Vanessa Ratten *Editor*

Entrepreneurship as Practice

Time for More Managerial Relevance

Springer

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I dedicate this book to my mum Kaye Ratten. I also thank my dad David Ratten, brothers Stuart Ratten and Hamish Ratten, niece Sakura Ratten and sister-in-law Tomomi Ratten. My mum always used to say 'focus on the roses' in terms of being positive about the future. I think this really applies to most of the life in general and highlights the beauty of nature. Therefore, it is a useful way to acknowledge my mum and also to understand the beauty of entrepreneurship as practice, which is the key theme of this book.

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Digital Transformation of the Quadruple Helix: Technological Management Interrelations for Sustainable Innovation

Entrepreneurship as Practice: An Overview

Vanessa Ratten

Abstract Entrepreneurship is a popular and important activity in society. It is practical pursuit as it involves hands on development with a business idea. The aim of this chapter is to discuss the role of entrepreneurship as practice in terms of new thoughts around the topic. This will enable a focus to be placed on the practical origins and reasons for entrepreneurship. Thereby providing a guide for those interested in entrepreneurship as practice.

Keywords Creativity · Entrepreneurship · Entrepreneurship as practice · Innovation · Practice studies · Strategy · Strategic management

Introduction

Entrepreneurship as practice is a useful way to understand the practical nature of entrepreneurship that differentiates it from other areas of study (Ferreira et al., 2017). Entrepreneurship as a subject has been emphasised in the past decade as a new way of embedding practical experiences in pedagogical practices. This means it differs from other subjects that have more of a theoretical leaning by highlighting the experiential nature of entrepreneurship (Jones et al., 2018).

Entrepreneurship can be studied but it can also be learnt by doing. This refers to engaging in the practice of entrepreneurship by trying to focus on innovation, proactivity and risk taking activity (Ratten, 2014). Rather than being content with current market conditions, the idea behind entrepreneurship is that it needs to be learnt through active engagement. This means only with practice and experience will someone be able to become a better entrepreneur.

Some people are born naturally entrepreneurial due to their inquisitiveness, creativity and interest in business (Ratten & Jones, 2021). This means they are more likely to go into self managed and owned businesses due to their need for independence and control. Many of these types of entrepreneurs continually engage

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in the process of entrepreneurship by being involved in owner operated businesses. Although they can also be part of family businesses and partnerships.

Not everyone is born a natural entrepreneur and for some it can take time to develop these skills. This is when education provides a way for people interested in entrepreneurship to finesse their skills. By taking courses on entrepreneurship, individuals can learn how to harness their interest in business and the skills they need to succeed (Ratten & Usmanij, 2021). Training courses are also part of this development as they enable a person to gets hands on experience with regards to entrepreneurship.

Overview of Chapters

This book consists of eight chapters related to entrepreneurship as practice. This first introductory chapter has provided an overview of the reason for the book and interest in the topic. The second chapter titled 'An entrepreneurship as practice framing of entrepreneurial learning and the entrepreneurial process' by Lisa Thomas and Véronique Ambrosini highlights how entrepreneurship is learnt. The third chapter titled 'Entrepreneurial self-identity, social ties and self-efficacy affecting persuasion ability' by Masoud Karami and Francisco Liñán analyses the role of self-identity in the practice field. The fourth chapter titled 'Returnee entrepreneurship in China: the multi-faced story in the travel of location, time and culture' by Zimu Xu analyses entrepreneurial practices in China. The fifth chapter titled 'Entrepreneurial practices in eco-innovation: circular challenges related to the Tomato Textile project in the Netherlands' by Iris Lommerse and Ellen Loots analyses the role of eco-innovation in entrepreneurial practices. The sixth chapter titled 'The influence of affects on workaholism in teleworking during the COVID-19 pandemic- a partial least squares model' by Ana Diogo, Patricia Gomes, Vanessa Ratten, Eulália Santos and Fernando Tavares focuses on the role of crises in entrepreneurial practices. The seventh chapter titled 'Is the impact of sustainability exploration on firm economic return so obvious? The case of internationalized Spanish firms operating in high-tech and low-tech industries' by Julen Castillo-Apraiz, Jesús Manuel Palma-Ruiz and Unai Arzubiaga highlights the role of internationalisation on entrepreneurial practices. The eighth chapter titled 'Digital Transformation of the Quadruple Helix: Technological Management: Interrelations for Sustainable Innovation' by José Luis Torres-Loredo, Jesús Manuel Palma-Ruiz and José Manuel Saiz-Álvarez analyses the role of collaboration in entrepreneurial practices.

Conclusion

This chapter has introduced the topic of entrepreneurship as practice to readers. It is an important and timely topic given the influence entrepreneurship has on society. The key theme of this edited book is entrepreneurship as practice so the next chapters will discuss in more depth the role this topic plays in different kinds of entrepreneurship contexts.

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An Entrepreneurship as Practice Framing of Entrepreneurial Learning and the Entrepreneurial Process

Lisa Thomas and Véronique Ambrosini

Abstract This chapter takes an entrepreneurship as practice (EAP) perspective to examine the entrepreneurial process conceiving entrepreneurial learning (EL) as a culturally and socially shaped achievement. We argue there is conceptual synergy between EAP and EL manifested in understanding entrepreneurs as active social actors, who develop an understanding of their surrounding environment and learn through social interactions. Anchoring EAP and EL in cognitive learning theory, we contribute to developing a nuanced and novel appreciation of the entrepreneurial process.

Keywords Entrepreneurship as practice (EAP) · Entrepreneurial learning · Asymmetrical learning · Symmetrical learning · Opportunities

Introduction

In this chapter we contribute to an understanding of the entrepreneurial process, and specifically of the entrepreneurial learning (EL) process. We do so as "entrepreneurship is a process of learning, and a theory of entrepreneurship requires a theory of learning" (Minniti & Bygrave, 2001, p. 7). We take an entrepreneurship as practice (EAP) perspective, as it is concerned with understanding the detailed activities of the entrepreneurial process (Steyaert, 2007; Thompson et al., 2020). EAP conceives this process as a culturally and socially shaped achievement (El-Awad et al., 2017). Interlacing key elements of cognitive learning theory (Piaget, 1960, 2000; Vygotsky, 1978, 2004) with EAP, our purpose is to inform how EL undergirds and affects the unfolding of identifying and exploiting opportunities. This matters as this process is a critical issue in entrepreneurship (Tang et al., 2021) and we need to better appreciate

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how entrepreneurs' ability to identify and exploit opportunities is dependent upon a learning process, not just knowledge per se (Corbett, 2007).

To bring to life our theorizing, throughout our argument we intersperse examples from Domaine Daumas Gassac, a French family-owned winery. This allows us to reflect upon our argument that entrepreneurs, their learning, and their context are inextricably linked. Our conceptual exploration contributes to the field by evidencing the role of social processes and context in EL. In mapping key elements of cognitive learning theory with EAP, we develop the entrepreneurial process corpus of work by adding a novel dimension to an understanding of EL. This approach also affords a better understanding of the conceptual relationships between the seemingly content related concepts of exploratory/exploitative learning (March, 1991) and asymmetrical (Vygotsky, 1978)/symmetrical learning (Piaget, 1960).

Theoretical Background

Entrepreneurial Learning

The entrepreneurial process has been conceptualized as an EL process, whereby knowledge is derived from and continuously modified by experience (Kolb, 1984). This means that EL is experiential. EL underpins the entrepreneur's ability to identify and exploit opportunities (Corbett, 2007). EL essentially includes two main types of experiential learning: explorative and exploitative learning (March, 1991). Exploratory learning often results from internal transformation through developing new knowledge. Exploitative learning relates to knowledge replication, refinement, choice, production, efficiency, selection, implementation, and execution. Research points to the need to pursue both types simultaneously (Sumanarathna et al., 2020). We expose how this can be possible.

An Entrepreneurship as Practice Perspective on Entrepreneurial Learning

When entrepreneurs engage in learning, they absorb and transform the knowledge necessary to develop new business ideas, operational, production or marketing techniques, solutions to strategic or operational problems, and business opportunities (Cantu et al., 2009; Wang & Han, 2011). While an objectivist view of knowledge emphasizes the separation between the knower and knowledge and conceives of learning as an intellectual activity, an EAP perspective of knowledge conceptualizes learning as rooted in human practice, socially constructed and culturally embedded (El-Awad et al., 2017; Lindgren & Packendorff, 2009). For EAP, entrepreneurship

(Thompson et al., 2020) is concerned with the doing and process of entrepreneurship, meaning context is critical (Gedajlovic et al., 2013; McKeever et al., 2015). Following a constructivist ontology, EAP considers that knowledge is acquired over time through experience, is relational and requires some form of participation as well as mediation through artefacts (Cook & Brown, 1999).

While there is an increasing body of work on EAP, we argue that to develop a sophisticated and holistic understanding of EL it is pertinent to incorporate cognitive learning theory to illuminate how entrepreneurs acquire, retain, and use knowledge (Young & Sexton, 1997). Specifically, we draw on Vygotsky's (1978) cognitive development theory to enhance our understanding of the EL process underpinning the identification and exploitation of opportunities. EAP is arguably anchored in cognitive theory as he argues that learning is experiential, situated in context, and that both culture and environment guide how people see the world around them. According to this theory learning is experiential. Experiential learning can be considered as cognitive and situative because individuals transform (using cognitive properties) their experiences (situative) into new knowledge. Consequently, learning from experience allows for the acquisition and accumulation of knowledge which adds to and alters entrepreneurs' stocks of knowledge from which they make subsequent decisions (Minniti & Bygrave, 2001). This implies that individuals learn by doing; they create knowledge by transforming their experiences (Honig & Hopp, 2019). In this respect it is path dependent yet dynamic. Vygotsky (1978, 2004) further unpacks the learning process to combine both cognitive and social learning. Learning experiences support the gradual development of capabilities through assistance and eventually individuals learn to do individually things that they could initially only do with assistance.

Proponents of cognitive learning theory also posit that learning develops in two ways: asymmetrical learning and symmetrical learning (Piaget, 1960, 2000). This section explains our theoretical framing. We illuminate by theorizing and illustrating the pertinence of EAP in bringing to the fore the role of EL, and notably asymmetrical and symmetrical learning in the entrepreneurial process. We uncover how the synergy between the two promotes the simultaneous pursuit of explorative and exploitative learning.

Asymmetrical and Symmetrical Learning and Opportunity Recognition and Exploitation

Asymmetrical Learning

Entrepreneurs are often faced with novel contexts within which interests, and concerns may be raised. To address these, they might first try to find solutions by relying on their existing skills and knowledge, i.e., their 'stocks of experience' (Reuber & Fischer, 1999). These stocks serve as personal frames of reference or

ways of knowing. However, while appropriate within certain contexts, they may not be so in others. Any pre-entry knowledge is often insufficient to generate strong firm performance and survival. In such cases, a state of disequilibrium occurs in the entrepreneur's learning process (Vygotsky, 1978).

Entrepreneurs may be unable to deal with the situation independently, and may need assistance (Clapper, 2015). Entrepreneurs need tutelage to adapt new knowledge to the local context or to transform their existing capability by effectively integrating new knowledge (Corredoira & McDermott, 2020; Pietrobelli & Rabellotti, 2010). Guidance provides an important means of moving forward for the entrepreneurs to develop their learning and embark meaningfully in the opportunity recognition and exploitation process. In so doing, the entrepreneur is engaging in what Vygotsky (1978) coined 'asymmetrical learning'.

He explained that an individual builds up cultural and social proficiencies as well as information by interacting with what the literature generally terms 'knowledgeable peers' (Wood & McKinley, 2010). This signals that there is an asymmetry in knowledge between the peers and the learner. This assistance, which guides the individual learner's development is oft referred to as scaffolding (Bruner, 1966; Wood et al., 1976). The learner assumes the role of apprentice. Scaffolding not only produces immediate results but instils skills necessary for future independent problem solving (McLeod, 2012). Through scaffolding, the entrepreneur not only acquires practical knowledge but also the social norms, behavior and values of the context in which the knowledgeable peer operates (Handley et al., 2007; Tran & Santarelli, 2014). Following the examples of Arikan et al. (2020) and Rindova and Courtney (2020), we now illustrate this argument using an example (in Table 1) based on the winery Domaine Daumas Gassac[1] founded by the entrepreneur Aimé Guibert.

Table 1 Asymmetrical Learning: A Vignette

Domaine Daumas Gassac, in the Languedoc-Roussillon region of southern France, is a small independent family business with a distinct international positioning in the production of premium wine—Mas Daumas Gassac. Accolades such as 'The only Grand Cru of the Midi' (Johnson & Robinson, 2008), confer the uniqueness of the wines produced and set the Domaine aside from others in the region.

Before acquiring the Domaine, the founder, Aimé Guibert, headed his family's 300-year-old glove manufacturing and leather goods firm. While he had considerable business experience, he was a winemaking novice. In 1970, he bought the Mas (farmhouse) Daumas Gassac as a weekend retreat. A year after the purchase of the property, Guibert contacted his friend, Professor Enjalbert, a Professor of geology, for a soil diagnosis and advice on planting a few grapevines. He assessed the soil as cultivable and ideally suited to grapevines (Chapuzet, 2016; Nalley, 2003). Then through the

[1] Our examples present excerpts from Domaine Daumas Gassac's historical development from the owner/entrepreneur Aimé Guibert's entry into the wine making business and his creation of the Domaine in 1978. Specific examples and quotes are taken from publicly available information (e.g. the Domaine's website, created and maintained by Domaine Daumas Gassac and articles found in the wine press).

years, Guibert invested heavily in the viticulture adventure, he planted cabernet sauvignon vines, constructed a winery and vat room (where the fermentation tanks stand). He learnt about types of wine barrels, harvesting and tasting.

Guibert invited Professor Peynaud, known as the world's most influential oenologist to help with the Domaine's first harvest in September 1978. Peynaud has been accredited with helping modernize Bordeaux wines and of improving the quality of wines worldwide. This marked his first meeting and the beginning of a mentoring relationship. Peynaud confirmed Enjalbert's assessment of the soil and advised Guibert he needed to defend such an exceptional terroir (Mansson, 2004).

Peynaud was renowned for his advice on convincing wineries' owners of the importance of harvesting fully ripe grapes, ageing the wine in clean and often new oak barrels. He encouraged the acceptance of low acid levels in the grapes and wines and on controlling temperatures in the cellars, especially during fermentation (Mansson, 2004). Guibert adopted the 'Peynaud style'. This resulted in the production of rich, ripe, and round wines. Their collaboration lasted for years. Guibert acknowledged that the first ten years of collaboration included many a rough day in the relationship and admitted to his naive arrogance in thinking that by now he had come to know everything about winemaking. Peynaud strongly admonished him and made him comprehend that 'in the vinification of very great wines, you never know anything, everything is always new and unique. Upon Peynaud's death in 2004, Guibert proudly stated he was both guided and trained by the most renowned winemaker of the twentieth century (Guibert, 2004). He described Peynaud as a 'midwife to the novice' within a very exclusive club of exceptional old European wines.

Source Author's own.

