klonek, Volery, & Parker, 2021). Regarding the role of knowledge coordination, prior literature has underscored its association with firm capabilities (Briel et al., 2019), which may take time to develop, and consequently, its effect may appear diminished in the distinctive context of small and young firms. More specific forms of knowledge coordination through social interaction such as knowledge sharing, are also dependent on team-level factors such as trust (Levin & Cross, 2004), however small and young

firms may be challenged by high employee turnover, few team members, remote workers, which may difficult the consolidation of working team-dynamics. While initially our study suggested that only systematic knowledge integration was relevant for innovation in this context (as seen in Model 1), further exploratory examinations indicate that knowledge coordination affects innovation indirectly (through systematization) while systematization does it directly. Furthermore, our analysis provides support to the mediating effect of the systematization of knowledge, both to facilitate the integration of knowledge that is coordinated, and, to counteract the effect of the dependence of the firm on their founders to access knowledge and innovation. Overall, our study aligns with previous theorizations that have established that the co-occurrence of both types of mechanisms are important to achieve innovation (Jansen et al., 2009), and refine the understanding of the interrelation between knowledge integration mechanisms in the context of small firms.

Awareness and dependence in the context of small and young firms.

A key contribution of our study is the application and validation of founder-related antecedents that allows us to identify individual and firm-level factors that affect knowledge integration mechanisms and their consecutive effects on innovation. As pointed out in the literature, founders are often the key decision-makers of their firms, which involves the management of an array of resources, including knowledge (Alvarez & Busenitz, 2001). However, the management of knowledge entails significant difficulties as knowledge can take many forms and be embedded at multiple levels (Schultze & Stabell, 2004). For example, tacit knowledge can be carried out by individuals who may not be able to readily articulate it but use it when appropriate. Explicit knowledge may be embedded in firm-level structures, but it needs to remain relevant and updated to be of any use (Corral de Zubielqui, Lindsay, Lindsay, & Jones, 2019). Consequently, founders need to be aware of these distinctions and be able to identify the relevant knowledge that is required by the firm at present to generate innovation (Nicolai J Foss & Jensen, 2019; J & Chakrabarti, 2012). Moreover, founders need to identify the knowledge that will be required in the future to ensure their firm's survival (Nicolai J. Foss, Lyngsie, & Zahra, 2013). Thus, we believe that *knowledge awareness* may be critical for young firms. In this regard, our study suggests that founders that are more aware of knowledge are more likely to implement the actions needed to integrate knowledge at the firm level, which in turn, will equip their firms to utilize knowledge as the firm grows. Interestingly, our study highlighted a special link between knowledge awareness and systematic knowledge

integration, which can be explained as an indication of the founder's aim to consolidate knowledge and ensure it can be carried through over time.

Our results around the dependence of firms on their founders to access knowledge and innovation are twofold and may require further investigation. While we found evidence of this phenomenon negatively impacting the integration of knowledge, and particularly affecting systematic integration, our study retrieved small effects and significance levels of $p < 0.1$, therefore our results may require further examination. Therefore, further exploration of this dependence and its effects on innovation can be a relevant opportunity for future research. Beyond this limitation, our study suggests that the dependence of the firm on their founders can carry negative consequences for knowledge integration. Concerning the dependence of firms on their founders to access knowledge, we believe that founders may restrict access to knowledge by distributing knowledge to their employees directly, preventing the development of firm-wide knowledge systems. Moreover, founders may choose to keep critical knowledge to themselves, for example, the contact information of key stakeholders, and technical or procedural information. This may occur to prevent knowledge from spilling out of their firms (Giarratana & Mariani, 2014). While these actions may prevent the broad use of knowledge internally, they may as well protect the firm's knowledge from spilling outside and facilitate the development of competitive advantages which can lead to improved performance (Grant, 1996; Matusik & Charles, 1998). Another form of dependence on the firm founders can occur when access to innovation is heavily reliant on the founders' ideas or when participation in innovation processes is restricted to certain individuals. Although the reliance on founders to access innovation can also be seen as a way to prevent knowledge spillovers, we believe that founders may have different motives to restrict the participation of members in the innovation process. For example, founders may see innovation as part of the strategic direction of their ventures and therefore may choose to be more heavily involved in this process. Restricting the participation of innovation to a few firm members may involve decisions around the assessment of new ideas and opportunities to pursue and the extent of radicalness to which these ideas will be developed. Moreover, founders may choose to develop new ideas in collaboration with external partners, advisors, mentors, or key suppliers or customers. These decisions may, in turn, align or not with market demands and other environmental factors and therefore may carry significant risks. As innovation is affected by contextual events and technological opportunities (Taalbi, 2017), we believe that the relationship between this type of dependence and firm performance may be affected by contextual differences and the market knowledge of the founders where these dependencies occur.

All in all, our study indicates that founders can play a critical role in their firm's integration of knowledge, which can be especially relevant when firms are young and small.

5. Limitations

Our study has some limitations. First, because our study focused on very small firms (70% have 10 employees or less) and explicitly excluded corporate entrepreneurship, our results must be interpreted carefully when examining large or very large firms. Second, while the second model includes relationships that were not considered in the preliminary theoretical model, we have opted for including it as it may provide an alternative explanation of the interrelation between knowledge integration mechanisms and their effect on innovation that was not considered in the initial conceptualization. Third, we acknowledge the limitations of our results considering the cross-sectional design of the study. Further, we encourage future research to examine these constructs in a longitudinal study as we believe that some emergent conceptualizations posed in this study may have a more significant long-term effect. For example, while the dependence of firms on their founders to access knowledge and innovation may not entail major obstacles to new firms' innovation in the short term, we believe that this phenomenon may have a more significant effect in the growing stages or scaling stages of the firm when the management of firms become more complex. Lastly, we acknowledge the limitations stemming from our sample size ($n=149$). While our study follows the recommendations for sample size and number-of-cases-per-variable-ratio (Kline, 2015), a larger sample may improve the robustness of the results (Stage et al., 2004). Moreover, we acknowledge the limitations of the statistical method employed (SEM) which may overlook case-level data. In that regard, we encourage the use of alternative analytical approaches that can assess these results at a finer grain.

6. Conclusion

Our study operationalizes and tests founder-related antecedents of knowledge integration in the context of small and young firms. By doing so, our findings underscore a less explored path between knowledge integration and innovation, highlighting the importance of the knowledge awareness of the founders and the systematization of knowledge. As such, founders that are more prone to identify relevant knowledge will be more likely to organize, store and retain knowledge for future uses, making it accessible to the whole organization. Although certain organizational enablers can facilitate coordination mechanisms, these processes may not warrant innovation in small and young firms on their own. In turn,

coordinated knowledge integration appears to support systematic knowledge integration which is deemed critical for innovation in small and young firms. Furthermore, our study underscores the mediating role of knowledge integration at several levels. We explain these findings as coordination mechanisms of integration require the existence of certain capabilities which may not be available to small and young firms.

OVERALL CONCLUSIONS AND FINAL REMARKS

I started this project seeking to advance the understanding of knowledge as an antecedent of innovation in the context of entrepreneurial post-entry conditions. Particularly, the extensive literature drawing on knowledge-based perspectives seemed to focus on two important themes: the knowledge of founders and the founding team and its implications to nascent entrepreneurship, and the required conditions for knowledge to be acquired, transformed, and leveraged for the firm benefit in the context of established entrepreneurial firms. Nonetheless, the question of *how* founders organized and structured knowledge in a way that transcended individuals remained overlooked, as going from founder knowledge to firm knowledge appeared as a logical progression in the development of emergent organizations.

To uncover this puzzle, I started by examining existing conceptualizations connecting knowledge, entrepreneurship, and innovation, seeking to generate an updated picture of the research conducted in this domain. This initial step involved the conduction of a systematic literature review which is presented in *Chapter 2*. As an overarching finding, the review emphasizes that knowledge needs to be accounted for from a process perspective. Such a perspective involves the recognition of knowledge at multiple stages throughout the entrepreneurial process, the mechanisms involved in its transformation, and the outcomes and sub-outcomes derived from such processes. A knowledge-based process perspective goes beyond the input-output approach by integrating the knowledge resources and processes that occur *between* those boundaries. This perspective also allows the incorporation of parallel theorizations such as learning views of entrepreneurship, by examining how entrepreneurial learning is accounted for as knowledge available to the firm and its members. Moreover, a process perspective of knowledge in entrepreneurship is appropriate and aligns with current recalls to strengthen our understanding of the entrepreneurial phenomena (Davidsson & Gruenhagen, 2021).

Regarding the initial question of how knowledge was organized in ventures, the review denotes that knowledge in the context of entrepreneurship is a complex phenomenon that involves multiple decisions and has multiple implications. Moreover, the synthesis of this literature facilitated the identification of overlooked areas, particularly related to internal processes and internal outcomes of knowledge. Yet, understanding the internal dynamics around knowledge can be critical to explain, for example, why firms with similar access to external knowledge sources and of similar characteristics can obtain different gains from knowledge.

Considering this, I opted for continuing this dissertation by focusing on one important internal process: *knowledge integration*. Not only knowledge integration is critical for innovation but is also a very complex phenomenon as it can involve several mechanisms such as knowledge share, transfer, creation, and retention. Aligned with the initial question, I sought to examine how knowledge was integrated into new firms, seeking to identify whether different strategies existed and if so, which factors were determining such differences. Consequently, I conducted an exploratory qualitative study which is presented in *Chapter 3*. This study extends the understanding of knowledge integration across three themes: antecedents, mechanisms, and archetypical configurations. Regarding antecedents, the qualitative study identifies two enablers and one barrier to knowledge integration. As enablers, the study underscores the importance of the founder's knowledge awareness along with certain organisational practices and characteristics. As a barrier, the study finds that the dependence of the firm on its founders to access knowledge and innovation can be detrimental to the integration of knowledge. Concerning knowledge integration mechanisms, this study offers a nuanced understanding by establishing relationships between antecedents (knowledge awareness, knowledge dependence, and organizational enablers) and two distinct mechanisms of knowledge integration, namely systematization, and coordination of knowledge. Lastly, this study develops a framework to characterize venture types according to their pathway to knowledge integration, by distinguishing between four archetypical configurations. By doing so, this thesis provides evidence of *ventures as organizations*, in the sense that entrepreneurial ventures are organized entities as opposed to chaotic structures.

Following the findings of the qualitative study, specifically, the emergent propositions connecting antecedents and mechanisms of knowledge integration, this thesis continued with a quantitative study aimed at theoretical generalization which is presented in *Chapter 4*. Particularly, I sought to clarify the role of founders in the integration of knowledge in new firms and its consecutive link with innovation. Correspondingly, this study validates a virtuous association between the founder's knowledge awareness, the mechanisms of knowledge integration, and innovation in small and young firms. Furthermore, this study underscores the importance of formal knowledge integration practices as an essential requisite for innovation and a catalyzer of informal ones. In the following, I summarize the theoretical and practical implications of this dissertation.

Theoretical Implications

Altogether this dissertation has used a multi-methodological approach to investigate knowledge and innovation in entrepreneurial firms. Furthermore, the thesis provides a refined

conceptualization of integration mechanisms and their effect on innovation in the context of small and young firms. Beyond the specific findings and contributions stemming from each study and detailed in their corresponding chapters of this dissertation, I pose that the compiled work provides some additional light onto three issues that have been previously answered from distinct theoretical perspectives.

The first is, *why do founders matter for knowledge in new firms?* Building from the knowledge-based view of the firm which underscores knowledge as a key resource, entrepreneurship scholars have extensively investigated the role of founders in the successful use of knowledge resources for firm-level benefits. Several theories have provided plausible explanations; however, these conceptualizations have offered partial solutions to this problem. For example, the human capital perspective has contributed to explaining entrepreneurial success (Unger et al., 2011) and innovation (Protogerou et al., 2017), but just to a small extent. While the founder's human capital has been generally depicted as beneficial for new firms (Dencker et al., 2009; Toft-Kehler, Wennberg, & Kim, 2014), this influence may only apply to specific areas of knowledge or in specific sectors such as high-tech industries (Colombo & Grilli, 2005). Moreover, the practice of entrepreneurship is abounded with examples of successful entrepreneurs who started their businesses with little professional experience or with a lack of formal education. Other theoretical views such as learning perspectives and social capital theory have provided additional clues on the role of founders and the firm's knowledge. Particularly, these views have shown how specific founders' abilities can maximise the use or facilitate access to knowledge for the firm's gain. In contrast to these perspectives, this dissertation offers an alternative view of the role of the founder's knowledge for the firm's benefits by pointing at two founder-related antecedents: the founders' *knowledge awareness* as the extent to which founders identify and assess knowledge, and the *firm's dependence on its founder's knowledge*, as the extent to which the firm relies on its founders to access knowledge and innovation. Regarding knowledge awareness, I believe this novel conceptualization can complement existing perspectives, especially human capital, as knowledge awareness can be applied to entrepreneurs coming from a diverse array of backgrounds and to firms that operate in different sectors. Knowledge awareness implies a primary but conscious recognition of knowledge that is sufficient to act upon. For example, a founder that is highly aware of knowledge can identify and manage the knowledge from their employees, protect the firm knowledge that is likely to grant competitiveness or be conscious of self-knowledge that needs to be transferred to others to sustain the firm over time. Although more research is needed to clarify the relationship between knowledge awareness and human capital, I believe that the

knowledge awareness conceptualization may better explain the relationship between individual-level knowledge and performance measures as the awareness of knowledge may not be necessarily linked to high levels of education or professional experience. Moreover, research on human capital has demonstrated a small effect on entrepreneurial success overall (Unger et al., 2011), and therefore, current theorizations may need further advancement. Regarding knowledge dependence on the founder, this thesis posits an interesting question that opens several opportunities for future research, can knowledge integration be deterred by their founders? Although our findings timidly point in that direction, I believe the firm dependence on its founders can have significant implications for specific types of firms and in specific stages of development. For example, small firms may be more prone to rely heavily on their founders and therefore have fewer incentives to integrate knowledge. Alternatively, firms that are undergoing scaling processes may struggle to succeed if the reliance on their founders is high.

The second issue that this thesis contributes to is *how is knowledge structured in entrepreneurial firms*. According to Galunic and Rodan (1998), knowledge structures are sets of interrelated knowledge elements that enable multiple combinations and therefore are key in supporting creative and innovative firm outcomes. However, knowledge structures that support the exploration and exploitation of new opportunities, are mediated by formal and informal knowledge integration mechanisms (Jansen et al., 2009). Thus, knowledge structures in entrepreneurial firms are far from rigid but flexible structures. While research on this domain has emphasized the importance of formal mechanisms in established firms, entrepreneurship research has focused mostly on informal integration mechanisms (Briel et al., 2019; Dingler & Enkel, 2016; Rauniar et al., 2019; Zhang et al., 2021). This thesis provides two hints that shed light on this issue. First, while entrepreneurial firms need both types of integration mechanisms, formal mechanisms can grant direct benefits to achieve innovation along with facilitating the utilization of informal ones. In simple words, while knowledge sharing through social interaction can help firms transfer knowledge between individuals, if this knowledge is not formally stored in firm-wide systems, it is less likely that this knowledge will be conducive to innovation. This might be especially relevant to small firms which have fewer resources and fewer opportunities to host social interactions. Second, there are different arrangements for the combination of formal and informal integration mechanisms. This thesis describes four distinct archetypes representing variations of these combinations. More research can be dedicated to further examine whether certain archetypes can be more successful in generating innovation, and in which contexts. Overall, a deeper understanding of knowledge integration mechanisms

can strengthen a process perspective of knowledge, by connecting the figure of the founder with the firm-level outcome of innovation.

The last issue that this thesis contributes to refers to *how is innovation achieved in the small firm*. Complementing the extensive research pointing at the implications of macro-level factors to firm performance including innovation and using cross-sectoral evidence of knowledge in ventures, the theorizations derived from this thesis focus on internal dynamics and innovation. As a result of this examination, this thesis posits new conceptualizations that go beyond sectoral differences, including the role of founders in the knowledge integration processes and knowledge-derived archetypical outcomes. By doing so, I advocate for the broader applicability of research findings arising from knowledge perspectives in the entrepreneurial context, in a similar way that resource perspectives have been broadly applied to different contexts (Nicolai J. Foss et al., 2008; Penrose, 1959). Moreover, given the pervasiveness of knowledge through technological advancement, the boundaries of sectoral categorizations related to knowledge (knowledge worker, knowledge-intensive) and technological differentiations (high-tech, low-tech) become blurry and may need to be revised by scholars focusing on this domain.

Practical Implications

There are many implications for practitioners that can be derived from the findings of this dissertation. In the following, I outline a few implications for founders and policy makers oriented toward the use of knowledge to foster innovation.

First, a distinction between knowledge and innovation is key to maximizing the gains from knowledge and translating them into economic value. While the literature suggests that knowledge and innovation are intertwined processes, the sole possession or access to knowledge cannot guarantee the achievement of innovation. Founders and managers play a critical role in this transformation, by recognizing, assessing, and managing knowledge resources throughout the innovation process. As synthesized in this dissertation, knowledge processes can be oriented toward the search, transfer, or integration of knowledge, the latter being an important one aimed at incorporating knowledge from several sources at the firm level. Furthermore, our findings suggest that knowledge integration sits at the intersection between external and internal dynamics, thus allowing external knowledge to be combined with the unique knowledge from the founder and their team. Moreover, knowledge integration can lead to the emergence of firm-knowledge repositories. Knowledge repositories are the receptacles of the knowledge that has been integrated into the firm and can take several forms.

More importantly, knowledge repositories can store knowledge and lessons gained by experience, thus supporting future activities related to innovation.

Second, given the importance of knowledge integration for innovation, practitioners need to be conscious of the mechanisms that are conducive to the integration of knowledge in entrepreneurial firms and the internal factors that are associated with its implementation. Regarding integration mechanisms, this thesis provides evidence that a combination of formal and informal mechanisms of knowledge integration is needed to support innovation. Moreover, formal mechanisms of integration such as the storing, organizing, and systematization of knowledge, can directly help firms achieve innovation. This thesis suggests that this is especially relevant to small firms, which have few resources at hand. Regarding the factors that can influence the integration of knowledge in new firms, this research suggests that founders can be critical as they make decisions concerning the management of knowledge. In that vein, founders that can identify the strengths and deficiencies of their firm's knowledge, are more likely to implement strategies to integrate knowledge. On the other hand, founders need to implement strategies to share, transfer and integrate their own knowledge, to minimize their firms' dependence on specific individuals and thus maximize the integration efforts. Similarly, founders, managers, and policymakers can promote organisational practices, values, and methodologies that are oriented toward the sharing, structure, and transfer of knowledge. Some of those practices are the use of digital tools to assist tasks, problem-solving methodologies, and the adoption of a flexible organizational structure that allows venture members to share roles and tasks.

Third, policymakers need to design and implement distinct strategies to help small firms achieve innovation. Because in small firms, founders can have a gravitating role, these firms may need additional resources to guide an integration of knowledge that can be conducive to innovation. Particularly, this research has identified two warning signs that are indicative of an excessive influence of the founders' knowledge over their own firms. The first one is when the firm heavily relies on the founder to access knowledge and innovation, which I broadly described in this thesis as knowledge dependence. The second is associated with certain archetypical configurations: when the founder controls and administers knowledge on a one-to-one basis (founder-driven organization), and when founders dictate rigid formats of knowledge content for its replication (standardized organization). Although more research is needed to consolidate these findings, this research suggests that these situations are detrimental to the integration of knowledge in a broader way.

APPENDICES

Appendix 1: List of Articles included in the Systematic Literature Review (Chapter Two)

1. Allen, T. J., Gloor, P. A., Colladon, A. F., Woerner, S. L., & Raz, O. (2016). The power of reciprocal knowledge sharing relationships for startup success. *Journal of Small Business and Enterprise Development*, 23(3), 636-651. <https://doi.org/10.1108/jsbed-08-2015-0110>
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Appendix 2: Examples of Coding Rationale included in the Qualitative Study (Chapter Three)

Excerpt from Interview (open coding)	1 st Order Concepts	2 nd Order Themes
- “There are multiple firms who do what I do, but they don't do what I do in the regions that I operate”. - “And then what I realised is I got more senior in the profession is that the real gap for computational techniques is in the early design phase”. - “The team and the lead architect who was the co-founder of the business, saw that there are a few technical components that needed to be created before blockchain could be adopted for real-world scenarios”.	Identification of Market's Knowledge Gap	
- “It was initially my co-founder's idea; he saw another product similar to ours in another office and basically thought that would be great”. - “The initial idea came about from looking at new research projects because there's a lot of research at (university)- it's research that isn't tapped into or exploited in any way”.	Identification of Opportunity to Exploit Existing Knowledge	Knowledge Opportunity Awareness
- “I have a significant advantage because I've done this for eight years where while others are actually starting to play around, they are just still tinkering in the laboratories”. - “The nice thing about the area where I applied that client-facing design stuff is it's a very low computational skill area, very few people actually have technical skills”. - “You look for something where you have some skills and give you a competitive advantage in that place”.	Identification of Knowledge Advantage	
- “The first thing I did is I wrote a book because I thought, OK, that will make me really consolidate what I know and kind of make sense of it”. - “I have a maths degree, and this is software that is used for something that's called generative design or computational design, where you create algorithms that create shapes”. - “I had three co-founders early. So, two of my brothers they are the technical co-founders, they actually do the programming”. - “We are in different industries; myself being marketing and business and himself being website and app design, where we could really come together and come up with something”. - “We (co-founders) don't have any well enough technical experience and coding to build a website from scratch”.	Perception of Founder's Specialised Knowledge	Founder's Knowledge Awareness

Excerpt from Interview (open coding)	1 st Order Concepts	2 nd Order Themes
- “I'm tech heavy, but not super into AI, I have done some and stuff, but I wouldn't trust myself to program it”.		
- “I have 11 years of work experience before I turn an entrepreneur. I have work for large groups, I have work for small groups, so there are lots of things that I have learnt on the job”. - “It was obviously an industry that we both had knowledge of, was just about honing that knowledge and building on it”. - “In my previous role, I was working at a startup for four years (...) and so I saw how a startup was built. Also, I do have generalist skills, I've done everything from marketing, sales, operations, product management”. - I've actually founded or co-founded seven businesses and managed to exit two previously successful”.	Perception of Founder's General Knowledge	
- “Generally, we wouldn't employ anyone that didn't know something more than us in some area”. - “Even our designers are quite technical”. - “In the past, when we've brought on new people, it's always been with something specific in mind. So, for example, with our software engineers, it was obvious because we created software engineering, but then also with the two interns, we've got one of them as a business intern”.	Perception of Employee's Knowledge	
- “A lot of the work is documented and saved in spots that are reasonably intuitive”. - I think the key problem is that the information in Google Drive is not particularly organised at the moment. It is certainly not well organised”. - “I think the way it's been laid out, it's pretty straightforward in terms of information, but being able to understand what needs to be done, that requires a bit more time and intuition”. - “Anyone that's an expert in those either industry, they would have the ability to pick up our platform”. - “We have, a sales management tool that we use. But it's not up to date or it's not as up to date as it should be”. - “I don't think we have documented any of how we operate or how we manage the team or anything like that”.	Perception of Knowledge Systems	Venture's Knowledge Awareness

Excerpt from Interview (open coding)	1 st Order Concepts	2 nd Order Themes
- “There is a lot of things of unlearn and relearn in certain areas that we have improved and certain areas where there is still room for improvement”. - “I think we're probably not really at that stage where we are particularly excellent at delivering value or are excellent at acquiring customers. We are not, I don't think we're there yet”. - “We try to find different ways to innovate all the time so that we were perpetually moving forward, having greater competitive advantage and also making it harder for any potential competitors to copy us so that the business has a little bit more longevity”. - Positive perception knowledge systems: - Our systems are: “easy”, “intuitive”, “organised”, or expressed confidence that their systems were sufficiently updated and contained all the information needed to support the business operations. - Negative perception knowledge systems: - Our systems are: “overwhelming”, “disorganised”, “not up to date”, or lacking important information such as key stakeholder’s contact details.	Perception of Venture’s Knowledge	
- “You do wear multiple hats”. - “Things change every day”. - “There really isn't any structure to how you do things”.	Flexibility	
- “People access the things that they need, to do the work that they run”. - “I share with them everything that is relevant to their position”. - “I do spend some time tracking the right information they need to know”. - “That's all they really need access to”. - “I provide them everything they need to do that job”. - Justifications: - “It would be overwhelming to give them everything”. - “We don't want to over-clutter everyone's workspace”. - “Rather helping this person to slowly settling and soaking information in a part-by-part basis”. - “Sometimes they (employees) need more than what I anticipated. And so, in that case, if they can't find it online or then I'll go and add whatever they request”. - “Probably 80 per cent of the meetings are one on one meetings rather than everyone in the room”.	Knowledge Distribution	Organisational Knowledge Enablers

Excerpt from Interview (open coding)	1 st Order Concepts	2 nd Order Themes
- “We save every document and a share them in SharePoint, so everything's in there. And if it doesn't exist in SharePoint, it doesn't exist”.		
- “I currently don't work expecting that someone will replace me at any stage”.		
- “I'm the only one that can access everything”.		
- “It would be difficult for a new team to come in and manage because it's all up in the head”.	High Knowledge Dependency	
- “I think a lot of it was just inside and we hadn't really put that out yet”.		
- “Marketing would basically disappear because that's just what I do. So, if I'm not there, then there's no marketing”.		
- “They'd probably be able to pick up my job”.		
- “If we vanish, I don't think it would be that big of a deal”.		
- “I had to figure out a way that other people can do what I'm doing”.	Low Knowledge Dependency	
- “I went through a whole process of basically documenting everything in my brain so that someone could replace me”.		
- “I think a lot of the innovation that comes from (The Founder)’ ideas come from observing what could work well in the community”.		
- “Currently just my co-founder and I have been through that process”.		
- “The deep innovation job is hard so... And that's my job, basically”.	High Innovation Dependency	Firm’s dependency on the founder
- “If I've come up with the problem, I would probably start that process myself just to think through the process. And then I would go and bounce it off the others”.		
- “If we say something that needs to be changed, it's basically an internal dialogue between my co-founder and me”.		
- “I'd say between the seven of us, he (founder) comes up with 50 per cent, then the rest of us together come up with another 50 per cent of ideas”.	Low Innovation Dependency	
- “If there is a problem, we speak about the problem, we raise it up internally and then if we can't solve it internally”.		
- “I have an advisory board that meets with me every six weeks, and when I have a wall or dead end or something, I throw it to them”.	Externally Moderated Innovation Dependency	
- “We really rely on those guys (advisors) for experience. A lot of them have over 10 to 15 years in their specific field”.		

Excerpt from Interview (open coding)	1 st Order Concepts	2 nd Order Themes
- “We do very few deliveries for clients who we think give us really cool insights into what's happening in the market. And, we had ventured into creating new products, depending on market demand or investor requests”.		

Appendix 3: Questionnaire items included in quantitative study (Chapter Four)

Variables	Items	Source
Knowledge Awareness	(1) Our venture was created by identifying a relevant knowledge gap in the market (2) Our venture was created by identifying an opportunity to exploit existing knowledge (3) Our venture was created by realizing that we had knowledge that could be advantageous in a specific market (4) Our venture's founders have relevant technical knowledge (5) Our venture's founders have relevant managerial or entrepreneurial knowledge (6) Our venture's employees have highly technical knowledge (7) Our venture has specific knowledge that is unique compared to our competitors	Self-developed based on data collected through interviews (See Chapter Three)
Firm's dependence on the Founder	(1) There are general areas in which the venture fully relies on the founder(s)' knowledge (i.e: contacts) (2) There are specific areas in which the venture fully relies on the founder(s)' skills (3) Innovation is carried upon the founder(s)' ideas (4) The founder(s) have a primary role in innovation	Adapted from Skinner and Guiltinan (1986) based on data collected through interviews (See Chapter Three)
Systematic Knowledge Integration	(1) We create new knowledge that is tangible such as but not limited to: Intellectual Property (IP), prototypes, organizational content, or scientific articles. (2) We document and store new knowledge in our databases which are up to date. (3) We have developed routines to coordinate tasks. (4) We use templates to structure knowledge or information.	Adapted from Runping Guo et al. (2019) based on data collected through interviews (See Chapter Three)
Coordinated Knowledge Integration	(1) We value and encourage knowledge share among our members (2) We transfer knowledge from more experienced to less experienced members, including the induction process (3) We learn new skills together (4) We maintain frequent and fluent communication across the entire team (5) We work collaboratively	
Innovation	(1) Number of new-to-the-market products or services introduced in the last 12 months (2) Number of in-development new products or services during the last 12 months	"Oslo manual 2018: guidelines for collecting, reporting and using data on innovation" 2018)

Firm Age	(1) Number of years of operation	
Firm Size	(1) Number of full-time employees including founders	
Firm Performance	(1) Overall Performance (2) Sales Growth (3) Market Share growth (4) Profit growth (5) Produce/service quality (6) Customer satisfaction	Wiklund and Shepherd (2003) Santoro et al. (2019)

Appendix 4: Supplementary tables on testing of control variables (Chapter Four)

Figure 1 illustrates the distribution of the control variable Firm Size in relation to the direct variable Innovation. As most of the firms correspond to small firms, where 71.1% have less than 10 employees, the scatter plot does not provide sufficient support to examine the correlation between the variables. Thus, we proceeded to log-linearize the variable Firm Size with the aim of examining a potential correlation based on percentages rather than on categorical data. Consequently, Figure 2 illustrates the distribution of the log of Firm Size ($\ln$ Firm Size) in relation to Innovation. While the scatter plot depicts an improved picture of the correlation between these variables, a strong correlation is not supported. Table 1 summarizes the correlation values for both cases.

Figure 1: Scatter plot showing distribution of Firm Size and Innovation

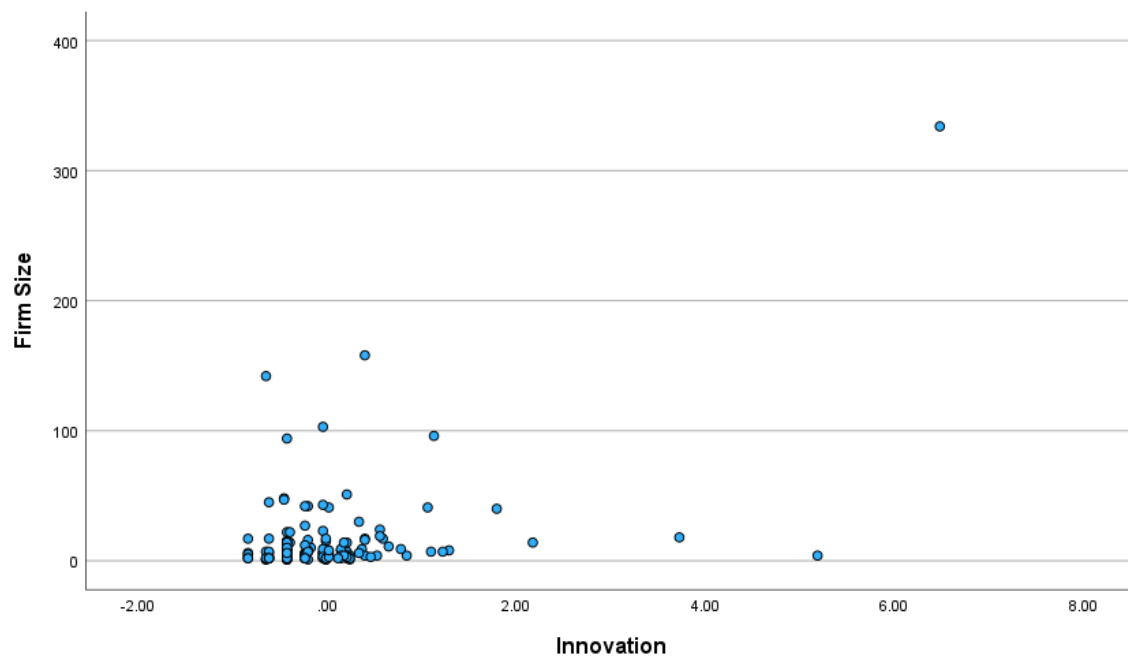


Figure 2: Scatter plot showing distribution of Firm Size (Log Linearized) and Innovation

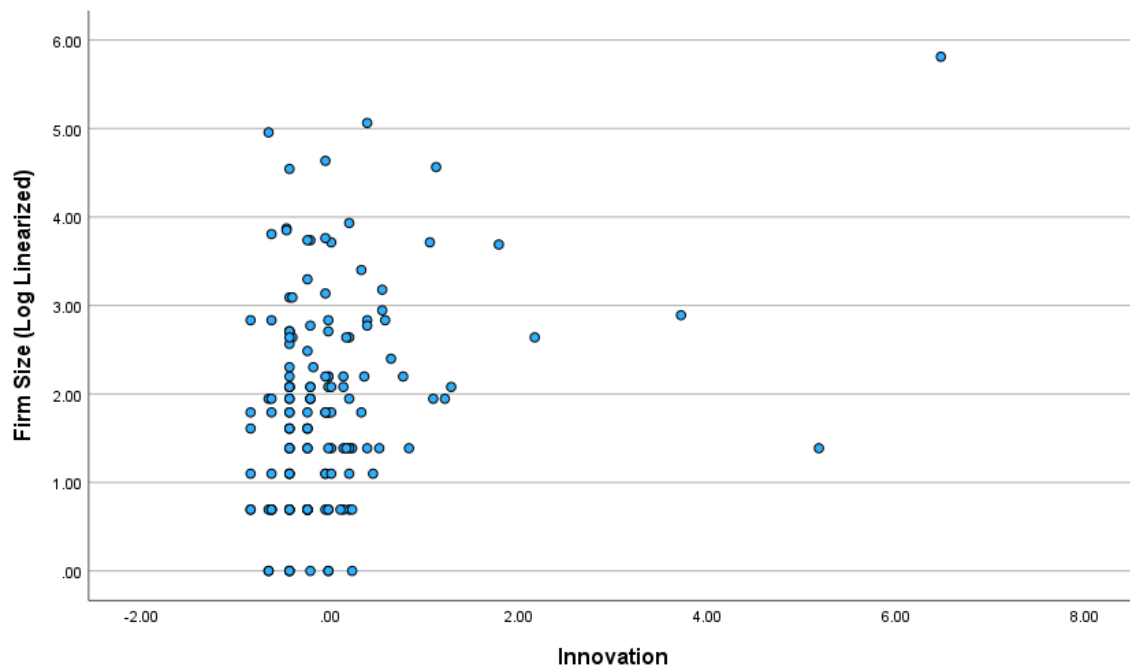


Table 1: Correlations

		1	2	3
1	Firm Size	1.000		
2	ln Firm Size	0.704**	1.000	
3	Innovation	0.489**	0.296**	1.000

**, Correlation is significant at the 0.01 level (2-tailed).

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December 5th, 2023

Associate Professor Stefan Meisiek

Chair of Examination Committee

Discipline of Strategy, Innovation and Entrepreneurship (SIE)

University of Sydney Business School

Dear Assoc. Professor Stefan Meisiek,

Thank you for taking the time to oversee the examination process of my doctoral dissertation titled “Knowledge Integration and Entrepreneurial Innovation, a multimethod approach” submitted on June 30th, 2023. I have carefully read and discussed with my supervisor the examiner’s reports, and consequently, prepared a revised document considering the corrections recommended by the second examiner. In the following, please find a summary of how I have addressed these concerns point by point.

CHAPTER 2

Comment 1 (p.24)

You found “793 studies including journal articles, conference proceedings, and book sections” and subsequently, 85 articles, 3 book sections, and 7 conference papers were retained. It is unusual I think to include conference proceedings or book sections since these are typically not (stringently) peer-reviewed and are excluded by most literature reviews. This may impart a bias in your findings – for example, an approach or a construct definition used by many in conference papers or books but rarely found in peer-reviewed papers may be less useful (or reliable) in a summary of the literature, and they would almost certainly be cited less frequently (not being found in the more credible journals). Maybe add a sentence or a footnote justifying the use of these sources. And maybe also delete the (misleading) 2022 citation data (truncated) from Figure 3 since newer papers take a few years to be cited after they are in print.

Response:

Following the suggestions made by the examiner, I have added a line explaining the rationale of this decision in the Method Section, Identification of Articles (3.1, p.24): “With the aim of conducting an unbiased search as recommended by Tranfield, Denyer, and Smart (2003, p. 215), we included unpublished studies such as Conference proceedings and book chapters”. In addition, I have added a footnote with the following quote on recommendations for systematic literature review searches: “*Searches should not*

only be conducted in published journals and listed in bibliographic databases but also comprise unpublished studies, conference proceedings, industry trials, the Internet and even personal requests to known investigators (Tranfield et al., 2003, p. 215)."

Regarding the concern about Figure 3, this has been deleted following the examiner's suggestion.

Comment 2 (p.29)

Patents in Table 3 refer to "or other forms of intellectual property created or acquired" and thus imply trademarks, registered designs, and copyrights (which likely outnumber the patents gained and distort intra-sample relativities). Please clarify if these other forms are indeed included.