The example in Table 1 highlights how appropriating knowledge of winemaking from this asymmetric interaction served as the conduit to developing Guibert's knowledge and his problem-solving ability. Guibert's learning from his friend's-Enjalbert- expertise triggered the identification of the opportunities confirming the entrepreneurship literature's argument that social capital is critical in the opportunity process (Davidsson & Honig, 2003). Pre-existing social ties are especially important for opportunity identification and proactive networking (contacting Peynaud) for opportunity exploration (Leyden & Link, 2015). Peynaud facilitated the development of Guibert's competencies in technical innovation and the acquisition of industry-specific knowledge. This fostered Guibert's ability to exploit the opportunity. This reflects the cognition stage of knowledge acquisition. He learnt by instruction and observation (Johnson, 1983). Peynaud accompanied Guibert in a supervisory role during his first vinification and vintage. His use of different scaffolding techniques guided direction and instruction in problem-solving via participation provide examples of how he nurtured the development of Guibert's immersion in his new social and cultural context (Lave & Wenger, 1991). Working alongside Guibert, Peynaud nurtured his participation within the winemaking community (Konopaski et al., 2015; Lave & Wenger, 1991). Collaboration with Peynaud as knowledgeable other allowed Guibert to understand winemaking tools. This represents the roots to Guibert's knowledge.

Implementing the 'Peynaud Style' in his venture illustrates the role of asymmetrical learning in opportunity exploration by showing the winemaker's application of new technically specific industry knowledge through his use of the cultural and traditional ways of making wine in context. This reveals that asymmetrical learning is multifaceted going beyond exploratory learning. They are related as both are about discovery and search—but foregrounding asymmetrical learning reveals how it is intertwined with the social context and rooted in practice. It is not an individualistic endeavor. Consequently, this affords us to develop the EAP literature through emphasizing the importance of the concept of asymmetrical learning as part of the activities, practices and processes of the entrepreneur. This provides a more sophisticated understanding of EL.

However, EL evolves through further interaction and guidance in context. The entrepreneur subsequently becomes an active agent in carrying out their intention through benefitting from challenging, debating and critically examining their assumptions through a dynamic exchange with their knowledgeable peers (Jones et al., 2010; Zaretskii, 2009). The entrepreneur is enabled to capture change, employ change, and create change as it forms new order within the sociocultural contexts in which they participate (Anderson et al., 2012).

Symmetrical Learning

Following a cognitive learning theory and an EAP perspective on EL, we suggest that symmetrical learning supplements asymmetrical learning. It occurs among peers through collaboration. Peers help the advancement of their partners' learning thanks to their distinctive ideas and beliefs (Izanlu & Feyli, 2015). This also acts as a form of scaffolding. Entrepreneurs benefit from collaborating with partners embedded in the same cultural context (Clapper, 2015). Partners may have different educational and work experiences, use different personal and professional networks, employ different judgment rules for evaluating situations (Page West & Gemmell, 2021). They may also have different understandings of products, and how to succeed in the given market. Such differences in knowledge based on experience and expertise leads to constructive conflict in open communication and dialogue (El-Awad et al., 2017). This can promote higher levels of reasoning and stimulates learning and problem-solving that can lead to innovation. This symmetrical learning develops from a newcomer's interaction in their context with parties who have similar levels of conceptual understanding of issues yet where none have necessarily a solution to a problem (Fernández et al., 2002). The illustration in Table 2 highlights the role of symmetrical learning in entrepreneuring.

Table 2 Symmetrical Learning: A Vignette

The Domaine subsequently organically grew and Guibert collaborated with his fellow wholesalers and wine producers from neighboring villages. For example, in addition to the premium product, the Domaine began in 1991 to produce and market a more affordable wine range (Moulin de Gassac) due to an opportunity they sensed arising predominantly from their close connection with customers, but also from working closely with their wholesalers. To help leverage the grapes for this venture, Guibert worked with other wineries that shared the same traditional know-how by buying both red and white grapes. While this range of wine is produced principally from grapes from these other vineyards, the vinification still takes place at Domaine Daumas Gassac, and the Domaine remains responsible for the wine's commercialization. Together with exploiting the affordable range opportunity, the Domaine gained the status of pioneer for his premium range, given that the 80 hectares vineyard was created from scratch and was 'not typical' of the Languedoc-Roussillon region. It evidenced the region could produce high-quality wines: It isn't every day that a French wine God, like Peynaud, confers an accolade usually reserved for, say, Château Margaux on a first-generation winery in the scrub-brush hinterlands of the Midi (Nalley, 2003).

Source Author's own.

The vignette underscores that the entrepreneur's interactions with others allowed him to recognize opportunities, i.e. the new affordable product, and that collaboration within his local winemaking community was important for leveraging strategic resources within the geographical space through securing the supply of grapes from other wineries. For Guibert, overtime such collaboration in learning helped the development of trust with his partners which materialized through the continuance of their collaboration. While such symmetrical learning allowed him to innovate, this interaction with his fellow winemakers was critical in Guibert's exploitation of opportunities. Thanks to using their grapes, he developed greater cost control, and increased efficiency in the use of the terroir, by using purchased grapes in the affordable range and keeping the best grapes for the premium range. In so doing, he modified the context of the local field and the understanding of how the terroir could be utilized. He maximized this terroir by introducing the Bordeaux ways of doing things and by developing a quality range of products. This helped bring new customers and awareness in winemaking to the region. This exemplifies EL shapes the social structure in which the entrepreneur operates (Lave & Wenger, 1991). So here too, while we can see similarities between symmetrical learning and exploitative learning, as they are both related to refinement of what you know or efficiency, symmetrical brings a more sophisticated theoretical treatment by embedding social practice and context in EL. For all these winemakers, terroir (the 'unique soil') acts as the sociocultural context within which geographically confined entrepreneurs incorporate a communal sense of origin into their strategies.

Our conceptualization of EL as involving asymmetrical and symmetrical learning allows us to better understand how and when EL occurs. However, our argument now begs for an examination of how such learning changes overtime and can be extended to explain simultaneous cycles of reproduction and transformation of activities within the entrepreneur's venture. This also allows us to address the question of over dependency on others in problem-solving (Aubrey & Riley, 2019) as well as the implication that such learning equates to imitation which may constrain performance in the long run (Handley et al., 2007).

Developing Entrepreneurial Learning

Beyond Replication

Regardless of the source of their accumulated knowledge, this knowledge may act as an antecedent to replicate certain actions close to those already taken, but it may also be the basis for change (Feldman & Rafaeli, 2002). Both symmetrical and asymmetrical learning increases the entrepreneur's cognitive capabilities which materializes in their reasoning for subsequent decision-making. While replication may become constraining and path dependent (Wang & Chugh, 2014) it is arguably also both a requirement for stability (Cyert & March, 1963), and a source for future business development. Entrepreneurs create the future by altering their own present achieved through their accumulated stock of knowledge.

The entrepreneur's curiosity fosters the sensing of opportunity and stimulates the scanning and interpreting of the environment by notably reflecting on failures of past actions as well as from feedback from others (Arikan et al., 2020). Any subsequent action is based on judgement and these judgements express commitments, both cognitively and practically (Dimov & Pistrui, 2020). They continue to create knowledge by transforming their experiences into new ways of seeing the world (Honig & Hopp, 2019). This argument emphasizes that explorative and exploitative learning are inextricably linked. They are two sides of the same coin and EL cannot be conceptualized as involving either or, or that one mode necessarily dominates the other. Given our arguments for asymmetry and symmetry in learning development, we can consider them both synergistically; and suggest that instead of looking for dichotomies it may be better to look at dualities to analyze EL. Using the principles of asymmetrical and symmetrical learning allows us to do so. They help us to understand the cognitive-social nature of entrepreneurial learning and foreshadow the need for a shift of focus in EL research towards emphasizing both opportunity identification and exploitation as ongoing and interlinked activities that underpin the establishment and subsequent development of the firm. Table 3 provides an example.

Table 3 Developing Entrepreneurial Learning and Going Beyond Replication: A Vignette

As asymmetrical collaboration evolved, Guibert not only adopted the Peynaud Style that had previously primarily only been implemented in the Bordeaux wine region, but he also learnt about tasting. Peynaud also shared with Guibert, his unique tasting technique to help him develop the skills necessary for the assemblage of the best quality wine. Guibert did so and later had the iconoclastic idea of assembling grape varieties that no one had thought of before while still using traditional vinification methods (Durand-Bazin, 2018). One of the outcomes was the premium accoladed Mas Daumas Gassac brand.

Source Author's own.

While the vignette in Table 3 reflects how Guibert was an agent in modifying the social milieu he operates in, it also highlights his will and intention or volition in learning the capability of maintaining commitment and effort towards his goal (Dittrich & Seidl, 2018). It also illustrates that the creation of his own specific grape assemblage and the ensuing identification and exploitation of the opportunity to sell new ranges of wine and the launch of new labels, reflects, that entrepreneuring occurs through interactions. The outcomes in terms of both incremental and more radical product development are the result of the entrepreneurs' learning and imagination through the interplay with others. Guibert shows that he practiced what he learnt independently and gained confidence as he embarked in a series of projects. The asymmetrical learning transformed into self-regulated learning and became a vehicle to identify new opportunities for future growth. This is an important route to entrepreneurial action (Hikkerova et al., 2016). It demonstrates he fined tuned his knowledge through practice (Anderson, 2013); and that he was not only engaged in a replication process. This also reinforces our argument that explorative and exploitative learning are intrinsically related, and when wanting to unpack the complexities of EL the concepts of asymmetrical and symmetrical learning are valuable.

Entrepreneurial Learning and Continuity

Our argument allows for the proposition that members joining the entrepreneurs' business will engage in symmetrical and asymmetrical learning. Given the asymmetrical learning argument, we can assume that overtime the entrepreneur will become a knowledgeable peer. This implies a generative process of continuity and enduring practice for venture development. However, the development may also entail discontinuity of some practices and the introduction of new ones (Hamilton, 2011) since these new members bring with them their own stocks of experience (Reuber & Fischer, 1999). This illuminates the notion of 'indeterminacy of practice' (Tsoukas, 1996) as regardless how deep the connection between the learner and the knowledgeable peer is, due to the context, the learning won't be 'simply' an imitation.

It will require active agency from the learner and judgement to fit to their specific circumstances. We provide an example in Table 4.

Table 4 Developing Entrepreneurial Learning and Continuity: A Vignette

The second-generation Guibert family is composed of five brothers, three of whom now work full time for the Domaine, each having their specific role and with each of them having had separate non-wine related business experiences. Guibert transmitted his 'savoir-faire' by providing his sons with hands-on experience. He gradually passed on the Domaine to his sons starting in 2000. Famously the sons said that he gave them 'roots and wings', encapsulating that they are embedded in their context, used their learning and became independent. Indeed, as their father, they support work on the old hillside vines and they have adopted by and large the traditional viticultural lifestyle. But they do not maintain the venture at a stand-still, they continue to identify and exploit more opportunities notably product differentiation. Product differentiation is specifically cultivated based on the uniqueness of the vineyard, its geography and mode of production. The notion of tradition has been carefully used in positioning a uniqueness in international markets, for example the UK or Benelux. They modified the wines' taste profile as they are now focused on freshness and immediate drinkability rather than the thicker and dryer tannic style of their father. The new products are tailored to their customers' taste. Knowledge exchange with resellers is key to the promotion of the Domaine's offerings especially internationally.

Source Author's own.

The example in Table 4 reflects that while Guibert's close connection and involvement with his sons have influenced their practice and sustains the longevity of the Domaine, the sons stand for themselves and do so by exploiting new sets of opportunities (Nielsen, 2008). The brothers have contributed to sustained growth and development of the Domaine particularly internationally. As per their father, this was made possible through symmetrical and asymmetrical learning. And from now on, our argument comes full circle, since one can surmise that they too will become the knowledgeable peer one day.

Discussion and Conclusion

Our conceptual study exemplifies that EL can be conceptualized as a social and situated endeavor, that encapsulates two forms of simultaneous and synergistic learning: symmetrical and asymmetrical. Our argument, visualized in Fig. 1, provides a more sophisticated understanding of the entrepreneurial process in action. The EAP lens generates an appreciation that these learning approaches facilitate entrepreneurs' understanding of context by adding to their stocks of knowledge and subsequently influence their decision-making. Hence, we add a further layer of understanding to studies in entrepreneurship which emphasize entrepreneurial effort as part of a complex adaptive system incorporating the sociocultural fabric of social relations

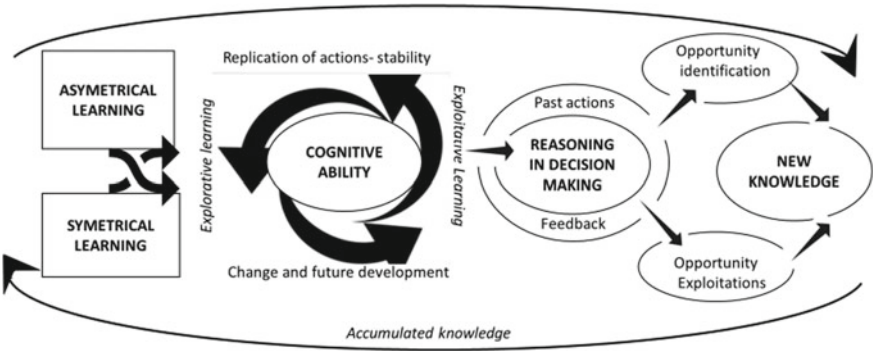

Fig. 1 A practice perspective of entrepreneurial learning (*Source* Author's own)

(Anderson et al., 2012; McKeever et al., 2015). We are thus able to emphasize EL as dynamic process that underpins entrepreneurial growth and the evolution of business over time (Cope, 2005; El-Awad et al., 2017).

Piaget's (1960) and Vygotsky's (1978) conceptualization of learning, represents a theoretical lens that has been scantly applied in the entrepreneurship literature. However, we believe this lens provides much insight into EL as underpinning the identification and exploitation process, a process that is still in need of clarity (Matricano, 2020; Plummer et al., 2007). The lens increases the explanatory power of the role of EL in the entrepreneurial process. Our argument acknowledges that undeniably the concepts of exploratory and exploitive learning, and, asymmetrical and symmetrical learning are closely related. Nevertheless, bringing cognitive learning theory and EAP theorizing to the EL and entrepreneurial process literature underscores that opportunities are inseparable from the entrepreneurs and their context.

Our work also offers some practical implications. We can emphasize how critical it is for entrepreneurs to enhance their learning, form a range of relationships including some outside their local environment (e.g. by engaging with business agencies or attending mixed industry events). Entrepreneurship professors should also stress to their students that entrepreneurship is not context-free, and engagement with peers is important. In terms of future research, we can posit that a range of longitudinal case studies is needed to unpack further how EL can help explain and enhance the cycles of replication and reproduction of practice and consequent business growth. We also need to understand whether the lack of asymmetrical and symmetrical learning influence entrepreneurial failure (Jenkins, 2021).

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Entrepreneurial Self-Identity, Social Ties and Self-Efficacy Affecting Persuasion Ability

Masoud Karami and Francisco Liñán

Abstract This study explains the role of entrepreneurial self-efficacy in transforming entrepreneurial self-identity and the potential, nascent, and current young entrepreneur's social networks as intangible means into persuasive ability to get others to join their new venture creation endeavours. A sample of 2341 potential, nascent, and current young entrepreneurs from Spain supports the direct impact of entrepreneurial self-identity and the entrepreneur's social networks on persuasive ability, as well as the mediating role of entrepreneurial self-efficacy in the focal associations between social network and persuasion. Our findings contribute to behavioural entrepreneurship research. We also provide implications of our findings for practitioners.

Keywords Entrepreneurial self-identity · Social identity · Entrepreneurial self-efficacy · Persuasion

Introduction

In behavioural entrepreneurship research, the cognitions and social interactions of entrepreneurs play a critical role in their creation and exploitation of new opportunities (Powell et al., 2011; Ramoglou & Tsang, 2017). Entrepreneurship research has investigated both factors with different conceptualisations. The entrepreneur's self-identity (individual cognition) and social ties (social cognition) are two well-established concepts (Marshall et al., 2020). However, the mechanism through which these important individual and social cogitations (Barbosa et al., 2007; Brändle et al.,

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2018) are activated and transformed into important resources and result in the creation of new opportunities is yet to be explained.