Response:

In agreement with the examiner's comment, I have added the following clarification in Table 3, Patents: "Patents refer to rights to commercially exploit inventions or other forms of intellectual property created or acquired by individuals or organizations, which have formally completed a patenting awarding process. Thus, this excludes trademarks, registered designs, and copyrights unless these have formally obtained an invention patent."

Comment 3 (p.34, now p.33)

You say HC and SC are treated "as assets rather than repositories of knowledge" (emphasis added) – do you mean static constructs rather than dynamic constructs? Knowledge is similar to other assets that earn interest or appreciate (and grow over time).

Response:

Acknowledging the confusion generated by the use of the term "asset", which from an economic perspective can indeed imply a value change over time, I have reworded this sentence to: "Although both human and social capital can continue changing and growing post-entry, we found that a prevailing view portrays them *as inputs rather than outputs of knowledge*."

Comment 4 (p.31)

In Figure 4, the thick vs. thin lines represent themes that are "more predominant" vs. "less examined areas" of the literature. Can you indicate what absolute number or percentage of sample numbers these terms reflect? Without these, it remains mysterious.

Response:

In agreement with this important suggestion, I have updated Figure 4 with the number of studies corresponding to each relationship illustrated in the model. In addition, I have added some clarification to the paragraph describing the model in section 4.4 Review Map, on page 39, by including in parenthesis that “more predominant research” corresponds to five or more studies, whereas “less predominant research” corresponds to four or less studies identified.

Comment 5 (several pages)

I see that you do not list Cohen, W. M., & Levinthal, D. A. (1990). Absorptive capacity: A new perspective on learning and innovation. *Administrative Science Quarterly*, 128-152. As a reference – I would have thought their “absorptive capacity” construct would be relevant here, notwithstanding that your search terms excluded retrieval of that paper. I feel that publication of your literature survey will require your acknowledgement of that seminal paper as well as a few others more recent in that stream of the broader management literature.

On p.44 you say “It is surprising that knowledge retention has not been studied in the entrepreneurship literature on knowledge and innovation” but I note that there are many papers that examine absorptive capacity in the context of entrepreneurship, such as

- Patel, P. C., Kohtamäki, M., Parida, V., & Wincent, J. (2015). Entrepreneurial orientation-as-experimentation and firm performance: The enabling role of absorptive capacity. *Strategic Management Journal*, 36(11), 1739-1749.
- Qian, H., & Acs, Z. J. (2013). An absorptive capacity theory of knowledge spillover entrepreneurship. *Small Business Economics*, 40, 185-197.
- Zahra, S. A., Filatotchev, I., & Wright, M. (2009). How do threshold firms sustain corporate entrepreneurship? The role of boards and absorptive capacity. *Journal of Business Venturing*, 24(3), 248-260.

It seems that your exclusion of studies in the corporate entrepreneurship realm (p.25) has led to your exclusion of these other studies, which I believe is problematic for publishing your Literature Survey paper. A new venture with a top management team soon morphs from entrepreneurial knowledge management to team (collective) knowledge management and one wonders where the boundary is between individual and corporate entrepreneurship. I think you will need a few sentences explaining why you do not mention absorptive capacity, or at least say that construct is associated with large corporate business firms where management turnover requires retention of knowledge that would otherwise be lost, and your focus is on the individual entrepreneur and how they share and build (etc) knowledge that is instrumental for

innovation by small entrepreneurial ventures. (That is, rule it “out of court” to use a tennis analogy).

Response:

While the capabilities perspective is not explicitly excluded from this review, I have added clarification on this point in section 2. *A process perspective of knowledge: sources, processes, repositories, and outcomes.* page 21:

“A key challenge to synthesizing the knowledge–innovation link from a process perspective is the inclusion of different knowledge conceptualizations without generating theoretical overlaps. An important consideration to this aim is the differentiation between the knowledge perspective (Grant, 1996) and the capabilities perspective (Teece et al., 1997). While both views underscore knowledge as a key resource for firm success and innovation, a capability perspective emphasizes what firms can do with knowledge, which is not the specific focus of this review. In contrast, as we aim to examine the empirical evidence of knowledge as a driver of innovation, we do not explicitly seek literature drawing on dynamic capabilities such as absorptive capacity (Cohen & Levinthal, 1990). Furthermore, the dynamic capabilities perspective in the context of entrepreneurship has been examined in seminal reviews (Zahra et al., 2006b). Nevertheless, this consideration does not exclude articles drawing from different theoretical approaches, including the capabilities perspective.”

CHAPTER 3

Comment 1

“Enablers” are a hot topics since Per Davidsson’s 2015 JBV paper, so this paper really should cite that paper to orient the reader’s thinking along those lines – enabler is a term now defined into the literature.

Response: While I find this comment valuable and worth consideration if pursuing further publication steps, in this chapter the term “enabler” has been used as a synonym of “facilitator” to knowledge integration. Furthermore, “enabler” has been used in opposition to the term “barrier” which represents an obstacle to knowledge integration.

Contrasting this aim, the suggestion made by the examiner refers to the studies drawing on the concept of “External Enablers” developed by Per Davidsson (Davidsson, 2015; Kimjeon & Davidsson, 2022) which are defined as “the aggregate-level circumstances—such as regulatory changes, technological breakthroughs, and demographic shifts—which may affect a variety of new venture creation attempts by several, different actors”

(Davidsson, 2015, p. 675). Given the nature of this conceptualization, which focuses on environmental conditions affecting opportunity identification and outcomes in entrepreneurship, I find that citing this paper could be misleading as it may mistakenly shift the attention to a completely different stream of the literature. For that reason and after careful consideration, I opted to abstain from including this citation.

Comment 2

p.71: Section 4.3 looks at the firm's dependence on the Founders. Here you are essentially channelling upper-echelon theory (UET), so an acknowledgement of that literature is necessary. You should perhaps also set a boundary condition for this paper (based on UET) to avoid readers and reviewers "straying" into the absorptive capacity literature. OR are your founder-driven organisations (type) exhibiting "upper echelons theory" whereby the founder tends to impose their personal preferences on the firm's strategy. I think UET might be relevant for that type of knowledge management where the founder does not share with others. If so, you must say so, or explain why not, since that type of entrepreneur overlaps somewhat with UET. Indeed, your study may add a new facet to the UET and knowledge management (KM) literatures. See e.g.

- Hambrick, D. C. (2007). Upper echelons theory: An update. *Academy of management review*, 32(2), 334-343.
- Abatecola, G., & Cristofaro, M. (2020). Hambrick and Mason's "Upper Echelons Theory": evolution and open avenues. *Journal of Management History*, 26(1), 116-136.
- Neely Jr, B. H., Lovelace, J. B., Cowen, A. P., & Hiller, N. J. (2020). Metacritiques of upper echelons theory: Verdicts and recommendations for future research. *Journal of Management*, 46(6), 1029-1062.
- Liu, X., Zhang, L., Gupta, A., Zheng, X., & Wu, C. (2022). Upper echelons and intra-organizational learning: How executive narcissism affects knowledge transfer among business units. *Strategic Management Journal*, 43(11), 2351-2381.

Response: While I find this suggestion relevant to further elaborate on the findings and implications of this study, I think that more data would be needed to justify the application of the Upper Echelons Theory (Hambrick, 2007). For example, to examine the relationship between the personal characteristics of founders (including values, background, experiences, etc.) and strategic outcomes, individual-level data on the founders' backgrounds would be needed. In contrast, this study examines integration mechanisms and corresponding outcomes, one of which is venture archetypes with varying levels of dependence on their founders. Considering that the Upper Echelons Theory could

potentially be a fruitful avenue to understand these differences, I have added a paragraph in the discussions section referring to venture archetypes (Section 5.3. p.78).:

“(…) In addition to the above, the variations in knowledge integration reflected in different types of firms could be further investigated through the lens of upper echelons theory (Hambrick, 2007). This theoretical perspective can be especially relevant to the understanding of founder-driven ventures, where the influence of the entrepreneur on the decisions regarding the management of knowledge is considerable. While more research is needed to establish how the background, values, cognitive biases, and other individual characteristics can influence strategic decisions regarding the integration of knowledge in ventures, our findings suggest that founder-driven ventures are more vulnerable organisational structures as their actions and outcomes can be highly tied to the perceptions and decisions of their founders.”

CHAPTER 4

Comment 1

For a published research paper the Introduction to this chapter may need a more explicit (yet brief) series of paragraphs focusing on (i) what is the research issue; (ii) what others have said (prior literature) ; (iii) what has not been said (the gap in the existing theory); (iv) Why is it important to fill that gap?; (v) What will this paper do to fill the gap (sample, measures and method); (vi) what theoretical and/or empirical contributions will this paper make? (See Shepherd, D. A., & Wiklund, J. (2020). Simple rules, templates, and heuristics! An attempt to deconstruct the craft of writing an entrepreneurship paper. *Entrepreneurship Theory and Practice*, 44(3), 371-390.) While your Introduction does address these points, reviewers will want to see them stated more strongly to overcome their hurdle of “why am I reading this paper?”

Response:

This is a very valuable comment that made me re-read the introduction of this Chapter in a more critical way. Because this chapter is embedded in a larger document, I may have mistakenly left aside the concepts that had been introduced or developed in previous sections to avoid overlaps or duplications of concepts and arguments. Considering that this comment is aimed at improving the paper’s clarity for future journal submissions, I have briefly corrected the structure of the paper, following the recommended guideline. By doing so, I have aimed at increasing the clarity of the writing, for example by including the purpose of the paper at a much earlier stage.

Keeping this comment in mind, I will continue to improve this paper in following stages to increase the likelihood of publication. Moreover, I think this is a good blueprint to apply to the writing of future articles.

Comment 2

I like the early placement of the Figure demonstrating the DV, IVs, and the Hs with the focus then on each of the variables. I did wonder if the DV should be covered first, then moving left to SKI and CKI, and then to the antecedent's FDE and KA, in each case defining the construct and theorizing why the DVs (mediators) and antecedents are causal.

Response: This is a valuable suggestion to consider further in following publication steps. Since the DV (innovation) was covered within the first section (knowledge integration mechanisms) but not acknowledged in the section title, I have opted for adding the words "and innovation" to the title section 2.1 in page 84. This section elaborates on the relationship between knowledge integration mechanisms and innovation which is key to understand the key assumptions of the model.

Comment 3

Top journals will expect self-developed scales to be validated in the development process. It is not mentioned explicitly if or how you validated your KA scale. For a journal publication you will need a strong statement arguing that these scales are reliable and actually measure the construct intended. Why not show the Cronbach alpha and composite reliability date for this variable at the time you introduce it. One wonders if any of the seven questions were dropped to low loadings?

Response:

Acknowledging that this issue required further clarification I have added a paragraph at the beginning of section 3.3 Analysis, Measurement Validation, in reference to the assessment of formative measures. As such, I have explained that formative measures differ from reflective ones as formative measures are built upon the aggregation of dimensions and sub-dimensions, whereas reflective measures convey constructs that are affected by changes in their dimensions and sub-dimensions. Consequently, where formative measures need the inclusion of all dimensions to accurately represent the construct, reflective measures require specific levels of consistency and reliability across their dimensions, which is demonstrated through a measurement validation process. As a result, existing methodological approaches underscore that reliability

measures such as Cronbach Alpha are not applicable to formative measures (George, 2011; Kenneth, 1989).

Comment 4

The measure for the DV is not clear here, maybe it is clarified in the Appendix but needs to be clear here, as reviewers will not dig for the answers to basic questions.

Response: Assuming this comment was referring to the initial description of the dependent variable (DV) in the section 3.2 Measures (Page 91), I have added clarification to this sentence as follows:

“As a dependent variable, we examined (6) firm innovation, through an index measure composed by the number of new products and services successfully introduced in the market over the last 12 months, and the number of products and services in development over the last 12 months.”

Also note, that a detailed description of all measures is included in Table 11: Overview of Variables and in Appendix 3: Questionnaire items included in quantitative study.

Comment 5

Why not use firm size (employees) as a continuous variable? Skew, I imagine. Why not log linearize that data? The binary variable of >20 employees (or not) seem like an arbitrary division which loses information that may allow greater explained variance.

Response:

This suggestion is relevant and worth of consideration as it fostered me to try an alternative way to test a control variable (Firm Size). After some initial examinations and additional tests of this variable (for example, by conducting the correlation test using the categorical data), I took on the suggestion of the examiner and proceeded to log-linearize this variable. While, this action allows a better understanding of the relationship between Firm Size and Innovation, the outcome remains the same, as no significant correlation can be supported. Furthermore, the distribution of the data regarding the size of firms follows a not-normal distribution which is demonstrated by the tests conducted (scatter plots and correlation matrix). Nonetheless, I agree with the examiner that a better way to incorporate this variable in the study and paper is as a Log of Firm size and not as a dummy variable as included in the original version of this dissertation. As a result of this, I have made the following corrections to this chapter:

- Modify the section 3.2 “Control Variables” describing the way the variable has been captured and the reasons why this is the best option.

- Corrected Table 14: Correlations with the new values corresponding to the amended variable.
- Corrected the section 3.4 “Results”
- Added an Appendix: 4 with supplementary graphs and table on the testing of Firm Size as a control variable.

Overall, although this change does not alter the results of the study, nor changes the implications of firm size to the observed variables examined, the treatment of the variable has been improved and with that, the whole study described in this chapter.

Comment 6

p.93: Self-rated performance across six items – how was that measured? Average on a Likert scale of 5, 7 or what? This should be stated explicitly here.

Response: The following words were added in page 93: “(...) using a five-point Likert scale from “much lower” (1) to “much higher” (5).

Comment 7

p.93: Your argument for using SEM is implicitly limited to other correlational methods such as stepwise multiple regression. Agreed, but SEM utilizes sample average data and necessarily suppresses case level data, and thereby loses fine-grained information that may lead to better theory to explain why particular (types of) firms do or don’t innovate (see Douglas, E. J., Shepherd, D. A., & Prentice, C. (2020). Using fuzzy-set qualitative comparative analysis for a finer-grained understanding of entrepreneurship. *Journal of Business Venturing*, 35(1), 105970.). Your data is amenable to the fsQCA method, so before submitting this paper to a top journal you might consider using that method and contrasting it with the SEM results to see exactly what finer-grained detail is revealed by the fsQCA method (to make the paper more publishable). For example, the insignificant impact of CKI and Innovation is at the mean level of CKI but for those cases with high values for CKI it might be causal for Innovation (but these are outnumbered by those with lesser CKI scores).

Response: This is an excellent suggestion that can be tested in following steps. Considering this comment, I have added a paragraph in the limitation’s section in page 104:

Lastly, we acknowledge the limitations stemming from our sample size (n=149). While our study follows the recommendations for sample size and number-of-cases-per-variable-ratio (Kline, 2015), a larger sample may improve the robustness of the results (Stage et al., 2004). *“Moreover, we acknowledge the limitations of the statistical method*

employed (SEM) which may overlook case-level data. In that regard, we encourage the use of alternative analytical approaches that can assess these results at a finer grain”.

Comment 8

p.97: “These results suggest a deficient fit overall” (?) I assume this is a mistake and you mean “sufficient”(?).

Response: I have provided further clarification to this sentence (now in page 98). The initial wording was correct, as Model 1 showcased some indices below the recommended values which motivated the testing of a second model (Model 2).

Comment 9

p.101: You say “our study underscores a seemingly overlooked path to innovation: the role of knowledge awareness in knowledge systematization to achieve innovation. our study suggests that these processes alone cannot grant the attainment of innovation in small and young firms.” This statement is limited to the silent caveats of “on average” and “using linear-additive independent variables considered discretely”- see Douglas et al. (2020). Explaining innovation by combinations of causal variables acting interdependently – i.e., the configurational approach – would likely identify that there are multiple equifinal pathways for individual firms to achieve the focal outcome. Your post-hoc analysis seems to confirm this possibility. You might soften your conclusion by saying “relatively to previous studies in this area” or even include as a limitation that your study limited by the requirements of the correlation method.

Response: Agreed and included “relatively to previous studies in this area” in Section 4. Discussion, page 101.

Comment 10

p.103: Under limitations, first point – I would simply say “Because our study focused on very small firms (70% have 10 employees or less) and explicitly excluded corporate entrepreneurship, our results must be interpreted carefully when examining large or very large firms” (and leave it at that).

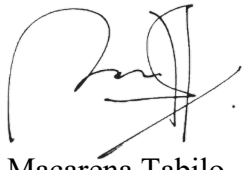
Response: Noted and corrected by including the examiner’s suggestion (now in page 104).

SMALL ISSUES FOR CORRECTION

1. p.17: You say “summarized in the table below.” – do you mean the earlier Figure 1 (on p.12) or the later Table 1, in the next chapter (on p.23)?
Response: Noted and corrected by eliminating the sentence, as the Table was previously removed.
2. p.20: “or have focused on processes in specific (Lumpkin & Lichtenstein, 2005; Zahra et al., 2006), we” – is there a word missing. such as “areas”?
Response: Noted and corrected by rearranging the sentence to: “or have focused specifically on processes”.
3. Some instances of unnecessary commas after a word in a sentence e.g., “is, the” (p.21); Although, (p.33)
Response: Noted and corrected by removing commas.
4. p.55: “grounded theory aim at generalisation”. “aim” should be “aimed”.
Response: Noted and changed.
5. p.72: you say “spread-out innovation” the meaning of which is not so clear – does it mean “disseminated” (knowledge shared with others) or does it mean “diversified” innovation across multiple new products), or something else. Please clarify.
6. Response: Noted and changed the word “spread-out” to “disseminated”: (...) “this may not translate into disseminated innovation resulting from collaboration among members”.
7. p.88 you use “European” style “2.088 ventures” which should be “2,088 ventures” for this paper where North American readers will be unimpressed by the Euro style.
Response: Noted and changed to “2,088”.
8. p.90: (1) the conduction of a preliminary study – “conduction” should be “conduct”.
Response: Noted and changed.

Lastly, I would like to emphasize that the comments discussed above have been valuable and taken as an opportunity to improve and strengthen the submitted dissertation. Thus, I appreciate the suggestions that have been aimed at improving the likelihood of publishing the doctoral dissertation results in peer-review journals. Further, I hope my responses above are providing sufficient clarification on the issues raised by the examiner.

With Kind Regards,



Macarena Tabilo

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December 7th, 2023

Ph.D. Examination Committee

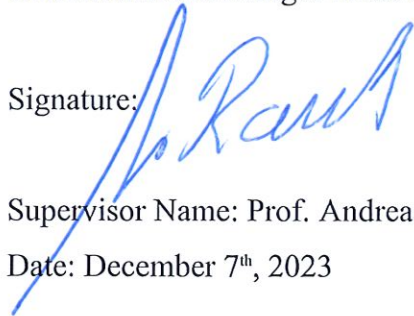
Discipline of Strategy, Innovation and Entrepreneurship (SIE)

University of Sydney Business School

STATEMENT

As the primary supervisor for the candidature upon which this thesis is based, I hereby confirm that the changes made to this document have been done to my satisfaction.

Signature:



Supervisor Name: Prof. Andreas Rauch

Date: December 7th, 2023

**KNOWLEDGE INTEGRATION AND ENTREPRENEURIAL INNOVATION,
A MULTIMETHOD APPROACH**

Thesis submitted in partial fulfillment of requirements for the degree of

Doctor of Philosophy

Author: Macarena Tabilo

The University of Sydney Business School

Discipline of Strategy Innovation and Entrepreneurship

Supervised by:

Professor Andreas Rauch

Associate Professor Massimo Garbuio

STATEMENT OF ORIGINALITY

I certify that the intellectual content of this thesis is the product of my own work and that all the assistance received in preparing this thesis and sources have been acknowledged. This thesis has not been submitted for any degree or other purposes.

Name : Macarena Tabilo

Date : December 5th, 2023

Signature:

PUBLICATIONS RELATED TO THE THESIS

The following sections draw on content presented or close to being presented at conferences, submitted, or close to being submitted to peer-reviewed journals. In all research outputs, I designed the study, collected, and analysed the data, and wrote the manuscript. Co-authors acted as mentors, orienting me throughout the theorizing process and helping me with the content and flow of my argumentations. Authorship is by order of contribution.

CHAPTER TWO (SYSTEMATIC LITERATURE REVIEW)

Preliminary versions of this article were presented in the following instances or included in the following publications:

Tabilo, M. & Rauch, A. (2021). *Organizing knowledge in the entrepreneurial firm: A systematic literature review* [Paper presentation]. Australian Centre for Entrepreneurship Research Conference ACERE 2021.

Tabilo, M. & Rauch, A. (2022). *Missing Links in knowledge-based entrepreneurship and innovation research: A review, a model, and agenda*. Manuscript submitted for review at the Journal of Business Venturing (JBV) in September 2022 and to the Journal of Management Studies (JMS) in December 2022.

CHAPTER THREE (QUALITATIVE STUDY)

Preliminary versions of this article were presented in the following instances or included in the following publications:

Tabilo, M. (2021). *An Understanding of Knowledge Integration in Ventures*. Australian and New Zealand Marketing Academy Conference ANZMAC 2021: something different. Conference proceedings. 29th November - 1st December 2021.

Tabilo, M. & Rauch, A. (2022). *An Understanding of Knowledge Integration in Ventures*. Frontiers of Entrepreneurship Research BCERC Proceedings 2022, Babson College Entrepreneurship Research Conference BCERC 2022.

Tabilo, M. & Rauch, A. (2022). *Enablers and Barriers of knowledge integration in new firms: four emerging archetypes*. Manuscript submitted for review at the Journal of Business Venturing (JBV) in January 2021 and to the Journal of Knowledge Management in December 2022.

CHAPTER FOUR (QUANTITATIVE STUDY)

Preliminary versions of this article were presented in the following instances or included in the following publications:

Tabilo, M. & Rauch, A. (2023). *The Innovative New Firm? An Exploration of Antecedents and Consequences of Knowledge Integration Mechanisms in Australian Ventures.* [Paper presentation]. Australian Centre for Entrepreneurship Research Conference ACERE 2023.

I hereby confirm that I received confirmation to include the published material by the corresponding authors. I further certify that this thesis has not been submitted for any degree or other purposes. The intellectual content of this thesis is the product of my own work. All assistance received in preparing this thesis and sources has been acknowledged.

Signature:

Doctoral Candidate: Macarena Tabilo

Date: December 5th, 2023

As the primary supervisor for the candidature upon which this thesis is based, I can confirm that the authorship attribution statements above are correct.

Signature:

Supervisor name: Prof. Andreas Rauch

Date: December 5th, 2023

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I am incredibly grateful to all the people who made this effort possible and contributed to the completion of this dissertation in different ways. First and foremost, thanks to my star supervisor Professor Andreas Rauch, for the countless meetings, paper reviews, advice, support, encouragement, and friendly conversations from which I learned so much. To my co-supervisors Professor Stephen Zhang and Associate Professor Massimo Garbuio who were always available to provide invaluable support. Thanks to the Strategy, Entrepreneurship, and Innovation discipline (SIE) of the University of Sydney Business School for welcoming me into the group in 2019 and offering ongoing support and encouragement. Especially important for me was the scholarship granted which I accepted humbly and with a personal resolution to make the most of this opportunity. To Professors Leanne Cutcher and David Oliver who provided guidance and assistance several times throughout this journey. To Angela O'Brien, Anna Groenendyk, and Ben Breeds, and fellow Ph.D. students, you were always there for me.

Besides my supervisors, I was lucky enough to receive advice from Professor Mirjam Knockaert and Andreas Schwab through friendly reviews which were key to moving my studies forward. Similarly, I was fortunate to participate in ACERE (Australian Conference for Entrepreneurship Research Exchange) every year as well as in BERC (Babson College Entrepreneurship Research Conference) a few times where I met amazing scholars, made friends, and strengthened my ties with the entrepreneurship research community. A separate note should be dedicated to the Australian Centre for Entrepreneurship (ACE) from the Queensland University of Technology (QUT) where I spent some weeks by the end of my candidature. Just watching this group interact and collaborate enthusiastically was an infinite source of motivation and hope in the academic work as I move forward on this path. Thanks to the journal editors and conference reviewers who provided feedback and thanks to my participants for sharing insights and data that were critical for the studies. Lastly, thanks to my colleagues at the Business Discipline of Federation University Australia. You have supported this work by sharing your experience and resilience at trying times in the post-pandemic educational sector.

On the personal front, I have an amazing family and group of friends to be grateful for. A special recognition to my husband and daughter who gave me the time and space to develop this work, shared the ups and downs of this journey, and tirelessly motivated me to “finish my book”.

To all of you, infinite thanks.

ABSTRACT

This thesis examines the role of knowledge as a precursor to innovation in the context of entrepreneurial post-entry conditions. Particularly this dissertation aims to clarify how entrepreneurial firms organize knowledge to achieve innovation, including the role of founders in the development of firm knowledge. To do so, this research uses a multimethodological approach, including a systematic literature review, a qualitative and a quantitative study. Besides underscoring the importance of adopting a process perspective to understand knowledge in entrepreneurship, this thesis findings include the identification of novel integration strategies and the factors determining such strategies. Moreover, this thesis provides a refined conceptualization of knowledge integration mechanisms, its founder-related antecedents and relationship with innovation. Consequently, this thesis contributes to a deeper understanding of the relationship between knowledge, entrepreneurship, and innovation in small firms. It offers insights into the role of founders, the integration of knowledge, and the pathways to innovation. By adopting a process perspective and exploring internal dynamics, this research advances the knowledge-based view of the firm and contributes to the broader applicability of knowledge perspectives in entrepreneurship.

Keywords: Entrepreneurship, knowledge, knowledge integration mechanisms, innovation.

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CHAPTER ONE

INTRODUCTION

1. Preface

I started my doctoral journey a few years after I had decided to move away from architecture and gradually transfer my skills to other areas. Back then, I was working as a leading architect at an innovation centre for timber construction, aiming to incorporate university-level research and new technologies into the lagging world of construction by promoting the use of timber in high-rise building projects. In a country like Chile, where seismic activity is a continuous concern and concrete structures are the standard, designing with timber was not only problematic from a regulatory perspective but it was also contended culturally. Developing social housing with community participation often involved adjusting the design to make the houses look *less like made out of timber* and *more like made out of stone*. Finding structural engineers specialized in high-rise timber construction was challenging. Convincing the local councils was a full-time job. And the list goes on. Soon we realized that we had to change the way we took on design briefings by incorporating stakeholders early in the process and start applying what non-designers call *design thinking*. Sharing the design process, taking decisions together, discussing alternatives with our non-designer partners, to name a few. Facilitating those meetings made me realize, for the first time, how natural it was for designers to integrate knowledge and how *unnatural* it could become for some. What I did not know then (or at least was not aware of) is that each person in the room held different pieces of knowledge, like a puzzle that needed to come together to reach a common understanding. Integration was key. Not long after, I was able to apply my observations into broader contexts, as I took a class on *organizational learning* lead by Professor Linda Argote at Carnegie Mellon University. This class introduced me to the world of knowledge management. Then I realized that regardless of size, organisations need to integrate knowledge, leverage the skills and expertise of its members, incorporate new learnings, and reach common understandings, especially when confronted with new challenges such as innovation. But *how* did they do it? (assuming they were not designers, of course!).

Keeping these experiences in mind, this thesis is an attempt to unravel the processes involved in knowledge integration in a learning-intensive context, entrepreneurship. Considering the constraints of the entrepreneurial activity, the question of *how* becomes even more puzzling and new questions emerge such as whether integration is always achieved and

to which implications for innovation. Regarding knowledge, this thesis implicitly advocates for a broader understanding of knowledge in firms, by moving away from theoretical streams that label specific types of firms as knowledge-intensive or examine knowledge in highly technological sectors. Considering knowledge as the outcome of learning (Argote & Miron-Spektor, 2011), every person and every organization capable of learning, can potentially be a holder of knowledge.

2. Motivation

The conceptualization of the relationship between knowledge and innovation in an entrepreneurial context, has involved the distinction between the knowledge acquired before the creation of a new venture such as the human capital of the entrepreneur, and the knowledge developed throughout the entrepreneurial process, such as the experience gained after undergoing critical events (Cope, 2011; Cope & Watts, 2000). Nonetheless, post-entry conditions entail a distinctive complexity whereby knowledge can be developed and stored at the individual level, at the firm level or both. For example, entrepreneurs might choose between keeping their learnings for themselves or sharing them by introducing firm-level improvements. Adding to this complexity, post-entry conditions often involve the management of knowledge across individuals, either inside the firm boundaries or in interaction with external sources (Alexander McKelvie, Wiklund, & Brattström, 2017). Yet, the entrepreneurship literature has predominantly conceptualized knowledge at the level of the entrepreneur prior to the start of the entrepreneurial process.

Firm-level knowledge must be integrated formally or informally to support growth by enabling knowledge application, learning, and innovation (Macpherson & Holt, 2007). Consequently, the integration of knowledge may involve practices oriented toward the dissemination of knowledge beyond individual boundaries to enable its utilization at the organizational level. Accordingly, firm-level knowledge entails both knowledge and knowledge-related practices. Specifically, firm-level knowledge that supports innovation must fulfill a double role by ensuring sufficient flexibility to enable openness and creativity in exploratory phases and providing consistency to leverage expertise in commercial exploitative phases (Cagliano & Spina, 2002). Formally actioned, the management of knowledge involves the identification of relevant knowledge and the implementation of “related processes of creation, organization, diffusion, use, and exploitation (Santoro, Thrassou, Bresciani, & Giudice, 2019)”. Building on these theorizations, this dissertation posits a conceptualization of firm-level knowledge along two dimensions; the knowledge that the ventures possess, and the

practices oriented at knowledge reconfiguration, transfer, and retention. Critical to this proposition is the idea that knowledge is a malleable resource, as it transforms over time (Brown & Duguid, 2001). As pointed out by Barley, Treem, and Kuhn (2017) there are significant differences across knowledge management frameworks as they convey different conceptualizations of knowledge. Accordingly, the distinctive characteristics of entrepreneurial knowledge should encompass a correspondent framework. Since firm-level knowledge requires organization, structuring, or integration to sustain innovation over time, I argue that specific decisions around knowledge must take place to achieve this goal. For example, which forms of knowledge and knowledge processes ensure the attainment of innovation in different entrepreneurial settings? How do entrepreneurs make these choices and to which consequences? Does the sole possession of knowledge and the implementation of processes lead to firm-level knowledge and innovation?

3. Research design and methodology

To address these issues, this thesis has aimed at examining firm-level knowledge in the context of entrepreneurship and its impact on innovation. As the main contribution, this thesis aims to advance the understanding of entrepreneurship knowledge at the firm level. A firm-level conceptualization of knowledge entails the examination of organizational perspectives, as firm-level knowledge needs to be organized and structured to enable firm-level outcomes (Macpherson & Holt, 2007). Given that the entrepreneurial context is characterized by economic and human capital resource scarcity (Rowe, 2001) and high employee rotation (Agarwal, Gambardella, & Olson, 2016); an understanding of post-entry knowledge may help explain differences in ventures' output that are not covered by existing frameworks.

Specifically, the overarching question of this thesis is: *How is knowledge organized in entrepreneurial firms, and what are the effects on the innovation outcome?* The first part, "How is knowledge organized in entrepreneurial ventures?" points at identifying and understanding the ways knowledge is embedded and promoted during the entrepreneurial process, focusing on differences and similarities among firms from different backgrounds. To aim at the identification of novel conceptualizations, this question is addressed through a qualitative study. The second part "(...) what are the effects in the innovation outcome?" aims at measuring the impact of implementing different knowledge approaches for innovation and therefore is tackled through a quantitative study. Underlying these questions, lies the assumption that the way knowledge is organized in entrepreneurial ventures differ from those of established firms, and therefore the concepts may be revised, and the frameworks refined or changed. Yet, to confront

these initial assumptions, I have started this project by investigating existing conceptualizations of knowledge in entrepreneurial settings toward innovation. Therefore, with the aim of clarifying, organizing, and conceptualizing different views of knowledge and its relationship to innovation, this thesis incorporates a systematic literature review. This review seeks to isolate firm-level conceptualizations of knowledge and incorporate views from different theoretical streams.

All in all, this thesis subscribes to a multimethod approach as a comprehensive method. Accordingly, the thesis adheres to the understanding of multimethod research as defined by Bazeley (2006): “Multimethod research is when different approaches or methods are used in parallel or sequence but are not integrated until inferences are being made”. A multiple methodology has been posed as a valuable tool at several levels of the research process, however, this study follows Edmondson and McManus (2007) rationale under the concept of “methodological fit” as a way to achieve consistency between the different components of this dissertation. This perspective highlights the state of prior knowledge around the intended phenomenon of study as a critical determinant of the research strategy selected. In general terms, this framework suggests that in fields where knowledge is in early development, the questions will be more open-ended, and thus the requirement of methods aimed at understanding and elaborating constructs will be needed. Conversely, in fields where knowledge is more robust, questions are more likely to be specific and aimed at explanatory theory building, thus methods that utilize existent constructs are more appropriate. Building on these principles, I suggest this thesis is situated in an *intermediate theoretical state*, which according to Edmondson and McManus (2007) occurs when a combination of existing frameworks are combined with novel concepts or constructs. In this case, prior conceptualizations of knowledge find new significance or give rise to new constructs in the light of the entrepreneurial context; therefore, a multi-method approach is appropriate for a study that draws on conceptual openness from qualitative data and hypothesis testing from quantitative data.

For the purpose of this thesis, the selection of a multimethod approach responds to the aim of i) synthesizing previous conceptualizations that are situated within the same research scope ii) confronting existing theoretical frameworks assessing their applicability to the entrepreneurial context through a qualitative study and, iii) applying suitable constructs and measure the effect of knowledge management in entrepreneurial venture innovation through quantitative methods. As a result, a multimethod approach has allowed the generation of three independent studies with independent research questions, findings, and contributions.

Moreover, the multi-method approach allowed the examination of the topic of study from different angles, reaching complementing views. In addition, a multiphase design (Creswell & Plano Clark, 2011) allowed the emerging findings and questions to strengthen the following phase and the thesis as a whole.

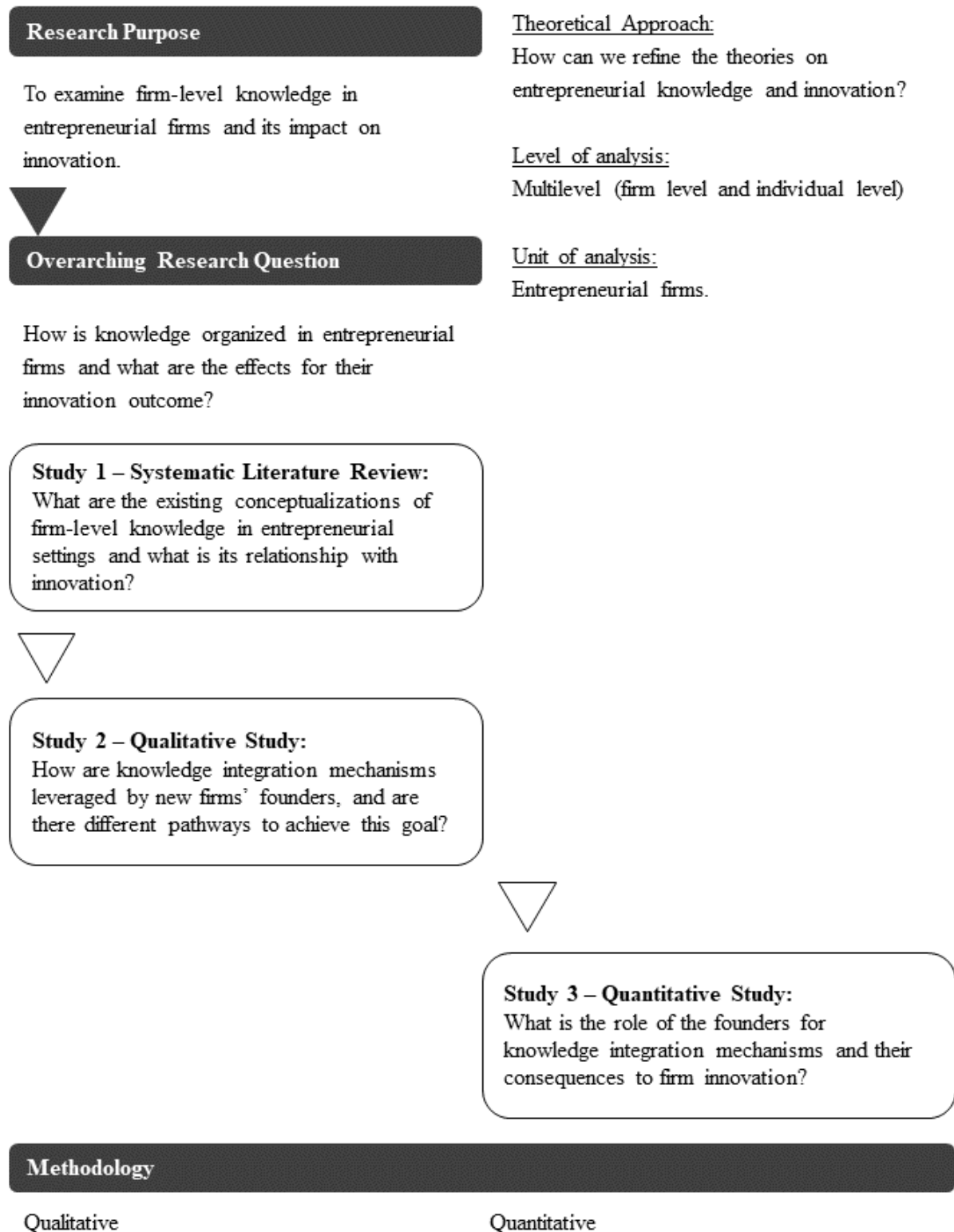
A summary of the studies included in this thesis is provided below:

- First, a *systematic literature review* (Study 1, Chapter Two) was conducted to organize previous findings around the conceptualization of entrepreneurial firm-level knowledge and its relationship with innovation.
- Second, a *qualitative study* (Study 2, Chapter Three) aims at examining knowledge integration in entrepreneurial ventures by characterizing different mechanisms and identifying its antecedents. Further, this study investigates the firm-level consequences of adopting different strategies, by elaborating four distinctive archetypes.
- Lastly, a *quantitative study* (Study 3, Chapter Four) was conducted aimed at testing the constructs identified in the precedent study and examining its relation with firm innovation. Correspondingly, this study aims to explain the variation in the innovation outcome of ventures.

Aligned with the purpose to submit a Thesis with Publications ¹, each study has been developed as an academic article and has been formatted accordingly. Moreover, each study uses an independent sample and a distinctive methodology. All three studies were conducted between June 2020 and December 2022. The sample for both empirical studies include ventures associated with start-up communities from the region of New South Wales in Australia. The reasons for targeting this group in specific responds to i) the intention to examine ventures for which innovation is a key aspect of their venture model ii) sample ventures that have just surpassed the initial development stage considering they may have a stronger need to back up their collective knowledge, and iii) ensure transferability of findings from Study 2 to Study 3, as both focused on ventures from the same population. A summary of studies included in this dissertation is described below. Further description of each of these studies is provided in the following section, and a summary of the research design rationale is shown in **Figure 1**.

¹ According to The University of Sydney “Thesis and examination of higher degrees by research Policy 2015”.

Figure 1: Overview of research design



4. Summary of Studies

Study 1: Systematic Literature Review

Study 1 aims at organizing prior research conducted around the concept of knowledge in entrepreneurship from an organizational perspective for innovation. As highlighted in the contributions, knowledge and entrepreneurship have been predominantly addressed from other theoretical lenses. Moreover, there is a lack of clarity around the concept of entrepreneurial knowledge at the venture level as most studies have mostly focused on the individual level. Consequently, this review addresses the following question: What do we know about entrepreneurial venture knowledge and innovation? In doing so this review provides a broader scope of the concept of entrepreneurial knowledge by organizing its findings across four conceptual dimensions: knowledge sources, knowledge repositories, knowledge processes, and knowledge outcomes. Further, the review offers a map of existing constructs and their interrelationships and elaborates on an extensive research agenda to continue the refinement of these propositions. The review includes 95 empirical studies –using qualitative, quantitative studies, and mixed methodologies– that contain the keywords “entrepreneurship”, “knowledge” and “innovation”.

Study 1 offer the following contributions. First, this study identifies, organize, and summarize prior research focusing on knowledge at the entrepreneurial venture level, particularly when innovation has been explained. This effort provides a synthesis of entrepreneurial innovation from the perspective of knowledge enabling a distinction between the aspects that have been previously studied and relevant gaps in the literature. Second, the study emphasizes single-level research (venture-level variables in relation to venture-level outcomes) compared to multi-level research (individual-level variables in relation to venture-level outcomes) within the entrepreneurship domain and particularly regarding innovation from a knowledge perspective. Third, this study brings an organizational lens to review the entrepreneurship literature by using a conceptualization of knowledge across dimensions that have been applied in other literatures (particularly on the concept of knowledge repositories) in the context of innovation. Consequently, this study outlines and synthesizes the evidence of knowledge involved in entrepreneurial innovation. More importantly, this study underscores the role of knowledge integration as a critical mechanism that sits in between external and internal dynamics, including the development of firm-level structures that can help sustain knowledge and innovation over time.

Study 2: Qualitative Study

Drawing on the findings from the systematic literature review, which highlighted the role of knowledge processes on the attainment of innovation, and particularly the importance of knowledge integration to the development of firm-level knowledge, the second study included in this thesis examines knowledge integration using an exploratory approach. Correspondingly, a qualitative study was conducted with the purpose of testing and refining existing theories regarding knowledge integration in the context of entrepreneurial ventures. Accordingly, the overall question of the study is: How are knowledge integration mechanisms leveraged by new firms' founders, and are there different pathways to achieve this goal? Aiming for generalizability this study adopts the abductive grounded theory method (Richardson & Kramer, 2006; Timmermans & Tavory, 2012) as a tool to achieve theoretical replicability. Furthermore, this study uses Hak and Dul (2009) recommendations for cross-case pattern search, emphasizing the idea that "multiple cases are needed for the test of new propositions" which resulted in the identification of four emergent venture archetypes.

The data for the study was collected through semi-structured interviews with members of 22 Australian ventures from different industries, recorded, transcribed, and coded using NVivo. Following the abductive theory methodology, the analysis incorporates deductive, inductive, and abductive steps. For example, to accommodate for the emergence of unbiased dimensions and constructs, the data collected was initially contrasted with existing theoretical constructs identified in the literature review (deductive codes). Depending on the fit between these frameworks and new data, uncategorized data allowed for the generation of new codes (inductive coding). Further, by cross comparing the similarities and differences between the codes across cases (ventures), the analysis included the generation of new plausible relationships which resulted in the identification of venture archetypes (abductive coding). Through these steps, the study intends to identify new ways to characterize and categorize knowledge integration in entrepreneurial contexts. The key findings of this study are the identification of multi-level antecedents of knowledge integration in entrepreneurial firms that can enable or hamper the occurrence of two distinctive mechanisms (systematization and coordination of knowledge), and the emergence of four distinctive archetypes that represent different pathways to knowledge integration.

Study 3: Quantitative Study

Drawing on the new conceptualizations obtained in Study 2 resulting from inductive steps, Study 3 quantitatively measures the role of founders in the implementation of knowledge

integration mechanisms and their consequences to innovation. Consequently, the data collected in Study 2 served as a base to develop measures for knowledge integration antecedents, and to adapt existing scales to measure knowledge integration mechanisms. In particular, this study aimed at explaining differences in the innovation output of new firms related to the type of integration mechanism pursued and their founder-related antecedents. The data was collected through a self-administered questionnaire responded to by 149 founders and employees of ventures from New South Wales in Australia. The data was analyzed using Structural Equation Modelling (SEM). This statistical method was selected for its suitability to analyze different relationships and nest the data in different random ways. Further, SEM allows the analysis and comparison of different theoretical models, thus incorporating different causal propositions. Lastly, by using SEM the study aims to achieve a higher level of generalizability and therefore, more robust results.

5. Contributions

Although each of the studies included in this thesis has specific contributions detailed in their corresponding sections, the compiled work offers the following contributions to existent theory:

- i) Extend the research focusing on knowledge and entrepreneurship by examining the effect of firm-level knowledge during the entrepreneurial process. As emphasized in the literature, knowledge is critical for entrepreneurial success and innovation, however, it has predominantly been studied from the perspective of the individual, associated with human capital and the experience obtained through the entrepreneurial process. Moreover, literature focusing on entrepreneurial learning has largely characterized entrepreneurial activity as a learning process posing that the ability of entrepreneurs to capitalize on their learning outcomes is a determinant of entrepreneurial success, survival, and innovation performance. Building on these theories and the evidence suggesting that individual knowledge can only explain a portion of entrepreneurial performance, the main proposition of this thesis is that knowledge must be conceptualized and integrated at the level of the firm to obtain performance benefits. To do so, this thesis incorporates conceptualizations from entrepreneurship and organizational perspectives, suggesting a broader scope to characterize knowledge in the entrepreneurial context. Given the relevance of knowledge in supporting the delivery of innovation and taking a stance on

innovation as a natural outcome of entrepreneurship, this thesis investigates the effect of venture-level knowledge on entrepreneurial innovation.

- ii) Examine the different forms that knowledge takes in entrepreneurial firms, especially inside the firm boundaries. Specifically, this thesis distinguishes and highlights multiple ways to account for knowledge, including external sources, internal repositories, distinctive mechanisms, and an array of firm-level outcomes, proposing an integrative framework to seize them together. In doing so, this work underscores overlooked elements of entrepreneurial activity that can also be examined under the lens of knowledge. For example, entrepreneurial culture or the role of prototypes as carriers of collective wisdom, are potential new avenues to broaden the scope of knowledge theorizations. Further, an integrative framework can help to connect long-standing conceptualizations stemming from views focusing on the input and output of economic resources, with organizational views that focus on the internal processes, firm-level benefits, and the conditions that sustain knowledge within firms. Moreover, by looking at this broader picture, it becomes easier to recognize the complexity of entrepreneurial activity which has to deal with intensive external and internal knowledge dynamics. In sum, an intersection between entrepreneurship and organizational theory is still in its infancy and this project aims to contribute to the advance of this effort along with outlining potential opportunities for future research.
- iii) Given the dynamic nature of entrepreneurship compared to established firms this thesis highlights and characterizes such differences concerning knowledge in an innovative context. As emphasized in the literature, entrepreneurship is characterized by continuous learning, high employee rotation, high flexibility, low levels of formalization, opportunistic behavior, high degree of collaboration and networking –among others. Despite these distinctive complexities, the appraisal of knowledge in entrepreneurial contexts has predominantly followed more traditional theorizations such as human capital in technology-driven innovation contexts. Although those conceptualizations have been fruitful to explain the use of knowledge in specific types of ventures, this thesis suggests that there is ample room to advance in new ways to characterize knowledge in broader entrepreneurial settings. Thereby, the present thesis contributes to this aim by introducing new constructs (antecedents of knowledge integration mechanisms), new theoretical models (awareness, dependency, and enablers framework), and emergent venture

archetypes stemming from distinctive pathways to knowledge integration in ventures. Beyond the need for further research to consolidate these findings, this thesis provides empirical evidence of a high level of variation in the way entrepreneurs promote and embed knowledge for collective use.

- iv) Lastly, this thesis helps to advance the understanding of entrepreneurial innovation. Following the meta-framework presented by Dean A. Shepherd, Wennberg, Suddaby, and Wiklund (2019) that organizes entrepreneurship research according to their explained variables (DV's), this project is aimed at explaining innovation as a firm-level outcome. In particular, this thesis tackles several points highlighted as future research opportunities in the abovementioned review, such as distinguishing between innovation input, output, and performance. Along the same line, this thesis clarifies the role of distinctive mechanisms of knowledge integration in the innovation output of entrepreneurial ventures.

Finally, at a practical level, the identification of effective strategies for successful innovative entrepreneurship could inform organizations and policies oriented toward the guidance and resource optimization of ventures. Currently, most education entrepreneurship programs do not offer a knowledge management approach despite the well-known recognition of knowledge as a critical resource for entrepreneurial firms. Further, this study also extends the perspective of knowledge management to entrepreneurial ventures regardless of their industry, as it can be argued that all entrepreneurial ventures possess valuable knowledge that will serve as a driver of survival, growth, and innovation over time.

CHAPTER TWO

MISSING LINKS IN KNOWLEDGE-BASED ENTREPRENEURSHIP AND INNOVATION RESEARCH: A MAP AND AGENDA

ABSTRACT

Knowledge is a core construct in entrepreneurship theorizing and it has been broadly related to firm innovation. However, entrepreneurship research has often conceptualized knowledge in a relatively static way referring to the knowledge and experiences of the founder entrepreneurs. This review uses a process perspective to synthesize multiple views on knowledge, thus providing a more dynamic conceptualization to strengthen our understanding of the knowledge–innovation link in entrepreneurial firms. Consequently, we review the entrepreneurship knowledge-based research with a focus on knowledge processes in relation to innovation, including the exploration, transfer, and integration of existing knowledge. We conduct a systematic literature review analyzing 95 empirical studies published over the past three decades. We map the key concepts related to the sources, repositories, processes and outcomes of knowledge, and their interrelationships, to identify opportunities for future research that could strengthen the integration of this literature.

Keywords: Entrepreneurship, innovation, knowledge, process, review

1. Introduction

A process perspective on entrepreneurship has multiple implications for entrepreneurship research theorizing (Davidsson & Gruenhagen, 2021). From the perspective of knowledge –a key resource for entrepreneurship and innovation (Acs & Audretsch, 1988; Nooteboom, 1994; Vossen, 1998)– a process perspective implies the understanding of knowledge as a changing outcome that stems from the experiences and learning of the entrepreneurs and their teams (Argote & Miron-Spektor, 2011). Since knowledge has been widely recognized as an antecedent of innovation (Acs, Audretsch, & Lehmann, 2013; Carlsson, Acs, Audretsch, & Braunerhjelm, 2009), a deficient understanding of knowledge may lead to an incomplete conceptualization of the knowledge-innovation link in the entrepreneurial context. Moreover, as entrepreneurship necessarily involves the interplay between the founding entrepreneur and her team (Nicolai J. Foss, Klein, Kor, & Mahoney, 2008), knowledge needs to be understood as a changing outcome from the experiences and learning at the level of the firm.

Contrasting this view, entrepreneurship theorizing has often conceptualized knowledge in a relatively static way referring to the knowledge and experiences of the founders at a certain point in time (Agarwal & Shah, 2014; Link & Ruhm, 2011). This is surprising given that knowledge involves new knowledge that needs to be shared, transferred, integrated, and stored and many of these processes involve more participants than just a founder entrepreneur. In fact, such knowledge processes allow employees to learn and develop new skills for the benefit of themselves and the organization (Zahra, Neubaum, & Hayton, 2019, p. 167) and provide the seeds for ongoing and sustained innovation. While there are studies emphasizing a more dynamic and firm-level conceptualization of knowledge (P. T. Bryant, 2014; Honig & Hopp, 2019) this literature is fragmented. Consequently, the motivation of this study is to integrate the research on knowledge and innovation at the level of the entrepreneurial firm in a way that captures the richness of the process perspective. By doing so, we aim at providing a more holistic understanding of this literature, its current challenges, and future opportunities.

To address this issue, we conduct a systematic literature review (Tranfield, Denyer, & Smart, 2003) to identify gaps and areas that require future research and to develop a framework of how knowledge affects innovation in entrepreneurial firms. There are a few considerations to our review. First, a firm-level conceptualization of entrepreneurship implies that entrepreneurial firms involve a certain type of organization (Alvarez & Barney, 2004; Burton,

Colombo, Rossi-Lamastra, & Wasserman, 2019; Teece, 2014). Therefore, we believe that prior theorizations stemming from organizational perspectives can provide suitable constructs to review this literature. Consequently, a process perspective of firm-level knowledge requires the inclusion of two key constructs: *knowledge processes*, as the processes and sub-processes aimed at the utilization and dissemination of knowledge in firms (Crossan, Lane, & White, 1999), and *knowledge repositories* as the firm-embedded knowledge that can result from the interplay of such processes (Argote & Ingram, 2000). In contrast, a non-process perspective of knowledge has long-established two additional constructs: *knowledge sources*, as the knowledge assets that are associated to a specific context (Srinivasan, Choo, Narayanan, Sarkar, & Tenhiälä, 2021), and *knowledge outcomes*, as the products of knowledge that can be leveraged by firms to survive and grow, such as innovation (Quintane, Mitch Casselman, Sebastian Reiche, & Nylund, 2011). We believe that both perspectives can be integrated to provide a broader picture of knowledge in firms. Thus, our proposition includes the four conceptualizations abovementioned, as dimensions of knowledge that enables a more holistic depiction of knowledge as a changing resource. While prior reviews on this literature have included some of these conceptualizations (Guckenbiehl, Corral de Zubielqui, & Lindsay, 2021) or have focused specifically on processes (Lumpkin & Lichtenstein, 2005; Zahra, Sapienza, & Davidsson, 2006a), we have not found previous reviews that includes the concept of knowledge repositories or that reconciles process and non-process views. Since learning implies the generation of knowledge as a continuum, we believe both elements are needed to better understand the knowledge phenomena at the firm level.

Our findings are disseminated in two ways. First, we offer a map of the literature that highlights the areas that have been most and least examined. Furthermore, the review map emphasizes the array and role of three groups of processes, namely, exploration, transfer, and integration of knowledge, as mediating mechanisms between sources, repositories, and outcomes of knowledge. Particularly, and although the literature has predominantly focused on transfer processes, the map has revealed the pivotal role of knowledge integration in bridging the intersection between knowledge sources and firm-level knowledge repositories. In addition, while processes aimed at the scan and exploration of new knowledge are quintessential for entrepreneurial firms, our map suggest that the three groups of processes must be closely intertwined to sustain innovation. Second, our findings elaborate on the gaps and future research opportunities which are described in an extensive agenda organized across the four knowledge conceptualizations and their interrelationships.

We thereby provide two contributions. First, we call for a process perspective on knowledge-based entrepreneurship. Going beyond a relatively static view allows a focus on knowledge processes, such as the creation of new knowledge, the retrieval of existing knowledge, and the transfer of knowledge, and their links to innovation (Argote & Guo, 2016). Moreover, a process perspective emphasizing knowledge processes allows the conceptualization of reverse processes, thus looking at knowledge not only as an antecedent of innovation but also as an outcome of innovation. Further, emphasizing knowledge processes at the level of the firm helps understand how founders, the management team and employees interact with each other to create unique knowledge that cannot be easily transferred to other organizations. Second, focusing on knowledge at the level of the firm necessarily conceptualizes it at the intersection of two literature streams: entrepreneurship, and organizational perspectives. Taken separately, organizational views tend to emphasize knowledge as an endogenous phenomenon (Levitt & March, 1988; Tsoukas & Vladimirou, 2001; Zander & Kogut, 1995), whereas entrepreneurship emphasizes it as an exogenous one (Acs, Braunerhjelm, Audretsch, & Carlsson, 2009; Ganco, 2013). Yet, as our review suggests, the intersection of both theorizations reveals that knowledge in entrepreneurial firms occurs as both endogenous and exogenous phenomena, and therefore, it adds a unique complexity to the entrepreneurial process, compared to non-entrepreneurial ones. For example, entrepreneurs must choose between leveraging ongoing learnings to introduce organizational improvements, or just using it to improve decision-making at the managerial level. At the same time, entrepreneurs must choose between consistently sourcing knowledge from external parties or just at the times when it is needed. Further, entrepreneurs must introduce innovations that are a result of the combination of resources and actions implemented both externally and internally. Thereby, we extend previous conceptualizations and findings to achieve what Zahra and Newey (2009) described as *borrowing and extending* theory building.

2. A process perspective of knowledge: sources, processes, repositories, and outcomes.

A key challenge to synthesize the knowledge–innovation link from a process perspective is the inclusion of different knowledge conceptualizations without generating theoretical overlaps. An important consideration to this aim, is the differentiation between the knowledge perspective (Grant, 1996) and the capabilities perspective (Teece, Pisano, & Shuen, 1997). While both views underscore knowledge as a key resource for firm success and innovation, a capability perspective emphasizes what firms *can do* with knowledge, which is not the specific focus of this review. In contrast, as we aim at examining the empirical evidence

of knowledge as a driver of innovation, we do not explicitly seek for literature drawing on dynamic capabilities such as absorptive capacity (Cohen & Levinthal, 1990). Furthermore, the dynamic capabilities perspective in the context of entrepreneurship has been examined in seminal reviews (Zahra, Sapienza, & Davidsson, 2006b). Nevertheless, this consideration does not exclude articles drawing from different theoretical approaches, including the capabilities perspective.

Correspondingly, we address this issue by using four constructs that can accommodate multiple perspectives and guide the whole review process: knowledge sources, knowledge processes, knowledge repositories and knowledge outcomes. We borrow such concepts from seminal knowledge-based articles from different streams, including management, innovation and organizational learning (see **Table 1**) and use them as a *coding frame* (Gibbs, 2007) to guide our analysis. A coding frame poses a critical distinction between a conceptual and a theoretical framework (Camp, 2001) which we explain in detail in our methodology section. Hence, we deliberately avoid applying existing theoretical frameworks (such as organizational learning frameworks) as our motivation is to incorporate multiple perspectives on the existing research related to the entrepreneurship knowledge–innovation link, not to develop a theory of entrepreneurial learning. Alternatively, as we analyse the interrelations between concepts, we develop a map of the literature that conveys the complexity of generating knowledge-driven innovation in entrepreneurial firms. A key consideration to the selection of such constructs is the incorporation of knowledge repositories as a key conceptualization of firm-level knowledge (Argote & Miron-Spektor, 2011). While the entrepreneurship literature often emphasizes the importance of external knowledge, there is vast evidence that the entrepreneurial process involves learning (Dahlin, Chuang, & Roulet, 2018; Wang & Chugh, 2014), and thus, we believe that the entrepreneurial process can involve the generation of firm-level knowledge as an outcome of learning. Through our map, we suggest that entrepreneurship provides a more challenging scenario to the management of knowledge than in established firms, given the need to curate and integrate knowledge from external sources, along with the generation of firm-level repositories for sustained performance in innovation.

Table 1: Conceptual Framework

Knowledge Dimension	Key Contribution	Author
Knowledge Sources	Definition of knowledge source as “the extent to which an organization prefers to develop new knowledge internally versus the extent to which it is more likely to seek inspiration in ideas developed externally (pp. 361)”.	Dibella et al. (1996)
	Implications of knowledge source’s breadth on innovation.	Leiponen and Helfat (2010)
	Implications of knowledge sources across boundaries on innovation.	Roper and Arvanitis (2012)
Knowledge Processes	Identification of the knowledge processes involved in organizational learning for firm renewal over time. The framework proposed includes individual, group, and organizational process levels: 1) Intuiting (individual) 2) Interpreting (group) 3) Integrating (group) 4) Institutionalizing (organization)	Crossan et al. (1999)
	Identification of the knowledge processes involved in firm innovation, which differentiation is determined by the radicalness of the innovation generated: 1) Syntactic transfer 2) Semantic translation 3) Pragmatic transformation	Carlile (2004)
	Identification of the knowledge processes involved in organizational learning from task performance: 1) Knowledge Transfer 2) Knowledge Creation 3) Knowledge Retention	Argote and Miron-Spektor (2011)
	Conceptualization of transactive memory as group-level knowledge structure that supports behavior	Wegner (1987)
Knowledge Repositories	Conceptualization of organizational memory as a firm-level knowledge structure that supports behavior and performance	Walsh and Ungson (1991)
	Identification of knowledge repositories in firms as structures that support knowledge transfer and enable learning across sub-units.	Argote and Ingram (2000)
Knowledge Outcomes	Conceptualization of the knowledge processes that lead to innovation in firms.	Nonaka (1994)
	Examination of knowledge attributes and knowledge processes leading to innovation in firms.	Galunic and Rodan (1998)
	Conceptualization of innovation as an outcome of knowledge.	Quintane et al. (2011)

3. Method

3.1 Identification of Articles

Following the recommendations of Tranfield et al. (2003) and Andreas Rauch (2019) for systematic literature reviews, we conducted searches in June 2020 using Boolean operators in three different scientific databases: Web of Science, ABI/Inform and ECONLIT. We did not set a starting date. With the aim of conducting an unbiased search as recommended by Tranfield et al. (2003, p. 215), we included unpublished studies such as Conference proceedings and book chapters². We used the same keyword combinations on each database generating a total of nine searches that contained the words “entrepreneur*”, “knowledge” and “innovation” either in the title, abstract or keywords. Additionally, we replaced the word “entrepreneur*” with the terms “venture”, “start-up” and “startup” in consecutive searches to include similar approaches. We used Boolean operators to extend the search to similar terms related to entrepreneurship such as “entrepreneurial”. We also used the operator “NEAR/5” between the words “knowledge” and “entrepreneur*/venture/start-up” to ensure that the term “knowledge” was included as a concept and did not refer to the existing literature. We developed a list of citations in an additive way by eliminating duplicates from previous searches before adding them to our final database. The search process resulted in a total of 793 studies including journal articles, conference proceedings and book sections by June 26, 2020.

3.2 Selection of Articles

We followed a selection protocol composed of inclusion and exclusion criteria. First, we included only empirical studies as the aim of our review was to synthesize the scientific evidence established in the field. Further, we included all article types (e.g., journal articles, conference proceedings, and book chapters) and all research designs including qualitative, quantitative, and mixed-methods studies. Thus, we conducted an integrative review, allowing us to triangulate findings across different methods, to identify patterns across studies and to develop a map of the relationships between concepts (Rousseau, Manning, & Denyer, 2008).

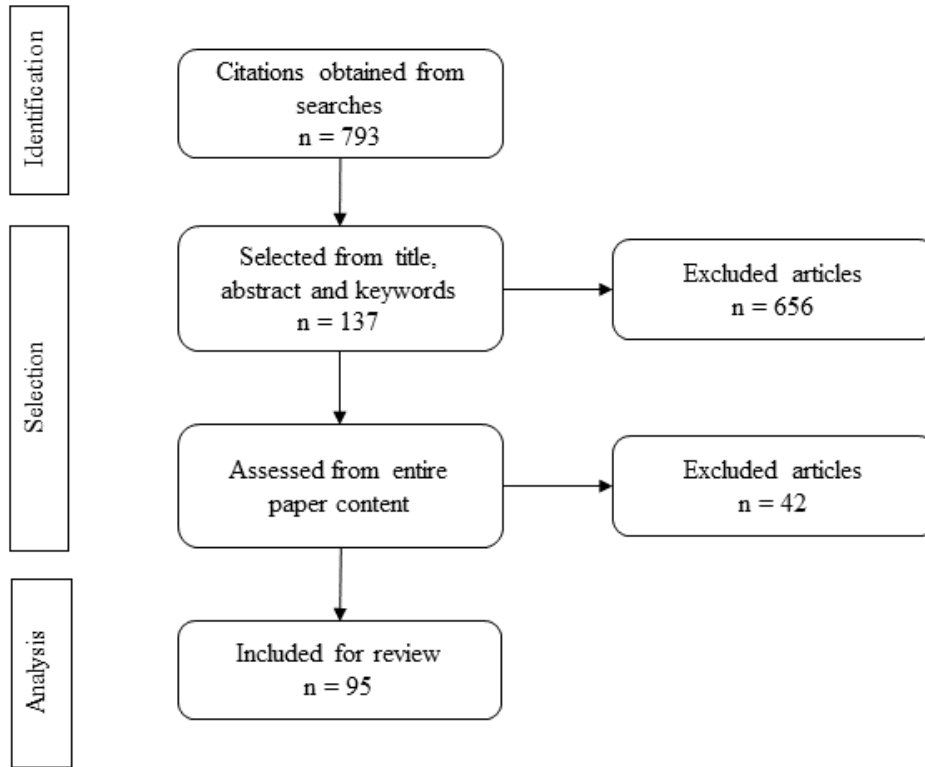
² According to Tranfield et al. (2003), “Searches should not only be conducted in published journals and listed in bibliographic databases, but also comprise unpublished studies, conference proceedings, industry trials, the Internet and even personal requests to known investigators”. However, while I have adopted a holistic approach for the purpose of this doctoral dissertation, I acknowledge the limitations of this perspective in the case of submitting this work to journal publication. Therefore, this criterion might be revised in further development stages.

As a second criteria, we included only studies that examined firm-level knowledge and innovation in entrepreneurial firms as a unit of analysis. By entrepreneurial firms, we considered a combination of entrepreneurial behavior (Shane & Venkataraman, 2000) and organizational status (Audretsch, Kuratko, & Link, 2015). For example, the studies included primarily examined new ventures, start-ups, and SMEs. Conversely, we excluded studies that focused on other levels of analysis. For example, we excluded all studies that focused on the entrepreneur at an individual level, such as studies that focused solely on entrepreneurs' cognition, experience and human capital. We also excluded studies that offered macro-level conceptualizations or examined multi-level relationships, for example, between firm-level and regional-level constructs, mostly found in papers from economic streams. In addition, as we target entrepreneurial firm-level knowledge we excluded studies focusing on corporate entrepreneurship, family businesses and institutional venturing. We excluded studies centred on corporate entrepreneurship because in those ventures the management of knowledge resources is generally associated with the resources and processes used by the parent company, and therefore we considered those findings might distort the overall dataset. Similarly, family businesses have distinct dynamics in which knowledge resources and processes transfer through generations and so their findings might vary significantly from studies on independent firms. In the same way, institutional entrepreneurship has access to specific knowledge resources and processes that focus on specific goals that are beyond the entrepreneurial activity.

As a third criteria and, to achieve a higher understanding of knowledge during entrepreneurial activity, we excluded papers that examined pre-entry or post-exit conditions. For example, we excluded articles about pre-entry conditions as predictors of future performance unless they provided evidence of knowledge during the entrepreneurial activity.

Following these criteria, we reduced the number of articles from 793 to 95 through two iterative inclusion–exclusion rounds. During the first round we considered the information available in the title, abstract and keywords. This round resulted in a preliminary dataset of 137 articles. We then read the entire paper and excluded 42 more studies using the same criteria described above, obtaining a final dataset of 95 articles for review published between 1994 and 2020. The whole process is illustrated in **Figure 2**. A supplementary list of all references of studies included in this review can be reviewed in **Appendix 1**.

Figure 2: Identification and selection of studies



Description of articles included in the review

Publication Type	Journal articles (85), Book Sections (3), Conference Papers (7)
Methodology	Quantitative (66), Qualitative (21), Mixed Methods (8)
Publication date range	1994–2020 (64 published 2015–2020)
Sample Type	New Ventures (46), SMEs (38), Start-ups (10), Other (1)
Number of articles incl.	95

3.3 Analysis

To conduct the analysis we developed a coding frame, defined as “a structured list of codes and the rules for their application” (Gibbs, 2007, p. 39). A coding frame differs from a theoretical framework, as it uses concepts grounded in the existing literature that are not necessarily interrelated (Camp, 2001), but are pertinent to the research question and can be used to organize and analyse a heterogenous data set (Miles, Huberman, & Saldaña, 2014). Our coding frame is based on the distinction of four conceptualizations of knowledge: 1) knowledge sources, 2) knowledge processes, 3) knowledge repositories, and 4) knowledge outcomes. For each group, we have identified key prior contributions and authors, as shown in **Table 1**. Although these concepts have been used in many literatures including the entrepreneurship field, we developed the coding frame guided by articles from organizational perspectives,

strategic management, and innovation streams to avoid theoretical bias. We used the coding frame to identify key contributions across our included articles using NVivo. For example, to identify sources of knowledge we searched for findings that indicated a recognition of the knowledge context and its implications for innovation, generally but not always associated with resources located outside the firm boundaries (Dibella, Nevis, & Gould, 1996; Leiponen & Helfat, 2010; Roper & Arvanitis, 2012). To identify knowledge processes, we primarily followed organizational conceptualizations as processes and sub-processes related to the use of knowledge for multiple strategic aims (Argote & Miron-Spektor, 2011; Carlile, 2004; Crossan et al., 1999). To identify knowledge repositories, we searched for firm-level structures where knowledge is embedded (Argote & Ingram, 2000; Walsh & Ungson, 1991; Wegner, 1987). Lastly, to identify knowledge outcomes, we followed prior propositions of innovation as a knowledge outcome and its implications in firms (Galunic & Rodan, 1998; Nonaka, 1994; Quintane et al., 2011). In addition, we coded each article according to the methodology and sample type.

Further, we analysed the content within each group to seek similarities and patterns which resulted in the identification of concepts as illustrated in **Table 2** and **Table 3**. There are two important considerations. First, not all studies analyse concepts at the same level and thus we opted not to aggregate the results within each group. For example, within the knowledge sources dimension, we found articles that focused on broad-level constructs such as “external knowledge” (Karagouni & Caloghirou, 2013; N. K. Kim & Ahn, 2020; Larraneta, Zahra, & Gonzalez, 2012; Nason, Wiklund, McKelvie, Hitt, & Yu, 2019; Ritala, Henttonen, Salojarvi, Sainio, & Saarenketo, 2013; Taheri, Ye, & van Geenhuizen, 2018) while other studies investigated more specific types or sub-types of external knowledge such as “market knowledge” or “customer knowledge” (Bettiol, De Marchi, & Di Maria, 2016; A. McKelvie, Wiklund, & Brattstrom, 2018; E. Shu, 2017; L. Z. Song, Di Benedetto, & Song, 2010; Tolstoy, 2009). Second, most studies we reviewed assessed more than one construct, and therefore the sum of articles identified per construct set is greater than the total number of articles.

Table 2: Identification of predominant constructs (highlighted terms correspond to concepts examined in 10+ studies)

Initial Codes	Constructs	Sub-constructs
Knowledge Sources	External Knowledge	External Knowledge (6 studies)
		Explicit Knowledge (2 studies)
		Tacit Knowledge (3 studies)
		Technological Knowledge (2 studies)
		Market Knowledge (7 studies)
	Congenital Knowledge	Customers (3 studies)
		Partners (4 studies)
		Human Capital
		Founder's Team HC (21 studies)
		Employee HC (3 studies)
Knowledge Repositories	Internal Knowledge	Social Capital (13 studies)
		Family Ties (1 study)
		Friends Ties (1 study)
		Business Ties (4 studies)
		Political Ties (1 study)
	External Knowledge	Internal Knowledge (1 study)
Knowledge Processes	Knowledge Transfer	Patents (11 studies)
		Routines (15 studies)
		Tools (6 studies)
		Prototypes (2 studies)
		Culture (2 studies)
	Knowledge Integration	Knowledge Acquisition (15 studies)
		Knowledge Sharing (6 studies)
		Knowledge Spillover (6 studies)
		Knowledge Transfer (6 studies)
		Knowledge Creation (7 studies)
	Knowledge Scanning and Exploration	Knowledge Application (3 studies)
		Knowledge Integration (2 studies)
		Knowledge Retention (0 studies)
		Knowledge Search (8 studies)
		Networking (17 studies)
Knowledge Outcomes	Innovation Performance	Collaboration (11 studies)
		Cooperation (3 studies)
		Firm Innovation (20 studies)
		Product Innovation (10 studies)
		Innovation Performance (6 studies)
	Innovation Capacity	Innovation Radicalness (2 studies)
		Disruptive Innovation (3 studies)
	Innovation Competences	Firm Innovativeness (10 studies)
		Likelihood of Innovation (2 studies)
		Innovation Competences (4 studies)

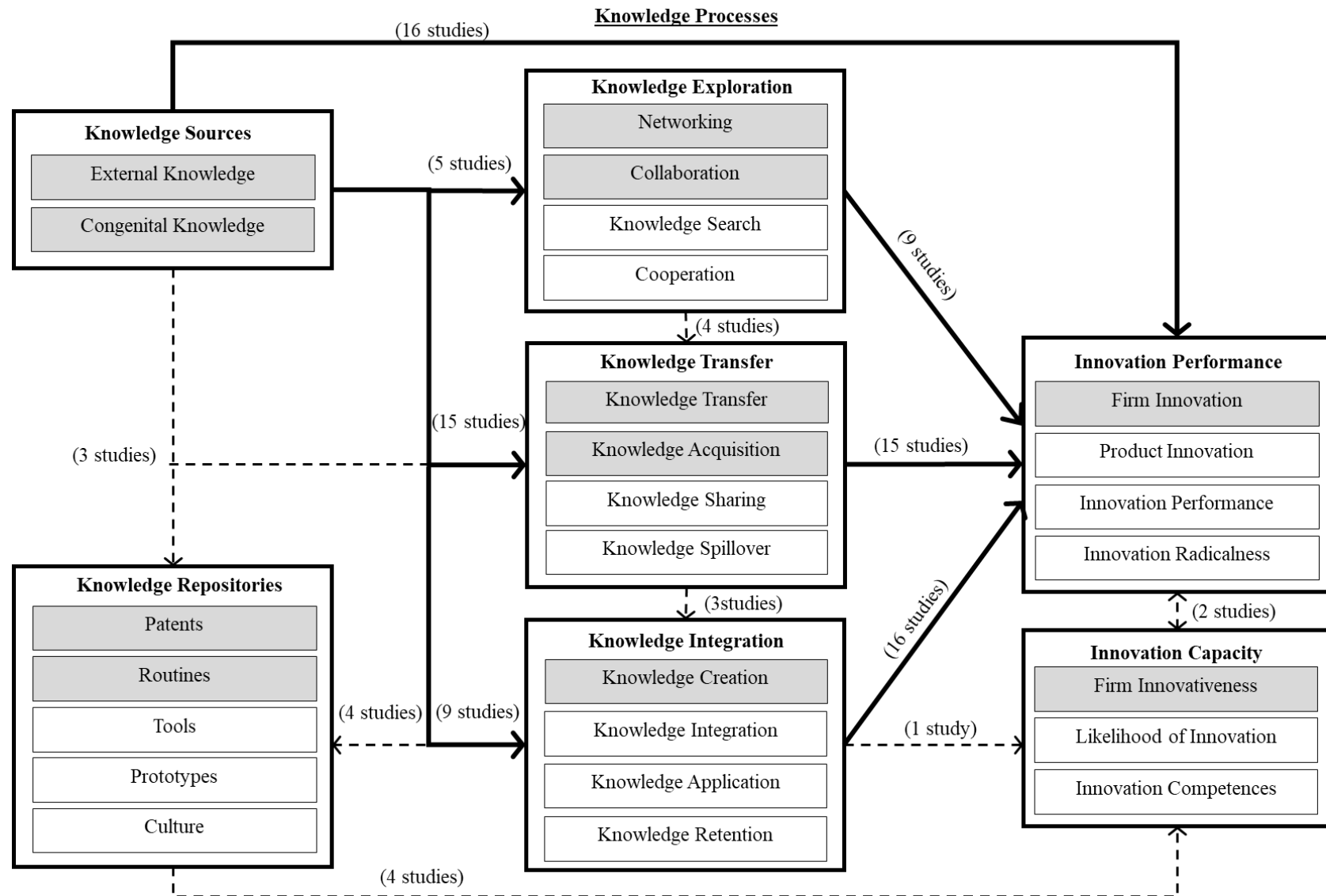
Table 3: Summary of dimensions, concepts and constructs

Knowledge Sources	
External Knowledge	<i>Technological knowledge</i> is often measured in the form of patents and licenses but also as published content, or codified knowledge. <i>Market knowledge</i> includes business-specific knowledge such as knowledge from customers, suppliers, competitors, and partners.
Congenital Knowledge	<i>Human capital</i>: Two common operationalizations to assess human capital are based on knowledge characteristics and knowledge content. Knowledge characteristics are associated with the depth and breadth of knowledge. Knowledge content distinguishes between general human capital or technical knowledge and experience acquired through formal education, and specific human capital, related to managerial and entrepreneurial knowledge. <i>Social capital</i> corresponds to social relations possessed by members of entrepreneurial ventures, enabling firms to access knowledge that would not otherwise be available (W. Tsai & Ghoshal, 1998). Research on this area has examined social capital characteristics such as depth and breadth, and distinguished between relevant sub-types, related to family, friends, business, and political ties.
Knowledge Repositories	
Patents	Patents refer to rights to commercially exploit inventions or other forms of intellectual property created or acquired by individuals or organizations, which have formally completed a patenting awarding process. Thus, this excludes trademarks, registered designs, and copyrights unless these have formally obtained an invention patent.
Routines	Routines correspond to coordinated activities between different members of an organization to perform tasks more efficiently.
Digital Tools	Tools are information systems that support conducting tasks, increasing the speed of knowledge transfer within and across organizations (Argote & Ingram, 2000).
Prototypes	Knowledge can be embedded in new products or services, as a result of collaboration between individuals, between external sources of information and individuals, tools or other repositories and leveraged at the organizational level for the use of the whole firm (Argote & Ingram, 2000).
Culture	Knowledge can be embedded in the organizational culture, modelling the values and practices that guide the actions of its members (Dana, Korot, & Tovstiga, 2005).
Knowledge Processes	
Knowledge Transfer	<i>Knowledge transfer</i> is a process by which knowledge is transmitted from one party to another enabling learning by the recipient from the transmitter's experience. Knowledge transfer can occur internally or externally to the firm's boundaries. Following this definition, several processes enable the conducting of knowledge between entities, and accordingly, we have incorporated the findings around the constructs of knowledge acquisition, knowledge sharing and knowledge spillovers in this category.