Entrepreneurial self-identity as an identity that confers distinctiveness from other (Shepherd & Haynie, 2009), represents the agency of the focal entrepreneur which activates and enables the partnership and new venture creation behaviours (Newbery et al., 2018; Nielsen & Lassen, 2012). The critical importance of the focal entrepreneur's existing social ties is also highlighted, since the creation of a new venture takes place as a *social construction* of reality (Aldrich & Martinez, 2003; Fletcher, 2006), which entails putting self-identity within the broader context of the entrepreneur's social interactions (Kaciak et al., 2021; Liñán & Fayolle, 2015; Liñán et al., 2016). This view proposes that entrepreneurship is embedded in a *network of continuing social relations* (Aldrich & Zimmer, 1986, p. 17). In this way, it mirrors Bandura's (2001) assertion that "individual agency works within broader socio-structural influences, wherein people both generate and are generated by social systems. The basic tenet here is that the individual agency acts along with the collective agency exercised through socially coordinative and interdependent effort" (Bandura, 2001, p. 1).

Putting the entrepreneur's self-identity in the broader context of social interactions enables us to address a key question that entrepreneurs have to answer: *what can I do with my existing means (entrepreneurial self-identity and social ties)?* (Sarasvathy, 2001). Entrepreneurial self-efficacy is an important mechanism that can address this question. Entrepreneurial self-efficacy refers to "people's beliefs about their capabilities to exercise control over their own level of functioning and over events that affect their lives" (Bandura, 1991, p. 257; Tsai et al., 2016; Villani et al., 2018). More specifically, entrepreneur s' self-efficacy reflects their confidence in their ability to attain their aspiration associated with new opportunity creation (Drnovšek et al., 2010; Emami & Dimov, 2017).

Entrepreneurship literature emphasize the importance of persuading others to join the initial aspirations in capitalizing on new opportunities. Others who join provide complementary resources to facilitate the exploitation of the new opportunity (e.g. Karami & Read, 2021; Sarasvathy, 2001), so that the survival of new venture depends a great deal on the focal entrepreneurs' capability to persuade others to join them (Artinger et al., 2015). The ability to have others' support (Chen et al., 2009; Patuelli et al., 2020; Wang et al., 2021), therefore, warrants access to several essential resources that are not initially under their control. Against this theoretical background, we formulate the focal question of our study as follows: *what mechanism enables potential, nascent, and current* young *entrepreneurs to utilise their self-identity and social ties to persuade others to join their new venture-creation efforts?*

In addressing our research question, we have proposed and examined a conceptual model using quantitative data from 2341 adults who are at different stages of their entrepreneurial journey in Spain. We contribute to behavioural entrepreneurship research by explaining how the focal entrepreneur transforms her personal and social cognition into a new opportunity to persuade others to join and provide complementary resources toward the new venture creation. As such, we shed light on the

cognitive and social aspects of new venture creation by potential, nascent, and current young entrepreneurs with no or limited access to conventional resources (Aldrich & Martinez, 2003; Powell et al., 2011).

Literature Review and Hypotheses Development

Entrepreneurial Self-Identity and Ability to Persuade Others

The entrepreneur's self-identity reflects the identification of the self with an entrepreneurial role (Obschonka et al., 2015). "Entrepreneurship may offer one of the most visible instances of identity, particularly as it exists apart from material or 'real' products or services, operational systems, or organisational systems" (Navis & Glynn, 2011, p. 480). Entrepreneurial self-identity which defines a person as a unique and distinguished one is largely based on the persons values and beliefs (O'Neil et al., 2020). Entrepreneurial self-identity and individual differences in self-identity reflect the agency bestowed upon each entrepreneur (Kerr & Coviello, 2020), which enables the entrepreneurs to take required actions for new venture creation (Shepherd & Haynie, 2009).

In behavioural entrepreneurship, the entrepreneur's self-identity is a key variable since it influences the way entrepreneurs make decisions and act in the entire process of new venture creation (Nielsen & Lassen, 2012). Entrepreneurial self-identity functions as a critical means that enables the entrepreneur to perceive uncertainty in a comfortable way. It also triggers the entire new venture creation process under conditions of uncertainty (Weber & Glynn, 2006). The entrepreneur's self-identity as a wilful agent (Kerr & Coviello, 2020) is vitally important to overcome their hesitance due to the lack of knowledge and other conventional resources (Brändle et al., 2018). In other words, identifying with the behaviours associated with entrepreneurship provides learned reactions to the unknown situation. Entrepreneurial self-identity gives rise to an urge to demonstrate that the person will be inclined to act in a typically entrepreneurial way (Navis & Glynn, 2011).

Entrepreneurial self-identity is enacted in a constellation of claims around the entrepreneur, the firm, and the new market opportunity of an entrepreneurial venture (Navis & Glynn, 2011). Therefore, entrepreneurial self-identity activates the new opportunity development process by making claims about the core attributes that constitute an entrepreneurial opportunity (Navis & Glynn, 2011). It enables the entrepreneur to make sense of existing and accessible means and start building a path towards the future. Entrepreneurial self-identity conveys the logic behind the proposed means to be used in potential opportunities and places the entrepreneurial actions within bigger contextual discourses (Martens et al., 2007). All of these cognitions and actions induce others to have a positive approach to the entrepreneurs and be inclined to make commitment to their general aspiration of new venture creation (Bhide, 1994).

Entrepreneurial self-identity, therefore, enables entrepreneurs to extend their agency and control over resources through persuading their existing social ties (who have complementary resources) to join them (Newbery et al., 2018). Exhibiting this prototypical profile of an entrepreneur encourages others to trust them and commit their resources to their new venture idea. Persuasion of others to join the initial aspirations of the focal entrepreneur when the future value of their offering is still unknown is a critical step that warrants the survival of the new venture (Artinger et al., 2015). They seek to extend their control over unpredictable situations through negotiating and persuading other accessible and trustworthy members of their social network (Emami & Dimov, 2017; Kaciak et al., 2021; Weick et al., 2005). Entrepreneurial self-identity triggers the process of social networking and partnership, which in turn increases the accessibility of complementary resources and fine-tunes the initial general aspiration of the focal entrepreneur (Artinger et al., 2015; Chen et al., 2009; Majid et al., 2021).

H1a: Entrepreneurial self-identity is positively associated with the ability to persuade others to join the focal entrepreneur's aspiration to create new ventures.

The Entrepreneur's Existing Social Ties and Ability to Persuade Others

The distinction between the existing social ties (as means), and partnership (as a mechanism that activates these important means) is important. It helps us understand the critical importance of the focal entrepreneur's existing social network, as well as the role of developing new partnerships in the dynamic process of new venture creation (Kerr & Coviello, 2020). By understanding the importance of partnership in successful new venture creation, the focal entrepreneurs capitalize in persuading others to join them in their endeavours (Artinger et al., 2015).

Easily accessible and supportive social relationships provide a good starting point for the entrepreneurs who try to sell their initial idea to others. Entrepreneurs see existing social ties as an important means and try to activate and expand those ties. To activate these existing ties, entrepreneurs build trust around the new venture idea and develop further commitments within the social network (Rodrigo-Alarcón et al., 2020). The cognition of social ties as an important means enables the focal entrepreneurs to persuade network members to commit their resources to their initial idea, which in turn helps further develop the new venture idea (Davidsson & Honig, 2003). When others commit their resources to the new idea of the focal entrepreneur, they become partners of the focal entrepreneur in perusing the new opportunity.

The entire process of new venture creation is influenced by the entrepreneur's pre-existing dyadic social relationships (Read et al., 2016). Some social skills such as making a positive first impression, the ability to read others, being persuasive in communication and adaptability to a wide range of social situations enable focal entrepreneur to move form dyadic ties to network ties (Baron & Markman, 2000). These social connections are vitally important at the early stages of the new venture

creation process because *bounded rationality* requires entrepreneurs to rely on "suggestions, recommendations, persuasion and information obtained through social channels as a major basis of choice" (Simon, 1993, p. 156). These relationships can facilitate or constrain the early thoughts and actions of the focal entrepreneur.

A successful entrepreneurship process entails transforming these dyadic personal relations into network relationships (Kerr & Coviello, 2020). The process transforms the initial subjective aspirations and cognitions of the focal entrepreneur into more objective goals, and network members commit their complementary resources to actualize the emerging goal (Read et al., 2016). As such, the quality of the focal entrepreneur's existing social ties (in terms of trust and commitment) influences the networking efforts and the quality of the resulting partnerships (Audretsch et al., 2018; Karami et al., 2020). The entire process of new venture creation becomes a co-creation process of exchanging means, ideas, and commitment among network members (Karami & Read, 2021; Rodrigo-Alarcón et al., 2020).

H1b: The entrepreneurs' existing social network is positively associated with the ability to persuade others to join the focal entrepreneur's aspiration to create new ventures.

Entrepreneurial Self-Efficacy

Self-efficacy reflects people's core beliefs about their ability to control their own actions and the external events that influence their lives (Bandura, 1991, 1998; Drnovšek et al., 2010; Tsai et al., 2016). It refers to the controllability of both the person's behaviour and its necessary modifications, as well as the situation (Ajzen, 2002; Santos & Liguori, 2020). Self-efficacy may reflect both internal and external factors (Ajzen, 2002; Laviolette et al., 2012). Entrepreneurial self-efficacy essentially refers to the belief in one's own ability and perceived control over starting and running a new venture (Emami & Dimov, 2017; Hsu et al., 2019; Rosique-Blasco et al., 2018). Entrepreneurial self-efficacy is associated with entrepreneurs' higher level of self-esteem, internal locus of control and emotional stability (Judge et al., 2003). All these attributes lead towards the subjective positive evaluation of the conditions and an increased confidence in the own capability to create a successful venture (Dimov, 2010). In the same vein, entrepreneurial self-efficacy enhances personal beliefs about opportunity feasibility (Davidsson, 2015; Dimov, 2010).

Entrepreneurial self-efficacy answers the important question of "*what can I do?*", related to the perceived control over the situation. As such, there is a close correlation between entrepreneurial self-efficacy and "perceived behavioural control" (Ajzen, 2002, p. 668). Self-efficacy enables entrepreneurs to gain control over the behaviours of other actors with mutual trust. Self-efficacy also strengthens the belief that they are able to manage contingencies that arise within the social network (Goel & Karri, 2006; Naktiyok et al., 2010). Self-efficacious entrepreneurs apply their logic of affordable loss to make sense and adjust to uncertain situations (Hinz, 2017; Maitlo et al., 2020) and focus on the opportunities rather than being afraid of the uncertainties and irregularities. As a result, the unexpected is considered as serendipity,

meaning that entrepreneurs welcome surprises and make the most of them (Dew, 2009). Such new situations can thus be framed as a potential opportunity (Engel et al., 2014), increasing the likelihood that these new opportunities are exploited (Cassar & Friedman, 2009). Empirical studies have also observed entrepreneurial self-efficacy as a reliable antecedent of entrepreneurial behaviour (Chen et al., 1998; Goel & Karri, 2006), as it is related to the entrepreneurs' perceived capability to gain required resources (Erikson, 2002; Goel & Karri, 2006). It has similarly been related to aspirations, commitment to new opportunities, persistence, and work attitudes (Goel & Karri, 2006; Maitlo et al., 2020).

The Mediating Effect of Entrepreneurial Self-Efficacy Between Entrepreneurial Self-Identity and Ability to Persuade Others

Being an entrepreneur provides the opportunity to fulfil the need for uniqueness and distinctiveness (Shepherd & Haynie, 2009). Entrepreneurial self-identity, therefore, motivates individuals to gain greater control over their lives (Brändle et al., 2018), and peruse and exploit new opportunities to fulfil such motivations (Cassar & Friedman, 2009). The embedded freedom inherent in entrepreneurship is seen as a way to have control over the formation of their entrepreneurial self-identity (Shepherd & Haynie, 2009).

Entrepreneurial self-identity enhances entrepreneurial self-efficacy by helping entrepreneurs identify themselves as different and unique individuals and focus on purposeful and meaningful activities (Bandura, 2001). In other words, entrepreneurial self-identity enables entrepreneurs to believe they have the ability to generate creative outcomes (Tierney & Farmer, 2002). Entrepreneurial self-efficacy relies on the sense of control and agency and as such, is reinforced by entrepreneurial self-identity (Engel et al., 2014). The main premise of this association is that self-efficacy enables entrepreneurs to act in such a way that allows them to satisfy a psychological need to be appreciated as somehow distinctive (Shepherd & Haynie, 2009). This sense of uniqueness and difference is important in the maintenance and improvement of one's entrepreneurial self-efficacy (Oyserman et al., 2002).

Entrepreneurial self-efficacy, in turn, activates entrepreneurial self-identity and associates it with entrepreneurial behaviours such as the encouragement of others to join the aspirations of the focal entrepreneur (Karri & Goel, 2008). This is because self-efficacy reflects the entrepreneur's reliance in making entrepreneurial decisions and performing entrepreneurial jobs (Busenitz & Barney, 1997; Koellinger et al., 2007). Entrepreneurial self-efficacy serves entrepreneurs to utilise their entrepreneurial self-identity and exercise their control over situations, owing to the belief in one's ability to control their own situation and extend that control to other people's resources (Kerr & Coviello, 2020).

This quality helps when persuading others to join the focal entrepreneur, in the sense that people often appreciate and trust the people that are confident enough in their ideas and aspirations and take actions (Bhide, 1994). Therefore, people who believe themselves competent at making decisions will take more risks and develop more opportunities by encouraging other members to join their aspirations for new venture creation (Kerr & Coviello, 2020).

H2: Entrepreneurial self-efficacy mediates the relationship between the focal entrepreneur's self-identity and the ability to persuade others to join their aspiration to create new ventures.

The Mediating Effect of the Entrepreneurs' Self-Efficacy Between Their Existing Social Network and Ability to Persuade Others

The need for social cognition is also critical, as it activates the basic need for inclusiveness and being identified with a group (Brändle et al., 2018). It gives individuals a social identity and motivate them to form and maintain interpersonal relationships (Baumeister & Leary, 1995; Purchase et al., 2018). Identification with a group helps entrepreneurs share the same positive attributes such as success and achievements within the group (Brändle et al., 2018). This gives them a sense of belonging and self-awareness of that belonging (Obschonka et al., 2015), which in turn enhances their perceived self-efficacy (Kannadhasan et al., 2018).

The entrepreneur's dual need for individual distinctiveness and social belonging (Shepherd & Haynie, 2009) becomes crucial in new venture creation because it makes entrepreneurs focus on opportunities and values that are in line with an in-group identity profile (Tajfel et al., 1979). The formation of in-group identity and social recognition also strengthens social network members' commitment to the initial aspiration of the focal entrepreneur. Such commitment in turn highlights the social validation of the endeavour (Davidsson & Honig, 2003; Hernández-Carrión et al., 2019).

Conceptualisation of network as a *means*, and network as a *partnership* (Karami et al., 2020; Kerr & Coviello, 2020) is particularly useful in understanding the importance of such social dynamics in new venture creation. The person's position within the network (the means) can reinforce her sense of control over the situation and resources and result in a higher perceived entrepreneurial self-efficacy (Zhang et al., 2020). Having a good position within a social network attracts others' attention and trust to the person's ideas. Social interactions encourage this association, because receiving trust and encouragement from people within the social network makes entrepreneurs feel more self-efficacious and therefore inclined to exert greater effort (Marshall et al., 2020; Wood & Bandura, 1989). Moreover, interactions within the network might provide valuable clues with respect to new opportunities (Davidsson & Honig, 2003). Also, the identities of committed members of their social network can convey a sense of legitimacy associated with the focal entrepreneur, the initial idea, and/or the entire entrepreneurship process (Kerr & Coviello, 2020, p. 10).