	<u>Knowledge acquisition</u>: What distinguishes knowledge acquisition from a generic construct of knowledge transfer seems to be the strategic intention of the firm to incorporate new knowledge for specific purposes. <u>Knowledge sharing</u>: Knowledge sharing refers to the exchange of knowledge in which both parties act as senders and recipients (Ipe, 2003). <u>Knowledge spillovers</u>: Knowledge spillovers are flows of knowledge from an originating firm to a recipient firm by which the receiver obtains a benefit (Yang et al., 2010).
Knowledge Integration	<u>Knowledge integration</u> includes all knowledge-related processes oriented towards the fusion or combination of different knowledge sources inside the firm (Lin & Chen, 2006). <u>Knowledge creation</u> refers to the generation of new knowledge created either internally or in conjunction with external partners, deriving knowledge conducive to commercialization or to organizational improvement. <u>Knowledge application and knowledge exploitation</u> are related terms that refer to the utilization of knowledge collected for specific purposes within the firm, often creating goods or improving processes. <u>Knowledge retention</u> refers to the act to store knowledge purposively for future uses.
Knowledge Exploration	<u>Knowledge search and networking</u> are activities that may lead to the acquisition of knowledge sources located outside the firm boundaries or to the acquisition of social capital. Knowledge search is a unilateral activity that involves the purposive scanning of knowledge that may be relevant for the new firm. <u>Collaboration</u> and <u>cooperation</u> are related to formal agreements between two parties to engage in knowledge transfer for mutual benefit. Often collaboration has been used to refer to agreements in which there is a shared objective that is usually associated with a timeframe and a financial goal, while cooperation has been mostly associated with asymmetrical or more open-ended arrangements.
Knowledge Outcomes	
Innovation Performance	Includes firm innovation, product innovation, innovation performance, disruptive innovation and radicalness of innovation.
Innovation Capacity	Refers to the skills and capabilities to achieve innovation including innovativeness, innovation capacity and likelihood of innovation.

Lastly, we coded the relationships established across concepts and then integrated the results in a map shown in **Figure 4**. Following (Habersang, Küberling-Jost, Reihlen, & Seckler, 2019) we distinguished between unidirectional and reciprocal relationships, illustrated with arrows in the figure. Further, based on the number of studies that established relationships between the concepts, we use strong lines to represent a higher volume of research, and dashed lines to represent less examined relationships.

Figure 3: Review Map (bold arrows and highlighted constructs denote predominance of research, dashed lines denote scarcity of



4. Findings

Our analysis yielded results across two areas: 1) predominant constructs and sub-constructs within conceptual dimensions (knowledge sources, knowledge repositories, knowledge processes and knowledge outcomes), as detailed in **Table 2** and **Table 3**, and 2) relationships between constructs, which enabled us to elaborate a conceptual map illustrated in **Figure 4**. Correspondingly, first we briefly describe the concepts identified, elaborating further on those that have received less attention in previous reviews. Particularly, we describe in more depth the concepts derived from the application of an organizational perspective, namely, knowledge processes and knowledge repositories, compared to those more extensively discussed such as knowledge sources and knowledge outcomes. Second, we describe the relationships identified between constructs and explain the review map.

4.1 Knowledge Sources

Studies focusing on knowledge sources emphasize knowledge as a static resource that is either external to the firm, or is congenital to the firm, as a required pre-existing asset (see **Table 3**). External knowledge needs to be acquired or integrated and is often examined according to its specific content, such as *technological knowledge* (often measured in the form of patents, licenses, and published content) and *market knowledge* (business-specific knowledge such as knowledge from customers, suppliers, competitors and partners). While technological knowledge is often acquired through economic transactions and therefore may only be available to certain firms, market knowledge seems easier to attain, even at early development stages. For example, market knowledge can be sourced through consumers (Balan & Ionita, 2011), competitors, industry fairs, conventions, government policies and agencies (Tassis, Tassi, Zois, Souchla, & Maroulas, 2017). External knowledge can be further characterized based on its nature, for example, some studies distinguish between explicit and tacit types of knowledge (Jin, Shu, & Zhou, 2019; Lee, Tsai, & Lee, 2011; Sousa-Ginel, Franco-Leal, & Camelo-Ordaz, 2017). Although technological and market knowledge can be either explicit or tacit, a dominant approach considers technological knowledge as an explicit source and market knowledge as a tacit one (Garcia-Cabrera, Garcia-Soto, & Nieves, 2020; Lee et al., 2011; R. Ma & Huang, 2016; Siegel & Renko, 2012). Across all perspectives, market knowledge as a tacit source was the most examined construct of external knowledge at the level of the firm.

Congenital knowledge refers to the sources of knowledge that belong to the firm at the time of its conception (Yli-Renko, Denoo, & Janakiraman, 2020). This group of studies

includes *human and social capital* perspectives to account for firm-level knowledge. Although both human and social capital can continue changing and growing post-entry, we found that a prevailing view portrays them as inputs rather than outputs of knowledge. Human capital, defined as knowledge and skills pertaining to individuals (Unger, Rauch, Frese, & Rosenbusch, 2011), provides firms with learning capabilities that equip them to better absorb new knowledge (Bettiol et al., 2016; Protogerou, Caloghirou, & Vonortas, 2017; Talebi & Tajeddin, 2011), increase their orientation towards collaboration with research institutions (Taheri et al., 2018; Tassis et al., 2017), improve their R&D activity (Jang, Hadley, & Lee, 2019), and facilitate product differentiation (L. Z. Song et al., 2010). Social capital corresponds to social relations between individuals that enable firms to access knowledge that would not otherwise be available (W. Tsai & Ghoshal, 1998) and may help overcome the difficulties derived from a resource-scarce context. The literature reviewed identified different types of social capital, particularly those related to the links between entrepreneurs and external knowledge sources. For example, while family ties enable entrepreneurs to access general business knowledge, friends can provide customer knowledge in the form of feedback (Burstrom, Harri, & Wilson, 2018) and political ties may grant early access to emergent industry or market policy which might be critical for entrepreneurial firms in highly regulated markets or economies that have frequent policy change (Shan & Lu, 2020). Across these views, research on social capital suggests two main issues for the entrepreneurial domain. First, social capital may be more relevant in certain stages of business development, particularly at the beginning when there are no formal systems in place to manage knowledge (Ladib, 2015). Second, social capital enables the acquisition of specific types of external knowledge and therefore the social ties possessed by the firm may influence its access to relevant information located outside the firm boundaries (Bai, Lind, & Johanson, 2016; Jiang, Wang, & Jiang, 2019; Khan, Lew, & Sinkovics, 2015; Shan & Lu, 2020).

4.2 Knowledge Repositories

Knowledge repositories are receptacles of knowledge after the firm has been created. While repositories of knowledge can take any form, our findings suggest a distinction between patents, digital tools, routines, prototypes, and culture. *Patents* can convey new knowledge owned by the firm. Although patents can be an outcome of internal activity associated with entrepreneurially-oriented firms (Jiang et al., 2019; Li, Liu, Wang, Li, & Guo, 2009), they are more likely to be found in firms operating in highly dynamic markets or in ventures undertaking open innovation strategies with high risks of spillovers (N. K. Kim & Ahn, 2020). Thus, one

of the shortcomings of accounting for patents as a proxy of knowledge in firms is that patents may only be relevant in some industries.

Routines correspond to coordinated activities between different members of an organization to perform tasks more efficiently (Argote & Guo, 2016). As such, routines can encompass procedural knowledge gained through coordinated experience, supporting ongoing operational processes. Unfortunately, most studies reviewed, cite routines to support hypotheses or as part of higher-order constructs without observing them directly. For example, studies build on the notion of routines as rigid structures based on prior research on established firms (C. L. Shu, Liu, Gao, & Shanley, 2014) or cite routines as an example of internal knowledge generation (A. McKelvie et al., 2018). Routines carry knowledge that is firm-specific and can be adapted to integrate new learning and information. Modification of organizational routines can signal those dynamics and, thus, routines have been studied as a result of learning processes, flows of knowledge and adaptation to environmental changes. In entrepreneurship research, routines have been described from two contrasting angles. On the one hand, there are approaches that build on the assumption that routines are rigid structures that constrain organizational change (X. F. Ma, Zhou, & Fan, 2015), are built over time and, therefore, are associated with more mature stages of business development (Burstrom et al., 2018). Often, studies in this tradition associate a higher level of organizational flexibility with an absence of routines. On the other hand, there are studies that pose that routines provide a template to which new knowledge can be incorporated (Sousa-Ginel et al., 2017). In particular, these studies emphasize the role of learning routines prior to interaction with external partners (Burns, Acar, & Datta, 2011; R. Guo, L. Cai, & Y. Fei, 2019; J. Y. Lin, 2017).

Digital tools might store firm-specific knowledge or may provide a space for social interaction and collaboration. Tools as enablers of knowledge in entrepreneurial firms have been examined as a space where social interaction takes place (Baskaran, 2018) and as an instrument for knowledge exchange and collaboration (Oliva & Kotabe, 2019). In our set of studies, we did not find any studies distinguishing between different types of digital tools and their implications for entrepreneurial outcomes.

Prior organizational conceptualizations have included *products and services* as knowledge repositories as they convey knowledge that has previously been integrated and modified (Argote, McEvily, & Reagans, 2003; Hansen, 1999). However, this approach may overlap with other theorizations, as new products and services can also be considered as knowledge outcomes, particularly innovation (Dolfsma & van der Panne, 2008). To avoid this confusion, we have included the concept of *prototypes* as preliminary forms of products or

services that have not yet progressed to commercialization phases. Prototypes can also include primary forms of business plans, operational processes, or other explicit forms of knowledge, and can be elaborated in a physical or digital format (Oliva & Kotabe, 2019). Seen this way, prototypes are important instruments to test knowledge integration as organizational structures evolve. The capability to generate prototypes as part of the concept of knowledge conversion has been studied by Sousa-Ginel et al. (2017) on a sample of Spanish ventures arising from academic research. Some of the findings include that a higher number of interactions between the venture and external partners does not influence the capacity to generate prototypes but rather the network size does. This may suggest that prototyping involves incorporating specific knowledge from different sources rather than iterating a solution with a particular partner.

Lastly, some attributes of *organizational culture*, have been found surprisingly similar among entrepreneurial ventures across different locations (Dana et al., 2005). Using a diverse sample, Wu, Lin, and Chen (2013) also reported that the innovation capabilities that lead to firm performance of 393 firms from different countries and industries are determined by both external and internal openness. By internal openness the authors referred to an organizational culture that includes practices of inter-disciplinary collaboration and knowledge sharing, as well as the awareness of team members' expertise within an organization. Specifically, Wu et al. (2013) study suggests that internal openness significantly influences the firm's absorptive capacity which further improves the innovation capability and firm performance.

4.3 Knowledge Processes

We found multiple firm-level processes related to knowledge in entrepreneurial firms. Following existing conceptualizations, we organize these processes into three groups: (1) knowledge exploration, (2) knowledge transfer, and (3) knowledge integration.

Knowledge Exploration

This category was composed of processes oriented towards the scanning, identification, and exploration of new knowledge. Within this group we have included knowledge search, networking, collaboration, and cooperation, as our studies particularly examined these processes. *Knowledge search* involves the purposive scanning of knowledge that may be relevant for the new firm. Knowledge search can be influenced by company size (Ritala et al., 2013), team diversity (Hayton & Zahra, 2005), and interpretation of environmental threats (J. J. Liu, Chen, & Kittilaksanawong, 2013). Because knowledge search is a strategic action (Ritala et al., 2013; E. Shu, 2017) firms that actively search for knowledge may be engaged in explorative or exploitative knowledge search strategies (Rui & Lyytinen, 2019), or engaged in

open innovation models (Karagouni, 2015). In contrast, *networking* is seen as an activity conducive to the generation and maintenance of social capital (Vasileiadou, Missler-Behr, & Ullrich, 2011), knowledge acquisition and opportunity recognition (G. Song, Min, Lee, & Seo, 2017). While *collaboration and cooperation* may occur both at the inter-organizational and intra-organizational level, often collaboration has been used to refer to agreements in which there is a clear objective with a timeframe and a financial goal. Examples of collaborative arrangements are alliances, joint ventures, partnerships between firms or technology licensing arrangements which could lead to knowledge transfer, knowledge sharing, knowledge spillovers or creation of new knowledge. Although in some cases the terms collaboration and cooperation have been used interchangeably (Grochowski, Warschat, & Dasher, 2016; McGee & Dowling, 1994; Ribeiro-Soriano, Benavides-Espinosa, & Mohedano-Suanes, 2013), in most cases cooperation is used when the parties have voluntarily agreed to interact with each other for independent goals, or when the objective is less specific or altruistic. Examples are cooperation between small scale enterprises and research institutions, or between firms and suppliers. Cooperative arrangements are likely to involve knowledge exchange (Karagouni, 2018; Ribeiro-Soriano et al., 2013).

Knowledge Transfer

As a generic construct, knowledge transfer refers to the transmission of knowledge, both at the inter and intra-organizational level (Argote & Ingram, 2000). Across the studies reviewed, a predominant approach addresses knowledge transfer as an inter-organizational phenomenon, focusing on external–internal transmission of knowledge in collaborative arrangements such as joint ventures, alliances, or academic spin-offs. Knowledge transfer in the entrepreneurial context might involve other simultaneous processes leading to commercialization, as external knowledge changes entrepreneurs' views on their own competencies, strategic focus and management of knowledge resources (Lockett, Cave, Kerr, & Robinson, 2009). At the intra-organizational level, knowledge transfer can occur between entrepreneurs and employees, among associates, from senior to junior members or between individuals with complementary capabilities through instances such as mentoring, meetings, discussions or presentations (Balan & Ionita, 2011). Other findings have emphasized factors associated with knowledge transfer success, such as the role of organizational similarity (Oxley & Wada, 2009). Moving on to more specific forms of knowledge transfer, we identified three sub-processes: knowledge acquisition, knowledge sharing, and knowledge spillovers. *Knowledge acquisition* often refers to the attainment of knowledge from external sources to

inside firms. From the studies reviewed, there are two predominant ways to account for knowledge acquisition. The first is limited to the acquisition of technological knowledge and is operationalized through patent citations, licenses or contracts of technological agreements. For example, a study examining knowledge acquisition and innovation performance based on a sample of US joint ventures examined patent citations for a period of 6 years after the alliance had been established as a proxy for knowledge acquisition (C. Chen, Lin, Lin, & Hsiao, 2017). A second way to measure knowledge acquisition includes both technological and market knowledge and it is often operationalized through a survey. For example, a study on knowledge acquisition and entrepreneurial alertness based on a sample of 138 Chinese suppliers used a Likert-scale survey to assess the extent of both technical and market knowledge acquired from a key customer (R. Ma & Huang, 2016). Another specific form of knowledge transfer corresponds to the sharing of knowledge. *Knowledge sharing* refers to the exchange of knowledge in which both parties act as senders and recipients (Ipe, 2003). Knowledge sharing has mostly been observed across entities who hold a similar status such as work peers or ventures using the same co-working space, excluding direct competitors. Because entrepreneurial firms often have flexible organizational structures, they are an ideal environment for knowledge sharing. For example, a high level of knowledge sharing is correlated with a lower organizational structure complexity (Burns et al., 2011). Additionally, knowledge sharing is positively related to entrepreneurial orientation (Li et al., 2009; Vafaei-Zadeh, Hanifah, Foroughi, & Salamzadeh, 2019). In line with these findings and based on interviews with start-up founders in Japan, Laitinen and Senoo (2017) observed that most entrepreneurs considered that incentivizing knowledge sharing within their ventures was unnecessary, arguing that working collaboratively was critical for the business operation. In contrast, knowledge sharing with external partners may be motivated by personal purposes, such as satisfaction derived from helping others or reciprocity in exchange of information, or by business purposes, in the hope it will lead to the development of business ties to collect specific knowledge (Allen, Gloor, Colladon, Woerner, & Raz, 2016). Further, knowledge sharing may be facilitated by the implementation of pre-established knowledge-sharing routines (J. Y. Lin, 2017).

Lastly, we find that the spillover of knowledge can be another form of knowledge transfer. Entrepreneurial firms can benefit from knowledge spillovers from external companies. A common case occurs when workers from established firms leave to start their own businesses and carry with them organizational knowledge from their previous institutions such as social capital (Lowe, Williams, Shaw, & Cudworth, 2012). Similarly, ventures engaged in open

innovation strategies have been found to profit from external spillovers, increasing innovation performance but decreasing innovation radicalness (Nason et al., 2019). Therefore, entrepreneurial firms that engage in R&D activities with external partners must gauge the permeability of the firm's boundaries in order to prevent drawbacks from knowledge spillovers. In the context of alliances, it has been observed that knowledge spillovers between partners are higher when the perception of knowledge protection between partners is also high (C. L. Shu et al., 2014).

Knowledge Integration

Knowledge integration processes include all knowledge-related processes oriented towards the fusion or combination of different knowledge sources inside the firm (B.-W. Lin & Chen, 2006). Because the concept of knowledge integration encompasses a broad range of processes, we include in this category the processes of *knowledge creation*, *knowledge application* and *knowledge retention*. As an overarching construct, the measuring of knowledge integration varies. For example, while one study distinguished between coordinated and systemic integration of knowledge measured through a differentiation between socialization and formalization practices (R. Guo et al., 2019), another study proposed a distinction between the knowledge aimed at exploration versus the knowledge aimed at exploitation (Rui & Lyytinen, 2019). Moving into more specific forms of knowledge integration, we found the most cited one was knowledge creation, as entrepreneurial firms seem especially suited to such processes (Jiang et al., 2019; M. T. Tsai & Li, 2007). From the studies focusing on knowledge creation, two studies used the measure proposed by Nonaka (1994) which includes four sub-processes: socialization, externalization, combination and internalization (Alshanty & Emeagwali, 2019; M. T. Tsai & Li, 2007), three studies measured knowledge creation through the assessment of its outcome (Jiang et al., 2019; A. McKelvie et al., 2018; Tolstoy, 2009), and one study used a mixed assessment of outcomes and other processes such as knowledge transfer, acquisition and exploitation of knowledge (Zacca, Dayan, & Ahrens, 2015). Less cited variants of knowledge integration are *knowledge application* and *knowledge exploitation*. However, a differentiation between those two lacks consistency across the studies reviewed and requires further examination. Lastly, *knowledge retention* as a purposeful aim of storing knowledge for future uses can also be considered as a form of integration of knowledge in firms. Despite its potential relevance, we did not find any study that rigorously examined knowledge retention or knowledge storage, however the study by Oliva and Kotabe (2019)

identified the action of resistance to documentation as one relevant barrier to knowledge management in start-ups.

Knowledge Outcomes

The studies reviewed cite several forms of innovation as consequences of knowledge in entrepreneurial firms. We make a distinction between the studies associating knowledge and related processes with *performance* measures such as firm and product innovation, innovation performance, disruptive innovation and radicalness of the innovation attained, and the studies aimed at conceptualizing innovation as a *capability* such as innovativeness, innovation capacity and likelihood of innovation. In general terms, performance measures are aimed at the quantification and/or qualification of innovation outputs given determined inputs, whereas innovation capabilities refer mostly to innovation as a behavior that is conducive to operational benefits. The latter can be measured by examining the frequency of certain behaviors, such as creative thinking, or by assessing the skills needed to innovate, regardless of contingent factors. While the first approach may fall short at clarifying whether the commitment to innovation is sustained over time, the second approach may fail at demonstrating if those capacities are in fact translated into market-valued innovation, and thus support short and long-term survival.

4.4 Review Map

The map shown in **Figure 4** provides a synthesis of concepts and their interrelations derived from our analysis. Broadly, concepts and arrows outlined with thick, continuous lines represent concepts and relationships that are more predominant in the literature (more than five studies). Conversely, concepts and arrows demarcated with dashed lines represent less examined areas that can offer opportunities for further research (four or less studies). At the centre of the map are knowledge processes. Because innovation involves both existing and new knowledge, knowledge processes facilitated the effects of knowledge sources through knowledge transfer, integration, retention, and exploration. The map generated emphasizes the importance of knowledge processes as a critical link between knowledge of any type. We have distinguished three main groups of processes, but the literature has placed a different emphasis on each of them. For example, those processes aimed at the scanning and exploration of knowledge along with transfer processes such as acquisition and sharing have been actively examined in entrepreneurial contexts. In most cases, these processes have been investigated in relation to knowledge sources rather than to firm-level repositories. Integration processes have been mostly examined from the perspective of knowledge creation, either through internal R&D investment or in collaboration with external partners.

Our review map indicates that the entrepreneurship research has strongly focused on knowledge from a resource perspective as an antecedent of innovation in firms. Following macro-level approaches aimed at understanding new venture creation, innovation and competitiveness, this research has elicited important contributions, particularly by emphasizing an input–output approach, where external knowledge plays a critical role. For example, the literature has thoroughly examined the acquisition of external knowledge or the creation of new knowledge in partnership with external entities, to generate innovation. Similarly, the literature has investigated how exploration processes such as knowledge search and networking affects innovation. In most cases, these relationships have been examined unidirectionally (knowledge to innovation), finding strong positive associations. For example, external knowledge from research institutions facilitates disruptive innovation (C. Chen et al., 2017) and market knowledge such as international business knowledge is positively associated with innovation performance (Bai et al., 2016). However, a closer examination of external sources suggests that not all types may be equally beneficial. For example, external knowledge that is tacit leads to innovation while explicit knowledge does not (Garcia-Cabrera et al., 2020). In addition, while explicit knowledge such as patents may be associated with opportunity recognition which can lead to innovation, certain sectors, such as biotechnology, may file patents before commercialization stages (Siegel & Renko, 2012), and therefore patents as a signal of innovation can be equivocal. Lastly, some sources of external knowledge have been found negatively related to venture innovation under certain conditions, such as customer knowledge when market dynamism is high (A. McKelvie et al., 2018). Regarding congenital knowledge, a similar association between human and social capital with innovation has been emphasized in the literature, with a shared distinction between knowledge base and innovation type. For example, human or social capital that is highly specialized and narrow in scope is associated with exploitative or incremental innovation (Hayton & Zahra, 2005; Hormiga & Desiderio Juan, 2016), while human or social capital that is broad facilitates explorative or more radical innovation (J. J. Liu et al., 2013; Protogerou et al., 2017).

We also note that knowledge can be stored in repositories to sustain innovation over time. The map offers a refined proposition on the link between knowledge and innovation in an entrepreneurial context, where processes mediate between sources and repositories to generate innovation. Considering that processes can be seen as strategic actions, we believe the implications of such decisions can be key to sustain innovation performance over time. Further, the map allows the recognition of underdeveloped areas that we discuss in the following section.

5. Future research agenda

5.1 Future Research on Knowledge Sources and Innovation

Entrepreneurship research has heavily focused on knowledge as an antecedent of innovation in firms. Opportunities for future research include (1) the outsourcing or reliance on external knowledge, (2) the knowledge embedded in employees, and (3) the negative side of social capital.

Within the stream of studies focusing on external knowledge we find there is an opportunity to explore external knowledge that temporarily becomes internal, such as knowledge from freelancers, consultants, contractors, incubators, and mentors. There are many different variants of these types of activities discussed in the literature on larger firm context, such as outsourcing and offshoring of knowledge related activities (Bustinza, Molina, & Gutierrez-Gutierrez, 2010; Ernst, 2000). Such activities might be highly attractive for many entrepreneurial ventures who are often resource constrained and have limited access to knowledge from highly skilled employees. Moreover, such activities provide the flexibility often associated with entrepreneurship. However, there might be many disadvantages as well, as outsourced knowledge might reduce tacit knowledge in the firm and hinder knowledge retention (Levallet & Chan, 2019). Therefore, future research might study which type of knowledge outsourcing might be efficient for entrepreneurs and also when the outsourcing of knowledge is beneficial and when knowledge is better created and maintained in the firm.

In addition, while we found three studies examining the role of the knowledge of entrepreneurial employees, we believe this topic could expand the understanding of knowledge in entrepreneurial firms and is highly undeveloped. In the context of entrepreneurship, the founder or founder team determines decision making and thus affects organizational learning and knowledge creation in the firm (Balan & Ionita, 2011), and there is evidence that such decisions are effective (A. Rauch, Frese, & Utsch, 2005). Moreover, there is ample evidence that employees matter in innovation processes in management research (B.-W. Lin & Chen, 2006; McEvily & Chakravarthy, 2002; Spencer, 2003) and they matter in entrepreneurial contexts as well (Y. Zhou, Hong, & Liu, 2013). It would be interesting to know how knowledge affects innovation in entrepreneurial firms. For example, is the effect of knowledge an imprint that supports innovation right from the start? Is it more effective to develop knowledge internally or to hire key employees to increase the knowledge stock? Is firm-level knowledge becoming increasingly important during the life cycle of the firm?

Regarding social capital, we find that most studies build on the assumption that social ties are beneficial for innovation since they allow firms to obtain knowledge that is not readily

available. However, often this view examines social ties at a point in time, ignoring the possibility that networks may develop and change strategically depending on the knowledge required to address uncertainty and innovation (Elfring & Hulsink, 2007; Engel, Kaandorp, & Elfring, 2017). In addition, there might be situations where social bonds are counteractive as knowledge obtained might be deficient, distorted or bad-intentioned but rooted in mutual trust (Levin & Cross, 2004). In particular, strong relationships might reduce external pressure to innovate and to see better ways of doing things. Thus, there might be a dark side of social capital inhibiting innovation processes (Anderson & Jap, 2005). Moreover, social capital and networking has been conceptualized at the level of the entrepreneur assuming that tie formation is goal directed, purposeful and driven by the entrepreneur (Elfring & Hulsink, 2007). However, particularly in highly uncertain environments that are typical for knowledge intensive industries, networking becomes less goal oriented and instrumental as desired ties are difficult to identify (Engel et al., 2017). As a consequence, networks become more means driven and depend on self-selected stakeholders (Hulsink & Elfring, 2019). As such, connections in the firm become important as some key employees have valuable relationships with potential collaborators of the firm.

5.2 Future Research on Knowledge Repositories

Recent entrepreneurship research has started looking at knowledge embedded in the organizational context either in tangible or intangible forms. Tangible forms of knowledge are observed in patents, tools or prototypes. Intangible forms of knowledge include routines and culture. We find that this space, traditionally occupied by studies focusing on patents as an indication of knowledge, has gradually moved towards research focusing on routines, tools, and prototypes. This approach poses several challenges and opportunities.

In general, it would be interesting to understand how knowledge repositories affect firm outcomes as more formalized knowledge might reduce flexibility and quick decision making. For example, on routines in the entrepreneurial context, literature does not agree on whether routines facilitate or hamper entrepreneurship and when. Considering the mixed findings on the implications of routines on innovation, more research is needed to clarify the role of these structures and the contextual characteristics that facilitate innovation through the entrepreneurial process. Moreover, as knowledge repositories are a result of learning processes, their capacity to stimulate innovation can vary across different developmental stages or across different learning capabilities. For example, it has been suggested that specific types of routines, such as learning routines, can be critical to incorporate new knowledge but a stronger

body of evidence is needed to support this idea. There is also an apparent lack of consensus on whether routines are developed over time or just modified from primary to more mature forms.

Overall, we see a promising future for research on how entrepreneurial firms choose to store their knowledge in a way that can be collectively accessed. For example, even though founders apparently highly value the use of digital tools and prototypes (Oliva, Couto, Santos, & Bresciani, 2019), we do not know the implications of storing knowledge in such ways or the specific outcomes. In the case of tools, while there are a few studies on the use of online platforms for interaction and collaboration, many other technological advances in the knowledge dimension have emerged in recent years that could be examined such as Internet of Things, AI, robotics or programming coding scripts just to name a few. Lastly, embedding knowledge in the organizational culture by purposively establishing practices and values that align with those of the founders seems to resonate greatly with the entrepreneurial context and could bring interesting findings. In sum, an examination of knowledge repositories in ventures may reveal strategic decisions associated with potential advantages or disadvantages of embedding knowledge in certain ways. For instance, a comparison between firms that choose to embed knowledge in organizational systems and those firms which rely mostly on individuals could suggest some implications of these decisions.

5.3 Future Research on Knowledge Processes

There has been considerable scholarly attention to knowledge processes in the entrepreneurship literature but there also remains much to be learned, specifically on (1) knowledge integration, (2) knowledge retention, 3) knowledge processes as strategic decisions, (4) conceptualization, differentiation and consistency of knowledge process operationalization and measures, and 5) interaction between knowledge processes.

First, the review denotes that a majority of the research conducted around processes has focused on processes that involve interaction with external stakeholders, such as knowledge scanning and exploration (knowledge search, networking, collaboration and cooperation), and knowledge transfer (knowledge sharing, knowledge acquisition and knowledge spillovers). Most of these studies are mainly concerned with how entrepreneurs assess, obtain, and transform external knowledge to generate internal benefits. Consequently, we know less about the processes associated with knowledge integration, and particularly around application and retention of knowledge. For example, almost no attention has been given to the integration processes that may help develop organizational structures where knowledge is embedded and stored to support sustained performance, and particularly innovation over time.

Second, it is surprising that knowledge retention has not been studied in the entrepreneurship literature on knowledge and innovation because organizational knowledge needs to be retained and passed on, otherwise it can be lost, for example, when key employees resign or move to other firms or when firms do not use this knowledge regularly. Knowledge retention may even become more important as innovations become increasingly complex in a dynamic environment. Retained knowledge influences the acquisition of new knowledge and thus affects organizational learning and transfer. In entrepreneurship research, knowledge retention is usually just a cognitive construct, assuming that it is inherent in the memory of the entrepreneur. Notably, this knowledge needs to be accessible to the employees. In the literature we see a propensity to assume that new knowledge is integrated to improve and transform the firm as it grows, while the notion of storing of relevant knowledge is mostly ignored. There are ample opportunities to study how retention takes place in the entrepreneurship process. For example, when ventures scale up to operate in new markets by establishing overseas teams, they may need to guide their new members through the main lessons already acquired to avoid repeating mistakes in the future.

Third, knowledge processes can be seen as strategic decisions. We see an opportunity to examine knowledge processes as strategic decisions carried out by entrepreneurial firms enabling a deeper understanding of the rationale and implications of those decisions. Because knowledge processes involve an action that leads to a specific outcome, we believe that entrepreneurs might have a preconceived idea of which processes to pursue and for which purposes. Conversely, a mismatch between action and outcome might have negative implications for firm performance. Following prior findings on the implications of different processes on firm performance, there are various levels of risk associated with each of them. Particularly in the context of innovation, ventures may struggle to prevent knowledge spillovers while promoting collaboration and knowledge sharing (Michelino, Cammarano, Lamberti, & Caputo, 2017). However, even firm knowledge spillovers have been observed as intentional practices, leading to benefits such as early investment attraction (Park, Shin, & Choy, 2020). Similarly, interaction with external actors has the same challenges. Thus, we believe entrepreneurial firms might gauge the advantages and disadvantages before engaging in any of these activities, particularly external versus internal collaboration.

Fourth, we see an opportunity to advance in the differentiation across existing conceptualizations of knowledge processes and implications for entrepreneurial activity. Our review found some overlap across knowledge process conceptualizations, specifically a lack of hierarchical classification of knowledge transfer and knowledge integration sub-types. For

example, the concept of knowledge transfer is relatively broad as it is not associated with a specific purpose. In contrast, the concepts of knowledge acquisition, sharing and spillover have clearer implications in firms, and therefore research on them poses a distinctive theoretical advance. While preparing this review, we noted other scholars have started to identify and tackle these issues, specifically the concepts of knowledge integration, and the distinction between collaboration and cooperation (Castañer & Oliveira, 2020; Zahra et al., 2019). Similarly, we noted research focusing on collaboration and cooperation may assume the occurrence of knowledge flow processes, such as knowledge transfer, acquisition or sharing, and wondered whether it would be more appropriate in these cases to use existing concepts or explain further how those concepts differ. The confusion around these terms also permeates the corresponding constructs and measures. For example, we observed that the concept of knowledge acquisition has been used to refer to the obtaining of knowledge without the mediation of financial transactions, in which case any new knowledge incorporated in firms may be treated as knowledge acquired. We believe this undermines research focusing on more specific actions and the implications and generates unnecessary confusion.

Finally, we see an opportunity for future research on the interrelation between knowledge processes. In most of the studies reviewed, knowledge processes are examined in isolation or directly related to innovation. However, we have less evidence of the sequence of processes and how these may be mutually affected. For example, we have found several studies that support the relevance of transferring external knowledge to generate innovation, including knowledge acquisition and knowledge sharing (Burns et al., 2011; C. J. Chen, Lin, Lin, & Hsiao, 2020; Jang et al., 2019). At the same time, the integration of knowledge through knowledge creation and application has also been highlighted as critical for innovation (J. Chen, Zhu, & Zhang, 2017; R. Guo et al., 2019; Zacca et al., 2015). However, the literature does not make a clear distinction about the implications of these processes, as the mere acquisition of knowledge has been associated with innovation directly. This prompts the question of whether integration is needed and to what extent and conversely, where is knowledge transferred and embedded if not integrated? We believe this domain may benefit from longitudinal studies that provide an in-depth understanding of transfer processes, particularly through learning and vicarious learning such as knowledge transfer from mentors, advisors, board members or temporary employees.

5.3 Future Research on Knowledge Inter-Relationships

A few recent studies have investigated knowledge resources and processes at the same time (Roper & Hewitt-Dundas, 2015; Rupietta & Backes-Gellner, 2019; Sung & Choi, 2018; van Wijk, Jansen, Van Den Bosch, & Volberda, 2012). This is important as these concepts are not independent from each other. While we recognize that more research is required on the relationships between each sub-element of the knowledge–innovation process, we highlight some specific relationships to show how future research can contribute to our understanding of the knowledge–innovation relationship in entrepreneurship research.

First, and possibly due to the dominance of a resource perspective, entrepreneurship research has looked predominantly at how knowledge affects innovation. Future research needs to highlight how innovation affects the sources of knowledge. A hypothesis could be that entrepreneurs exploit those innovations that provide the best learning potential to them and their firms and, thus, the opportunity to acquire unique knowledge resources (Haynie, Shepherd, & McMullen, 2009). Innovations that allow firms to learn and develop new knowledge might be attractive as they allow firms to develop and maintain a sustained competitive advantage. Thus, the tacitness of experience-based knowledge developed in the firm provides unique new sources of innovation. In addition, there might be reciprocal effects between knowledge sources and innovation as well as potential upward spirals of reinforcing processes in entrepreneurial firms. Thus, prior knowledge is associated with future innovation, which is, in turn, associated with subsequent knowledge.

In addition, it can be attractive to exploit the relationship between existing knowledge resources and innovations that imply productivity, efficiency, cost, and experience. Specifically, exploiting innovation requires learning and knowledge that focuses on endurance and existing trajectories (Wenke, Zapkau, & Schwens, 2021). Focusing on endurance requires different structures and processes in the firm compared to focusing on newness and change (Koryak, Lockett, Hayton, Nicolaou, & Mole, 2018). Some of these structures may have already been imprinted from the inception of the firm (Baron & Hannan, 2003; DeSantola & Gulati, 2017). While the imprinting literature argues that such effects are possibly initiated at the time of the firm formation when individual agency was high, our map in **Figure 4** suggests that knowledge repositories help to ensure that knowledge is stored, available and not lost in the innovation process. Such knowledge processes may help to address imprinting effects that diminish a firm's ability to exploit existing knowledge in order to enhance the innovation output of the firm. There are two key questions that could be tackled by research in this area. The first is how do entrepreneurial firms not only innovate but sustain innovation-driven

behavior across growth and scaling stages (D. Shepherd & Patzelt, 2021). The second is the reclaiming and adaptation of the conceptualization of organizational memory in an entrepreneurial context. Moving beyond team-level and networking perspectives such as transactive memory systems (Dai, Roundy, Chok, Ding, & Byun, 2016), investigating how entrepreneurial firms carry out processes for the retention, forgetting and discarding of knowledge and how these processes support long-term innovation could extend the scope of research based on knowledge theories and offer a deeper understanding of how innovation-led performance is attained.

Third, there are ample opportunities to look more specifically at how knowledge processes interact with knowledge sources, repositories, and innovation outcomes. For example, future research could investigate how knowledge is affected by the way in which knowledge is shared and connected in a firm. For example, do people know where information is located (e.g., digital tools, culture) and who possesses the knowledge required for innovation? Some knowledge processes may need to be implemented to make sure that any knowledge that diminishes the ability to create new knowledge required for innovation can be unlearned. Additionally, are different knowledge processes required for different types of innovation?

Fourth, we did not find much literature on knowledge and its relationships to processes in the external environment. However, knowledge by definition relies on experiences and the experiences differ in different contexts and situations (Tsoukas & Vladimirou, 2001). Thus, the environment is an antecedent of knowledge sources. At the same time, the environment might function as a moderator affecting the interrelationships between knowledge processes and innovation. For example, a resource constrained environment may not easily provide knowledge sources to a firm, for example due to difficulties recruiting knowledgeable human capital. Therefore, knowledge processes and measures to develop new knowledge internally may be critical for innovative firms operating in a resource constrained environment. Finally, there are reciprocal effects between entrepreneurs and their environment, for example between knowledge spillovers as enablers of recognition and exploitation of opportunities and economic growth enabled by the entrepreneurial activity (Acs et al., 2013).

6. Concluding remarks

The domain of entrepreneurship has repeatedly recognized the critical role of knowledge in the entrepreneurial process. Surprisingly, the study of entrepreneurs' knowledge has led to results of little practical significance. In fact, there are several meta-analyses showing

that the effect sizes of entrepreneurs' individual knowledge are small. For example, Rauch and Saeed (2021) aggregated six meta-analyses on entrepreneurs' human capital and reported an average effect size of $r = .019$. We aimed to contribute to the discussion about the importance of knowledge and entrepreneurship by moving away from an individual-level conceptualization of knowledge to a firm-level conceptualization, summarizing the literature that is available at this level of analysis, developing a conceptual map and discussing areas for future research. We believe that conceptualizing knowledge at the level of the entrepreneurial firm is timely. For example, technological developments such as digitalization, process automation, and artificial intelligence move knowledge away from the individual. Moreover, there are global trends that call for emphasizing knowledge in entrepreneurial firms. About 15 years ago, the World Bank called for a knowledge-based economy emphasizing innovation and institutions that stimulate entrepreneurship (Bank, 2007). The intersection between knowledge, entrepreneurship and innovation is not only relevant on the political agenda but is also reflected by the huge number of studies that have recently addressed this topic. For example, Piñeiro-Chousa, López-Cabarcos, Romero-Castro, and Pérez-Pico (2020) identified 424 studies published between 2015 to 2019, although many of them were at the individual level. Technological advancement and the importance of innovation is one of the megatrends that will decide how we live in the future (Hajkowicz, 2015). We hope that our research agenda inspires scholars to study and understand the role of entrepreneurship in these trends.

CHAPTER THREE

ENABLERS AND BARRIERS OF KNOWLEDGE INTEGRATION IN NEW FIRMS: FOUR EMERGING ARCHETYPES.

ABSTRACT

Knowledge integration has been defined as a multi-level organizational capability through which firms combine knowledge to generate firm-level benefits such as innovation. Therefore, knowledge integration is critical for new firms. While knowledge integration occurs through contrasting mechanisms, namely, systematization and coordination of knowledge, prior research has supported the idea that both types are needed to sustain innovation. Yet, systematization and coordination practices have different aims and require different resources and therefore we argue that new firm's founders may choose these mechanisms in distinctive ways leading to differentiated firm-outcomes. Consequently, we formulate the following question: How are knowledge integration mechanisms leveraged by new firms' founders and are there any differences in the way these are configured? We tackle this question through an exploratory qualitative study oriented towards theory generation using abductive grounded theory method. Our findings emphasize important variations in the way venture-level integration is achieved and include the identification of multilevel enablers and barriers associated to knowledge integration mechanisms, and the identification of four distinct firm archetypes. Our study contributes to the knowledge-based entrepreneurship research by suggesting antecedents of knowledge integration in new firms. Further, our study contributes to the literature focusing on venture archetypes stemming from knowledge-based perspectives.

Keywords: entrepreneurship, knowledge integration, venture archetypes, resource dependence

1. Introduction

Knowledge integration is key for innovation and thus for entrepreneurial ventures (Amankwah-Amoah & Adomako, 2021; Salunke, Weerawardena, & McColl-Kennedy, 2019; K.-H. Tsai, Liao, & Hsu, 2015; K. Z. Zhou & Li, 2012). Regardless, the extant literature suggests that innovation stemming from knowledge integration can deem particularly challenging for new firms. For example, knowledge integration has been largely associated to firm-level capabilities (Zahra et al., 2019) which may be difficult to attain in a limited timeframe and with few resources (Alvarez & Busenitz, 2001). Accordingly, one might expect that knowledge integration might only become important once firms grow and mature (Crossan et al., 1999; De Boer, Van Den Bosch, & Volberda, 1999). Moreover, while knowledge integration is a firm-level capability (Zahra et al., 2019), its occurrence can be a result of multi-level contributions (Alegre & Chiva, 2008; Argote & Guo, 2016). Yet, often new firms hold knowledge in individuals and founder entrepreneurs (Schulz, 2001; Wegner, 1987) and we do not know precisely when and how firm knowledge integration occurs, if at all. Further, knowledge integration is enabled by two contrasting mechanisms: while knowledge systematization enables integration through knowledge codification and storing in firm-level systems, knowledge coordination does it through the share of knowledge via social interaction and collaboration (Jansen, Tempelaar, van den Bosch, & Volberda, 2009; Zahra et al., 2019). Since systematization and coordination of knowledge have distinctive aims and require different resources and capabilities, it can be argued that the selection and implementation of one strategy over the other may lead to advantages or disadvantages in the capacity of firms to innovate.

Considering the above, we believe that new firm's founders may have a key role in navigating these difficulties. Moreover, since early management decisions can have long term consequences (Baron, Hannan, & Burton, 1999) we believe that the selection and implementation of knowledge integration mechanisms can be determinant in the way knowledge is structured (Macpherson & Holt, 2007) and thus affect the capacity of new firms to innovate. Following existing theorizations, founders are the key decision makers of new firms and their influence can have firm-level effects (Beckman & Burton, 2008). For example, founders who choose to predominantly integrate knowledge by systematization can generate a constrained environment that hampers creativity and affect certain types of innovation (García-Muiña, Pelechano-Barahona, & Navas-López, 2009). Conversely, founders who choose to predominantly integrate knowledge by coordination can generate an environment that prevents knowledge from being sustained over time (Levallet & Chan, 2019). Furthermore, we believe

that the attainment of firm-wide integration is complex, and therefore not all new firms may be able to achieve it, which may affect innovation. With all the above, we pose the following question: How are knowledge integration mechanisms leveraged by new firms' founders and are there any differences in the way these are configured?

We address this question through an exploratory qualitative study aimed at theory generation using the abductive grounded theory method. We use data collected from interviews with founders and employees from 22 new Australian firms. We conduct deductive steps to distinguish between two main mechanisms of knowledge integration, which we detail and refine further for contextual pertinency. In addition, we perform inductive analysis to identify enablers and barriers to the selection and implementation of knowledge integration mechanisms. Lastly, we use abductive analysis to generate venture archetypes based on the interrelation of the concepts identified.

Our findings, grounded in multilevel concepts, emphasize variances in the way knowledge is integrated in new firms. This allows us to theorise different venture archetypes that derived from it. Consequently, our findings are organised across three areas: first, we provide a description of knowledge integration mechanisms in the context of new firms. Second, we explain the concepts identified as enablers and barriers to the selection and implementation of each of these strategies. Importantly, we suggest one individual-level enabler (knowledge awareness), one firm-level enabler (organizational enablers) and one firm-level barrier (firm dependence on the founders). Third, we synthesize different combinations of mechanisms, enablers, and barriers into four empirically grounded archetypes, namely, *founder-driven*, *shared organizations*, *shared in silos* and *standardized organizations*. These archetypes depict a range of arrangements related to knowledge integration, including two extreme types (knowledge fully integrated and knowledge not integrated) and two hybrid types (where knowledge is partially integrated).

We offer three contributions. We contribute to the knowledge-based view entrepreneurship literature in two ways. First, by identifying the enablers and barriers associated to knowledge integration mechanisms in new firms. These are related to the recognition of knowledge (awareness) leveraged by new firms, specific organisational characteristics that facilitate the integration of knowledge, and the dependence of the firm on the founders to access knowledge and innovation. By doing so, we add to the literature focusing on antecedents of knowledge integration (Koch, 2011; Luca & Atuahene-Gima, 2007; W. Tsai, 2002; K. Z. Zhou & Li, 2012) by explaining how individual views can determine the selection of different firm-integration mechanisms. Second, by disentangling the relationship between

the founder and their firm regarding the integration of knowledge. Particularly, our study suggest that the implementation of integration mechanisms not always guarantee firm-level access to knowledge and innovation which could be detrimental for the capacity of new firms to innovate. Although these are preliminary findings, more research on this topic can more deeply investigate whether this phenomenon is associated with control mechanisms at the micro level, as posed by resource-dependency theories (Drees & Heugens, 2013; Hillman, Withers, & Collins, 2009). Third, by elaborating on venture archetypes based on different arrangements of knowledge integration at the firm level, we contribute to the literature on new firm archetypes from the perspective of knowledge. Although these findings are emergent, we believe our study offers a preliminary understanding of knowledge integration in new firms by suggesting that integration may concur in different ways. By doing this we offer an alternative approach that contrasts with existing views that have treated firm-level integration as a process applicable to firms in the same way (Amankwah-Amoah & Adomako, 2021; Y. J. Kim, Song, Sambamurthy, & Lee, 2012; Salunke et al., 2019).

2. Background

Prior research emphasizes knowledge integration as an antecedent of innovation in new firms (Chang, Tsai, Fu, Chen, & De Peng, 2016; De Boer et al., 1999; Koch, 2011; B.-W. Lin & Chen, 2006). Considering that innovation has been defined as a context-dependent phenomenon (Rosenbusch, Brinckmann, & Bausch, 2011), it can be argued that the use of different knowledge integration mechanisms may facilitate innovation in different settings. In line with these arguments, further research supports the idea that firms pursuing innovation need to implement a combination of knowledge integration mechanisms (Runping Guo, Li Cai, & Yupeng Fei, 2019; Guo, Lv, Wang, Chaudhry, & Chaudhry, 2020). Specifically, prior studies have distinguished between two contrasting knowledge integration mechanisms: 1) coordination, the processes oriented at knowledge exchange through social interaction, and 2) systematisation, the processes aimed at the storage, documentation and visibility of information and knowledge (Runping Guo et al., 2019). Although prior studies have used different terms to refer to these groups of mechanisms—for example, informal and formal mechanisms (Jansen et al., 2009), processes and structures (K.-H. Tsai et al., 2015), socialisation and formalisation (Briel, Schneider, & Lowry, 2019; Zahra et al., 2019), knowledge dissemination or storage (Alegre, Sengupta, & Lapedra, 2011), and knowledge share and knowledge acquisition (K. Z. Zhou & Li, 2012)—they all contend a difference between integrating knowledge through interactions and integrating knowledge through systems. Considering that both coordination

and systematisation of knowledge have their own difficulties and require different resources, entrepreneurial ventures may be more prone to implement one type over the other depending on the resources they have at hand (Guo et al., 2020; Sarasvathy, 2001). Given that key knowledge integration mechanisms differ significantly, an inclination to either one may result in a more “coordinated” or “systematised” venture that may affect its ability to innovate. Because knowledge integration and firm formation can occur simultaneously, we believe that knowledge integration mechanisms can greatly affect the way the organisation is shaped from the very beginning. Furthermore, the propensity towards one or the other strategy may be derived from the founder’s own experience, values, or beliefs. For example, literature focusing on imprinted founding characteristics have emphasised that the founding team’s prior experience can influence the organisational trajectory in the long term (P. T. Bryant, 2014; Hsu & Lim, 2014). Consequently, we believe that, in the context of entrepreneurship, knowledge integration must be examined as a multi-level phenomenon. Given that new firms are started by individuals who possess knowledge and experience (Dencker, Gruber, & Shah, 2009), understanding how this knowledge is transferred and integrated at the firm-level can add a new perspective on how innovation is achieved and sustained over time from individual knowledge contributions.

However, the empirical literature in entrepreneurship has predominantly studied knowledge integration at one single level of analysis, often at the individual or firm level. Broadly, at the individual level, research has mostly focused on antecedents such as learning processes (Pisano, 1994), human capital (Chang et al., 2016), and social capital (Yli-Renko, Autio, & Sapienza, 2001). At the firm level, research has distinguished between antecedents such as organisational capabilities (Briel et al., 2019; Chirico & Salvato, 2008) and consequences such as operational benefits (Bahlmann, 2016; Chang et al., 2016; Runping Guo et al., 2019; Jansen et al., 2009; Y. J. Kim et al., 2012; Mehta & Mehta, 2018; K.-H. Tsai et al., 2015). In such studies, knowledge is often aggregated at the firm level, without examining whether integration occurs at other levels simultaneously. Only, a few multi-level studies have drawn links across macro-level perspectives, for example, between firm-level integration and market’s dynamism (K. Z. Zhou & Li, 2012). Extending these multi-level studies, research needs to incorporate individual and organisational perspectives of firm-level knowledge integration (Casson, 2005). While there is no evidence of how firm-level integration is achieved, it is suggested that entrepreneurial firms that attain venture-wide integration are more likely to survive employee turnover and can better leverage pre-entry human capital due to the embedding of organisational resources that can withstand employee rotation (Argote & Guo,

2016; Chirico & Salvato, 2008; Gardner, Gino, & Staats, 2012). Finally, knowledge integration varies across firms (Zahra et al., 2019), and this variation needs to be covered by a theory of knowledge integration in new firms.

3. Methodology

To examine knowledge integration in the context of new firms and to allow for the generation of new ideas, we adopt an exploratory qualitative approach (Corbin & Strauss, 2008). Specifically, we employ the abductive grounded theory (Rahmani & Leifels, 2018; Richardson & Kramer, 2006; Timmermans & Tavory, 2012) as a way to build new theoretical propositions based on findings that confront existing research. Grounded theory was initially posed as a purely inductive method aimed at the discovery of emerging patterns in observed data (Glaser & Strauss, 1967); however, critical views have questioned its feasibility, arguing that the formulation of research inquiries are inevitably supported by pre-existing knowledge. In response to these concerns, refined variants of the method have arisen (A. Bryant, 2019). For example, Strauss and Corbin (1997) propose a structured process that integrates inductive and deductive steps iteratively, and Charmaz (2014) describes a constructivist approach that accounts for the researcher's background and context. In a similar vein, Timmermans and Tavory (2012) pose that integrating deductive and inductive analysis enables an abductive conceptualisation of data by generating plausible explanations that connect both existing and new ideas. Hence, by identifying and incorporating existing concepts of knowledge, particularly knowledge integration mechanisms of coordinating and systematising as a preliminary framework to extract new data, we adopt an abductive approach.

3.1 Data Sources

Consistent with grounded theory aimed at generalisation by providing evidence of research synthesis, we followed a purposeful sampling strategy consisting of a combination of criterion and maximum variation sampling (Suri, 2011). First, we established preliminary inclusion and exclusion criteria to select firms for our study. In doing so, we included firms that self-identified as ventures, including young and small firms. We included ventures that had been operating for at least one year, as knowledge integration as an organisational process develops over time (Zahra et al., 2019). Following previous conceptualisations of young firms, we established a cut-off firm age of 12 years (Rosenbusch et al., 2011). We included all team sizes, as long as the entrepreneur had at least one other collaborator, as we wanted to examine the integration of different sources of knowledge, including among individuals. Second, to achieve maximum variation within our sampling scope, we included firms from different

industries and with different aims, including manufacture, services, ICT and social enterprises. By recruiting ventures of different characteristics, we aimed at gathering contrasting cases that may lead to the collection of rich and diverse data. Third, we followed theoretical sampling in the data collection stages by adjusting the number of interviews to the emergence or absence of new insights (Corbin & Strauss, 2015). As a result of our sampling strategy, we conducted 22 interviews with 28 members of Australian ventures, as detailed in **Table 4**.

3.2 Data Collection

Over a 7-month period from January to July of 2021, we carried out one-off interviews with members of our selected firms, including founders and employees. To recruit our participants, we posted an invitation to participate in the study in different public-access entrepreneurial forums. The invitation to participate included a link to a short survey where we completed a check of our inclusion criteria. We sent group invitations to the eligible ventures' contact information they had specified in the survey, encouraging them to pass the invitation on to the rest of their members. From a total of 29 invitations, we obtained 22 positive responses from ventures to conduct interviews. Over the 22 interviews conducted, six were carried out with two participants, either one founder and one employee or two co-founders, reaching a total of 28 participants.

Table 4: Overview of interviews

Interview No.	Industry	Firm Size	Firm Age	Participant (s)
1	Financial Services	11	7	Founder
2	Healthcare	2	3	Founder
3	Social Enterprise	2	3	Founder, Employee
4	ICT	10	10	Founder, Employee
5	Transportation	6	2	Founder, Employee
6	Consulting	10	10	Founder
7	ICT	6	3	Founder
8	ICT	4	2	Founder
9	Social Enterprise	2	3	Founder
10	Marketing	5	2	Founder
11	Financial Services	15	3	Employee
12	Social Enterprise	2	2	Founder
13	Manufacturing	3	2	Founder
14	Transportation	8	3	Founder
15	Human Resources	5	1	Founder, Co-Founder
16	Education	4	1	Founder
17	Financial Services	7	1.5	Founder
18	Education	7	1.5	Founder
19	Healthcare	5	3	Founder
20	Entertainment	6	2.5	Founder
21	Hardware Automation	5	1	Founder, Employee
22	Energy	10	1	Founder, Employee

3.3 Interview Procedure

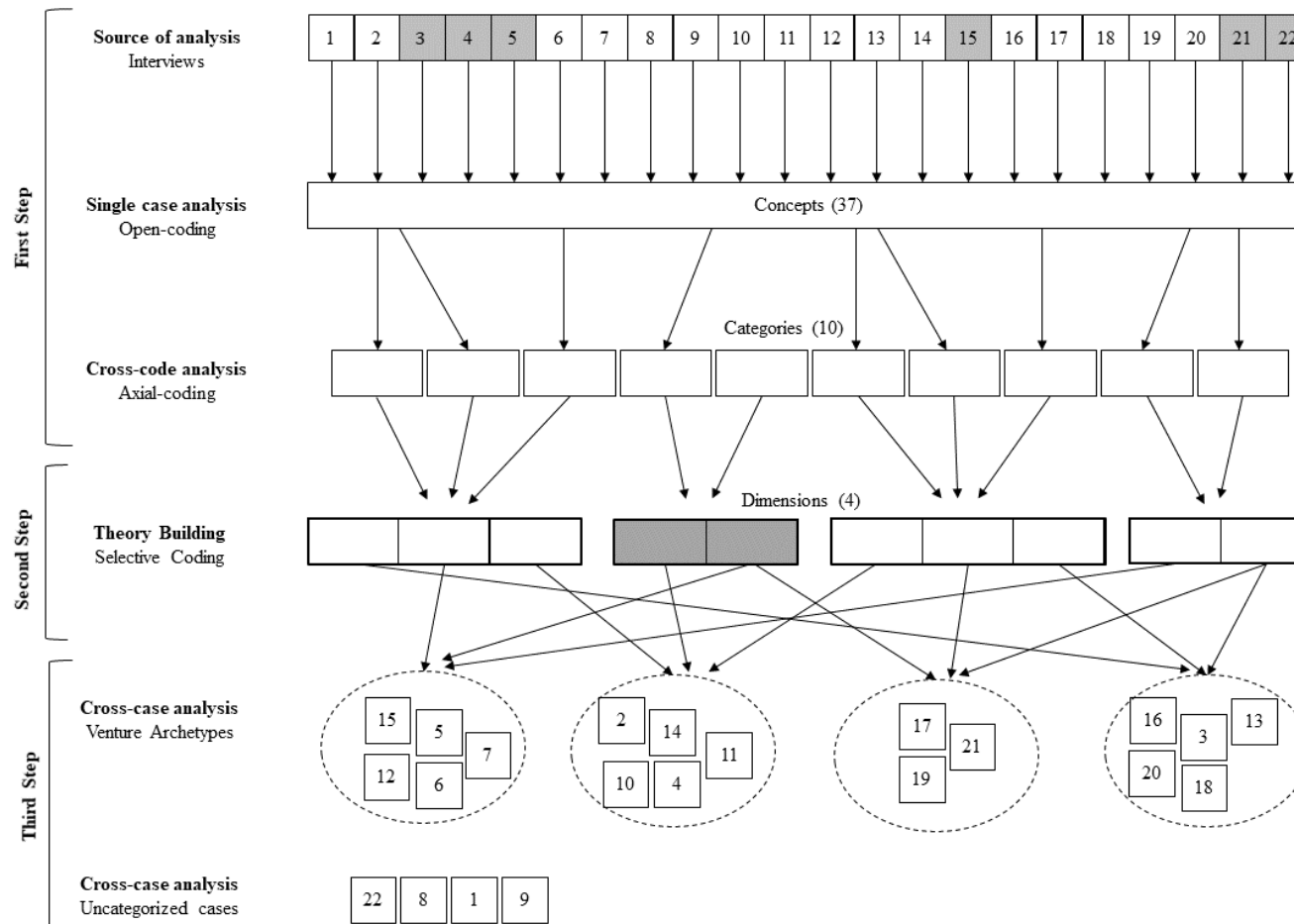
While group interviews represented a small percentage of the whole sample, we used them to increase data validity through the participants' spontaneous interactions, as group interviews "based on existing networks are likely to be more representative of people's actual daily interactions" (Hollander, 2004, p. 628). Consistent with the exploratory aim of the study, we followed a semi-structured protocol consisting of three main questions and a varying number of secondary questions depending on the answers provided. We focused our enquiries on entrepreneurial behaviour rather than entrepreneurial beliefs to minimise interpretive manipulation of the data in subsequent stages. We started our interviews by asking participants to summarise their venture journey, focusing on how they went from an idea to a business. This question led to different sub-topics such as the resources, people, and entities involved in the business development process, as well as the nature of the business opportunity, including its innovation radicalness. To assess knowledge integration, we used situational questions (Oostrom, Melchers, Ingold, & Kleinmann, 2016) across two dimensions—systemic and coordinated integration—following existent theoretical propositions (Runping Guo et al., 2019; Jansen, Van Den Bosch, & Volberda, 2005). For that purpose, we encouraged our participants to use their own definitions and understandings of the term "knowledge", avoiding the reliance on academic terminology. Situational questions have been identified as accurate predictors of human behaviour in work-related contexts (Klehe & Latham, 2006; Oostrom et al., 2016) and are a useful tool to simulate and contextualise the participant's real environment. To explore systemic integration, we asked our participants to imagine a situation where the whole team, including founders, had to be replaced by new members without notice. In that scenario, we asked them to comment on how they thought the new team would manage to continue the work they had been doing for the last few weeks. This question elicited responses of "where" knowledge was embedded, "what" this venture's knowledge was, and to what extent this information was available and accessible to new members. To assess coordinated integration, we asked participants to imagine a situation where a new skilled member would join the venture for a limited period of time while the business continued with its normal operations and activities. In this case, we asked them to describe what would they normally do to use or assess all the knowledge available. This scenario prompted responses focused on socialisation practices and coordination dynamics, such as the description of meetings and their frequency, existing induction and recruitment protocols, aspects of the venture's culture and other established organisational activities. All interviews were conducted via videoconference, recorded and transcribed for analysis.

3.4 Data Analysis

Following recommendations from grounded theory scholars, we started analysing the data as we collected it, allowing for comparison and refinement between codes and comparison with existing theoretical conceptualisations. We conducted the analysis in three iterative steps using NVivo as illustrated in **Figure 5**. First, we coded, structured, and aggregated the data following the systematic approach proposed by Gioia, Corley, and Hamilton (2013) to ensure the validity of inductive concept development and of our propositions. We started by conducting open coding on the entire content of each interview transcript, including additional information such as the venture industry, the number of the venture's members and the firm age, gathered in the selection survey. By connecting this information to each interview transcript, we generated basic cases. In addition, we produced notes or "memos" as we went along with the collection and analysis of the data to keep track of emerging insights derived from the comparison between codes and cases. We started to observe code saturation at around 15 interviews (Hennink, Kaiser, & Marconi, 2016). We conducted axial coding by subsuming codes into larger categories, thereby creating a preliminary structure of first- and second-order concepts. We continued with iterative steps of open and axial coding until we reached data saturation at around 20 interviews. Then we started conducting selective coding by aggregating categories³, revising and consolidating the data structure into first-order concepts, second-order themes and aggregated dimensions, as illustrated in **Table 5**. We used deductive codes for only one dimension—knowledge integration—in accordance with our research question. Further, in the analysis, we incorporated two deductive second-order codes: coordinated knowledge integration and systemic knowledge integration, as our data appeared to fit well into those existing theoretical conceptualisations. The following remaining codes were generated inductively: knowledge awareness as an individual-level knowledge integration enabler, organizational knowledge integration enablers and firm's dependence on their founders to access knowledge and innovation, as a firm-level barrier.

³ For additional information on the coding rationale refer to the Appendix 2.

Figure 4: Overview of the Analysis

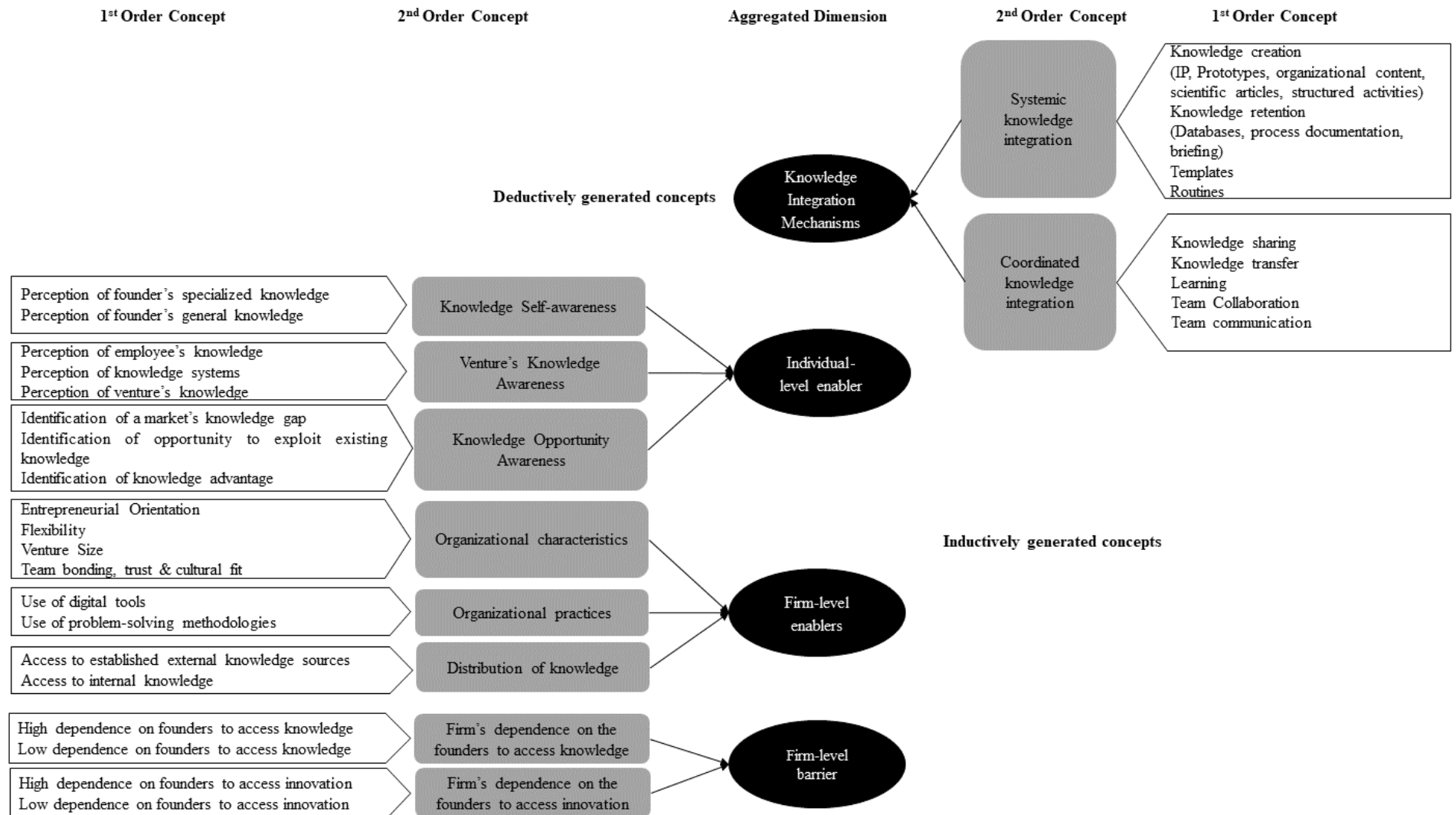


Notes:

Interviews: Highlighted squares correspond to group interviews

Theory Building: Highlighted dimension correspond to knowledge Integrated mechanisms

Table 5: Data Structure



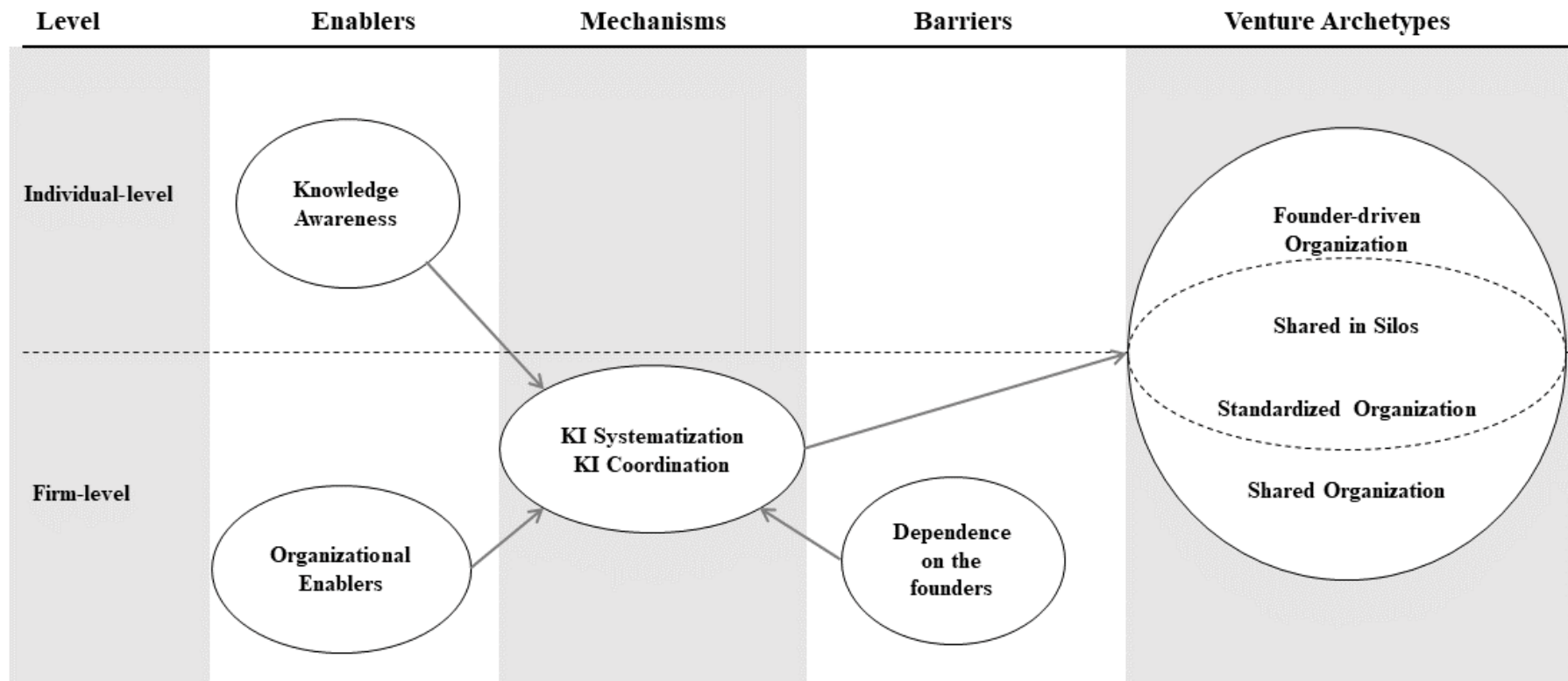
Second, we coded each interview seeking evidence of relationships between our concepts. Following similar analytical approaches, we distinguished between unidirectional and reciprocal relationships (Habersang et al., 2019). We coded unidirectional relationships as relationships between codes that follow a sequential (causal) logic, that is, when the participant provided an explanation of an issue by citing another. For example, in the excerpt *“It’s critical to have systems and processes in place to leverage other people’s knowledge so that it is not just in my own head”*, it can be inferred that this participant-founder’s knowledge awareness motivates systematic knowledge integration. In contrast, we coded reciprocal relationships when we found concepts that were interrelated but had no identifiable causal direction. For example, in the excerpt *“We have meetings internally, very open discussions. Everyone has the right to speak their mind on what they’re doing”*, it can be deducted that team communication and team bonding are mutually entwined. We compared, triangulated, and aggregated all relationships. As a result, we further grouped the concepts into 1) knowledge integration mechanisms, 2) knowledge integration enablers and 3) knowledge integration barriers.

As a final step, we compared codes between cases seeking cross-case similarities and differences as illustrated in. Following prior research with similar aims (Bronstein & Reihlen, 2014), we generated a cross-tabulation table (**Table 6**) using NVivo to compare all ventures interviewed in relation to the categories of codes generated. Since interviews differed significantly in the amount of time spent on one topic or another depending on the participant’s responses, we opted to compare our cases based on coding presence (Yes/No) instead of coding frequency. We sought patterns of similarity in relation to our coding dimensions, starting by examining similarities in knowledge integration codes. However, we only began to observe patterns when we grouped ventures together that had similar coding structures at the barriers dimension. We then identified four coding patterns from which we abductively generated archetypes by examining similarities and differences in the remaining categories. In addition, we identified a group of ventures that did not fit into the established archetypes nor follow a distinguishable pattern. As our yielded archetypes are elaborated upon the concepts and relationships described in the previous steps, we consolidate our findings in a model shown in **Figure 6**. We describe and discuss this group of ventures in the findings and discussion sections respectively.