Interactions within the network represent an activation of dyadic ties that become embedded as a result of commitment (or partnership) development (Kerr & Coviello, 2020). Partnership within the social networks plays two important roles in the entrepreneurship process. Firstly, it facilitates the commitment of members of the network to invest their resources; and secondly, it facilitates the convergence of different goals into one feasible final goal (Sarasvathy, 2001). Partnership, therefore, facilitates trust building and transfer among the members of the social network, and contributes to providing time, money and other necessary resources (Mueller, 2021; Read et al., 2016). Overall, therefore, social ties provide trust and commitment, helping to consolidate self-efficacy beliefs.

Perceived entrepreneurial self-efficacy, in turn, plays an important role in extending and strengthening the existent social ties and transforming them into an active partnership. It helps entrepreneurs feel that they are able to address the uncertainty of new venture creation (Brändle et al., 2018) by increasing the perceived controllability of the situation (Ajzen, 2002). As such, self-efficacy helps focal entrepreneurs focus on the opportunity rather than the uncertainty by persuading others to commit more resources to their new venture idea (Cassar & Friedman, 2009; Villani et al., 2018). This helps build confidence in focal entrepreneurs and in others. Entrepreneurial self-efficacy also facilitates the entrepreneurs' cognition of promising relationships. Similarly, the belief that they are able to control the situation through partnership enables cognitive activation of the social ties (Kerr & Coviello, 2020). As such, entrepreneurial self-efficacy is reinforced by network size and centrality (Prajapati & Biswas, 2011). In summary, trust and reciprocity within the network influence the level of perceived entrepreneurial self-efficacy (Mueller, 2021), which in turn increases the focal entrepreneurs' inclination and ability to persuade other people to join them in pursuing an opportunity.

H3: Entrepreneurial self-efficacy mediates the relationship between the focal entrepreneurs' initially supportive social network and the ability to persuade others to join their aspiration to create new ventures.

Methodology

Sample and Data Collection

We tested our hypotheses using data from a population of Spanish adults with different levels of involvement in entrepreneurship. Involvement in entrepreneurship is relatively low in this country (Peña et al., 2019). Therefore, a purposive sample was used. Data were collected between March and May 2018.

On the one hand, a number of entrepreneurship support organisations were approached and, through them, potential, nascent and current young entrepreneurs were invited to participate. The organisations included four that are regional (Andalucia Emprende, Catalunya Empren, Bic Galicia, and Emprendelo [in Madrid]), and two national networks (Chambers of Commerce and the Explorer

program). Exact response rates cannot be produced because most centres have not informed of the number of invitations that they sent out.[1] In the case of Explorer, they sent invitations to over 1000 participants in their annual incubation programme and obtained 137 valid responses (a response rate of around 13 percent). These response rates are in line with the 9.4 percent reported by Deutskens et al. (2004) for a similarly structured online questionnaire. More recently, in a business context, Frese et al. (2020) obtained a 16.8 percent response rate with a shorter questionnaire. Overall, we collected 620 responses through entrepreneurship centres.

Furthermore, adults with university education (alumni from a large university in the South of Spain who have graduated in the last five years) were also approached and invited to participate. In this case, a total of 22,400 alumni were invited, and 1721 complete responses were returned, representing a 7.7 percent response rate. This is in line with the 8.6 percent response rate reported by Breznitz and Zhang (2020) for a similar population of university alumni. The final sample obtained included a total of 2341 complete responses, including 1002 graduates with no intention yet to start up a business (SS1), 601 potential entrepreneurs with intention to start up a business in the subsequent three years (SS2), 281 nascent entrepreneurs (SS3), and 457 current young entrepreneurs (SS4).

Measures

Dependent Variable: Persuasive ability is measured through a three-item scale taken from Santos et al. (2013). It assesses the extent to which the respondents consider themselves able to influence, convince or persuade others. The scale items for all scales used in the analysis are listed in Table 1. Response options range from 1 (strongly disagree) to 5 (strongly agree).

Independent Variables: Entrepreneurial self-identity is measured based on the work by Cardon et al. (2013). The scale measures identity centrality based on the extent to which individuals consider different entrepreneurial functions (inventing, founding and developing) to be important parts of who they are. Responses range from 1 (strongly disagree) to 5 (strongly agree). *Entrepreneurial Self-efficacy* is measured through a 6-item scale (Liñán et al., 2016) assessing the self-perceived efficacy in carrying out start-up-related tasks, as is common in previous research (Van Gelderen et al., 2008). Response options range from 1 (very ineffective) to 5 (very effective).

Several different dimensions of *social networks* may be used to assess its support to the entrepreneur (Stam et al., 2014). Network ties (size and diversity of contacts) and network configuration (density, connectivity and centrality) are important elements. Thus, we have built a composite measure of social network supportiveness to include these basic characteristics. The items assess these four dimensions: size and diversity

[1] Due to data protection regulations, the researchers did not have access to the personal information of the respondents. In turn, the centres forwarded our invitation message to their affiliates/users.

Table 1 Exploratory factor analysis

Item\factor	Factor loading			
Self-efficacy				
To define my business idea and the strategy of a new company	0.76			
To maintain control over the process of creating a new company	0.76			
To negotiate and maintain favourable relationships with potential investors and banks	0.72			
To recognise opportunities in the market for new products and/or services	0.71			
To connect with key people to obtain capital to create a new company	0.70			
To start a new company	0.70			
Ability to persuade others				
I am able to influence people to do things that I want		0.86		
I am able to convince people to change their opinion		0.83		
I am able to persuade people easily		0.82		
Social network				
My social network is very broad and diverse			0.83	
I often communicate with members of my social network			0.79	
I easily get information or other resources from my social network			0.79	
Generally, I locate myself in an important position within my social network (a central position with many connections with other members)			0.75	
Self-identity				
Inventing new solutions to problems				0.84
To be a founder of a business				0.74
To make companies grow and develop				0.43

Note Principal components extraction method, Varimax rotation method/loadings below 0.4 are not shown

(Elfring & Hulsink, 2003), density (Runyan et al., 2006), connectivity (Stam & Elfring, 2008) and centrality (Perry-Smith & Shalley, 2003). Respondents were asked to rate their agreement with each item from 1 (strongly disagree) to 5 (strongly agree).

Control Variables: According to the literature reviewed in Sect. "Literature Review and Hypotheses Development" above, several variables are included as controls, since they are frequently found to affect entrepreneurial cognition and action. Specifically, gender, parents and friends as role models, self-employment experience, employee experience and entrepreneurship training are controlled for. Gender is an important factor in individual's entrepreneurial self-efficacy (Mueller & Dato-on, 2013). Work experience has been identified as an important variable influencing entrepreneurs' networking activities. Research has also found that entrepreneurial experience influences networking activities (Greve & Salaff, 2003; Majid et al., 2021) due to the opportunity cost of time (Levesque & Minniti, 2006), Experience also influences entrepreneurial self-efficacy (Kasouf et al., 2015). Work

experience is assessed through two variables. *Employee experience* indicates whether the respondent has previous work experience as an employee, while *self-employment experience* refers to experience as a self-employed person or entrepreneur. They are both devised as ordinal variables to consider the length of experience. They take the value 0 if the respondent has no experience, 1 if they have less than 1 year of experience, 2 for up to 3 years of experience, and value 3 when they have more than 3 years of experience.

The influence of role models is argued to be an influential factor in people's entrepreneurial attempts (Santos & Liguori, 2020). A role model can be anyone who sets examples to be followed by others and is able to motivate and inspire them to follow certain paths (Bosma et al., 2012). Role models are a reference and a source of vicarious learning (Ahsan et al., 2018). Some authors argue that the effect is different depending on the evaluation made by the individual about the model's performance as an entrepreneur (Scherer et al., 1991). Therefore, we have controlled for the personal knowledge and evaluation of the entrepreneurial activity of two important players who can serve as a reference for the respondent: *parents and friends as role models.* Finally, *entrepreneurship training* (Ahsan et al., 2018) is a binary variable taking the value 1 for those respondents who have received specific training in entrepreneurship and 0 otherwise. Descriptive statistics for all variables are shown in Table 2.

Controlling for Common Method Variance

To control for common method variance (CMV), some ex-ante steps were taken. First, some reverse items were used as a built-in check to reduce the effect of acquiescence responding (Knowles & Condon, 1999). Second, strong confidentiality and anonymity was assured by mentioning that findings will only be published in aggregate. Thus, participants were demotivated from providing socially desirable responses. Third, different response anchors were used to decrease the likelihood of receiving careless responses. Nevertheless, since respondents voluntarily answered the survey, the likelihood of responding carelessly was not high (Meade & Craig, 2012), which in turn reduced the measurement error (Dillman, 1991). Fourth, the order of scales in the questionnaire did not follow independent, mediator, and dependent variables. In fact, scales were ordered randomly to prevent respondents from recognising the possible relationships among the variables (Podsakoff et al., 2003). Fifth, to prevent the social desirability impact, respondents were told that there is no right or wrong answer to questions and there are no preconceived expectations for responses (Wechtler et al., 2017).

We ran two tests to control for potential common method variance (CMV). First, we conducted Harman's single factor test (Podsakoff et al., 2012). All of our construct items were entered into one exploratory factor analysis. As a result, four factors emerged explaining 58.7 percent of the total variance. The top factor accounted for only 17.69 percent of the total variance, suggesting CMV is not a problem. We also

Table 2 Descriptors and correlations

Variable	Composite Reliability	Cronbach's Alpha	AVE	Mean	S.D.	1	2	3	4	5	6	7	8	9	10
1. Gender	–	–	–	1.51	0.50										
2. Parents as role model	–	–	–	1.54	0.86	0.02									
3. Friends as role model	–	–	–	2.07	0.95	–0.04*	0.12**								
4. Employee experience	–	–	–	1.94	1.05	–0.05**	0.02	0.21**							
5. Self-employed/entrepr. Experience	–	–	–	0.56	1.02	–0.12**	0.09**	0.15**	0.22**						
6. Entrepreneurship training	–	–	–	0.78	1.19	–0.10**	0.05*	0.07**	0.07**	0.14**					
7. Self-identity	0.84	0.71	0.64	3.55	0.96	–0.07**	0.10**	0.14**	0.16**	0.23**	0.14**	(0.80)			
8. Social network	0.91	0.87	0.72	3.55	0.83	0.02	0.08**	0.15**	0.12**	0.08**	0.07**	0.23**	(0.85)		
9. Self-efficacy	0.90	0.87	0.74	3.55	0.74	–0.04*	0.12**	0.19**	0.17**	0.23**	0.18**	0.45**	0.37**	(0.86)	
10. Persuasion	0.92	0.88	0.80	3.53	0.78	–0.02	0.08**	0.09**	0.06**	0.07**	0.05*	0.15**	0.33**	0.34**	(0.89)

Note In parenthesis, the square root of AVE. * Correlation is significant at the 0.05 level. ** Correlation is significant at the 0.01 level. Two-tailed test

applied Williams et al. (1989) technique, using AMOS software to compare the full measurement model including all of our substantive variables with another CMV model including all variables and a common method factor. The fit indices for this latter model (RMSEA = 0.07, GFI = 0.92, CFI = 0.92, NFI = 0.92) were lower than those for our proposed research model (RMSEA = 0.07, GFI = 0.94, CFI = 0.95, NFI = 0.94). This indicates a very low likelihood of CMV being present.

Analysis and Results

Exploratory factor analysis (EFA) is used to examine the discriminant validity of the constructs. The direct oblimin rotation method permits any item to load on multiple different factors, and therefore demonstrates its true load across factors (Samiee & Chabowski, 2012). All items are represented by relevant constructs and have loading scores above 0.6 (see Table 1). A confirmatory factor analysis (CFA) is carried out with AMOS, producing a model with highly acceptable fit indices (CFI = 0.95, GFI = 0.94, AGFI = 0.92). SmartPLS is also used to check the validity and reliability of our scales. Cronbach's alpha for all substantive constructs is above the accepted threshold of 0.7 (Nunnaly, 1978), as is the case with composite reliability (above 0.7, Hair et al., 2013). The average variance extracted (AVE) of all items is above 0.5 (Hulland, 1999), showing a satisfactory convergent validity for our measures. Finally, the discriminant validity of our substantive measures is assessed by calculating the square root of the AVE (indicated on the main diagonal in Table 2). All scores are higher than the correlation coefficients in related columns and rows, representing the acceptable discriminant validity of our measures (Birkinshaw et al., 1995). Table 2 shows the descriptive statistics of all variables.

We tested our hypotheses for the aggregated data first. Tables 3 and 4 show the SPSS 25.0 (IBM) results of the hierarchical regression analyses used to test our hypotheses. Control variables are entered in the first step (model 1). Having parents and friends who are role models significantly helps in persuading others to join their endeavour ($\beta = 0.06$, $p < 0.01$), and ($\beta = 0.07$, $p < 0.01$), respectively. There was a positive association between parents as role models ($\beta = 0.09$, $p < 0.01$), friends as role model ($\beta = 0.07$, $p < 0.05$), and persuading others to join them in their endeavour for SS1. Only friends had the role model effect for SS2 ($\beta = 0.10$, $p < 0.01$), and no role model effect for SS3 and SS4.

To test Hypotheses 1a and 1b, the second step involves entering entrepreneurial self-identity and social network as our independent variables (model 2 in both Tables 3 and 4). For both, results show a significant relationship with the ability to persuade others as our dependent variable ($\beta = 0.07$, $p < 0.00$ and $\beta = 0.31$, $p < 0.00$, respectively, $\Delta R^2 = 0.12$) in the aggregated sample, as well as SS1 ($\beta = 0.16$, $p < 0.00$ and $\beta = 0.28$, $p < 0.00$, respectively, $\Delta R^2 = 0.12$), SS2 ($\beta = 0.11$, $p < 0.00$ and $\beta = 0.30$, $p < 0.00$, respectively, $\Delta R^2 = 0.11$), SS3 ($\beta = 0.25$, $p < 0.00$ and $\beta = 0.22$, $p < 0.00$, respectively, $\Delta R^2 = 0.14$), and SS4 ($\beta = 0.14$, $p < 0.00$ and $\beta = 0.32$, $p < 0.00$, respectively, $\Delta R^2 = 0.14$).

Table 3 Hierarchical regression results for the agregated sample ($n = 2341$)

Variable	DV: Persuading others			DV: self-efficacy
	Model 1	Model 2	Model 3	Model 4 mediation
Gender	–0.01	–0.02	–0.02	0.01
Parents as role model	0.06**	0.04	0.03	0.04*
Friends as role model	0.07**	0.03	0.01	0.04*
Self-employed/entrepr. experience	0.04	0.02	–0.01	0.07**
Employee experience	0.03	–0.00	–0.01	0.02
Entrepreneurship training	0.03	0.01	–0.01	0.08**
Self-identity		0.07**	–0.02	0.49**
Social network		0.31**	0.24**	0.19**
Self-efficacy			0.27**	–
ΔR^2	0.02	0.12	0.04	–
Adjusted R^2	0.02	0.13	0.17	0.40
ΔF	6.9	44.5	52.5	198.33

Standardised coefficents are reported $^{*}p < 0.05$, $^{**}p < 0.01$

Hypotheses 2 and 3 propose that entrepreneurial self-efficacy mediates the effects of entrepreneurial self-identity and the social network on the ability to persuade others. We adopt Baron and Kenny's (1986) three-step procedure to test this mediation effect. First, entrepreneurial self-identity and the social network are significantly related to the ability to persuade others (model 2 in both Tables 3 and 4). Second (model 4 in both Tables 3 and 4), both entrepreneurial self-identity ($\beta = 0.49$, $p < 0.00$), and the social network ($\beta = 0.19$, $p < 0.00$) significantly affect entrepreneurial self-efficacy perceptions in the aggregated sample, SS1 (entrepreneurial self-identity $\beta = 0.45$, $p < 0.00$, social network $\beta = 0.17$, $p < 0.00$), SS2 (entrepreneurial self-identity $\beta = 0.40$, $p < 0.00$, social network $\beta = 0.21$, $p < 0.00$), SS3 (entrepreneurial self-identity $\beta = 0.44$, $p < 0.00$, social network $\beta = 0.24$, $p < 0.00$), and SS4 (entrepreneurial self-identity $\beta = 0.45$, $p < 0.00$, social network $\beta = 0.24$, $p < 0.00$). And third (model 3 in both Tables 3 and 4), in the aggregated sample entrepreneurial self-efficacy significantly affects persuasive ability ($\beta = 0.27$, $p < 0.00$), while the coefficient for entrepreneurial self-identity on persuasive ability becomes non-significant ($\beta = –0.02$, n.s.). This provides support for hypothesis H2. However, the effect of the social network on persuasive ability remains significant ($\beta = 0.24$, $p < 0.00$), meaning that entrepreneurial self-efficacy just partially mediates the relationship between these two variables. The results for subsamples were as follows: SS1 ($\beta = 0.05$, n.s. and $\beta = 0.24$, $p < 0.00$, respectively), SS2 ($\beta = 0.01$, n.s. and $\beta = 0.25$, $p < 0.00$, respectively,), SS3 ($\beta = 0.21$, $p < 0.00$ and $\beta = 0.20$, $p < 0.00$, respectively), SS4 ($\beta = 0.02$, n.s. and $\beta = 0.25$, $p < 0.00$, respectively). Thus, hypothesis H3 is partially supported.

To test the significance of the indirect effects of entrepreneurial self-identity and the social network on persuasive ability via self-efficacy, we used the Sobel test

Table 4 Hierarchical regression results for all subsamples. (SS1 = 1002, SS2 = 601, SS3 = 281, SS4 = 457)

Variable	DV: Persuading others												DV: self-efficacy			
	Model 1 SS1	Model 1 SS2	Model 1 SS3	Model 1 SS4	Model 2 SS1	Model 2 SS2	Model 2 SS3	Model 2 SS4	Model 3 SS1	Model 3 SS2	Model 3 SS3	Model 3 SS4	Model 4 SS1	Model 4 SS2	Model 4 SS3	Model 4 SS4
Gender	0.04	0.01	–0.03	–0.09*	0.04	–0.02	–0.07	–0.11*	0.03	–0.03	–0.06	–0.11*	0.05	0.02	–0.06	–0.01
Parents as role model	0.09**	0.06	–0.05	0.06	0.06*	0.03	–0.05	0.04	0.06*	0.03	–0.05	0.02	0.01	0.01	0.05	0.06
Friends as role model	0.07*	0.10*	0.00	0.03	0.04	0.07	–0.02	–0.01	0.02	0.04	–0.02	–0.01	0.05	0.12**	–0.02	–0.01
Selfemp/entre exp	0.02	0.02	0.01	0.12**	0.01	0.02	–0.02	0.14**	0.00	0.01	–0.02	0.11*	0.03	0.05	–0.02	0.11**
Employee experience	0.03	0.04	0.03	0.03	–0.03	0.05	–0.00	0.02	–0.04	0.04	0.00	0.01	0.02	0.03	–0.06	0.05
Entrepre training	0.06	–0.02	0.09	0.02	0.04	–0.05	0.06	0.02	0.01	–0.06	0.06	0.00	0.10**	0.06	0.07	0.08
Self-identity	–	–	–	–	0.16**	0.11**	0.25**	0.14**	0.05	0.01	0.21**	0.02	0.45**	0.40**	0.44**	0.45**
Social network	–	–	–	–	0.28**	0.30**	0.22**	0.32**	0.24**	0.25**	0.20**	0.25**	0.17**	0.21**	0.24**	0.24**
Self-efficacy	–	–	–	–	–	–	–	–	0.25**	0.24**	0.08	0.27**	–	–	–	–
ΔR^2	0.02	0.02	0.01	0.03	0.12	0.11	0.14	0.14	0.04	0.04	0.01	0.05	0.27	0.24	0.32	–
Adjusted R^2	0.02	0.01	–0.01	0.02	0.14	0.12	0.13	0.16	0.18	0.16	0.13	0.20	0.31	0.28	0.32	–
ΔF	3.76**	1.96	0.55	2.58	72.36**	37.50**	22.85**	37.05**	52.18**	29.12**	1.47	27.94**	192.24**	99.25**	65.15**	–

(Preacher & Leonardelli, 2012). As a result, both indirect associations between entrepreneurial self-identity (*Sobel test statistics* = 15.66, $SE = 0.01$, $p < 0.01$) and the social network (*Sobel test statistics* = 13.29, $SE = 0.01$, $p < 0.01$) with persuasive ability were confirmed.

Robustness Checks

First, we examined whether entrepreneurial self-efficacy mediates the effects of both independent variables when examined simultaneously. The results confirmed this significant mediation. Second, the possible existence of multicollinearity between our variables was checked, and the results show the highest variance inflation factor (VIF) to be 1.24, well below the accepted threshold value of 5. Third, SmartPLS allows the structural equation model (SEM) to be tested and the size and significance of our structural paths to be examined. As the results in Fig. 1 show, the direct relationship between entrepreneurial self-identity and ability to persuade others is not significant, indicating full mediation. In turn, the direct relationship between the social network and ability to persuade others is still significant, denoting only a partial mediation effect (see Fig. 1). Therefore, our SEM fully confirms our regression analyses results.

Discussion

Discussion of the Findings

Persuasion of others plays a key role in gaining their commitments to the new venture. Persuasion becomes critically important in the early stages of new venture creation when the future value of the offering is not yet known (Artinger et al., 2015). It becomes even more critical for potential, nascent, and current young entrepreneurs who are suffering from the liability of limited resources and experience. In addressing this important issue, a growing body of research has investigated the networking behaviours of entrepreneurs, and how networks provide access to complementary resources (Davidsson & Honig, 2003; Kerr & Coviello, 2020; Majid et al., 2021). We contribute to this line of research by investigating the role of cognition and actions of potential, nascent, and current young entrepreneurs and the way their cognitions and actions enable them to persuade others to join their general aspiration and endeavours to create a new venture.

Our study investigated self-efficacy as a mediation mechanism which activates the potential, nascent, and current young entrepreneurs' intangible means (e.g. self-identity and social network) and links them to their networking behaviour. Self-efficacy is a well-developed and established concept in psychology and

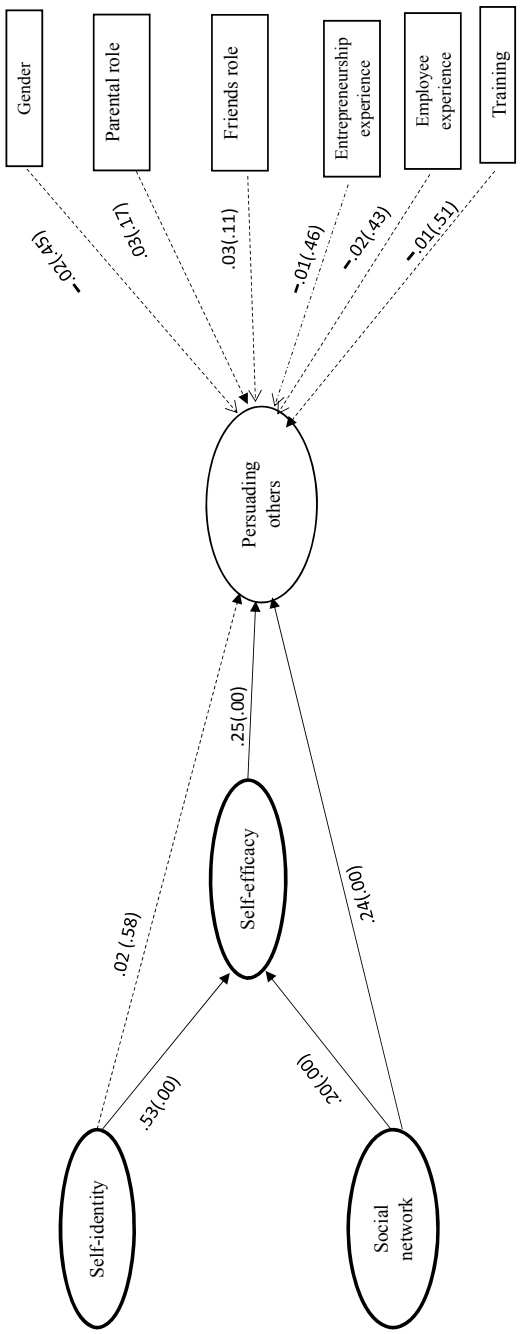

Fig. 1 The Structural equation model for aggregated sample (Standardised parameter estimates are shown with *p* values in parentheses)

entrepreneurship literature. In our model, entrepreneurial self-efficacy bridges the gap between the initial (individual and social) cognitions of the potential, and current young entrepreneurs and persuading others to join the entrepreneurial endeavour as a critical step in establishing a new venture (Artinger et al., 2015).

The results are notably robust for the full sample and each subsample. For lay persons, potential and actual entrepreneurs, a higher self-identity is associated to higher persuasive ability, through the mediating influence of self-efficacy. However, self-efficacy did not mediate this relationship for nascent entrepreneurs. This is an interesting finding that deserves further research. One possible interpretation of this result is that, for those who are presently acting to start a venture (nascent), their self-identity (learned roles and automated responses) become essential in persuasion. They are so immersed in their new role that play their part irrespective of their own feeling of capacity (self-efficacy) to move on with the entrepreneurial process.

The results confirmed the important role of self-identity and social identity in potential, nascent, and current young entrepreneurs' ability to persuade others to join and support their aspirations (Baron & Markman, 2000). The interesting finding was that the entrepreneurial self-efficacy enables these entrepreneurs to move forward by getting access to other s' resources. Self-efficacy is the important factor that enables them to see new opportunities for creating new venture. The role of self-efficacy is especially relevant when deciding whether to consider entrepreneurship (lay persons) or when planning how to do it (potential entrepreneurs). In turn, once action starts, self-efficacy stops being determinant.

Our findings add to Alsos et al.'s (2016) observation on the association between the entrepreneurial missionary identity and partnership behaviours. Similarly, we confirm previous observations on the influence of collective identity in enabling entrepreneurial behaviours. Our findings are in line with Hinz's (2017) observation that entrepreneurial self-efficacy is the mechanism that enables partnership. Our findings equally support the theory that entrepreneurial self-efficacy triggers action and interaction among network members, which results in getting feedback from others to better understand and activate their entrepreneurial self-identity (Nielsen & Lassen, 2012).

Theoretical Implications

Potential, nascent, and current young entrepreneurs' cognition and actions in new venture development are central issues in entrepreneurship research. In turn, most potential, nascent, and current young entrepreneurs do not have access to conventional resources such as funding, thus needing to get others involved in their project. However, persuading others to commit their resources to these entrepreneurs' initial aspiration is not an easy job as it requires a great deal of trust. Therefore, having access to the complementary resources remains a critical issue for potential, nascent, and current young entrepreneurs.

Our research has exposed the importance of self-identity and social network as most relevant intangible resources needed to persuade others to join the entrepreneur's project. However, self-efficacy (what I can do) has been revealed as a key mediating mechanism for these resources to be activated. Understanding the factors and mechanisms that enable potential, nascent, and current young entrepreneurs to persuade and convince others to join their initial aspiration is of critical theoretical and practical importance (Davidsson & Honig, 2003; Kerr & Coviello, 2020). These mechanisms are essential to finetuning goals and accessing complementary resources. Our study contributes to behavioural entrepreneurship research by investigating the central role of entrepreneurial self-identity, social networks and partnership in entrepreneurship processes (Kerr & Coviello, 2020). Our findings provide a clear picture of how entrepreneurial self-efficacy activates the individual and social cognition to persuade others to join the entrepreneurial endeavour. In particular, the full mediation of self-efficacy on the self-identity-persuasive ability relationship is specially revealing. Lack of sufficient confidence on one's own abilities completely undermines the strength derived from an entrepreneurial identity, especially during the initial stages, when considering and planning about entrepreneurship. Whereas a strong entrepreneurial identity encourages others to believe in the focal entrepreneur's narrative of the future and the identified opportunity, self-efficacy is needed to materialize this encouragement. Self-efficacy helps us better understand how cognitive and social means are activated and used in creating new opportunities.

Practical Implications

Our findings provide some interesting and practical insights for potential, nascent, and current young entrepreneurs who wish to start up their new ventures in different industries. First, we show that personal intangible means are important in triggering the process of new venture creation (Sarasvathy, 2001). Potential, nascent, and current young entrepreneurs should have a realistic and pragmatic understanding of themselves and their existing relationships. They should reconsider the traditional understanding of resources as conventional operands, such as money, land, or technology. Thus, potential, nascent, and current young entrepreneurs can start investing in their personal and social means in the right way (Rotefoss & Kolvereid, 2005). Reflective learning and enhancing self-concept during the university years and the early years of working in different organisations can help young people to nurture their entrepreneurial self-identity and develop their social ties as two critically important resources for their entrepreneurial aspiration.

Second, potential, nascent, and current young entrepreneurs should be able to see the important association between these personal means and their ability to persuade others to "buying" their new business start-up aspirations (Read et al., 2016). According to our findings, successful persuasion of others to support the focal entrepreneurs' new venture idea relies heavily on the quality of self-identity and the social networks that entrepreneurs develop around themselves. The quality

of a network simply means the amount of trust and commitment among members within the network (Johanson & Vahlne, 2009). It implies that potential, nascent, and current young entrepreneurs should be mindful of their personal means and try to enhance the quality of those means with the aim of developing better network ties.

Third, we show that entrepreneurial self-efficacy is the mediation mechanism that activates personal and social means and enables potential and current young entrepreneurs to persuade others to join them. Since entrepreneurial self-efficacy is a quality that evolves over time, potential, nascent, and current young entrepreneurs should do their best to invest in education and training, learn from their work experience, and nurture relationships with their mentors and role models to develop their entrepreneurial self-efficacy. In our study we emphasised that entrepreneurial self-efficacy, as the perceived control over behaviour and performance (Ajzen, 2002), helps entrepreneurs answer a key question in the process of venture development, namely *what can I do*? And we find this to be of utmost importance during the initial (pre-actional) phases of the process. Accurately answering this question based on existing means is extremely important for potential, nascent, and current young entrepreneurs, as it will serve to accelerate the process under uncertain conditions. Without a clear answer to this important question, entrepreneurs will be confused (Sarasvathy, 2001).

Finally, entrepreneurship educators and supporting incubators can also benefit from our findings. Business schools and other entrepreneurship education providers should invest in developing the students' entrepreneurial self-identity and self-efficacy as important dynamic capabilities for transforming their ideas into new ventures and encouraging others to join them (OctoSkills, 2017). Incubators could also provide a range of services such as mentorship, networking opportunities, and practical assistance to further develop the initial self-efficacy of the students, as well as their social network (OECD/EU, 2018).