Table 6: Cross-case analysis and archetype generation

Coding Presence / Archetypes			Standardized organization					Shared organization					Shared in Silos			Founder-driven					Uncategorized			
Dimension	Category	Concepts	15	5	7	12	6	14	11	10	4	2	17	21	19	16	20	3	13	18	9	22	8	1
Knowledge Integration Mechanisms	Coordinated Integration	Knowledge Sharing	•	•				•	•			•				•	•	•			•		•	
		Knowledge transfer		•			•		•	•			•						•			•		•
		Learning			•		•			•	•	•		•	•				•				•	•
		Team Collaboration		•					•			•		•	•							•	•	•
		Team Communication	•	•				•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
	Systemic Integration	Knowledge Creation		•	•		•		•			•		•		•			•	•		•		
		Knowledge Retention	•	•	•	•	•	•	•		•	•	•	•	•	•	•	•	•	•	•	•	•	•
		Routines	•	•																				
		Templates	•		•						•				•									•
Individual-level enabler: Knowledge Awareness	Founder's Knowledge Awareness	Perception of founder's general knowledge			•	•				•	•			•	•		•	•			•		•	•
		Perception of founder's specialized knowledge	•	•	•	•	•	•		•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
	Knowledge Opportunity Awareness	Identification of knowledge advantage			•									•				•					•	
		Identification of market's knowledge gap	•	•	•			•	•	•	•	•		•			•		•	•			•	•
		Identification of opp. to exploit existing knowledge		•													•		•			•		
	Venture's Knowledge Awareness	Employee knowledge	•	•	•	•	•	•	•				•	•	•	•	•	•	•	•	•	•	•	•
		Perception of knowledge systems: Negative		•								•		•	•	•	•	•	•	•	•	•	•	•
		Perception of knowledge systems: Positive	•	•				•		•	•										•			
		Venture's knowledge perception	•	•				•						•			•					•		•
Firm-level Knowledge Enablers	Distribution of knowledge	Access to established external knowledge	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
		Access to Internal Knowledge					•	•					•	•	•	•	•	•	•	•		•		•
	Organizational Enablers	Entrepreneurial Orientation	•				•	•										•					•	
		Flexibility	•	•				•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
		Team Bonding, Trust & Cultural Fit					•			•	•			•			•	•				•		•
		Venture Size					•			•	•	•										•		•
	Organizational Practices	Use of Digital Tools	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•			•	
		Use of problem-solving methodologies	•	•			•	•			•	•	•	•	•	•	•					•		
Firm-level Knowledge Barriers	Firm's dependence on the founders to access innovation	High level of dependence	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
		Low level of dependence						•	•	•	•	•	•	•	•	•	•	•	•	•				
	Firm's dependence on the founders to access knowledge	High level of dependence					•	•					•	•	•	•	•	•	•	•				
		Low level of dependence	•	•	•	•	•	•	•	•	•	•	•									•		

Figure 5: Theoretical Model



4 Findings

Consistent with existing theoretical propositions (Runping Guo et al., 2019; Jansen et al., 2009), we found evidence of knowledge integration across two main mechanisms: coordinated knowledge integration and systematic knowledge integration. We refer to mechanisms as the differentiating strategies, methods or processes involved in knowledge integration as identified in prior research (De Boer et al., 1999; Zahra et al., 2019). Interestingly, the number of ventures and codes associated with each of these categories was very similar, which suggests that new firms “coordinate” as much as “systematise” their knowledge. By embedding knowledge into formal systems, ventures generate horizontal linkages to exchange knowledge across differentiated units. Consequently, within the systematic integration dimension, we found the following practices: knowledge retention, knowledge creation, routines and the use of templates. Regarding coordinated integration of knowledge, we identified five main categories: knowledge sharing, knowledge transfer, learning, team collaboration and team communication. We provide contextual description of these mechanisms in **Table 7**.

Drawing on our iterative analysis, our study indicates that there are variations in the way knowledge is integrated in new firms. Based on the examination of relationships among the concepts yielded by this research, we organise our findings in two subsections. First, we identify, describe, and explain enablers and barriers of knowledge integration in new firms across two distinct mechanisms, namely systematic and coordinated integration. We identify knowledge integration enablers as the factors associated with the adoption of knowledge integration mechanisms and knowledge integration barriers as the factors found associated with the absence or scarcity of knowledge integration. We summarize these concepts in

Table 8. Lastly, we identify, elaborate, and explain four venture archetypes stemming from the combination of mechanisms, enablers and barriers found across our cases.

Table 7: Knowledge integration mechanisms in the context of new firms

SYSTEMATIC INTEGRATION OF KNOWLEDGE IN CONTEXT	
Knowledge retention	Deemed critical for business assessment and planning, knowledge retention was cited by 81% of firms surveyed across two themes: process documentation and briefing and possession of databases. Process documentation includes: - The documentation of external knowledge (i.e.: information related to customers, suppliers and advisors) - The documentation of internal processes and activities (i.e.: meeting briefings, product development roadmaps) Databases includes: - day-to-day repositories - archival repositories (i.e.: sales history and customer records)
Knowledge creation	Cited by 45% of firms surveyed in the following forms: - Prototypes - Patents, - Organisational content such as assessments, workshops, activities and legal documents. - Scientific papers derived from technological research.
Use of templates	Cited by 27% of firms surveyed, we found that often founder(s) were responsible for the creation of templates the use of templates involves: - Both the documentation of a process and the creation of new knowledge. - The identification of relevant knowledge that structures a specific process while allowing for flexibility to adjust to new use-cases. - A way to ensure that the sustenance of specific knowledge will prevail over time (knowledge consistency). - A way to facilitate internal cohesion within their teams.
Routines	Only 9% of firms surveyed referred to routines as a structured sequence of tasks conducive to a specific outcome.
COORDINATED INTEGRATION OF KNOWLEDGE IN CONTEXT	
Team communication	Cited by 77% of firms surveyed, as the fastest way to exchange information and coordinate different tasks within the team. Communication among team members include: - Verbal communication within founders or managers, team members and one-on-one meetings. - Written communication (i.e.: software-based forums, chat groups or topic-organized digital channels). Communication effectiveness was associated to communication frequency and periodicity in a verbal format even if they had multiple written communication channels as it facilitated spontaneous interaction and socialization needed, for example, in brainstorming sessions.

Knowledge transfer	Cited by 68% of firms surveyed, knowledge transfer included: - Transfer of knowledge among co-founders, seemingly more likely in earlier stages of business development. - Transfer of knowledge from founders to employees (directly through interaction) - Transfer of knowledge between employees (i.e.: through handover of roles) - Transfer of firm-level knowledge to new employees (through induction processes)
Knowledge sharing	Cited by 36% of firms surveyed, knowledge sharing was more prominent in teams where synchronous collaboration occurred and included: - Informal verbal exchanges of information - Digitally enabled knowledge sharing
Team collaboration	Cited by 36% of firms surveyed, team collaboration referred to the interdependence of team members to achieve a common goal, including: - Synchronous collaboration—often when team members have similar skills. - Asynchronous collaboration, when different skills are applied separately in consecutive steps.
Learning	Cited by 36% of firms surveyed, coordinated learning instances included formalized team meetings to reflect on failure experiences.

Table 8: Enablers and Barriers of Knowledge Integration Mechanisms

INDIVIDUAL-LEVEL ENABLER: KNOWLEDGE AWARENESS		
Knowledge Awareness	Founders' knowledge self-awareness	Founders interviewed demonstrated different degrees of awareness of their own knowledge, including: - General knowledge, cited by 77% of firms' founders surveyed as the possession or lack thereof (i.e.: through formal education or technical training) - Specific knowledge cited by 50% of firms' founders surveyed as the possession of (i.e.: prior managerial, entrepreneurial, or industry-specific experience).
	Founders' awareness of their firm's knowledge	Founders interviewed expressed different degrees of awareness of their firms' knowledge, including: - Awareness of the knowledge of their employees, mainly related to general knowledge and skills, as founders often recruit employees that can perform specific tasks. Recruitment of employees without the possession of general knowledge was also cited, as interns or mentees that can assist founders and gradually take over specific tasks.

	- Awareness of the firm's knowledge systems expressed through positive or negative perceptions of the firm's information systems. - Awareness of the knowledge of their firms as a whole, referred to the general state of knowledge of the venture compared to others.
Founders' awareness of the knowledge related to the business opportunity pursued	Founders interviewed expressed varying perceptions of knowledge related to the business opportunity that prompted the creation of their ventures, including: - The identification of a market knowledge gap (i.e., when there is a need to create new knowledge to solve an existing problem in a specific market), was cited by 59% of firms' founders. - The identification of an opportunity to exploit existing knowledge, cited by 18% of firms' founders (i.e.: by applying knowledge into a different market or leveraging specific technology) - The identification of a knowledge advantage (i.e., when the founder has realised, he or she possess specific knowledge that could be advantageous in a specific market) was cited by 18% of firms' founders
FIRM-LEVEL ENABLERS	
Organizational Enablers	Specific organisational characteristics were cited in 77% of the interviews conducted including: - Entrepreneurial orientation, cited in 22% of interviews was associated to innovation as "having a mindset of agility and always looking for opportunities to innovate", resilience and self-motivation to work in a determined industry - Flexibility, cited in 68% of interviews (i.e.: flexibility of roles and flexibility of work arrangements) - Team bonding, trust and cultural fit, were cited in association to coordinated mechanisms. - Team size, particularly small team size, was cited in 22% of interviews in association to coordination mechanisms.
	Organisational practices were cited in 86% of the interviews conducted and include: - Problem-solving methodologies to structure outcome-driven processes such as project management and innovation (i.e.: use of formal frameworks such as <i>Agile</i>, <i>Lean Canvas</i> or <i>McKinsey's Final Plan</i> or informal processes such as customer discovery or go-market strategies).

	- The use of digital tools Digital supporting systematic integration (i.e.: by providing a shared space to store and update knowledge) and coordinated integration (i.e.: by facilitating communication and collaboration).
Knowledge distribution	Cited by knowledge distribution as the concentration of knowledge in relation to the venture's members (Rulke & Galaskiewicz, 2000), including: - Established access to external holders of knowledge (i.e.: advisory board members, key customers, suppliers or other frequent collaborators). - Established access to internal holders of knowledge (i.e.: extent to which founders grant employees access to the firm's integrated knowledge)

FIRM-LEVEL BARRIERS

Firm's dependence on the founders	Firm's dependence on the founders to access knowledge	A high firm's dependence on the founders to access knowledge occurs when firm-level knowledge is concentrated and controlled by the entrepreneur, either because it is not integrated at this level, because it is not uniformly distributed, or because the founders possess specific knowledge that is difficult to access, such as social networks.
	Firm's dependence on the founders to access innovation	A high firm's dependence on the founders to access innovation occurs when innovation is predominantly carried out by the entrepreneurs, either because employees do not have access to the full extent of the venture's knowledge or because they have restricted roles in this process.

4.1 Individual level enabler of knowledge integration: Knowledge Awareness

As an individual-level enabler of knowledge integration we identified the founder's awareness of knowledge as a key factor influencing the type and extent of mechanism employed. Knowledge awareness has been referred to as "an individual's state of being informed and having perceived information about others' knowledge" (Engelmann, Dehler, Bodemer, & Buder, 2009). We found differences in the way venture members refer to and perceive knowledge across three distinct areas: the knowledge pertaining to the founders (self-knowledge awareness), the knowledge pertaining to the venture, and the knowledge related to the business opportunity exploited. Overall, we found knowledge awareness mostly related to systematic knowledge integration. Particularly, we observed that entrepreneurs who demonstrated high levels of knowledge self-awareness, specifically about technical knowledge obtained through formal education, were more likely to document, structure and store their knowledge in formal systems. Conversely, entrepreneurs who identified deficiencies in their firm's knowledge systems often associated them with the absence of formalization about their own specific knowledge such as contacts' information and social relationships, which was not available to other members of their teams. The founder's knowledge awareness about their own ventures and particularly about their employee's knowledge, was found to influence decisions such as who gets access to which information and when, as founders need to match each employee's skills with the knowledge needed to complete specific tasks. Awareness about the venture's knowledge systems was also associated with decisions around accessibility to knowledge, as often a negative perception of knowledge systems was used as a justification for a more restricted distribution of internal knowledge. Interestingly, we did not find any relevant associations between knowledge opportunity awareness and the rest of our concepts, being the only theme unlinked among our data. We presume the type of knowledge opportunity that motivates venture creation may have some implications for knowledge integration, but that area would require further research.

4.2 Firm level enablers of knowledge integration: Organizational characteristics, practices, and distribution of knowledge

We found three groups of knowledge integration enablers at the firm level: organisational characteristics, organisational practices, and knowledge distribution. Organisational characteristics included entrepreneurial orientation, flexibility, team bonding, trust and cultural fit, and team size as important factors that facilitate knowledge integration in ventures. Organisational practices included problem-solving methodologies and the use of

digital tools as enablers of knowledge integration. We suggest that these methodologies may help entrepreneurs identify, structure, and organise relevant knowledge through manageable steps so they can better adjust to unexpected scenarios. Knowledge distribution can be understood as the concentration of knowledge across the venture's members (Rulke & Galaskiewicz, 2000) including access to external and internal holders of knowledge. We identified several reasons for which founders restrict their employees' access to knowledge. Arguably, the most common reason is to protect firm-specific knowledge from spilling outside the venture, especially if the firm possesses patents or has engaged in non-disclosure agreements with other partners or clients. Another justification given by our respondents was to improve employees' performance by providing them only with the information they need to complete their tasks. In addition, respondents justified restrictions in knowledge distribution to facilitate the process of navigation and identification of relevant information. In some of these cases, a negative perception or a lack of formal knowledge systems may be accompanying these decisions. Sometimes, founders underestimated the amount of knowledge an employee would require completing their tasks, in which case, the distribution needed to be adjusted. We also found that restricting the access to internal knowledge not only affected knowledge that had been integrated systematically, but also affected the knowledge that was integrated through coordination.

4.3 Firm level barriers of knowledge integration: Firm's dependence on the founders

We identify the two firm-level barriers to knowledge integration: the firm's dependence on the founders to access knowledge and the firm's dependence on the founders to access innovation. The first occurs when knowledge is concentrated and controlled by the entrepreneur, either because it is not integrated at the firm level or because it is not uniformly distributed. We found varying degrees of knowledge dependence that we organised in two groups: high and low dependence on the founders to access knowledge. In a few cases, we found that even when knowledge was well integrated and distributed, there were specific areas of knowledge that would still be dependent on the entrepreneurs such as network contacts, stakeholders and social ties.

Similarly, we identify the firm's dependence on the founders to access innovation as a firm-level barrier to knowledge integration. This occurs when innovation is predominantly carried out by the entrepreneurs, either because employees do not have access to the full extent of the venture's knowledge or because they have restricted roles in this process. As we found varying degrees of firm's dependence on the founders to access innovation across our

participants, we distinguish between high and low firm's dependence on the founders to access innovation. In addition, we found that, in some cases, innovation was carried out by the founders with the active involvement of external partners such as members of an advisory board, customers or close collaborators, in which case the dependence on the founder diminished.

Concerning the relationship between integration mechanisms and firm's dependence on their founders, we found that systematic knowledge integration can counteract the dependency to access knowledge but not innovation. Conversely, we found that coordinated knowledge integration can counteract both. For example, a venture that has formal systems to integrate its knowledge may have a lower risk of relying on their founders to access knowledge, as the information has been supported in firm-level systems. Yet, this may not translate into disseminated innovation resulting from collaboration among members. In turn, a venture that consistently coordinates knowledge ensures less dependency on the entrepreneur to access knowledge while facilitating interaction and participation in the innovation process. Lastly, we found that knowledge dependence is related to innovation dependence, as founders who concentrated most of the venture's knowledge were more likely to lead and control the innovation activities.

Lastly, we did not find evidence of a link between the firm's age and its level of dependence with their founders, thus we suggest that entrepreneurs may choose to embed knowledge at different levels for different reasons. Although our study did not examine the rationale behind these strategies, we found support to propose that knowledge-related challenges, such as fear of spillovers, may explain a hesitancy of founders to integrate knowledge or restrict its access, in varying extents. However, innovation dependency poses a more entangled puzzle, as founders from firms with a high level of dependence related to innovation, seemed inclined to dominate the innovation process for other reasons such as strategic alignment or to provide a holistic perspective of the business problem.

4.4 Venture Archetypes stemming from knowledge integration strategies.

Through the inductive analysis based on the cross-case comparison summarized in **Table 6**, we identified four distinct venture archetypes stemming from different combinations of mechanisms, enablers and barriers: a) Founder-driven organisations, b) Shared organisations, c) Standardised organisations, and d) Shared in silos organisations, as illustrated in Figure 2. From these types, the former two correspond to extreme cases with either absence

of knowledge integration or full extent of it, whereas the two latter correspond to intermediate cases where knowledge integration is partially pursued.

Founder-driven organisation. This archetype is characterised by the minimum extent or absence of knowledge integration at the firm level. Consequently, neither systematic nor coordinated mechanisms of integration can be observable with ease. Specifically, we found little evidence of coordinated integration other than team communication and rudimentary forms of systematic integration usually related to unstructured storage of data and the creation of specific knowledge. From the group of knowledge enablers, the most relevant for this type was organisational characteristics, specifically flexibility. Likely, to compensate for the lack of organizational structure, team members and working arrangements need to remain flexible to maintain this firm afloat. Concerning other firm attributes, we found examples of this type in different firm ages, however most of them were relatively young (<3 Years) and had relatively small teams (between 2-7). Regarding individual-level enablers, particularly founders' knowledge awareness, we did not find a consistent parameter of knowledge self-awareness or specific awareness of the knowledge related to the business opportunity exploited. In turn, we did find this type associated with awareness of knowledge concerning the firm, particularly regarding the knowledge of their employees. Based on our observations, in this type of firms the founder has a one-to-one relation with each employee or collaborator, whom has specific tasks and goals to fulfill, and specific knowledge needs and requirements. Aligned with this arrangement, the founder-driven organisation often showcase a negative perception of the firm's knowledge systems. Concerning firm-level barriers, we find this type of firms relying strongly on the founders to access both knowledge and innovation which can be closely linked to its inability to integrate knowledge at the firm level.

Shared organisation. This archetype is characterised by a maximum extent of knowledge integration at the firm level. Concerning knowledge integration mechanisms, this type of firm was the one that presented more evidence of coordinated integration in all sub-categories and particularly around knowledge sharing, transfer, and learning, across all archetypes. However, we did not find a specific pattern of systematic knowledge integration. Regarding firm-level enablers this type seems to benefit mostly from organisational characteristics such as flexibility, venture size but particularly from team bonding, trust, and cultural fit. Concerning other firm attributes, all our cases grouped in this category corresponded to ventures that have been operating for three years or more, and most of them (4 out of 5 ventures) had teams larger than five members. Regarding individual-level enablers, we did not find specific associations of founder knowledge awareness or venture knowledge

awareness to this type, but surprisingly, all ventures grouped in this category presented high levels of awareness concerning the knowledge related to the business opportunity exploited, more specifically, around the recognition of a market's knowledge gap. In other words, shared organizations showcased highly motivated teams that worked cohesively and coordinately to develop a solution where knowledge-led innovation was critical for its success. In relation to firm-level barriers, this type of firm shows a low dependence on the founders to access knowledge and innovation which facilitate the integration of knowledge at the firm-level.

Standardised organisation. This type of firm is characterized by a high extent of knowledge integration and rely primarily on systematic over coordinated integration mechanisms. This type of firm showcased a variety of systematization strategies, especially related to knowledge retention through data storing practices, the documentation of processes, the creation and utilization of templates, and, notably, the implementation of routines (which were not found in any other archetype). Regarding firm-level enablers, this type seems to benefit mostly from access to established external partners and the use of digital tools. In relation to firm attributes, we found a variety of ventures within this category, from very small and young firms (less than 2-years-old and two members) to larger and more mature ventures (10-years-old, ten members). Regarding individual-level enablers, we found this type associated with a high level of founder's knowledge awareness, particularly of technical knowledge acquired through formal education. Consistent with our findings related to the systematization of knowledge, we found this type associated to positive perceptions of the firm's knowledge systems. Concerning firm-level barriers, we find this type of firms barely reliant on their founders to access knowledge, likely due to the existence of robust and updated knowledge systems. However, we find this type of firms highly reliant on their founders to access innovation, with founders controlling the innovation process by leveraging their own ideas or by restricting the tasks associated to the development of new ideas to specific firm members and collaborators. Some clues on the rationale behind these decisions given by the founders interviewed in our study, were for example, that the complexity of the problems tackled by innovation was not understood by all team members, not related to their roles either, so the founders would lead the process and identify the relevant knowledge and relevant skills needed to carry it on. Alternatively, based on our observations, this type of firms is primarily concerned with performance (for example through knowledge exploitation) and only secondarily concerned with innovation through knowledge exploration.

Shared in silos. This type of firms are characterized by presenting intermediate to low extents of knowledge integration at the firm level and rely primarily on coordinated over

systematic integration mechanisms. This archetype is distinguished by having members with highly specialised roles conforming a team with complementary skills. Regarding knowledge integration mechanisms, coordinated integration was found to be important for this type, particularly in relation to collaboration, team communication and learning, while systematic integration was mostly focused on basic knowledge retention, such as the maintenance of updated databases. Regarding firm-level enablers, this type of firms emphasizes the implementation of organisational practices such as problem-solving methodologies and the use of digital tools, and an internal distribution of knowledge that grants its access across the firm. For this group of firms, we did not find a clear pattern of age, but they all had at least five members. In relation to individual-level enablers, we found this type associated with a high level of founders' knowledge awareness, specifically around technical knowledge, and employee knowledge. Concerning firm-level barriers, this type of firms showcases a high level of reliance on their members instead of on their founders to access knowledge which is generally sorted through socialization and interaction mechanisms. Moreover, as each member hold specific knowledge and information, we find that firm-level of knowledge integration was partially attained but did not seem problematic. Alternatively, these firms show an interdependency among its members to generate innovation which translates in highly collaborative teams where innovation is achieved through firm-wide participation.

Aside from the identification of the archetypes described above, we found four ventures that did not fit in any of our previous categories, nor did they conform to a new one. The ventures included in this group ranged from newly formed (1-year-old) to mature firms (>7-years-old) and with a diversity of team sizes (from 2 to 10 members). As illustrated in Figure 2, the main reason we could not fit them into our established patterns was that the analysis did not retrieve data on resource dependence dynamics. We discuss this issue in the limitations section of this paper.

5 Discussion

Although knowledge integration in entrepreneurial contexts has not been absent from prior empirical examinations, we believe that entrepreneurship poses distinct challenges to the integration of knowledge, thus the implications for theory and practice are not fully unfolded. Complementing existing theorising that examines external and inter-organisational dynamics (Briel et al., 2019; B.-W. Lin & Chen, 2006; K. Z. Zhou & Li, 2012), we examine intra-organisational behaviour to offer a contrasting view on this issue. In line with prior propositions, we found that knowledge in ventures can be integrated in different ways.

However, more importantly, our findings suggest that those differences are influenced by a combination of individual and firm-level factors such as entrepreneurial awareness of knowledge, organisational characteristics, organisational practices, and knowledge distribution. Furthermore, our analysis reveals that the absence of knowledge integration at the firm level can be associated to firm-level barriers, such as the dependence of firms on their founders to access knowledge and innovation. We discuss the implications of our findings for theory and practice, limitations, in the following sections.

5.1 Knowledge integration enablers in new firms, towards a multi-level understanding of knowledge in ventures

Bridging existing concepts of knowledge at the macro and the micro level (Zahra et al., 2019), our findings offer a novel understanding of knowledge integration in ventures by outlining how the individual's views and decisions, along with organisational characteristics and practices, can influence knowledge integration mechanisms. At the individual level, the notion of "awareness" sits at the centre of the entrepreneurship debate, specifically supporting concepts of entrepreneurship as a discovery (Kirzner, 1997; Venkataraman, 1997) rather than a creation of new opportunities (Schumpeter, 1934). Entrepreneurial alertness, for its part, is a similar concept, just more closely associated with the ability to identify, judge, evaluate and make decisions on external situations such as opportunities (Gaglio & Katz, 2001; Tang, Kacmar, & Busenitz, 2012). Focusing on knowledge, our findings expand on these propositions by suggesting that knowledge is identified, appraised, evaluated and judged by entrepreneurs at different levels, and that, according to those perceptions, entrepreneurs make decisions that have firm-level implications. Our concept of the founder's knowledge awareness includes three sub-categories: knowledge self-awareness, venture's knowledge awareness and knowledge opportunity awareness. Concerning knowledge self-awareness and venture's knowledge awareness, our analysis offers a step further towards a multi-level understanding of knowledge integration in ventures by suggesting that entrepreneurs may be focusing on their own knowledge, the knowledge of their employees or the knowledge of the venture as a whole to sustain the firm's knowledge structure. Although more research is needed to understand the link between knowledge opportunity awareness and knowledge integration mechanisms, our findings resonate with studies that have started to draw this connection (Guo et al., 2020) and with studies that have examined opportunity identification and entrepreneurial knowledge (Ucbasaran, Westhead, & Wright, 2008).

Several relationships were identified between knowledge enablers and the remaining concepts. For example, some organisational characteristics were found to be related to coordinated integration. The most prominent, team bonding and trust, was found to have a reciprocal relationship with knowledge share. This is supported by previous findings that emphasise the importance of trust for knowledge transfer (Levin & Cross, 2004). Similarly, venture size was often cited by participants as a facilitator of team communication. Regarding organisational practices, we found that the use of digital tools significantly supported systematic and coordinated integration. For example, digital tools proved to be essential to enable communication, collaboration, learning and sharing of knowledge, while facilitating knowledge retention. Notably, all ventures interviewed had members working in different geographical locations, so digitalisation was key. However, we did not find associations between the use of problem-solving methodologies and other concepts of our analysis. Regarding knowledge distribution, we found that access to established external sources of knowledge and access to internal knowledge was associated with both low knowledge dependence and low innovation dependence. For example, when ventures had a board of advisors that met regularly, we noted that entrepreneurs were less reliant on their own knowledge and included external partners in the innovation process. Similarly, ventures from entrepreneurs who granted employees more access to knowledge seemed less reliant on the founder's knowledge, and the innovation process appeared more inclusive.

5.2 Knowledge integration barriers in new firms: the dependence on their founders

Prior research drawing on resource dependence theory has distinguished resource dependence based on specific human capital on key entrepreneurs (Arthurs, Busenitz, Hoskisson, & Johnson, 2009), on key employees (K. Liu & Arthurs, 2019), and on key stakeholders such as key customers (Yli-Renko et al., 2020). Knowledge dependence of ventures has also been studied from the perspective of external links driven from inter-organisational director connections (Howard, Withers, & Tihanyi, 2017). Resource dependencies on specific individuals have been found to restrict venture autonomy, which in turn affects firm performance (Drees & Heugens, 2013). Conversely, resource interdependence based on human capital complementarity has been linked to improved firm performance (Ethiraj & Garg, 2012). In line with previous findings, our study adds to the research focusing on new firm's dependencies by highlighting potential shortcomings associated with the dependence of the firm on their founders to access knowledge and innovation. Particularly, our findings suggest that this reliance may entail negative implications at the firm level, such as

the inability to achieve knowledge integration. In doing so, we add to the research on resource dependency theory by providing evidence of intra-organisational dependencies on key members (Arthurs et al., 2009; K. Liu & Arthurs, 2019). In line with key findings in this domain, our study suggests that such dependencies, particularly innovation dependence, can be compensated by establishing inter-organisational arrangements (Drees & Heugens, 2013). For example, our analysis indicates that innovation dependence diminishes when the venture has a formal external counterpart, such as an advisory board or established clients.

5.3 Archetypes, Variations in Knowledge Integration and Potential Implications for Innovation in Ventures

Our study adds to the research focusing on entrepreneurial archetypes (Angel, Jenkins, & Stephens, 2018; Bronstein & Reihlen, 2014; Gartner, 2008; Habersang et al., 2019). As such, our study suggests that different types of firms may arise from the interrelation between the processes of firm formation and knowledge integration mechanisms. Broadly, our analysis suggests that differences are associated with the extent to which knowledge is recognised, shared, systematised, and distributed within firms, where the entrepreneur plays a pivotal role as knowledge and innovation manager. Although more research is needed to clarify the specific implications of these variations to performance outcomes, we believe that different venture archetypes may develop different capabilities over time. For example, knowledge integration can create path dependencies that could affect the firm's ability to adapt (P. T. Bryant, 2014). As more rigid knowledge structures have been associated with growth and more flexible knowledge structures have been linked to innovation (Macpherson & Holt, 2007), knowledge that is integrated in certain ways at the beginning may determine the firm's ability to grow or innovate or do both simultaneously.

In addition to the above, the variations in knowledge integration reflected in different types of firms could be further investigated through the lens of the Upper Echelons Theory (Hambrick, 2007). This theoretical perspective can be especially relevant to the understanding of founder-driven ventures, where the influence of the entrepreneur on the decisions regarding the management of knowledge is considerable. While more research is needed to establish how the background, values, cognitive biases and other individual characteristics can influence the strategic decisions regarding the integration of knowledge in ventures, our findings suggest that founder-driven ventures are more vulnerable organisational structures as their actions and outcomes can be highly tied to the perceptions and decisions of their founders.

5.4 Limitations

This study has some limitations. The first and most important one is the exclusion of external integration mechanisms due to our focus on intra-organisational dynamics. For example, we did not examine socialisation mechanisms associated with external networking or collaboration with other organisations. Research focusing on external mechanisms and entrepreneurship has established a strong association between organisational capabilities and macro-level dynamics (Briel et al., 2019; Runping Guo et al., 2019). Complementing those views, we aimed to offer a micro level understanding of knowledge integration in ventures. By doing so, we are cognisant that an important part of entrepreneurial knowledge conceptualisation is excluded from our theoretical propositions; however, we think this allows us to offer an alternative perspective on entrepreneurial knowledge integration and a broader look into the interrelation between the entrepreneur and their developing venture. Secondly, we acknowledge the limitations derived from using interviews as a primary source of data and that most of our participants were founders. To reduce the bias created by these concerns, we conducted very open conversations with our participants, adding several follow-up questions depending on each participant's responses. We used situational questions to allow our respondents to elaborate freely on the topics presented, which generated a wide range of interview content. Furthermore, we analysed and synthesised the data by aggregating it into similar concepts through cross-pattern identification. As a third limitation, we note that our sample included relatively small ventures (≤ 15 employees), and therefore, our findings must be applied with caution to firms that are significantly larger. Lastly, regarding the group of ventures that did not fit into our archetype categories (seen as “uncategorised” in **Table 6**), we note the difficulties of extracting insights around resource dependency from managers as a unique source of data collection. Looking back at our interviews, we note those inconclusive results may be caused by the caution or dissent in disclosing sensitive information from the managerial perspective.

6 Conclusion

Our analysis indicates that there are differences in the way knowledge is integrated in ventures. We explain those differences across two areas generated through deductive, inductive, and abductive steps: the enablers and barriers of knowledge integration mechanisms, and the venture archetypes associated with them. This study offers several potential contributions to research on entrepreneurship, knowledge, and innovation. First, through a qualitative examination of knowledge integration in ventures, the study demonstrates that both

socialisation and formalisation practices are implemented by new firms and identifies the factors that facilitate and hamper the selection and implementation of such mechanisms. By doing so, we offer an alternative approach to propositions that links knowledge integration to more mature stages of firm development. While literature on knowledge integration in entrepreneurial firms exists (Macpherson & Holt, 2007; Zahra et al., 2006a), we see an opportunity to advance the understanding of the implications of knowledge at the firm level, particularly how knowledge is articulated and structured, and to what extent the flexibility or rigidity arising from those initial arrangements can facilitate or undermine the known advantages of knowledge. For example, our findings on knowledge enablers and particularly the identification of organisational practices (such as the use of problem-solving methodologies) can be further investigated as tools to structure knowledge from different sources in contexts of high uncertainty such as entrepreneurial activity. Similarly, we suggest that the use of prototypes, as opposed to templates, for knowledge integration can be observed as early indications of different approaches to knowledge sharing, collaboration, knowledge distribution and potentially resource dependencies. Therefore, more research in this domain could bring greater clarity to these issues. Secondly, we contribute to the entrepreneurship literature focusing on knowledge, by developing a model that integrates multi-level conceptualizations by explaining how entrepreneurs' views and firm attributes can lead to differentiated firm types. Third, we identify venture archetypes conveying different levels of formalisation and socialisation practices for knowledge integration. While our study offers a preliminary approach, more research around archetypes linked to knowledge structuring can contend with or refine our findings. For example, future research could investigate whether differences in knowledge integration may be associated with the venture focusing on innovation or performance independently.

CHAPTER FOUR

A SYSTEMATIC PATH TO INNOVATION? THE ROLE OF FOUNDERS IN THE KNOWLEDGE INTEGRATION OF SMALL FIRMS

ABSTRACT

Knowledge integration is critical for innovation and entrepreneurship. We thus seek to unravel the role of founders in the implementation of knowledge integration mechanisms, including knowledge coordination and knowledge systematization. We do so by investigating two antecedents of integration mechanisms: the knowledge awareness of the founder and the firm dependence on its founders to access knowledge and innovation. We use data collected through an online questionnaire, including 149 ventures from different sectors based in the region of New South Wales, Australia. We analyse the data using structural equation modelling (SEM). Our findings emphasize the role of knowledge awareness in systematic knowledge integration to achieve innovation in the context of small firms. Further, our study underscores the role of coordinated knowledge integration as an indirect pathway to innovation through systematic knowledge integration. By highlighting the role of knowledge systematization in small firms we contribute to the literature on knowledge integration in an entrepreneurial context. Furthermore, by identifying significant factors related to the role of founders in the integration of knowledge, we contribute to the entrepreneurship literature that focuses on knowledge-based perspectives.

Keywords: Entrepreneurship, knowledge integration mechanisms, innovation, knowledge awareness, knowledge dependence.

1. Introduction

Knowledge-based approaches have emphasized knowledge as a core resource and conceptualized firms as *knowledge integration institutions* (Grant, 1996). Accordingly, the main purpose of firms is the application of knowledge for the creation of value, a goal that is only achievable through the combination of different types of knowledge broadly distinguished between explicit and tacit types. Correspondingly, knowledge integration involves the mechanisms suited to articulate both strands, for example by embedding explicit knowledge into systems, or by coordinating tacit knowledge across individuals. Furthermore, knowledge integration has been deemed critical for firm innovation, including in entrepreneurial firms (Amankwah-Amoah & Adomako, 2021; Salunke et al., 2019).

Nonetheless, knowledge is context-dependent (Argote & Miron-Spektor, 2011; Brown & Duguid, 2001; Tsoukas & Vladimirou, 2001) and therefore most studies focusing on knowledge processes such as knowledge integration, have examined the conditions upon which these processes can grant firm-level benefits (Chang et al., 2016; Koch, 2011; K.-H. Tsai et al., 2015). Accordingly, the entrepreneurial activity offers a unique context for the integration of knowledge, a resource that may be both scarce and critical for firm existence (Acs et al., 2013; Dolmans, Burg, Reymen, & Romme, 2014). Furthermore, the entrepreneurship literature has characterized new firms' outcomes as heavily influenced by its founders, for example, the founders' knowledge (Dencker et al., 2009), capabilities (Teece, 2016), beliefs (Cliff, Jennings, & Greenwood, 2006), or decision making (Dean A Shepherd, Williams, & Patzelt, 2015). Considering the above, this paper aims at examining the role of founders in the knowledge integration of their firms, by exploring founder-related antecedents of knowledge integration mechanisms and their subsequent effect on innovation.

Previous research has depicted founders as critical knowledge holders (Colombo & Grilli, 2005; Dencker et al., 2009; Unger et al., 2011). However, integrating this knowledge in the firm can create several difficulties. For example, founders who hold highly specialized knowledge may need to ascertain whether to transfer those skills to employees by direct interaction, by creating manuals and procedures, or by keeping this knowledge to themselves. Similarly, founders may need to assess their employees' knowledge and choose the mechanisms to make those resources available to the rest of the firm members. In addition, previous research building on a resource-based perspective has pointed at the difficulties of managing knowledge within an entrepreneurial context. For example, new and small firms have few resources available (Baker & Nelson, 2005), may require a more flexible allocation

of tasks (Fisher, Kotha, & Lahiri, 2016; Zolin, Kuckertz, & Kautonen, 2011), and may have asynchronous work arrangements (Montoya-Weiss, Massey, & Song, 2001). These challenges place a pressing demand for knowledge integration to the founders of new and small firms.