Limitations and Suggestions for Future Research

This study is not free from limitations. First, we only focus on entrepreneurial self-identity and social ties in investigating the process of new venture creation. To provide a more thorough picture of potential, nascent, and current young entrepreneurs' available means, future research could go further by bringing basic values and attitude into the equation (Caliendo et al., 2009; O'Neil et al., 2020). We also exclude an important means, namely entrepreneurial knowledge. To obtain a more realistic understanding of potential, nascent, and current young entrepreneurs' cognition and actions, future research needs to include these constructs and provide a more comprehensive picture of means in the entrepreneurship process. Nevertheless, entrepreneurial knowledge should be strongly related to entrepreneurial self-efficacy. It is very unlikely the focal entrepreneur feels a high self-efficacy with substantial lack of basic knowledge. By analysing all means, future research can build on more realistic assumptions about "human cognition, emotion, and social interaction" (Powell et al., 2011, p. 1369).

Finally, we did not hypothesise the association between entrepreneurial self-identity and entrepreneurs' social ties. Future research may want to theorise this association.

Second, opportunity is an important construct in entrepreneurship research (Alvarez & Barney, 2007; Shane & Venkataraman, 2000). We did not investigate this substantive construct in this study. Future research could consider opportunity creation as a dependent variable to study how the whole process results in the creation of new entrepreneurial opportunities. There is an ongoing discussion in entrepreneurial opportunity literature on different types of opportunity such as recognition, discovery and creation (Alvarez & Barney, 2007; Karami et al., 2020). Future research could also investigate the different processes and factors that result in different types of opportunities at the individual level of analysis. Exploitation of either discovered or created opportunities for new ventures can be another fruitful direction for future research.

Lastly, the data is collected based on self-reports. Although we took several ex-ante and ex-post steps to reduce potential CMV, we cannot claim to have reduced it to zero. Future research could also take some further steps such as collecting data in two different time periods from each respondent, or triangulating responses with data from complementary sources (Podsakoff et al., 2003). Specifically, we measured "persuasive ability' with a subjective measure and as a generic concept. Future research could use objective measures and the specific concept of persuading others to join the focal entrepreneur's aspirations. Moreover, our data was cross-sectional. Since entrepreneurs' means and entrepreneurial self-efficacy might change over time, especially after becoming involved in the new venture creation process, longitudinal studies can provide a better chance to understand the relationship dynamics between our substantive constructs. Studying the process of mediation and the outcome of the entire process entails obtaining more detailed data which should be collected over a longer period.

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Returnee Entrepreneurship in China: The Multi-Faced Story in the Travel of Location, Time and Culture

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Introduction: Definition and Significance

The significant contributions made by high-skilled immigrants to the developed economies such as US are widely acknowledged (Kenney et al., 2013). On the other side, the home countries, often the emerging economies, that are losing those talents allegedly suffer from "brain drain" which negatively impact on their economies (Gruenhagen et al., 2020; Kenney et al., 2013). However, the "brain drain" situation sees some recovery as the "brain circulation" (where talents returning home) phenomena starting to be observed (Lin et al., 2016) particularly in the last decade. Those people who returned to their home countries after spending considerable time abroad in more developed countries to setup new ventures are termed as returnee entrepreneurs.

The concept of returnee entrepreneurs has gone through some evolution of changes in its boundary of study. Early scholars have defined them as "scientist and engineers returning to their home countries" to set up businesses after gaining considerable experience in education and/or business in developed economies (Drori et al., 2009, p. 1006). Over time, scholars start to question such restricted view and indeed argue that the term should not be constrained to just "scientists and engineers" to ensure the phenomena can be captured in a more complete and compelling way (Gruenhagen et al., 2020). This chapter follows suits of the latest trend on adopting a more inclusive definition.

With their experience, knowledge and skills accumulated in both home and host countries, returnee entrepreneurs are regarded to be the international knowledge brokers and make significant contributions to the countries' social-economic development (Kenney et al., 2013; Lin et al., 2016). For instance, they can help with

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developing different industries, facilitating knowledge transfer to local areas, cultivating internationalisation activities which in turn have positioned themselves in a key role in the entrepreneurial ecosystems (Ahlstrom & Ding, 2014; Eckhardt & Shane, 2003; Ellis, 2011; Filatotchev et al., 2009; Gruenhagen et al., 2020). However, just like any other entrepreneurs, there is no guarantee to success (Wentrup et al., 2020). Returnee entrepreneurs are at no exception and need to face their own challenges. For instance, does the knowledge and experience gained from foreign market really transferrable especially when culture differences are unavoidable? Networks and social capital are important in entrepreneurship. Having considerable time spent away from the home country, how do returnee entrepreneurs re-integrate themselves into the local community? How do they compensate for lack of local knowledge and connections compared with local entrepreneurs?

To address those questions, it is essential to first to recognise the importance of context in entrepreneurship as induced by location, time and culture. This returnee entrepreneurship phenomenon has become particularly important in Eastern and African countries. Out of these, China emerged as an important context for its high number of global mobility of citizens, the rapid development of the economy, various policies initiatives designed to attract returnees, and the national effort in high-tech industries (Gruenhagen et al., 2020). The following chapter focuses on discussing the returnee entrepreneurship in China, outlining its changing nature and current challenges and opportunities.

Returnee Entrepreneurship in China

The Changing Perception Towards Returnees

Since the inception of the China's open-door policy in 1978, the number of Chinese citizens who have studied or worked abroad have grown exponentially. Recognising the "brain drain", the state government has designed various policies and initiatives in hope of bringing these talents back home. Those returnees have also been given a special label, "sea turtle", which is a homonym for "returnee" in Chinese. More than a decade ago, the perception towards returnees is predominately positive where "sea turtles" are mainly viewed as an asset (Zweig & Han, 2011). However, this overwhelmingly positive attitude starting to see a change in recent years.

The reasons behind the change in views are multi-faced. Partly, it is due to the increasing number of returnees. According to the National Bureau of Statistics of China and Ministry of Education of China, in year 1978, 860 citizens went study abroad and 248 returned. These numbers jumped to 399,600 and 272,900 respectively in year 2012; and then to 703,500 and 580,300 in year 2019. The total number of students who studied abroad and subsequently returned between 1978 and 2019 accumulated to 6,560,600 and 4,231,700 respectively. As the country develops, people's disposable income increases drastically which drives up the number of self-funded

students. As a result, it seemingly becomes much easier to study abroad in recent years: it is no longer the elite or ultra-intelligence class who are often funded by the state government can study abroad. At the same time, the massive increase in number also means the overall quality of students went abroad and subsequently returned are compromised compared with many years ago. Indeed, while some students studied abroad because of their high academic achievements, there are also a group of the students who went abroad for the exact opposite reason. There is also a general perception that the self-funded students are less capable than those funded by the states (Zweig & Du, 2021) even though the exact situation might depend on individual cases. Nevertheless, when the mix flushes back to the home country, disparities in performance start to show which in turn alert people to view the group more critically.

Another key factor is the rapid development of China economy. Indeed, as Chen and Miller (2010) pointed out such expeditious growth of the economies in the East countries together with the accelerated global integration among different economies have transformed the business reality from the conventionally "West-leads-East" to the new "West-meets-East". China's rapid evolution has enabled the country to narrow the gaps with the West and in some areas, even surpassing. On one hand, it influences people's perception towards returnees from predominately worshiping to adopt a more critical lens. On the other hand, the rapid development of the country means being abroad for considerable length of time may lead to disconnection with the local market and expectations.

On the job markets, it reflects as some employers start to prefer local graduates as they are perceived to be more familiar with the local market and expectations. As the situation develops, in 2005, there is even another term "seaweed" being developed to refer to people who returned but did manage to secure a job (Zweig & Du, 2021). On the entrepreneurship side, it poses challenges for the returnees to establish themselves in the home market and compete against with the local entrepreneurs who may have an advantage on having updated knowledge and already established social capital. Prior research has evidenced that the returning experiences are often associated with pessimism, tensions, struggles, confusions, and maladjustment (Chen et al., 2003; Dong, 2017; Gill, 2010; Hao & Welch, 2011). Sometimes the experience can be so negative that some returnees consider re-expatriate (Zweig & Han, 2011).

The Fantasy and Reality of Returnee Entrepreneurship

According to the 2019 report issued by the Centre for China and Globalization and Zhaopin Ltd, Sea turtles' decisions for returning can vary where the non-neglectable thoughts and the feeling of missing families and home country is the major reason; and the positive outlook of the China's continuous economic development trend comes second. Just like any entrepreneurs, returnee entrepreneurs returning home with an ambitious future painted ahead. It is true that there is no lack of headline stories of returnees made their fortune and become role models in various industries particularly in technology or related industries (Liu et al., 2012; Zhang et al., 2011).

The experience of being abroad in more developed countries have blessed them with advantages such as having an international perspective, language abilities and sometimes knowledge on more advanced technology and innovations. It is understandable that returnees come back home with confidence. Indeed, China's modern day high-tech industry is believed to be largely shaped by returnee entrepreneurs (Zhang et al., 2011). For instance, returnees have either directly founded or brought majority of the Chinese high-tech businesses (e.g. Baidu, Sina, Sohu, Ctrip, 51job, Kongzhong.com, Suntech Power) to be listed on European and the US exchange market (Zhang et al., 2011). These listed businesses have introduced latest technologies and new operational and management systems, as well as brought in talents and overseas capital into the country (Wang, 2007). All of these have not only contributed to China's economic reform but also placed great influence on people's live particularly for the younger generation.

Upon recognizing returnee entrepreneurs' contribution, both state and local governments have introduced various policies and initiatives in hope of attracting high potential returnees to set up ventures in China. Some common incentives and benefits include providing start-up capital in form of grants or easy to access low interest loans; easing the settle down requirements and simplifying the process[1]; eligible for tax-free cars; subsidising with accommodation and assisting with arranging local schools for children. As part of a nation-wide effort, there are 224 venture parks established for returnee entrepreneurs to date. As part of the offering, returnees can enjoy an array of additional benefits ranging from investment, free office space, access to established network of resources including potential clients or partners.

While it may look promising with such nation-wide support, returnee entrepreneurs are not short of challenges especially in recent years. First of all, lack of insights of local markets and policy remain challenging. From management perspective, Western economies rely more on "legal contracts and explicit rules (formality)" whereas Eastern economies' governess system are found to have higher associated with "social relationships and implicit norms (informality)" (Lin et al., 2015). Returnees are often found to suffer from experiencing "culture re-shock" while they re-adjusting to the home country social norms upon their return. In particular, as China experiencing rapid economic growth and the "entrepreneurship rush" partly pushed by the "mass innovation, mass entrepreneurship" initiative in 2015, the current domestic market operates more like a "test ground" where consumers are sometimes being spoiled with choices and regulations are lagging behind to protect businesses' rights. Being away from the country and having limited first-hand experience with consumers can lead to misjudgement of the market needs and demand.

Secondly, social capital and networks are key in the successful operating of the businesses. Often such networks and connections can be difficult to establish and manoeuvre especially for returnees due to their prior absence in the country. Speed

[1] Getting settlement status can be attractive as it is difficult to get settlement status in big cities such as Beijing and Shanghai where many benefits and extra resources are often associated with.

of market entry can be slowed down by such absence from the home market context (Qin et al., 2017). However, Qin et al. (2017) also argue that the combination of latest technical knowledge and access to international networks can help advance China's technology industry development. In fact, the presence of capable returnee founder can help mitigate the slow entry speed induced by the liability of novelty and foreignness. It is therefore important to take a critical lens on returnee entrepreneurship and address it accordingly.

It is also worth noting that China's appetite for technology can lead to different stories depending on whether the venture idea falls into the category or not. Returnee entrepreneurs who possess key latest technical knowhow are generally welcomed with a wealth of support and opportunities from government, industries and venture capitalists and alike. On the other hand, venture ideas fell outside the category, for instances ideas based on replicating particular business model into the China context may see less enthusiasm from the supporting organisations.

Conclusion and Recommendations

As context has been particular empathized in recent entrepreneurship study, China's returnee entrepreneurship deserves a special place not only for its significant social and economic contributions but also for its uniqueness induced by their physical travel of locations, experiencing and adjusting to multi-cultures, as well as changes brought by time moving forward. Some common advantages associated with returnee entrepreneurs' oversea experience are acknowledged such as the global outlook, language ability and some may also come with latest technological knowledge and skills. At the same time, the challenges faced by returnee entrepreneurs should not be overlooked. The issue with culture re-integration is reflected in multi-aspects such as lack of in-depth understanding on the local markets and policies, absence of social capital and networks. It is also worth noting that while efforts are and should be made towards better understanding of the particular group, it is important to also bear in mind of the individual differences which may come from the returnees' own backgrounds, skillsets (both technical and soft skills) and the industry their venture is setup in.

In supporting returnee entrepreneurs in hope of maximising their contributions and benefits to the economy and society, it is essential to understand the context and design approaches that are guided by evidence. As Ahlstrom and Ding (2014) point out, returnee entrepreneurs have a significant role in entrepreneurial ecosystems. It is therefore important to develop and guide the development of the ecosystems with returnee entrepreneurs in mind in seeking of ways to better facilitate multi-dimensional resources flow. For instance, venture parks can act as a hub in facilitating such process. However, effectively executing this role requires key personnel to be well connected, resourceful and have a good understanding on businesses so that appropriate connections and advice can be given. At the same time, ecosystem

stakeholders/players (e.g. entrepreneurs, governments, various support agents) also need to adopt a supportive and collaborative attitude in playing their part.

On the other hand, it is equally important for returnee entrepreneurs to adopt a proactive approach in their entrepreneurial endeavours. It starts with returnees apply a critical effort in evaluating their positions taking into considerations of the advantages and disadvantages as discussed previously. In particular, acknowledging shortcomings is the first step towards improvements. In general, entrepreneurs would benefit from adopting a learning organisation attitude in rapid changing dynamic market. Additionally, being part of a relevant and supportive network or community has also reported to be beneficial. These organisations often can help smooth the re-integration journey of returnee entrepreneurs as well as providing tailor support or referrals. In fact, there is currently scarce empirical academic research looking at supporting returnee entrepreneurs from an ecosystem perspective. Therefore, a recommended future research direction would be on supporting and integrating returnee entrepreneurship from holistic ecosystem perspective.

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Entrepreneurial Practices in Eco-Innovation: Circular Challenges Related to the Tomato Textile Project in the Netherlands

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Abstract Values such as circularity, local production, and the use of more environmental-friendly materials have started to reshape various domestic industries. Because of the social and environmental challenges that the Textile & Clothing industry faces, solutions proper to slow fashion practices are gaining importance. The present chapter presents a case study of a local production network that roots in the maker movement and experiments with various aspects of circular practices, to develop new material: the Tomato Textile project. Based on ethnography and action research methods, the challenges of entrepreneurial practices in eco-innovation are identified and discussed.

Keywords Eco-innovation · New materials · Circular practices · Slow fashion · Maker movement · Local production

Introduction

The impact of global warming on our planet is pressing. Policy reports by the Intergovernmental Panel on Climate Change and the United Nations acknowledge technology as a way to reduce, tackle, or even prevent the threats caused by climate changes (Harvey, 2018; IPCC, 2018). Equally, a variety of influential works call for more holistic, circular approaches to our economy, necessary to keep society from reaching its limits (Ellen MacArthur Foundation, 2017; McKinsey & BOF, 2018; Murray et al., 2015; Raworth, 2017). The publication of the United Nations' Sustainable Development Goals (SDG) has fed the public debate on the need for a systemic change (United Nations, 2015), and the Circular Economy (CE) has entered the arena as a new paradigm. For example, honoring the SDG's, the European Commission (2018) considers the CE as an opportunity to develop a continent that respects the world's boundaries to resources, which can equally create employment and a competitive advantage for various industries in its member states. Its

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Circular Economy Action Plan articulates a focus "on the design and production for a circular economy, with the aim to ensure that the resources used are kept in the EU economy for as long as possible" (European Commission, 2020). Efforts to simplify and harmonize the Extended Producer Responsibility systems (EPR) in Europe are at the top of the agenda, likely to lead to a dedicated forum "where stakeholders could take stock of best practices" (Ecommerce Europe, 2022).