While the literature on entrepreneurship and knowledge integration has concentrated on the identification of firm-level antecedents and consequences (Runping Guo et al., 2019; Y. J. Kim et al., 2012; Salunke et al., 2019), more focused research is needed to understand the role of founders in the adoption of knowledge integration mechanisms and their subsequent effect on innovation. We believe that the distinction between formal and informal mechanisms can be key to understand these relationships, specifically by examining founder-related antecedents for the application of knowledge integration mechanisms. For example, formal and informal mechanisms require different resources and capabilities to be implemented (Chang et al., 2016; Chirico & Salvato, 2008), may suit specific types of knowledge (Jensen, Johnson, Lorenz, & Lundvall, 2007), and may lead to different organizational arrangements, which can, in turn, affect innovation. Further, the new firm's founders may choose to integrate knowledge based on their own beliefs, past experiences, needs, aims, and resources (Cliff et al., 2006). Therefore, we believe that new firms' founders may be confronted with important challenges when pursuing innovation by leveraging knowledge integration mechanisms. Lastly, the entrepreneurship research has placed a special emphasis on the role of informal knowledge integration mechanisms such as networking, collaboration, and social interaction (Briel et al., 2019; Hulsink & Elfring, 2019; Sorenson, Rivkin, & Fleming, 2006), thus overlooking the role of formal mechanisms which are generally associated with established firms. Consequently, an improved understanding of the role of knowledge integration mechanisms in the context of entrepreneurship, and the factors associated with their occurrence may advance current theorizations and help entrepreneurs navigate these challenges in a more efficient way.

To examine the role of founders in the knowledge integration of new firms, we focus on two antecedents: the *knowledge awareness of the founder*, as the extent to which founders identify and appraise firm knowledge, and the *firm's dependence on its founders*, as the extent to which the firm relies on the founder to access knowledge and innovation (Tabilo & Rauch, 2022). Consequently, we investigate the interrelation between these founder-related antecedents, systematic and coordinated knowledge integration mechanisms, and its effect on innovation, through a quantitative study using structural equation modelling (SEM) to analyse data collected from 149 Australian ventures from different sectors.

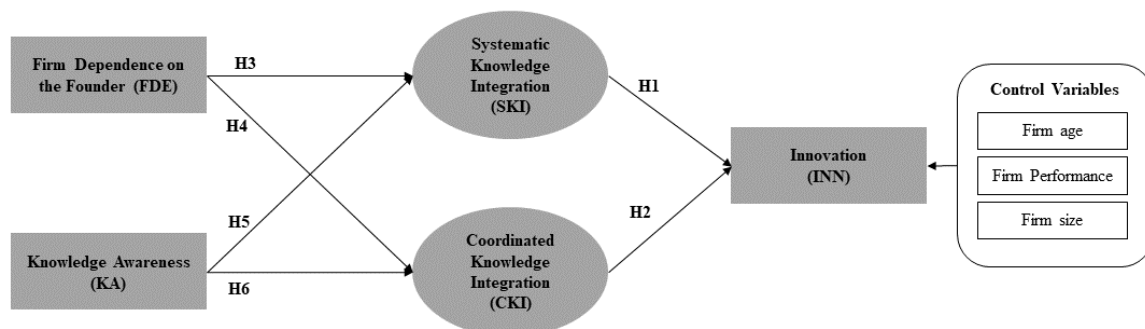
Our findings underscore the role of the founder's knowledge awareness which is found positively associated with knowledge integration mechanisms leading to innovation,

particularly systematic knowledge integration. In addition, we find that coordinated integration facilitates systematic knowledge integration which in turn leads to innovation. These findings contribute to the knowledge-based view of new firms. First, by looking at the role of founders in knowledge integration and its effect on firm-level outcomes such as innovation, we bridge the understanding between micro and macro-level perspectives (Zahra et al., 2019). We do so by offering a nuanced view on the role of founders suggesting that the founder's identification and appraisal of knowledge can be sufficient to action distinctive knowledge integration mechanisms, conducive to innovation. Second, by looking at and comparing different knowledge integration mechanisms concurrently, we refine existing conceptualizations of knowledge integration concerning innovation. Specifically, by highlighting the importance of systematic knowledge integration, our study contends a seemingly large number of studies focusing on coordination mechanisms, and their effect on innovation in the context of new and small firms. Moreover, in line with conceptualizations advocating for the complementarity of both types of mechanisms (Jansen et al., 2009), we provide a refined conceptualization of the relationship between them in the context of small firms. Third, we contribute to the literature focusing on innovation in new and small firms – a context where founders have a larger impact compared to larger firms (Andries & Czarnitzki, 2014).

2. Background

In the following, we elaborate on the role of founders in knowledge integration mechanisms and their subsequent link with innovation. We discuss these concepts and generate hypotheses that are illustrated in **Figure 7**.

Figure 6: Conceptual Model and Hypotheses



2.1 Knowledge integration mechanisms and innovation

Knowledge integration – the firm-level capability to create and recombine knowledge through formal and informal mechanisms (Zahra et al., 2019) – is important for firm-level

outcomes such as innovation (Barley et al., 2017; Koch, 2011; K.-H. Tsai et al., 2015), which in turn is key for entrepreneurship (Colombelli, Krafft, & Vivarelli, 2016; Minola, Hahn, & Cassia, 2019; Protogerou et al., 2017). The literature discusses two mechanisms of how knowledge is integrated at the level of the firm: formal or systematic mechanisms refer to the encoding, embedding, and storage of knowledge in systems that are accessible to the whole organization, and, informal or coordinated mechanisms focus on the exchange of knowledge through social interaction (Briel et al., 2019; Runping Guo et al., 2019; K. Z. Zhou & Li, 2012).

Systematic Knowledge Integration

The integration of knowledge through systematization involves the practices aimed at the encoding, organizing, and storing of knowledge in formal systems (Runping Guo et al., 2019; K.-H. Tsai et al., 2015; Zahra et al., 2019; K. Z. Zhou & Li, 2012). While knowledge systematization has been found beneficial for activities that require consistency over time, for example, operational processes (Kah-Hin & Nebus, 2012), knowledge systematization has also been posed as a firm constraint (Macpherson & Holt, 2007). Nonetheless, in some specific contexts, knowledge systematization can support learning and decision-making toward change. For example, the systematization of knowledge through codification can enable vicarious learning from complex and heterogenous experiences (Echajari & Thomas, 2015), therefore, knowledge systematization may be especially relevant to the integration of knowledge in interdisciplinary teams. In addition, the extent to which knowledge is systematized within a firm appears relevant, as higher levels of knowledge codification can hinder decision inertia and change in the context of post-acquisition integration, compared to lower levels of codification (Castellaneta, Valentini, & Zollo, 2018).

Coordinated Knowledge Integration

The integration of knowledge through knowledge coordination includes practices oriented toward the transfer and creation of knowledge via social interaction (Runping Guo et al., 2019; K.-H. Tsai et al., 2015; Zahra et al., 2019; K. Z. Zhou & Li, 2012). As suggested in the literature, the coordination of knowledge is a key ingredient for innovation (Dingler & Enkel, 2016). Since innovation involves the combination of existing knowledge (Collins & Smith, 2006), the aim at share, transferring, and exchange of knowledge through social interaction facilitates this process (Tödtling, Lehner, & Kaufmann, 2009). Specifically, knowledge coordination can support the absorptive capacity of firms (Jansen et al., 2005), enabling them to leverage external knowledge resources, such as social capital (Moreira,

Markus, & Laursen, 2018). In addition, knowledge coordination can facilitate the leverage of internal knowledge, for example through knowledge sharing, however, this relies on team-level factors such as trust (Rauniar, Rawski, Morgan, & Mishra, 2019), un-hierarchical structures and the existence of informal lateral ties among team members (W. Tsai, 2002).

While prior research on knowledge integration mechanisms in the context of new firms, has mostly focused on coordination processes (Briel et al., 2019; Salunke et al., 2019), existing theorizations point to the complementarity of systematization and coordination of knowledge to achieve innovation (Jansen et al., 2009; López-Nicolás & Meroño-Cerdán, 2011).

Since the systematization of knowledge can facilitate the storing, codification, organization, and management of firm-level knowledge, we hypothesize that:

Hypothesis 1: Systematic knowledge integration positively affects innovation in new firms.

Further, since the coordination of knowledge through social interaction can involve the transfer of tacit knowledge, which is difficult to articulate and access, we hypothesize that:

Hypothesis 2: Coordinated knowledge integration positively affects innovation in new firms.

2.2 Founder-related antecedents of knowledge integration mechanisms

There is an extensive discussion in the literature about the antecedents of knowledge integration (Zahra et al., 2019). At the individual level, existing theorizations have relied on resource-based theories, including human and social capital approaches (Bahlmann, 2016; Chang et al., 2016; Zhang, Wang, & Zhao, 2021), and capabilities, such as managerial, leadership, and decision-making capacity (Caridi-Zahavi, Carmeli, & Arazy, 2016; Guo et al., 2020). Correspondingly, the entrepreneurship literature drawing from knowledge-based view approaches has underscored two key roles of founders regarding knowledge in new firms. First, founders are depicted as key knowledge holders within their firms (Kato, Okamuro, & Honjo, 2015; Protogerou et al., 2017; Unger et al., 2011). Second, founders are the key decision-makers within their firms (Dean A Shepherd et al., 2015), including decisions about the management of resources such as knowledge (Sirmon & Hitt, 2003; Sirmon, Hitt, Ireland, & Gilbert, 2011). Playing this double role around knowledge can lead founders to encounter many difficulties, for example, gauging between integrating their own knowledge at the firm level, or, keeping the knowledge of others to themselves. In the context of new and small firms, these actions can determine the extent of control that founders have over the firm resources. Alternatively, knowledge decision-making may require specific capabilities or understandings

that go beyond formal education and experience, for example choosing an effective integration mechanism to achieve a firm-level purpose such as innovation.

Considering these views and based on the findings of a precedent study (See Chapter Three), we introduce two plausible antecedents of knowledge integration mechanisms related to the role of founders. First, drawing from scholarly views of entrepreneurs as key knowledge holders, we argue that the concentration of knowledge on the firm's founders can lead to knowledge dependence, which in turn, may hinder the integration of knowledge at the firm level. Second, drawing from research underscoring the role of founders as decision-makers, and extending views linking the perception of resources with managerial actions (Dolmans et al., 2014; Voss, Sirdeshmukh, & Voss, 2008), we argue that the founder's knowledge awareness can facilitate the recognition and assessment of different types of knowledge, leading to the implementation of knowledge integration mechanisms. We elaborate on these concepts in the following.

Knowledge dependence

While the integration of knowledge through systems or practices has been generally found beneficial for firms, the sole implementation of these mechanisms may not suffice to grant firm-wide access to knowledge and innovation. Prior studies have examined the *knowledge dependence* of the firm on key individuals (Howard et al., 2017; K. Liu & Arthurs, 2019), however, as salient reviews suggest, the literature on this domain has predominantly explained the dependence of firms from its external environment, using a resource perspective (Drees & Heugens, 2013; Hillman et al., 2009). Yet, a potential dependence of firms upon their founders can also lead to control mechanisms over the use and access to knowledge and innovation which may reduce their ability to innovate through knowledge. Furthermore, the reliance of knowledge on key individuals appears contrary to the idea of firm-level integration, which aims at the combination of knowledge from multiple sources with its consequent firm-wide knowledge appropriability (Toh & Ahuja, 2022). This idea extends to both knowledge integration mechanisms. For example, a firm that has robust knowledge systems, where information is frequently codified, stored, and updated, might be less likely to rely on its founders to access knowledge and innovation. In the same way, a firm that coordinates knowledge frequently, by transferring and sharing knowledge across members through social interaction, might be able to distribute knowledge across its members, reducing its reliance on individual knowledge. In both cases, the knowledge held by the founders might be embedded in systems or transferred across individuals.

Consequently, we hypothesize that:

Hypothesis 3: The dependence of the firm on its founders to access knowledge and innovation can negatively affect systematic knowledge integration in new firms.

Hypothesis 4: The dependence of the firm on its founders to access knowledge and innovation can negatively affect coordinated knowledge integration in new firms.

Knowledge Awareness

At the individual level, we propose that the *knowledge awareness* of the founder regarding their knowledge and the knowledge of others (Engelmann et al., 2009) can affect the extent to which knowledge is systematized or coordinated in young firms. Being aware of knowledge involves the recognition and assessment of knowledge in the firm, for example, being able to identify whether the firm possesses unique knowledge compared to its competitors, whether its members including themselves possess highly technical or general knowledge, or whether the firm aims at creating, exploiting, or transferring knowledge in the market where it operates. Our preliminary study (See Chapter Three) suggested that knowledge awareness could influence the founder's decisions on how to integrate knowledge. For example, founders who were highly aware of technical knowledge were more inclined to codify and store their knowledge in formal systems and organize knowledge through structured material such as templates and forms. In those cases, the recognition and appraisal of valuable knowledge, motivated founders to preserve knowledge in a way that can be used iteratively and reliably over time. This response was observed upon the recognition of knowledge from different sources and at different levels, for example when the valuable knowledge was held by the founder, by key employees, or by external advisors, and also when the knowledge was collectively assembled.

Similarly, founders who were highly aware of knowledge were also prone to coordinate knowledge frequently. In this case, the recognition and appraisal of valuable knowledge that is contingent (for example, the knowledge generated throughout projects) motivated founders to establish instances for the transfer, sharing, and exchange of knowledge such as regular meetings, mentorship practices, and social events.

Based on those findings, we hypothesize that:

Hypothesis 5: The knowledge awareness of the founder positively affects systematic knowledge integration in new firms.

Hypothesis 6: The knowledge awareness of the founder positively affects coordinated knowledge integration in new firms.

3. Method

3.1 Sample

The sample corresponds to 149 ventures operating in the state of New South Wales, Australia. The data was collected through a self-administered questionnaire distributed to ventures from different sectors, that have been operating for less than 10 years and were composed of at least 2 members. The questionnaire was distributed via email to 2,088 ventures, corresponding to the total number of listings found at the following public databases (NSW Start-up hub, Crunchbase) by July 2022. From that group, 657 invitations were returned undelivered due to different situations for example because of companies ceasing to operate. Correspondingly, a total of 1.431 invitations were successfully delivered. The data collection process resulted in 225 submitted questionnaires from which 149 corresponded to complete responses that were included in the analysis, representing a response rate of 10.4%.

The firm profiles and respondent profiles can be seen in detail in **Table 9**. The sample is varied across industries (31.4% technology sector, 68.6% spread out around 25 other sectors) and corresponds mostly to young firms (4.2 Years on average) and small firms (15.6 employees on average). Furthermore, 59% of the firms declared to be in the initial stages of development (pre-seed, seed, and early stage).

Table 9: Firm Profiles and respondent characteristics

Firm characteristics	Mean / Range	Category	Percentage
Age (years)	4.2 / 0.5-14	0-5	77.2
		6-10	18.8
		11-14	4.0
Size (no. of full-time employees, incl. founders)	15.6 / 1-334	1-10	71.1
		11-100	26.2
		101-334	2.7
Number of founders	2 / 1-6	1	33.6
		2-3	57.7
		4-6	8.7
Business Stage		Pre-seed (1.3%) & Seed (20.8%)	23.4
		Early stage (36.9%) & Growth (34.9%)	70.6

	Expansion (scale) & Exit	6.0
Industry sector	Technology	31.4
	Other 25 industries (<10%)	68.6
Type of firm	For-profit	100
Respondent characteristics	Category	Percentage
Gender	Female	24.2
	Male	73.8
	Other	2.0
Role in the firm	Founder	91.9
	Full-time employee	6.0
	Part-time employee	2.1
Sample size: 149		

Table 10 summarizes the composition of firms regarding the role of their members, this is the number of founders, full-time, part-time, and freelance employees of each firm. Accordingly, most firms had more than one founder (66.4% between 2-10 founders) and a minimal number of part-time and freelance collaborators (between 0 and 1).

Table 10: Firm Composition by Role

Role	Mean/range	Category	Percentage
Founder(s)	2.05 / 1-6	1	33.6
		2-3	57.7
		4-6	8.7
Full-time employees	10.18 / 0-150	0-1	37.5
		2-10	40.3
		11-50	18.1
		50-150	4
Part-time employees	3.33 / 0-223	0-1	64.5
		2-10	32.8
		11-223	2.7
Freelancers	9.49 / 0-823	0-1	44.3
		2-10	19.7
		11-823	6

3.2 Measures

The measures included in the questionnaire were derived from the extant literature and others were self-developed based on our qualitative pilot study. To develop a questionnaire, we conducted the following preliminary steps: (1) the conduct of a preliminary qualitative study on a separate group of ventures to identify items to develop scales, (2) a draft of the survey was piloted on a separate group of 34 ventures to test the clarity and effectiveness of the questions included, (3) the inclusion of a detailed participant information sheet at the beginning of the survey to explain the project's purpose and method, (4) the inclusion of a consent form as a mandatory field to submit a response. A full list of questionnaire items is provided in **Appendix 3**.

An overview of the variables included is showcased in **Table 11**. The independent variables include (1) knowledge awareness, and (2) the firm's dependence on its founders to access knowledge and innovation. As mediating variables, we included the following knowledge integration mechanisms: (4) systematic knowledge integration, and (5) coordinated knowledge integration. As a dependent variable, we examined (6) firm innovation, through an index measure composed by the number of new products and services successfully introduced in the market over the last 12 months, and the number of products and services in development over the last 12 months. In addition, we included control variables such as firm age, firm size, and firm performance. The survey questions were measured using a five-point Likert scale (anchored from strongly disagree[^] (= 1) to strongly agree[^] (= 5)). Reliability measures and construct validity tests (using confirmatory factor analyses) were performed for all reflective measures. Cronbach's alpha results are also presented in **Table 13**.

Table 11: Overview of variables

Variable Type	Abb	Variable Name	Description
Independent Variable	KA	Knowledge Awareness	The extent to which individuals identify and appraise knowledge
	FDE	Firm's dependence on the founder	Perceived reliance on the founder to access knowledge and innovation
Mediating Variables	CKI	Coordinated Knowledge Integration	Informal practices aimed at capturing, interpreting, and synthesizing knowledge
	SKI	Systematic Knowledge Integration	Formal practices aimed at capturing, interpreting, and synthesizing knowledge

Dependent Variable	INN	Innovation	New to the market Innovation: Number of products or services that are new to the local market where the venture is operating
			Innovation in Development: Number of new products or services that the venture is currently working on; not introduced yet
Control Variables	AGE	Firm Age	Number of years that the firm has been operating
	SIZE	Firm Size	Number of venture's full-time employees, including founders
	PER	Firm Performance	Perceived performance against competitors across different areas

Independent variables

The measures for knowledge awareness and firms' dependence were self-developed based on our qualitative pilot study. We opted to develop formative over reflective measures as the items for each variable measured specific forms of each construct, therefore, conveying different degrees of the variable rather than complementing each other (Hulland, 1999). Specifically, we computed indices for these variables by adding the standardized items divided by the number of items as used in other studies (Andreas Rauch & Rijsdijk, 2013).

Correspondingly, *knowledge awareness (KA)* is a 7-item indexed measure developed upon responses about seven questions assessing: i) the awareness of knowledge related to the business opportunity pursued, ii) founders' knowledge self-awareness and ii) the awareness of the knowledge of the firm as a whole. The measure for *dependence of the firm on its founders (FDE)* was adapted from Skinner and Gultinan (1986), based on the data collected through interviews shown in Chapter Three. Correspondingly, this variable was assessed using a 4-item indexed measure containing responses from two areas, i) the reliance of the firm on their founders to access knowledge, and ii) the reliance of the firm on their founders to access innovation.

Mediation variables

To assess knowledge integration mechanisms –systematic knowledge integration (SKI) and coordinated knowledge integration (CKI), we adapted existent scales previously applied in the literature (De Boer et al., 1999; Runping Guo et al., 2019) based on the data collected through interviews and shown in Chapter Three. For systematic knowledge integration, the

Cronbach's alpha is 0.767, and the composite reliability is 0.853. For coordinated knowledge integration, the Cronbach's alpha is 0.875, and the composite reliability is 0.877.

Dependent variable

We measured innovation using recommendations from the "Oslo manual 2018: guidelines for collecting, reporting and using data on innovation" (2018). Particularly, we created an index measure combining the number of new products and services that were successfully introduced in the market (*new-to-the-market innovation*) and the *innovation in development* over the last 12 months. We opted for including innovation in development due to the characteristics of our targeted firms, particularly age. Innovation that is new to the market was assessed by the number of products or services that are new to the market where the firm is operating and introduced in the last 12 months. Innovation in development was assessed by the number of new products or services that the firm has been working on for the last 12 months.

Control variables

As control variables, we included firm age, firm size, and firm performance. Specifically, while young firms have been found more innovative compared to mature firms (Huergo & Jaumandreu, 2004) young firms may face more challenges leveraging knowledge to achieve innovation (Balasubramanian & Lee, 2008). Accordingly, we measured firm age as the number of years that the firm has been operating. Similarly, firm size can influence the innovation output of firms (Shefer & Frenkel, 2005) as large firms have more resources and capabilities at hand to leverage knowledge (Knott & Vieregger, 2020). As shown in Table 9 71.1% of our sample corresponded to firms of less than 10 employees, and 97.3% of our sample corresponded to firms of less than 100 employees. As a result, the data corresponding to firm size was not normally distributed but skewed and therefore, we tested firm size as a log-linear variable to depict the relationship between this control variable and innovation more accurately. We detail these tests on a separate reference in Appendix 4. Lastly, following existing operationalizations (Santoro et al., 2019; Wiklund & Shepherd, 2003) we captured firm performance by asking respondents to rate their firm's performance against their competitors across six areas: overall performance, sales growth, market share, profit growth, product and service quality and customer satisfaction using a five-point Likert scale from much lower (1) to much higher (5).

3.3 Analysis

Given that our hypotheses involve the examination of a series of interrelations between constructs, we use structural equation modelling (SEM) to test our propositions. SEM is a technique that allows the conduction of path analysis, this is, the conceptualization and estimation of “the magnitude and significance of hypothesized causal connections among a set of variables” (Stage, Carter, & Nora, 2004, p. 5). Because path analysis requires the examination of a model grounded in a theoretical framework, we believe this technique is well suited to assess the propositions included in our conceptual model. Importantly, while path analysis is not aimed at exploratory research, it allows the comparison between models that entail refined propositions of the relationship between variables, such as competing direct and indirect paths to the explained variables. More specifically, SEM was chosen above other techniques for the following reasons: i) it allows the inclusion of observed and unobserved variables, ii) it accounts for the measurement of error iii) it facilitates the depiction, assessment, and refinement of both theoretical conceptualizations and measures (Hulland, 1999). Correspondingly, the data was analysed in two steps. First, we run descriptive analyses and measurement validation using SPSS, version 28. Second, we employed AMOS 28 to conduct structural equation modelling to assess and estimate the structural model by testing the hypothesis proposed.

Measurement Validation

Regarding the assessment of the formative measures employed (Knowledge Awareness and Firm dependence on their founders) we adhere to most methodological approaches that underscore the difference between reflective and formative measures and the requirement of differentiated methodological treatments (George, 2011). As such, formative measures represent constructs that are *formed by* the aggregation of its multiple dimensions, regardless of whether these dimensions are or not correlated (George, 2011; Kenneth, 1989). Consequently, all dimensions need to be incorporated in order to represent the construct appropriately. Thus, the measurement validation process applied to reflective measures, does not apply to formative ones. Specifically, as posed by George (2011, p. 1299) “measures of internal consistency reliability such as Chronbach’s alpha are not valid indicators of reliability for a formative construct since it represents the extent to which the indicators represent a common underlying construct.”

To estimate the validity and reliability of the reflective measures, we conducted the following assessments. We conducted an exploratory factor analysis to assess the internal

reliability of our latent variables as summarized in **Table 12**, followed by a confirmatory factor analysis. **Table 13** shows the reliability of the scales employed in the study. First, we assessed Cronbach's alpha and composite reliability (CR) of the latent variables employed. Following existing theorizations for reliability measures, all our latent variable's alphas were above the recommended 0.70, the lowest being 0.767 pertaining to Systematic Knowledge Integration (SKI). Second, we assessed construct reliability (CR) measures, with all values above the recommended threshold of 0.70 (Hu & Bentler, 1999) with the lowest being 0.853 corresponding to systematic knowledge integration (SKI). Third, we assessed convergent validity by calculating the average variance extracted (AVE) which retrieved values above the recommended 0.5. Further, AVE values are lower than CR. Fourth, we assessed discriminant validity by calculating the maximum shared variance (MSV), which values are lower than AVE. All in all, we did not find problems related to the validity of the measures employed in the study.

Acknowledging potential issues derived from the use of data collected through single sources, we assessed the common method variance (CMV) present in the study. To do so, we conducted the following tests. First, we conducted Harman's one-factor test by reducing all the variables to a single factor constrained without rotation. As a result, we obtained a single factor explaining 33.81% of the total variance which is lower than the maximum of 50% recommended. Second, we conducted a common latent factor analysis (CLF) by estimating the common variance among all variables when a common latent variable is introduced. The result retrieved a common variance of 15.21% which is below the recommended threshold of 50%.

Table 12: Exploratory Factor Analysis (EFA)

	Rotated Component Matrix^a	
	Component	
	1	2
CKI_1	0.808	0.049
CKI_2	0.747	0.221
CKI_3	0.781	0.221
CKI_4	0.851	0.212
CKI_5	0.797	0.292
SKI_1	0.107	0.583
SKI_2	0.226	0.842

SKI_3	0.284	0.764
SKI_4	0.123	0.772
Extraction Method: Principal Component Analysis.		
Rotation Method: Varimax with Kaiser Normalization.		
a. Rotation converged in 3 iterations.		

Table 13: Scale validity and reliability measures

	Cronbach's alpha (> 0.70)	CR (> 0.70)	AVE (> 0.50)	MSV
Systematic Knowledge Integration (SKI)	0.767	0.853	0.681	0.556
Coordinated Knowledge Integration (CKI)	0.875	0.877	0.592	0.556

Regarding correlations between variables as shown in **Table 14**, we did not find high correlations between independent variables.

3.4 Results

To test our hypothesis, the study included the development of SEM models using SPSS AMOS version 28. We present the results of two models. Since our initial model (Model 1) retrieved goodness-of-fit indices that partially meet the recommended values, we developed an exploratory model (Model 2) to examine additional propositions of the relationship between variables. Thereby, this section describes the results obtained by *Model 1* and *Model 2*. A comparison of the indices obtained for both models is summarized in **Table 15**.

Table 14: Correlations between variables

		Correlations									
	Variable	Mean	St. Dev.	1	2	3	4	5	6	7	8
1.	KA- Knowledge Awareness	0.000	0.501	1.000							
2.	FDE- Firm dependence on founder	0.000	0.809	.314**	1.000						
3.	SKI- Systematic Knowledge Integration	4.001	0.708	.291**	-0.003	1.000					
4.	CKI- Coordinated Knowledge Integration	4.422	0.615	.189*	-0.033	.471**	1.000				
5.	INN- Innovation	0.000	0.926	.323**	.868**	0.018	-0.041	1.000			
6.	PER- Firm Performance	0.000	1.000	.218**	0.033	.165*	.210*	-0.030	1.000		
7.	AGE- Firm Age	0.000	1.000	0.078	0.038	0.042	-0.057	0.009	0.112	1.000	
8.	SIZ- Firm Size	0.190	1.155	0.097	-0.074	0.242**	0.175*	0.296**	.349**	.418**	1.000

** . Correlation is significant at the 0.01 level (2-tailed).

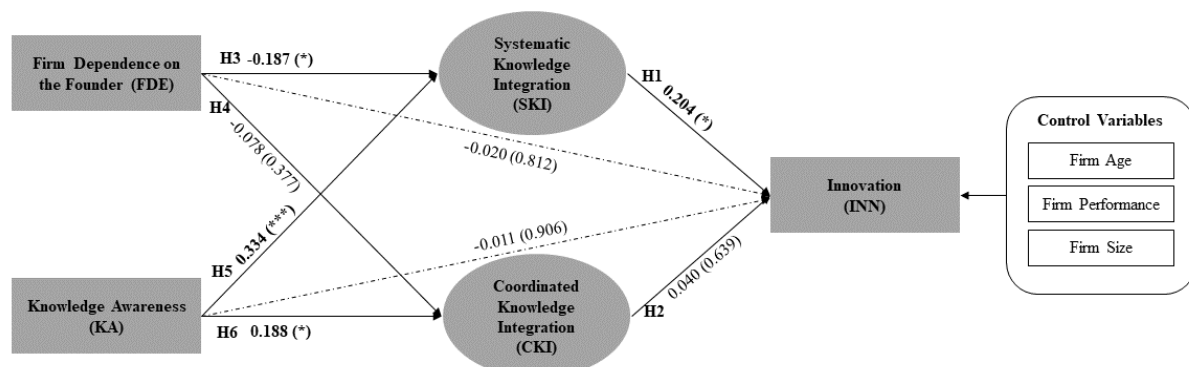
* . Correlation is significant at the 0.05 level (2-tailed).

Table 15: Summary of fit indices among models

Model Fit	Model 1	Model 2	Ref. values
Chi Square	123.334	94.966	
Degrees of freedom	67	66	
X2/ (df)	1.841	1.439	<3
CFI	0.919	0.959	>0.95
TLI	0.874	0.934	>0.95
RMSEA	0.075	0.054	<0.050
P-level	0.000	0.011	p>0.05
AIC	259.334	232.966	
SRMR	0.1152	0.0521	(~0)

Model 1

Figure 8 illustrated the results from Model 1. To assess Model 1, we used maximum likelihood estimation and fit indices as recommended in the literature (Hu & Bentler, 1999). Accordingly, we assessed Model 1 overall fit based on the chi-square (123.334), degrees of freedom (67), and Bollen-Stine p -value of 0.000. In addition, we assessed additional indices such as the root-mean-square error of approximation (RMSEA=0.075), Tucker-Lewis Index (TLI=0.874), and Comparative Fit Index (CFI=0.919). While these results suggest a sufficient fit overall, some indices were slightly below the recommended values including the p -value is significant, CFI and TLI is below the recommended value of 0.95, and RMSEA is above the recommended value of 0.050.

Figure 7: Model 1 Results

Regarding the hypotheses tested, the analysis suggested the following results. First, the analysis conducted indicates that systematic knowledge integration (SKI) has a positive and significant effect on innovation ($\beta=0.204$, $p=0.038$), therefore, H1 is supported. Yet, we did not

find a significant effect of coordinated knowledge integration (CKI) on innovation. Therefore, H2 is not supported. We find a significant negative effect of the dependence of the firm on its founders (FDE) on systematic knowledge integration (SKI) ($\beta=-0.187, p=0.041$), therefore H3 is supported. Further, while the effect of the dependence of the firm on its founders (FDE) on coordinated knowledge integration (CKI) is also negative, this effect was not significant and therefore H4 is not supported. Third, knowledge awareness (KA) has a positive and significant effect on systematic knowledge integration (SKI) ($\beta=0.334, p=0.000$) and therefore H5 is supported. In addition, we find a positive and significant relationship between knowledge awareness (KA) and coordinated knowledge integration (CKI) ($\beta=0.188, p=0.039$), consequently, H6 is also supported. In addition, we tested for control variables such as firm age, firm size, and firm performance but did not find a significant effect of the control variables on exogenous variables, including knowledge integration mechanisms and innovation (See Appendix 4).

Table 16 shows unstandardized direct, and indirect effects of Model 1. The analysis underlines a significant indirect effect of knowledge awareness on innovation mediated by systematic knowledge integration ($\beta=0.122, p=0.020$). In addition, the analysis retrieved a significant negative small indirect effect of the firm's dependence on the founder on innovation mediated by systematic knowledge integration ($\beta=-0.043, p=0.020$). No significant direct effects were found between knowledge awareness and innovation, neither between the firm's dependence on its founders and innovation.

While Model 1 retrieved most fit indices within acceptable ranges, we believe there are still unresolved issues that required further clarification. The literature (Briel et al., 2019; Dingler & Enkel, 2016) has highly emphasized the role of coordinated knowledge integration on innovation, which is not supported in our results in Model 1. To shed light on this issue, we proceeded to test an alternative model which is detailed in the following.

Table 16: Model 1, unstandardized direct, indirect and mediation effects

Model 1 - Relationship	Direct Effect	P-Value	Indirect Effect	Confidence Interval		P-Value	Conclusion
Knowledge Awareness >Systematic Knowledge Integration >Innovation	-0.011	0.906	0.122	Lower	0.017	0.020*	Full mediation
				Upper	0.387		
Knowledge Awareness> Coordinated Knowledge Integration >Innovation	-0.011	0.906	0.013	Lower	-0.021	0.356	No mediation
				Upper	0.086		

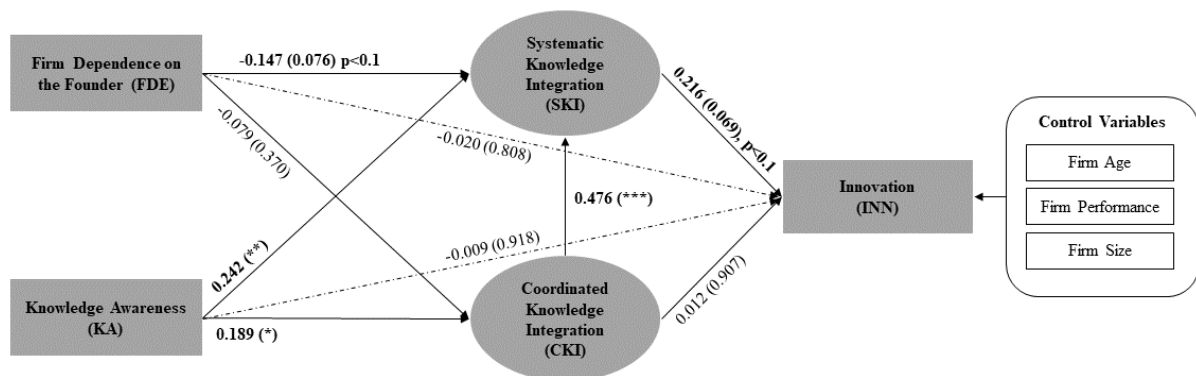
Firm's Dependence> Systematic Knowledge Integration >Innovation	-0.020	0.812	-0.043	Lower	-0.147	0.020*	Full mediation
				Upper	-0.006		
Firm's dependence >Coordinated Knowledge Integration >Innovation	-0.020	0.812	-0.003	Lower	-0.030	0.273	No mediation
				Upper	0.005		

Model 2

Model 2 aims at exploring alternative or additional explanations to the theoretical model proposed initially, complementing the findings retrieved by Model 1. To do so, we maintained the hypotheses supported in Model 1 and tested one new proposition among the variables that remained unlinked in the previous model. Specifically, we further examined the relationship between coordinated knowledge integration (CKI) and innovation by exploring an indirect path through the mediation of systematic knowledge integration (SKI).

To assess Model 2 (shown in **Figure 9**), we used the same parameters used to analyse the results of Model 1. Accordingly, we tested Model 2 and assessed its overall fit based on the chi-square (94.966), degrees of freedom (66), and Bollen-Stine *p*-value of 0.011. In addition, we assessed additional indices such as the root-mean-square error of approximation (RMSEA=0.052), Tucker-Lewis Index (TLI=0.934), and Comparative Fit Index (CFI=0.959). As suggested by these results, Model 2 exhibits improved goodness-of-fit indices than Model 1, including *p*-value, RMSEA, TLI, and CFI. Moreover, another suitable fit index for comparison is the Akaike Information Criteria (AIC) (Akaike, 1987), being the lowest value as an indication of a better fit. Accordingly, Model 2 presents a better AIC value (232. 966) than Model 1 as showcased in **Table 15**.

Figure 8: Model 2 Results



Regarding the initial hypotheses posed, the analysis suggested the following results. First, the analysis corroborates a positive and significant effect of systematic knowledge integration (SKI) on innovation ($\beta=0.216, p=0.069, p<0.1$), therefore, H2 is supported. Second, Model 2 finds a small significant negative effect of the firms' dependence on their founders (FDE) and systematic knowledge integration (SKI) ($\beta=-0.147, p=0.076, p<0.1$), therefore H3 is supported. In contrast the analysis did not retrieve a significant effect of the firms' dependence on their founders on coordinated knowledge integration (CKI) therefore H4 is not supported. Third, Model 2 confirms a positive and significant effect of knowledge awareness (KA) on coordinated knowledge integration (CKI) ($\beta=0.189, p=0.038$) and on systematic knowledge integration (SKI) ($\beta=0.242, p=0.006$) and therefore H5 and H6 are supported. Further, the coefficients and significance values of the abovementioned relationships retrieved similar values between Models 1 and 2.

The new relationship suggested by this model retrieved that, coordinated knowledge integration (CKI) has a positive and significant effect on systematic knowledge integration (SKI) ($\beta=0.476, p=0.000$) which suggest an indirect effect on innovation.

Table 17 summarizes the unstandardized direct, indirect, and mediation effects found in Model 2, underscoring a significant indirect effect of CKI on innovation, mediated by systematic knowledge integration (SKI). We discuss our results in the following section.