An industry that faces severe challenges in the transformation into a new economy, is the Textile and Clothing (T&C) industry (Ellen MacArthur Foundation, 2017, 2021; McKinsey & BOF, 2018). While 'growth' epitomizes the old economic paradigm, it has become a core value of the T&C industry: between 2000 and 2015, global clothing production almost doubled to approximately 100 billion units produced in 2015 (Ellen MacArthur Foundation, 2017), accounting for a growth rate of 4 to 5% per year (Global Fashion Agenda, 2019). Particularly the 'fast fashion' phenomenon has been responsible for such growth rates and detrimental impacts on society and the planet. Characterized by mass-production, offshoring to developing countries, and other bad habits such as 'take-make-dispose' and the 'race to the bottom',[1] the fast fashion industry has been accountable for severe environmental catastrophes (e.g., the exhaustion of the Aral Sea Basin in Kazakhstan by cotton production [Hoskins, 2014]) and humanitarian dramas (e.g., the collapse of the Rana Plaza factory in Bangladesh).

Alternative practices have started seeing the light, one being the 'slow fashion' movement in which values such as sustainability, social responsibility, and transparency take center stage (Clark, 2008) and traditional production and innovative design techniques are used to develop products with a long lifecycle (Bakker et al., 2014; Fletcher, 2010). Exemplary of the movement are eco-innovations such as the production of new materials based on CE principles. With its manifestation mainly in niche markets and local production networks, eco-innovations in a slow fashion can be considered part of the umbrella term of the 'maker movement' that refers to individuals who collaborate to produce tangible products outside of the traditional manufacturing firm (Doussard et al., 2018). The usage of technology (Anderson, 2012), open innovation, and knowledge-sharing are core characteristics of the maker movement (Browder et al., 2019). The notion captures the innovations and entrepreneurship by various makers—including entrepreneurs, designers, hobbyists, artists, researchers, students, and educators—which are commonly part of a 'making and sharing economy' (Browder et al., 2019). The maker movement has sparked the interest of policymakers because of its potential to catalyze an entrepreneurial environment and act as a precursor of the next industrial revolution (Browder et al., 2019).

Eco-innovations are confronted with challenges related to learning processes and entrepreneurship, in particular when it comes to technology and the creation of

[1] Take-make refers to a profit-model based on the production of low quality products that end up in landfill sites. In the 'race to the bottom', firms seek to produce as much and fast as possible at the lowest price. Both principles are exemplary for linear ways of production and business.

a market (Brown et al., 2019; Dougherty & Dunne, 2011). While presently eco-innovation practices are championed in several sectors of society, at the same time, the quest for new business models (BM) that help firms analyze, plan, and communicate within the increasing complexity of the new economy is at full pace (Bocken et al., 2019; Boons & Lüdeke-Freund, 2013; EMF, 2015; Geissdoerfer et al., 2018; Hultberg & Pal, 2021). BM for the CE underwrite the circular values and seek to integrate the radical changes in production and consumption, as well as the collaborative aspects of innovation. Several authors have argued that experimentation and innovation in BM are needed (Antikainen & Valkokari, 2016; Bocken et al., 2016; Boons & Lüdeke-Freund, 2013) because circular goals stand in contrast with the bias toward growth common to business (Tunn et al., 2019). However, clear and theoretically grounded ways to determine which BM best suits CE (closed-loop) practices are (still) in development (Lüdeke-Freund et al., 2018). A transition to a CE requires that experimental innovations turn into more embedded (decision-making, resourcing, networking, selling,…) practices organized around a shared understanding of how things should go (Thompson et al., 2020).

The present chapter seeks to unravel the challenges of eco-innovations, using a case study of the production process of new material for a circular T&C industry. Located in Rotterdam, a city that claims to be "the European centre of the bio-based and circular economy" (City of Rotterdam, 2015), the Tomato Textile (TT) project involves pioneers who are collaborating in a process for producing a yarn made out of tomato stems, a residual product of one of the largest export products of the Netherlands. The TT-project is an ongoing journey from cradle to cradle in which waste is considered to be a valuable resource. Stakeholders from various parts of the supply chain (from horticulture to fashion designers and scientists, to marketers and business leaders) are involved in the development of technology and a market, two of the greater challenges in the maker movement (Brown et al., 2019).

Our empirical study entails ethnography and an action component with the aims to, first, reveal emerging entrepreneurial practices related to eco-innovations, second, fuel the recent developments in circular practices and business model innovation with the perspective of makers in the slow fashion movement (cf. Antikainen & Bocken, 2019; Bocken et al., 2016; Boons & Lüdeke-Freund, 2013; Hultberg & Pal, 2021), and third, establish a link between eco-innovation and the maker movement (cf. Browder et al., 2019; Brown et al., 2019). After a compact literature overview of the T&C industry, Circular Economy business models, and eco-innovation, several key challenges of circular eco-innovation practices in the maker movement are derived from the case study.

The Textile and Clothing Industry

The Textile and Clothing industry is an integral part of everyday life and an important sector of the global economy (Ellen MacArthur Foundation, 2017). The industry consists of the production of fibers (such as cotton, wool, silk, nylon, and polyester),

knitting and weaving of garments, and finishing activities (such as dying, bleaching, and printing). On a global scale, societal and environmental issues have become increasingly intertwined with the T&C industry. In a report of 2018 on the state of fashion, McKinsey and BOF predict major changes:

> For fashion players, 2019 will be a year of awakening. The ones who will succeed will have to come to terms with the fact that in the new paradigm that is taking shape around them, some of the old rules simply don't work. (p. 10)

More recently, the Ellen MacArthur Foundation (2021) reported the following vision:

> Material innovation and recycling are important elements of the solution, but they alone cannot create a thriving fashion industry. In a circular economy for fashion, clothes are used more, made to be made again, and made from safe and recycled or renewable inputs. (p. 4)

The environmental and social challenges that typify the T&C industry arise at all stages of its complex supply chain (Franco, 2017). Already at the initial stage of production, the materials for garment production are often extracted from non-renewable resources such as polyester (98 million tonnes annually) and water-consuming resources such as cotton (using around 93 billion cubic meters annually) (Ellen MacArthur Foundation, 2017). Production processes heavily pollute the environment and account for severe social costs, such as damages to crops and workers by the chemical pesticides of the cotton industry, and social problems like low wages, child labor, and unhealthy labor conditions associated with garment production in lower-income countries (Lueg et al., 2013).

Designed to be short-lived (Fletcher, 2010), fast fashion has affected people's consumption patterns, currently characterized by disposability (Global Fashion Agenda, 2019) and under-utilization of items. There is a lack of innovative and economically viable solutions for up-cycling and recycling: the donation of garments for good causes to developing countries leads to a transportation burden and the abolishment of domestic clothing industries (Brooks, 2015); not to speak about the impact of the destruction (burning) of non-sold items (Celie, 2017).

While the demand for garments is still unremittingly accumulating (Ellen MacArthur Foundation, 2017, 2021; McKinsey & BOF, 2018), consumers do gain an increasing awareness of the (un)ethical side of the fashion industry, caused by sweatshop scandals associated with brand names such as Nike and Levi-Strauss (Brito et al., 2008), and the disastrous collapse of the Rana Plaza factory in Bangladesh. Today, in search of more transparency and sincere brand narratives, consumers are increasingly susceptible to smaller brands that put purpose and values at the heart of their strategies. Such an "explosion of the small" (McKinsey & BOF, 2018, p. 74), converges with the rise of platforms and niche markets that broaden purchasing opportunities (Ellen MacArthur Foundation, 2017).

Established fashion brands have started to feel pressure to meet new standards (Brydges, 2018), and turn to corporate social responsibility strategies such as integrating sustainable innovation solutions into their collections and awarding sustainable initiatives. Still, even if the financial gains of tackling societal and environmental

problems have been estimated at €160 billion per year (Global Fashion Agenda, 2019), 40% of the companies have in 2019 not seriously considered sustainability practices, and of those who have, 60% are SMEs or start-ups.

The disposability and short-life cycles of garments in today's fast fashion industry stand in contrast with the slow fashion movement and its paradigm of sustainable fashion solutions that include alternative strategies for design, production, and consumption (Fletcher, 2010). A key characteristic of the slow fashion movement is the valuation of local resources (Clark, 2008). However, upscaling and mass-production in the T&C industry urge businesses in the slow fashion movement to reinvent production networks closer to home. A variety of local resources are used to compete locally and abroad by local production networks that are organized as "collaborative linkages between local firms and local factors of production" (Simmie & Hart, 1999, p. 445). These networks could benefit from agglomeration economies that increase the ability to adapt to radical changes, cluster and network effects, and from innovation (Feld, 2012; Simmie & Hart, 1999). However, the mere nature and effectiveness of the practices of such networks are underexposed.

The Circular Economy and its Business Models

The Circular Economy arose as an alternative to a linear system in which waste had become the natural result of the usage of products (Pearce & Turner, 1990). While a linear economy is one of "converting natural resources into waste, via production" (Murray et al., 2015, p. 371), in a circular approach, products remain in the 'loop' or 'cycle' and eventually return to the system by either repairing, manufacturing or recycling. In the CE, furthermore, waste is being reduced through efficient production methods and extended product life cycles in which producers remain involved, and thus responsible (Bocken et al., 2016; Erler & Rieger, 2016).

Several approaches to the CE co-exist. The 'cradle to cradle principle', for example, states that products should either be treated as long-life goods or reused as resources because they will always remain on earth (McDonough & Braungart, 2002). Similarly, in the perspective of 'a looped and performance economy', the loop of reusing, repairing, and remanufacturing goods up to their molecular components takes centre stage (Stahel, 2010). The Blue Economy framework articulates that small, local, and clean technologies are needed to increase resource efficiency in the production of goods and solutions for a more sustainable economy (Pauli, 2010). Common to those schools of thought are the central roles of designers, entrepreneurs, and pioneers to instil change and innovation.

Business models for the CE are considered operational tools that have the potential to support businesses with the implementation of practices to address circular and sustainability goals (Ellen MacArthur Foundation, 2021; Hultberg & Pal, 2021; Kirchherr et al., 2017; Linder & Williander, 2017; Murray et al., 2015). A BM is a simplified version of how a firm arranges its business in which commonly a value proposition (what the firm delivers, its target consumers, and competitive advantage),

value creation and delivery, and value capture (the revenue model) are distinguished (Barney, 2002; Richardson, 2008). The nine 'building blocks' of the 'Business Model Canvas' are an extension of such a value framework that give business developers the flexibility needed in today's increasingly complex economy where innovation and experimentation are key (Osterwalder & Pigneur, 2010). Ries (2012) and the lean start-up movement take the experimentation further, relying on principles such as hypothesis-testing and the agile development of a minimum viable product that is adapted according to immediate consumer feedback (Blank, 2013).

Circular business models challenge the traditional BM mainly by its distinct objectives in terms of value creation that resides in social and environmental concerns rather than in the gains that result from strategically marketing a product and creating competitive advantage (Geissdoerfer et al., 2018). Furthermore, circular BM need to address the peculiar challenges of narrowing, closing, and/or slowing the loop (Antikainen & Bocken, 2019; Nußholz, 2017; Stahel, 1994). Circular businesses could either choose to innovate and update existing business models or create new business models to implement their circular economy practices (Bocken et al., 2019). While some scholars advocate a radical change in BM (e.g., Raworth, 2017), others suggest that existing models could integrate practices crucial to the CE: the focus on sustainable value and stakeholder and supply chain management (Geissdoerfer et al., 2018), sustainable innovations (Boons & Lüdeke-Freund, 2013), and various strategies for closing the loops (Bocken et al., 2016; Linder & Williander, 2017; Nußholz, 2017).

Eco-Innovation and the Maker Movement

During transitions such as the techno-economic paradigm shift that society has been experiencing for some years, there could be a leading role for entrepreneurship in developing innovative industrial and systemic solutions (Perez, 2002), as well as for local production networks that engage with niche and pioneering experiments (Brydges, 2018; Grin et al., 2010; Perez, 2002; Simmie & Hart, 1999). Within such complex processes of opportunity search and development, especially at the front-end of innovation, research through design (Maher et al., 2018) is a common practice: through iterations, reflections and experimentation, innovations can be developed while potential risks are kept at a minimum (Bocken et al., 2014a, 2014b). The inclusion of circular concerns at those early stages of innovation allows for the development of really new value propositions and production systems (Bocken et al., 2016; Nußholz, 2018). 'Eco-innovation' as an umbrella term for any "form of innovation aiming at significant and demonstrable progress towards the goal of sustainable development" (European Commission, n.d.) is particularly discrete in those front-end processes, because of the heterogeneous, yet very specialized knowledge that is needed at the early stage. Oftentimes start-ups and their inter-disciplinary teams engage with eco-innovation (Perez, 2002), motivated not just by economic benefits, but more so by the search for new knowledge or enhanced skills, or ego-centric

motives as career progression or the status that follows from becoming a CE thought leader (Brown et al., 2019). Eco-innovation can be sustainably oriented (Brown et al., 2019), and aim at "competitively priced products and technologies with better environmental performance than relevant alternatives" (Bocken et al., 2014a, 2014b, p. 43). Eco-innovation can also be circularly oriented, and take the process one step further by aiming at the integration of "CE goals, principles, and recovery strategies into technical and market-based innovations, such that the circular products and services that are brought to market purposively maintain product integrity and value capture potential across the full life-cycle" (Brown et al., 2019, p. 3).

According to Brown et al. (2019), the success of eco-innovation is dependent on two aspects: technical advancement, and the creation of a market. Still, to succeed, eco-innovation must overcome challenges, particularly related to its collaborative learning aspect: the installation and maintenance of an "innovation-oriented learning culture" (as well as 'unlearning') that can help partners to adapt their visions and critically reflect on the process (Brown et al., 2019, p. 6), coordination between interdependent partners whose goals may not be aligned, and entrepreneurial processes more in general (Dougherty & Dunne, 2011). When they take place outside the firm, those collaborative learning processes aimed at innovative manufacturing practices are prototypical of the maker movement (Browder et al., 2019; Doussard et al., 2018).

Policymakers in the European Union have recognized the potential of eco-innovation in the start-up landscape, in that "SMEs and especially start-ups can be ideal incubators for eco-innovation and can bring to market new, less environmentally damaging products, services, and processes" (European Commission, 2012). Policies of several EU countries have led to several 'start-up hubs' that concentrate on the design of innovative products and technologies aimed at addressing the many social and environmental challenges of today (Smale, 2018).

The Case Study

Using an empirical study, we identify the challenges that pioneering entrepreneurs in eco-innovation face. Because little is known still about circular practices, strategic processes, new forms of organizing, and the dynamics within the stakeholder networks (van Dijk et al., 2014), an exploratory case study has been conducted (cf. Ghisellini et al., 2016). Such an inductive approach has been effectuated using ethnographic research in combination with an action component. More specifically, between February and May 2019, a *micro-ethnography* (Wolcott, 1991) of the crucial front-end processes of the eco-innovation (Bocken et al., 2014a, 2014b) within the Tomato Textile project in Rotterdam (the Netherlands) was conducted by the first author who took up the insider's role of a *complete participant* (Gold, 1958).