Table 17: Model 2, unstandardized direct, indirect, and mediation effects

Model 2 - Relationship	Direct Effect	P- Value	Indirect Effect	Confidence Interval	P- Value	Conclusion
Knowledge Awareness->Systematic Knowledge Integration->Innovation	-0.017	0.918	0.094	Lower 0.016 Upper 0.300	0.030 *	Full mediation
Knowledge Awareness->Coordinated Knowledge Integration->Innovation	-0.017	0.918	0.004	Lower -0.036 Upper 0.051	0.760	No mediation
Firm's Dependence ->Systematic Knowledge Integration->Innovation	-0.023	0.808	-0.035	Lower -0.121 Upper -0.007	0.035*	Full mediation
Firm's Dependence ->Coordinated Knowledge Integration->Innovation	-0.023	0.808	-0.001	Lower -0.019 Upper 0.008	0.570	No mediation
	0.012	0.907	0.147	Lower 0.033	0.024*	

Coordinated Knowledge Integration>Systematic Knowledge Integration >Innovation	Upper	0.364	Full mediation
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4. Discussion

Our findings provide an insightful understanding of the role of founders in the implementation of contrasting knowledge integration mechanisms and their consequences for innovation in young entrepreneurial firms. Particularly, our study underscores a seemingly overlooked path to innovation: the role of knowledge awareness in knowledge systematization to achieve innovation. While an extensive body of research has concentrated on socialization mechanisms for knowledge transfer, share, and innovation (Rupietta & Backes-Gellner, 2019; Spencer, 2003), our study suggests that these processes alone cannot grant the attainment of innovation in small and young firms relatively to previous studies in this area. The integration and further utilization of knowledge inside firms require broad access to knowledge which is key to enabling innovation (Sung & Choi, 2018). We discuss the findings around the role of knowledge integration mechanisms, the role of the founders' knowledge awareness and firms' dependence in the context of new and small firms, and the limitations of this study in the following.

Systematization versus coordination of knowledge: an unlikely path.

Despite extensive theorizations on the link between informal mechanisms of knowledge integration, particularly those aimed at social interaction, and innovation (W. Tsai & Ghoshal, 1998; Yli-Renko et al., 2001; Zhang et al., 2021), our results suggest that the systematization of knowledge may contend an even more critical role to achieve innovation in the context of small and young firms. Although somewhat surprising, our results can be seen as an indication of the role of embedding knowledge at the firm level in a way that is widely accessible to all members of the organization and that can be sustained over time. This might be especially important for young firms with a small number of members considering the likelihood of employees performing several roles (Klonek, Volery, & Parker, 2021). Regarding the role of knowledge coordination, prior literature has underscored its association with firm capabilities (Briel et al., 2019), which may take time to develop, and consequently, its effect may appear diminished in the distinctive context of small and young firms. More specific forms of knowledge coordination through social interaction such as knowledge sharing, are also dependent on team-level factors such as trust (Levin & Cross, 2004), however small and young

firms may be challenged by high employee turnover, few team members, remote workers, which may difficult the consolidation of working team-dynamics. While initially our study suggested that only systematic knowledge integration was relevant for innovation in this context (as seen in Model 1), further exploratory examinations indicate that knowledge coordination affects innovation indirectly (through systematization) while systematization does it directly. Furthermore, our analysis provides support to the mediating effect of the systematization of knowledge, both to facilitate the integration of knowledge that is coordinated, and, to counteract the effect of the dependence of the firm on their founders to access knowledge and innovation. Overall, our study aligns with previous theorizations that have established that the co-occurrence of both types of mechanisms are important to achieve innovation (Jansen et al., 2009), and refine the understanding of the interrelation between knowledge integration mechanisms in the context of small firms.

Awareness and dependence in the context of small and young firms.

A key contribution of our study is the application and validation of founder-related antecedents that allows us to identify individual and firm-level factors that affect knowledge integration mechanisms and their consecutive effects on innovation. As pointed out in the literature, founders are often the key decision-makers of their firms, which involves the management of an array of resources, including knowledge (Alvarez & Busenitz, 2001). However, the management of knowledge entails significant difficulties as knowledge can take many forms and be embedded at multiple levels (Schultze & Stabell, 2004). For example, tacit knowledge can be carried out by individuals who may not be able to readily articulate it but use it when appropriate. Explicit knowledge may be embedded in firm-level structures, but it needs to remain relevant and updated to be of any use (Corral de Zubielqui, Lindsay, Lindsay, & Jones, 2019). Consequently, founders need to be aware of these distinctions and be able to identify the relevant knowledge that is required by the firm at present to generate innovation (Nicolai J Foss & Jensen, 2019; J & Chakrabarti, 2012). Moreover, founders need to identify the knowledge that will be required in the future to ensure their firm's survival (Nicolai J. Foss, Lyngsie, & Zahra, 2013). Thus, we believe that *knowledge awareness* may be critical for young firms. In this regard, our study suggests that founders that are more aware of knowledge are more likely to implement the actions needed to integrate knowledge at the firm level, which in turn, will equip their firms to utilize knowledge as the firm grows. Interestingly, our study highlighted a special link between knowledge awareness and systematic knowledge

integration, which can be explained as an indication of the founder's aim to consolidate knowledge and ensure it can be carried through over time.

Our results around the dependence of firms on their founders to access knowledge and innovation are twofold and may require further investigation. While we found evidence of this phenomenon negatively impacting the integration of knowledge, and particularly affecting systematic integration, our study retrieved small effects and significance levels of $p < 0.1$, therefore our results may require further examination. Therefore, further exploration of this dependence and its effects on innovation can be a relevant opportunity for future research. Beyond this limitation, our study suggests that the dependence of the firm on their founders can carry negative consequences for knowledge integration. Concerning the dependence of firms on their founders to access knowledge, we believe that founders may restrict access to knowledge by distributing knowledge to their employees directly, preventing the development of firm-wide knowledge systems. Moreover, founders may choose to keep critical knowledge to themselves, for example, the contact information of key stakeholders, and technical or procedural information. This may occur to prevent knowledge from spilling out of their firms (Giarratana & Mariani, 2014). While these actions may prevent the broad use of knowledge internally, they may as well protect the firm's knowledge from spilling outside and facilitate the development of competitive advantages which can lead to improved performance (Grant, 1996; Matusik & Charles, 1998). Another form of dependence on the firm founders can occur when access to innovation is heavily reliant on the founders' ideas or when participation in innovation processes is restricted to certain individuals. Although the reliance on founders to access innovation can also be seen as a way to prevent knowledge spillovers, we believe that founders may have different motives to restrict the participation of members in the innovation process. For example, founders may see innovation as part of the strategic direction of their ventures and therefore may choose to be more heavily involved in this process. Restricting the participation of innovation to a few firm members may involve decisions around the assessment of new ideas and opportunities to pursue and the extent of radicalness to which these ideas will be developed. Moreover, founders may choose to develop new ideas in collaboration with external partners, advisors, mentors, or key suppliers or customers. These decisions may, in turn, align or not with market demands and other environmental factors and therefore may carry significant risks. As innovation is affected by contextual events and technological opportunities (Taalbi, 2017), we believe that the relationship between this type of dependence and firm performance may be affected by contextual differences and the market knowledge of the founders where these dependencies occur.

All in all, our study indicates that founders can play a critical role in their firm's integration of knowledge, which can be especially relevant when firms are young and small.

5. Limitations

Our study has some limitations. First, because our study focused on very small firms (70% have 10 employees or less) and explicitly excluded corporate entrepreneurship, our results must be interpreted carefully when examining large or very large firms. Second, while the second model includes relationships that were not considered in the preliminary theoretical model, we have opted for including it as it may provide an alternative explanation of the interrelation between knowledge integration mechanisms and their effect on innovation that was not considered in the initial conceptualization. Third, we acknowledge the limitations of our results considering the cross-sectional design of the study. Further, we encourage future research to examine these constructs in a longitudinal study as we believe that some emergent conceptualizations posed in this study may have a more significant long-term effect. For example, while the dependence of firms on their founders to access knowledge and innovation may not entail major obstacles to new firms' innovation in the short term, we believe that this phenomenon may have a more significant effect in the growing stages or scaling stages of the firm when the management of firms become more complex. Lastly, we acknowledge the limitations stemming from our sample size ($n=149$). While our study follows the recommendations for sample size and number-of-cases-per-variable-ratio (Kline, 2015), a larger sample may improve the robustness of the results (Stage et al., 2004). Moreover, we acknowledge the limitations of the statistical method employed (SEM) which may overlook case-level data. In that regard, we encourage the use of alternative analytical approaches that can assess these results at a finer grain.

6. Conclusion

Our study operationalizes and tests founder-related antecedents of knowledge integration in the context of small and young firms. By doing so, our findings underscore a less explored path between knowledge integration and innovation, highlighting the importance of the knowledge awareness of the founders and the systematization of knowledge. As such, founders that are more prone to identify relevant knowledge will be more likely to organize, store and retain knowledge for future uses, making it accessible to the whole organization. Although certain organizational enablers can facilitate coordination mechanisms, these processes may not warrant innovation in small and young firms on their own. In turn,

coordinated knowledge integration appears to support systematic knowledge integration which is deemed critical for innovation in small and young firms. Furthermore, our study underscores the mediating role of knowledge integration at several levels. We explain these findings as coordination mechanisms of integration require the existence of certain capabilities which may not be available to small and young firms.

OVERALL CONCLUSIONS AND FINAL REMARKS

I started this project seeking to advance the understanding of knowledge as an antecedent of innovation in the context of entrepreneurial post-entry conditions. Particularly, the extensive literature drawing on knowledge-based perspectives seemed to focus on two important themes: the knowledge of founders and the founding team and its implications to nascent entrepreneurship, and the required conditions for knowledge to be acquired, transformed, and leveraged for the firm benefit in the context of established entrepreneurial firms. Nonetheless, the question of *how* founders organized and structured knowledge in a way that transcended individuals remained overlooked, as going from founder knowledge to firm knowledge appeared as a logical progression in the development of emergent organizations.

To uncover this puzzle, I started by examining existing conceptualizations connecting knowledge, entrepreneurship, and innovation, seeking to generate an updated picture of the research conducted in this domain. This initial step involved the conduction of a systematic literature review which is presented in *Chapter 2*. As an overarching finding, the review emphasizes that knowledge needs to be accounted for from a process perspective. Such a perspective involves the recognition of knowledge at multiple stages throughout the entrepreneurial process, the mechanisms involved in its transformation, and the outcomes and sub-outcomes derived from such processes. A knowledge-based process perspective goes beyond the input-output approach by integrating the knowledge resources and processes that occur *between* those boundaries. This perspective also allows the incorporation of parallel theorizations such as learning views of entrepreneurship, by examining how entrepreneurial learning is accounted for as knowledge available to the firm and its members. Moreover, a process perspective of knowledge in entrepreneurship is appropriate and aligns with current recalls to strengthen our understanding of the entrepreneurial phenomena (Davidsson & Gruenhagen, 2021).

Regarding the initial question of how knowledge was organized in ventures, the review denotes that knowledge in the context of entrepreneurship is a complex phenomenon that involves multiple decisions and has multiple implications. Moreover, the synthesis of this literature facilitated the identification of overlooked areas, particularly related to internal processes and internal outcomes of knowledge. Yet, understanding the internal dynamics around knowledge can be critical to explain, for example, why firms with similar access to external knowledge sources and of similar characteristics can obtain different gains from knowledge.

Considering this, I opted for continuing this dissertation by focusing on one important internal process: *knowledge integration*. Not only knowledge integration is critical for innovation but is also a very complex phenomenon as it can involve several mechanisms such as knowledge share, transfer, creation, and retention. Aligned with the initial question, I sought to examine how knowledge was integrated into new firms, seeking to identify whether different strategies existed and if so, which factors were determining such differences. Consequently, I conducted an exploratory qualitative study which is presented in *Chapter 3*. This study extends the understanding of knowledge integration across three themes: antecedents, mechanisms, and archetypical configurations. Regarding antecedents, the qualitative study identifies two enablers and one barrier to knowledge integration. As enablers, the study underscores the importance of the founder's knowledge awareness along with certain organisational practices and characteristics. As a barrier, the study finds that the dependence of the firm on its founders to access knowledge and innovation can be detrimental to the integration of knowledge. Concerning knowledge integration mechanisms, this study offers a nuanced understanding by establishing relationships between antecedents (knowledge awareness, knowledge dependence, and organizational enablers) and two distinct mechanisms of knowledge integration, namely systematization, and coordination of knowledge. Lastly, this study develops a framework to characterize venture types according to their pathway to knowledge integration, by distinguishing between four archetypical configurations. By doing so, this thesis provides evidence of *ventures as organizations*, in the sense that entrepreneurial ventures are organized entities as opposed to chaotic structures.

Following the findings of the qualitative study, specifically, the emergent propositions connecting antecedents and mechanisms of knowledge integration, this thesis continued with a quantitative study aimed at theoretical generalization which is presented in *Chapter 4*. Particularly, I sought to clarify the role of founders in the integration of knowledge in new firms and its consecutive link with innovation. Correspondingly, this study validates a virtuous association between the founder's knowledge awareness, the mechanisms of knowledge integration, and innovation in small and young firms. Furthermore, this study underscores the importance of formal knowledge integration practices as an essential requisite for innovation and a catalyzer of informal ones. In the following, I summarize the theoretical and practical implications of this dissertation.

Theoretical Implications

Altogether this dissertation has used a multi-methodological approach to investigate knowledge and innovation in entrepreneurial firms. Furthermore, the thesis provides a refined

conceptualization of integration mechanisms and their effect on innovation in the context of small and young firms. Beyond the specific findings and contributions stemming from each study and detailed in their corresponding chapters of this dissertation, I pose that the compiled work provides some additional light onto three issues that have been previously answered from distinct theoretical perspectives.

The first is, *why do founders matter for knowledge in new firms?* Building from the knowledge-based view of the firm which underscores knowledge as a key resource, entrepreneurship scholars have extensively investigated the role of founders in the successful use of knowledge resources for firm-level benefits. Several theories have provided plausible explanations; however, these conceptualizations have offered partial solutions to this problem. For example, the human capital perspective has contributed to explaining entrepreneurial success (Unger et al., 2011) and innovation (Protogerou et al., 2017), but just to a small extent. While the founder's human capital has been generally depicted as beneficial for new firms (Dencker et al., 2009; Toft-Kehler, Wennberg, & Kim, 2014), this influence may only apply to specific areas of knowledge or in specific sectors such as high-tech industries (Colombo & Grilli, 2005). Moreover, the practice of entrepreneurship is abounded with examples of successful entrepreneurs who started their businesses with little professional experience or with a lack of formal education. Other theoretical views such as learning perspectives and social capital theory have provided additional clues on the role of founders and the firm's knowledge. Particularly, these views have shown how specific founders' abilities can maximise the use or facilitate access to knowledge for the firm's gain. In contrast to these perspectives, this dissertation offers an alternative view of the role of the founder's knowledge for the firm's benefits by pointing at two founder-related antecedents: the founders' *knowledge awareness* as the extent to which founders identify and assess knowledge, and the *firm's dependence on its founder's knowledge*, as the extent to which the firm relies on its founders to access knowledge and innovation. Regarding knowledge awareness, I believe this novel conceptualization can complement existing perspectives, especially human capital, as knowledge awareness can be applied to entrepreneurs coming from a diverse array of backgrounds and to firms that operate in different sectors. Knowledge awareness implies a primary but conscious recognition of knowledge that is sufficient to act upon. For example, a founder that is highly aware of knowledge can identify and manage the knowledge from their employees, protect the firm knowledge that is likely to grant competitiveness or be conscious of self-knowledge that needs to be transferred to others to sustain the firm over time. Although more research is needed to clarify the relationship between knowledge awareness and human capital, I believe that the

knowledge awareness conceptualization may better explain the relationship between individual-level knowledge and performance measures as the awareness of knowledge may not be necessarily linked to high levels of education or professional experience. Moreover, research on human capital has demonstrated a small effect on entrepreneurial success overall (Unger et al., 2011), and therefore, current theorizations may need further advancement. Regarding knowledge dependence on the founder, this thesis posits an interesting question that opens several opportunities for future research, can knowledge integration be deterred by their founders? Although our findings timidly point in that direction, I believe the firm dependence on its founders can have significant implications for specific types of firms and in specific stages of development. For example, small firms may be more prone to rely heavily on their founders and therefore have fewer incentives to integrate knowledge. Alternatively, firms that are undergoing scaling processes may struggle to succeed if the reliance on their founders is high.

The second issue that this thesis contributes to is *how is knowledge structured in entrepreneurial firms*. According to Galunic and Rodan (1998), knowledge structures are sets of interrelated knowledge elements that enable multiple combinations and therefore are key in supporting creative and innovative firm outcomes. However, knowledge structures that support the exploration and exploitation of new opportunities, are mediated by formal and informal knowledge integration mechanisms (Jansen et al., 2009). Thus, knowledge structures in entrepreneurial firms are far from rigid but flexible structures. While research on this domain has emphasized the importance of formal mechanisms in established firms, entrepreneurship research has focused mostly on informal integration mechanisms (Briel et al., 2019; Dingler & Enkel, 2016; Rauniar et al., 2019; Zhang et al., 2021). This thesis provides two hints that shed light on this issue. First, while entrepreneurial firms need both types of integration mechanisms, formal mechanisms can grant direct benefits to achieve innovation along with facilitating the utilization of informal ones. In simple words, while knowledge sharing through social interaction can help firms transfer knowledge between individuals, if this knowledge is not formally stored in firm-wide systems, it is less likely that this knowledge will be conducive to innovation. This might be especially relevant to small firms which have fewer resources and fewer opportunities to host social interactions. Second, there are different arrangements for the combination of formal and informal integration mechanisms. This thesis describes four distinct archetypes representing variations of these combinations. More research can be dedicated to further examine whether certain archetypes can be more successful in generating innovation, and in which contexts. Overall, a deeper understanding of knowledge integration mechanisms

can strengthen a process perspective of knowledge, by connecting the figure of the founder with the firm-level outcome of innovation.

The last issue that this thesis contributes to refers to *how is innovation achieved in the small firm*. Complementing the extensive research pointing at the implications of macro-level factors to firm performance including innovation and using cross-sectoral evidence of knowledge in ventures, the theorizations derived from this thesis focus on internal dynamics and innovation. As a result of this examination, this thesis posits new conceptualizations that go beyond sectoral differences, including the role of founders in the knowledge integration processes and knowledge-derived archetypical outcomes. By doing so, I advocate for the broader applicability of research findings arising from knowledge perspectives in the entrepreneurial context, in a similar way that resource perspectives have been broadly applied to different contexts (Nicolai J. Foss et al., 2008; Penrose, 1959). Moreover, given the pervasiveness of knowledge through technological advancement, the boundaries of sectoral categorizations related to knowledge (knowledge worker, knowledge-intensive) and technological differentiations (high-tech, low-tech) become blurry and may need to be revised by scholars focusing on this domain.

Practical Implications

There are many implications for practitioners that can be derived from the findings of this dissertation. In the following, I outline a few implications for founders and policy makers oriented toward the use of knowledge to foster innovation.

First, a distinction between knowledge and innovation is key to maximizing the gains from knowledge and translating them into economic value. While the literature suggests that knowledge and innovation are intertwined processes, the sole possession or access to knowledge cannot guarantee the achievement of innovation. Founders and managers play a critical role in this transformation, by recognizing, assessing, and managing knowledge resources throughout the innovation process. As synthesized in this dissertation, knowledge processes can be oriented toward the search, transfer, or integration of knowledge, the latter being an important one aimed at incorporating knowledge from several sources at the firm level. Furthermore, our findings suggest that knowledge integration sits at the intersection between external and internal dynamics, thus allowing external knowledge to be combined with the unique knowledge from the founder and their team. Moreover, knowledge integration can lead to the emergence of firm-knowledge repositories. Knowledge repositories are the receptacles of the knowledge that has been integrated into the firm and can take several forms.

More importantly, knowledge repositories can store knowledge and lessons gained by experience, thus supporting future activities related to innovation.

Second, given the importance of knowledge integration for innovation, practitioners need to be conscious of the mechanisms that are conducive to the integration of knowledge in entrepreneurial firms and the internal factors that are associated with its implementation. Regarding integration mechanisms, this thesis provides evidence that a combination of formal and informal mechanisms of knowledge integration is needed to support innovation. Moreover, formal mechanisms of integration such as the storing, organizing, and systematization of knowledge, can directly help firms achieve innovation. This thesis suggests that this is especially relevant to small firms, which have few resources at hand. Regarding the factors that can influence the integration of knowledge in new firms, this research suggests that founders can be critical as they make decisions concerning the management of knowledge. In that vein, founders that can identify the strengths and deficiencies of their firm's knowledge, are more likely to implement strategies to integrate knowledge. On the other hand, founders need to implement strategies to share, transfer and integrate their own knowledge, to minimize their firms' dependence on specific individuals and thus maximize the integration efforts. Similarly, founders, managers, and policymakers can promote organisational practices, values, and methodologies that are oriented toward the sharing, structure, and transfer of knowledge. Some of those practices are the use of digital tools to assist tasks, problem-solving methodologies, and the adoption of a flexible organizational structure that allows venture members to share roles and tasks.

Third, policymakers need to design and implement distinct strategies to help small firms achieve innovation. Because in small firms, founders can have a gravitating role, these firms may need additional resources to guide an integration of knowledge that can be conducive to innovation. Particularly, this research has identified two warning signs that are indicative of an excessive influence of the founders' knowledge over their own firms. The first one is when the firm heavily relies on the founder to access knowledge and innovation, which I broadly described in this thesis as knowledge dependence. The second is associated with certain archetypical configurations: when the founder controls and administers knowledge on a one-to-one basis (founder-driven organization), and when founders dictate rigid formats of knowledge content for its replication (standardized organization). Although more research is needed to consolidate these findings, this research suggests that these situations are detrimental to the integration of knowledge in a broader way.

APPENDICES

Appendix 1: List of Articles included in the Systematic Literature Review (Chapter Two)

1. Allen, T. J., Gloor, P. A., Colladon, A. F., Woerner, S. L., & Raz, O. (2016). The power of reciprocal knowledge sharing relationships for startup success. *Journal of Small Business and Enterprise Development*, 23(3), 636-651. <https://doi.org/10.1108/jsbed-08-2015-0110>
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Appendix 2: Examples of Coding Rationale included in the Qualitative Study (Chapter Three)

Excerpt from Interview (open coding)	1 st Order Concepts	2 nd Order Themes
- “There are multiple firms who do what I do, but they don't do what I do in the regions that I operate”. - “And then what I realised is I got more senior in the profession is that the real gap for computational techniques is in the early design phase”. - “The team and the lead architect who was the co-founder of the business, saw that there are a few technical components that needed to be created before blockchain could be adopted for real-world scenarios”.	Identification of Market's Knowledge Gap	
- “It was initially my co-founder's idea; he saw another product similar to ours in another office and basically thought that would be great”. - “The initial idea came about from looking at new research projects because there's a lot of research at (university)- it's research that isn't tapped into or exploited in any way”.	Identification of Opportunity to Exploit Existing Knowledge	Knowledge Opportunity Awareness
- “I have a significant advantage because I've done this for eight years where while others are actually starting to play around, they are just still tinkering in the laboratories”. - “The nice thing about the area where I applied that client-facing design stuff is it's a very low computational skill area, very few people actually have technical skills”. - “You look for something where you have some skills and give you a competitive advantage in that place”.	Identification of Knowledge Advantage	
- “The first thing I did is I wrote a book because I thought, OK, that will make me really consolidate what I know and kind of make sense of it”. - “I have a maths degree, and this is software that is used for something that's called generative design or computational design, where you create algorithms that create shapes”. - “I had three co-founders early. So, two of my brothers they are the technical co-founders, they actually do the programming”. - “We are in different industries; myself being marketing and business and himself being website and app design, where we could really come together and come up with something”. - “We (co-founders) don't have any well enough technical experience and coding to build a website from scratch”.	Perception of Founder's Specialised Knowledge	Founder's Knowledge Awareness

Excerpt from Interview (open coding)	1 st Order Concepts	2 nd Order Themes
- “I'm tech heavy, but not super into AI, I have done some and stuff, but I wouldn't trust myself to program it”.		
- “I have 11 years of work experience before I turn an entrepreneur. I have work for large groups, I have work for small groups, so there are lots of things that I have learnt on the job”. - “It was obviously an industry that we both had knowledge of, was just about honing that knowledge and building on it”. - “In my previous role, I was working at a startup for four years (...) and so I saw how a startup was built. Also, I do have generalist skills, I've done everything from marketing, sales, operations, product management”. - I've actually founded or co-founded seven businesses and managed to exit two previously successful”.	Perception of Founder's General Knowledge	
- “Generally, we wouldn't employ anyone that didn't know something more than us in some area”. - “Even our designers are quite technical”. - “In the past, when we've brought on new people, it's always been with something specific in mind. So, for example, with our software engineers, it was obvious because we created software engineering, but then also with the two interns, we've got one of them as a business intern”.	Perception of Employee's Knowledge	
- “A lot of the work is documented and saved in spots that are reasonably intuitive”. - I think the key problem is that the information in Google Drive is not particularly organised at the moment. It is certainly not well organised”. - “I think the way it's been laid out, it's pretty straightforward in terms of information, but being able to understand what needs to be done, that requires a bit more time and intuition”. - “Anyone that's an expert in those either industry, they would have the ability to pick up our platform”. - “We have, a sales management tool that we use. But it's not up to date or it's not as up to date as it should be”. - “I don't think we have documented any of how we operate or how we manage the team or anything like that”.	Perception of Knowledge Systems	Venture's Knowledge Awareness

Excerpt from Interview (open coding)	1 st Order Concepts	2 nd Order Themes
- “There is a lot of things of unlearn and relearn in certain areas that we have improved and certain areas where there is still room for improvement”. - “I think we're probably not really at that stage where we are particularly excellent at delivering value or are excellent at acquiring customers. We are not, I don't think we're there yet”. - “We try to find different ways to innovate all the time so that we were perpetually moving forward, having greater competitive advantage and also making it harder for any potential competitors to copy us so that the business has a little bit more longevity”. - Positive perception knowledge systems: - Our systems are: “easy”, “intuitive”, “organised”, or expressed confidence that their systems were sufficiently updated and contained all the information needed to support the business operations. - Negative perception knowledge systems: - Our systems are: “overwhelming”, “disorganised”, “not up to date”, or lacking important information such as key stakeholder’s contact details.	Perception of Venture’s Knowledge	
- “You do wear multiple hats”. - “Things change every day”. - “There really isn't any structure to how you do things”.	Flexibility	
- “People access the things that they need, to do the work that they run”. - “I share with them everything that is relevant to their position”. - “I do spend some time tracking the right information they need to know”. - “That's all they really need access to”. - “I provide them everything they need to do that job”. - Justifications: - “It would be overwhelming to give them everything”. - “We don't want to over-clutter everyone's workspace”. - “Rather helping this person to slowly settling and soaking information in a part-by-part basis”. - “Sometimes they (employees) need more than what I anticipated. And so, in that case, if they can't find it online or then I'll go and add whatever they request”. - “Probably 80 per cent of the meetings are one on one meetings rather than everyone in the room”.	Knowledge Distribution	Organisational Knowledge Enablers

Excerpt from Interview (open coding)	1 st Order Concepts	2 nd Order Themes
- “We save every document and a share them in SharePoint, so everything's in there. And if it doesn't exist in SharePoint, it doesn't exist”.		
- “I currently don't work expecting that someone will replace me at any stage”.		
- “I'm the only one that can access everything”.		
- “It would be difficult for a new team to come in and manage because it's all up in the head”.	High Knowledge Dependency	
- “I think a lot of it was just inside and we hadn't really put that out yet”.		
- “Marketing would basically disappear because that's just what I do. So, if I'm not there, then there's no marketing”.		
- “They'd probably be able to pick up my job”.		
- “If we vanish, I don't think it would be that big of a deal”.		
- “I had to figure out a way that other people can do what I'm doing”.	Low Knowledge Dependency	
- “I went through a whole process of basically documenting everything in my brain so that someone could replace me”.		
- “I think a lot of the innovation that comes from (The Founder)’ ideas come from observing what could work well in the community”.		
- “Currently just my co-founder and I have been through that process”.		
- “The deep innovation job is hard so... And that's my job, basically”.	High Innovation Dependency	Firm’s dependency on the founder
- “If I've come up with the problem, I would probably start that process myself just to think through the process. And then I would go and bounce it off the others”.		
- “If we say something that needs to be changed, it's basically an internal dialogue between my co-founder and me”.		
- “I'd say between the seven of us, he (founder) comes up with 50 per cent, then the rest of us together come up with another 50 per cent of ideas”.	Low Innovation Dependency	
- “If there is a problem, we speak about the problem, we raise it up internally and then if we can't solve it internally”.		
- “I have an advisory board that meets with me every six weeks, and when I have a wall or dead end or something, I throw it to them”.	Externally Moderated Innovation Dependency	
- “We really rely on those guys (advisors) for experience. A lot of them have over 10 to 15 years in their specific field”.		

Excerpt from Interview (open coding)	1 st Order Concepts	2 nd Order Themes
- “We do very few deliveries for clients who we think give us really cool insights into what's happening in the market. And, we had ventured into creating new products, depending on market demand or investor requests”.		

Appendix 3: Questionnaire items included in quantitative study (Chapter Four)

Variables	Items	Source
Knowledge Awareness	(1) Our venture was created by identifying a relevant knowledge gap in the market (2) Our venture was created by identifying an opportunity to exploit existing knowledge (3) Our venture was created by realizing that we had knowledge that could be advantageous in a specific market (4) Our venture's founders have relevant technical knowledge (5) Our venture's founders have relevant managerial or entrepreneurial knowledge (6) Our venture's employees have highly technical knowledge (7) Our venture has specific knowledge that is unique compared to our competitors	Self-developed based on data collected through interviews (See Chapter Three)
Firm's dependence on the Founder	(1) There are general areas in which the venture fully relies on the founder(s)' knowledge (i.e: contacts) (2) There are specific areas in which the venture fully relies on the founder(s)' skills (3) Innovation is carried upon the founder(s)' ideas (4) The founder(s) have a primary role in innovation	Adapted from Skinner and Guiltinan (1986) based on data collected through interviews (See Chapter Three)
Systematic Knowledge Integration	(1) We create new knowledge that is tangible such as but not limited to: Intellectual Property (IP), prototypes, organizational content, or scientific articles. (2) We document and store new knowledge in our databases which are up to date. (3) We have developed routines to coordinate tasks. (4) We use templates to structure knowledge or information.	Adapted from Runping Guo et al. (2019) based on data collected through interviews (See Chapter Three)
Coordinated Knowledge Integration	(1) We value and encourage knowledge share among our members (2) We transfer knowledge from more experienced to less experienced members, including the induction process (3) We learn new skills together (4) We maintain frequent and fluent communication across the entire team (5) We work collaboratively	
Innovation	(1) Number of new-to-the-market products or services introduced in the last 12 months (2) Number of in-development new products or services during the last 12 months	"Oslo manual 2018: guidelines for collecting, reporting and using data on innovation" 2018)

Firm Age	(1) Number of years of operation	
Firm Size	(1) Number of full-time employees including founders	
Firm Performance	(1) Overall Performance (2) Sales Growth (3) Market Share growth (4) Profit growth (5) Produce/service quality (6) Customer satisfaction	Wiklund and Shepherd (2003) Santoro et al. (2019)

Appendix 4: Supplementary tables on testing of control variables (Chapter Four)

Figure 1 illustrates the distribution of the control variable Firm Size in relation to the direct variable Innovation. As most of the firms correspond to small firms, where 71.1% have less than 10 employees, the scatter plot does not provide sufficient support to examine the correlation between the variables. Thus, we proceeded to log-linearize the variable Firm Size with the aim of examining a potential correlation based on percentages rather than on categorical data. Consequently, Figure 2 illustrates the distribution of the log of Firm Size ($\ln$ Firm Size) in relation to Innovation. While the scatter plot depicts an improved picture of the correlation between these variables, a strong correlation is not supported. Table 1 summarizes the correlation values for both cases.

Figure 1: Scatter plot showing distribution of Firm Size and Innovation

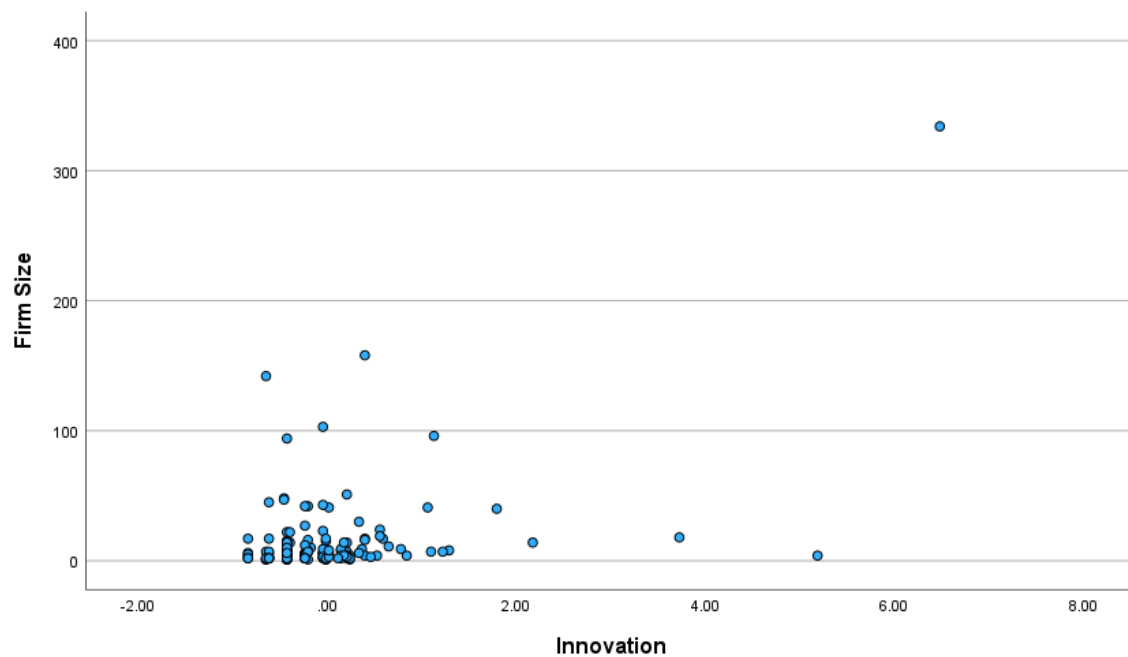


Figure 2: Scatter plot showing distribution of Firm Size (Log Linearized) and Innovation

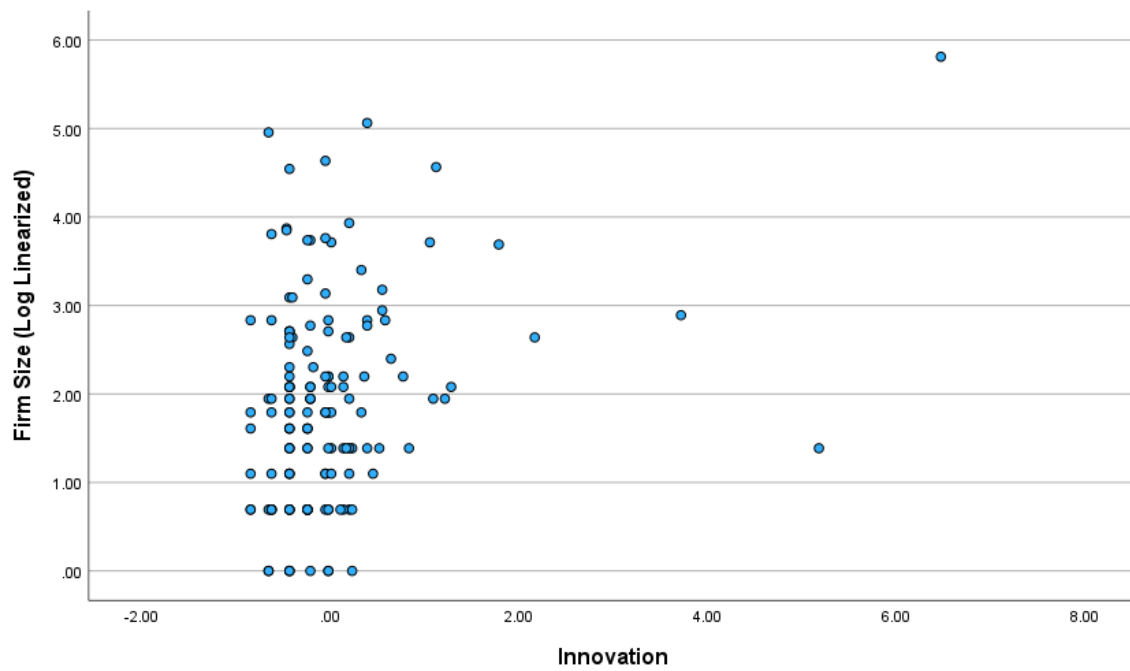


Table 1: Correlations

		1	2	3
1	Firm Size	1.000		
2	ln Firm Size	0.704**	1.000	
3	Innovation	0.489**	0.296**	1.000

**, Correlation is significant at the 0.01 level (2-tailed).

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