The case was purposely selected because it exemplifies an eco-innovation situated in the maker movement, which involves multiple stakeholders with a shared interest in innovative circular economy practices. It is experimental, because it is a small-scale activity with access to limited resources only, with the aim of collective learning,

that takes place before larger scale piloting and eventually scaling up. Yet, because it did not have a clear BM for hands to address value creation, capture, and delivery, it allowed the first author to experience the entrepreneurial process during which these value-related processes were experienced and negotiated (cf. Antikainen & Bocken, 2019; Bocken et al., 2018). The first author was granted access to all documents and meetings, including expert meetings and events organized by Blue City Lab—the hub that hosts the TT-project as well as other start-ups in the new material maker movement—and could rely on the coordinator of the project as a key informant. To learn from frontrunners, the first author conducted interviews with four Dutch entrepreneurs who are equally developing textile products in the T&C Industry from residual waste. Field notes, pictures and videos, and the interview transcripts were subject to a thematic analysis based on a hybrid coding procedure (Strauss & Corbin, 1990).

The Challenges of Circular Practices and Eco-Innovation

Transforming tomato waste into a competitively priced textile product with better environmental performance than its alternatives (cf. Bocken et al., 2014a, 2014b), entails numerous big and small challenges (cf. Brown et al., 2019). The TT-project is initiated by the Dutch horticulture organization Greenport West-Holland (2022) (a triple helix organization consisting of entrepreneurs, governments, and knowledge institutions) with the aims to become the first horticulture region independent of fossil fuel, switch the horticulture's energy to sustainable sources, and reduce the combined CO2 emissions. To showcase a bio-based economy, Greenport decided to invest in the waste flows that are created by tomato production, and more specifically the tomato stems that are left behind after grubbing the plants. After previous projects in which the fibers in the tomato stems have been transferred into paper and packaging material already used by some local tomato producers, Greenport wanted to pivot a business case (a T-shirt) and develop the technology and market until a stage where an entrepreneurial start-up could take over and scale-up.

Blue City, "an incubator for circular entrepreneurs in and around Rotterdam" (Blue City, 2019) created on the Blue Economy principles (Pauli, 2010), hosts the TT-project. As a hub for makers, Blue City houses a wide range of entrepreneurs, start-ups, and small initiatives that work on sustainable solutions in which values such as cooperation, waste elimination, and local production are central. The organization makes her *wet* and *dry labs* available to numerous makers to create and develop new materials and products.

The TT-project team represents various stakeholders that share the CE vision and values such as the promotion of the maker industry, innovation in the T&C industry, and the advancement of local production and consumption. At an early stage of the process, a roadmap of three consecutive stages had been conceptualized:

- Stage 1: The tomato plant is shredded and made into a 'pulp soup', which is transformed into cellulose that can be used to make fibers;
- Stage 2: The tomato fibers are turned into yarn;
- Stage 3: The yarn is used to knit a textile product such as a T-shirt.

At the time of the study, the project is at the front-end innovation process (step 1), in which the possibilities for extracting the cellulose out of the pulp are being researched and tested. Up until that point, besides the technological and market challenges that eco-innovations typically face, we identified four other challenges.

* 1: The Technological Challenge

In determining the direction of the project, already during the creation of the cellulose, competing possibilities with distinct financial, societal, and environmental implications had to be assessed, with the trade-off between time and place found most urgent. Eventually, it was decided to save on time and search costs, and to involve a lab in Bavaria (Germany) that would test the pulp of the plant, next to two local entrepreneurs.[2] Thus, the decision to develop the product locally was compromised by the choice for including an international partner that would be able to add to the speed of the creation of a minimum viable product of a decent quality. As was testified by the project coordinator:

> We have decided to continue to work in the direction of a product, meaning that for now, we do not focus on researching the most responsible [sustainable] way of producing but to focus on craftsmanship production.

During the first stage (from cellulose to fibers), more restrictions related to the timing and place of future production processes had been identified. Time would become an issue because harvesting tomatoes only occurs for three months a year, and drying pulp is time-consuming. While currently pulp is being created by hand, scaling up will lead to location decisions because of the absence of pulp-producing plants in the Netherlands. Lüdeke-Freund et al. (2018) have suggested that circular BM can imply "complex trade-offs", including those between a company's private benefits or losses on the one hand, and social benefits and costs on the other hand. Considering that eco-innovation entails environmental and societal values, such decisions cannot rely on straightforward calculations of costs and benefits but intricately relate to the fundamental mission of the project and the shared values of the team members. In line with the "affordable loss" principle common to the effectuation approach to strategy (Sarasvathy, 2001), the team decided that the loss in terms of locality was acceptable because it would contribute to the technical advancements of the TT-project (material development).

[2] A start-up that collects and recycles second-hand textiles (post-consumer waste) and a pulp specialist.

During the second stage of the TT-project (from fibers to yarn), the team will investigate if the fiber is suitable for the production of textile yarns. The lab in Germany is expected to develop a 'recipe' for cellulose that will lead to a yarn suitable for textile production. The main goal is not to be a frontrunner in the market but rather the advancement of knowledge and innovation in the T&C industry using horizontal cooperation (Feld, 2012). Therefore, it was decided that the recipe would be shared under a Creative Commons license that could enable future users and producers to develop the initial work further. This decision epitomizes the values of the maker movement and stands in contrast with how manufacturing firms that would rely on their legal departments normally proceed with technological innovations (Browder et al., 2019).

*2: The Market Challenge

Several business models attribute a prominent role to the consumer, and to value propositions that aim to increase consumer satisfaction (e.g., Blank, 2013). Hence, a key issue in BM that seek to meet the objectives of the CE, relates to the value propositions of producers who face new relations with their consumers as well as with their products. For example, Erler and Rieger (2016) acknowledge how a shift to circular business practices expands the responsibility of the producer for the entire lifecycle of her products. Such an extension of the product-value relationship implies practices such as re-manufacturing, preparing, and recycling, and forms of ownership that are not restricted to a consumer solely but entail product-related services such as renting and leasing (Bocken et al., 2014a, 2014b). Thus, recently, BM in the CE started to shift from being product-oriented to service-oriented (Antikainen & Bocken, 2019; Heiskanen & Jalas, 2003), and design thinking and lean thinking methods have been used to engage consumers more in the development of viable value propositions (Blank, 2013).

However, the centrality of customers is less salient in eco-innovation because of its strong orientation toward inputs and technology rather than toward products or services that address consumer needs. Especially when alternatives are for hands, consumers may not care too much about eco-innovations that seek to develop new products or materials. While makers in eco-innovation look for a circular BM that could epitomize how their environmental and societal responsibilities can be translated into value creation, consumers still need to become incentivized to participate in narrowing, slowing down, or closing the loop (Antikainen & Bocken, 2019). Therefore, eco-innovation in slow fashion may face severe market challenges, but also great opportunities, not in the least because of how the fast fashion industry has evolved and cast bad aspersions on itself. While the highly subjective nature of taste preferences in fashion and the concomitant structural uncertainty for many suppliers has incentivized the industry to produce large numbers of 'push products' that are pushed into the market to increase the likelihood of success (Jin & Cedrola, 2018; McKinsey & BOF, 2018), the drawbacks of fast fashion have longer been recognized

(Fletcher, 2010). Equally, the T&C industry is characterized by asymmetric information that has reduced the transparency for consumers of its production processes and supply chain, to which objections have started to emerge (McKinsey & BOF, 2018). Here could lay room for the introduction of innovative, transparent, and local material production methods that underwrite a novel approach to fashion, appealing to consumers. Yet, producers and developers have to take into account consumer behavior, which has been found to diverge greatly among consumer groups and product types when it comes to circularity (Edbring et al., 2016; Tunn et al., 2019).

For slow fashion products to be able to succeed, the added value and aesthetics of the items are vital to create an appealing brand for consumers. Circular brands should find ways to distinguish themselves from the incumbents in the fast fashion industry because they generally appeal to a consumer segment only that possesses relatively higher levels of willingness to pay. This was recognized for the TT-textile as well, and emphasized during a discussion of the TT-business case: "It [Tomato Textile] will never be fast fashion, we are in a different price category" (Participant, Blue business club 21/03/2019). Therefore, a fair balance needs to be sought when the product is put on the market and scaled up, as linear practices are currently still the status quo and more conducive to economies of scale.

*3: The Circular Challenge

In the TT-project, a valuable waste stream is created, in line with the BM strategy of *industrial symbiosis* (Bocken et al., 2014a, 2014b): the waste of one industry (Dutch horticulture industry), is used as a resource for another industry. Industrial symbiosis aims at creating an interconnected network of partners that eliminates waste and eventually creates surplus-value. As such, next to the consumer, also the supplier of the raw materials should be considered in the further development of the TT-project, particularly in addressing the question of how to close the loop, where responsibilities lie and "efforts" need to be made (Tunn et al., 2019). Because the team's focus has mainly been on technology rather than on market development up until the stage when the study took place, the B2B (network) aspect needs to be addressed more to determine how to evolve from a sustainable to a circular BM that implies a closed-loop (Brown et al., 2019). Closing the loop of the TT-project still required three solutions, regarding:

1. the residual waste in the production process (extraction of the cellulose);
2. the emissions by the transportation of the products, considered to be a bottleneck in CE; and
3. the end-use phase (after usage by the consumer).

At the moment of the study, the team had an awareness of those issues but had not developed a strategy, partly because decisions about final products and the involvement of extra partners were in the pipeline.

* 4: The Collaborative Challenge

Key in eco-innovation is collaborative learning. Even if shared motivation acts as the glue that holds a team together, coordination problems and leadership issues may emerge (Brown et al., 2019). Overcoming the differences in knowledge and professional values are vital in eco-innovation practices; in the TT-project, those emerged strongest between scientific and industrial partners, and between fashion and product designers. While design processes regularly depart from the available (raw) materials and/or the ideas of the designers, the end product (a T-shirt) had been determined; what needed to be established was the roadmap to the product. At the early stage of production, the quality of the polymers and cellulose was uncertain, and this rose questions about the ideal end product (a T-shirt or a fabric?), particularly by the material experts and designers. As formulated during a discussion, "the freedom for designers is important; if you attach yourself to a product, you will limit this freedom" (Participant, Blue business club 21/03/2019). Still, the collaborative nature of the project seemed to be able to create strong bonds toward a joint purpose. However, the heterogeneous 'role-related values' and interests of stakeholders could form a challenge in future stages, because the commissioner and the designers may target other goals.

Managing collaborative learning such as eco-innovations implies good HR-practices. While eco-innovators would ideally dispose of the upfront knowledge of specific CE design processes and resource and recovery strategies (such as reuse and repair), the intended value cycle of the innovation is more frequently unpredictable than known (cf. Brown et al., 2019). To be able to forecast the impact of eco-innovations at the system level and across multiple life cycles, designers, as well as other team members, need skills and knowledge that they normally do not rely on (Brown et al., 2019). Additionally, members of eco-innovation teams could benefit from some soft skills that benefit a smooth collaboration between various professional roles. Motivation, vision, and enthusiasm are important (Brown et al., 2019), but do not guarantee the absence of thorough disagreements and coordination problems. In the TT-project, the inclusion of a team member with a specialization in circular textile innovation had been very fruitful for aligning the team members and creating a form of interdisciplinary empathy and engagement.

Future steps will continue to challenge the collaboration, particularly when extra partners become involved in B2B relationships. At the stage of the research, four directions are considered:

1. the development of an iconic tomato T-shirt for the horticulture industry, with mostly a symbolic value;
2. the development of a product for the B2C market;
3. a collaboration with an incumbent in the T&C industry, for example in outdoor clothing production (B2B);
4. collaborations with small local brands and stores (B2B).

Each direction would challenge the collaborative process and the goal to keep the fabric in the loop because of the additional stakes, and thus call for a distinct BM, acknowledged by the project leader: "the eventual product is an important component in the development of the textile and the business plan."

*5: The Institutional Challenge

Circular business models challenge the wider institutional context, and, inversely, they are challenged by the context as well (Antikainen & Bocken, 2019; Schaltegger et al., 2016). Hence, besides the customer proposition, companies in the CE need to formulate environmental and societal propositions (Antikainen & Bocken, 2019; Manninen et al., 2018). A major challenge here is to complement the typical idea of the "value-added" that refers to the economic value accumulated by firms along linear or "forward" supply chains, with the "value retained" of a used product and its composite elements, also at the societal level (EMF, 2015; Lüdeke-Freund et al., 2018).

While underwriting the blue economy values (Pauli, 2010) and the premise of local production and consumption, the TT-project was confronted with the consequences of the de-industrialization in the region. The lack of pulping facilities led the team to Germany, which affects its circularity goals. So, the institutional context, including the stage of transition that an industry is in at the local level, creates both drivers and barriers to eco-innovation (Brown et al., 2019). According to our interviewees, the T&C industry is not in transition yet: even if the TT-team sought to deliver value to society using a local production process, the context urged them to alleviate their aspirations.

A critical mass in terms of producers, stakeholders, and start-up communities in a place (cf. Feld, 2012; Lorenzen & Fredrikson, 2008) may be necessary to leverage place-based eco-innovations that seek solutions for local waste. For eco-innovations to thrive, a concentration of resources (in terms of specific knowledge, suppliers, and equipment), economies of scale (sharing fixed costs), and concomitant network effects could be necessary. Such clustering processes may be especially palpable for interdisciplinary projects such as the production of new materials, which, because of their newness, could be expected to only slowly integrate into the political, economic, and socio-economic spheres. Being a frontrunner in an eco-innovation, the TT-project cannot benefit (yet) from the spillover effects onto the local economy in terms of employment or reputational benefits; even if consumers and producers of the waste stream might at some point start responding to the new offering, at the moment of study, the TT-project needed financial support because otherwise, it would not survive. Benevolence and trust present within the institutional environment are crucial for the survival of entrepreneurs and start-ups with innovative high-risk projects that prioritize environmental and societal value over clear profit, particularly when they have yet to overcome the (R&D) phase between starting-up

and early-stage, referred to as 'the valley of death' (Circle Economy, 2016; Fischer & Achterberg, 2016).

In terms of institutional support, the TT-project could benefit from the policies on T&C at the national level of governance. Based on a report about circular consumer behavior commissioned by the Dutch Ministry of Infrastructure and Environment (Drijver & Broer, 2014), already in 2016 a covenant about 'sustainable clothing' was developed by a consortium of branch organizations, unions, NGOs, and the government, with the aims of reducing environmental and social damages, increasing the transparency of the supply chain, and developing tools (SER, 2016). In a subsequent 'implementation program circular economy 2019–2023', the national government articulates the importance of new materials development within the T&C industry, with the inclusion of grants for the 'circular make and craftsmanship industry'. A landmark project ('Dutch circular textile valley') should set the standards for circular textile development and inspire suppliers to focus on new materials, recycling, and craftsmanship, while research and legislation are being adjusted accordingly. Taken together, those measures favorably affect the institutional context of the TT-project; still, the policy is not likely to wait when collaborative learning processes falter.

*6: The Existential Challenge

The starting point of the TT-project is 15.000 tonnes of waste that are yearly produced by the Dutch tomato sector. As an eco-innovation at the front end of a possible innovation, the TT-project relies on a local production network that needs experimentation and iterations to learn whether a minimally viable product can be developed (Brydges, 2018; Grin et al., 2010; Maher et al., 2018; Perez, 2002; Simmie & Hart, 1999). Hence, during the first stage of the project (from cellulose to fibers), a key question that would determine the direction of the project needed to be addressed: is it relevant and achievable to create this new material and technology? It soon became clear that the question converged with another one, more impactful: is it relevant and achievable to create a new industry? Even if the raw materials and prototyping equipment come cheaply at the first stage of technological production, and the capital formation challenges necessary for accessing a market may be overcome, the TT-project will face scale-up challenges from the moment larger batches of the input material will be produced. At that crucial point, the absence of the benefits of a larger firm's infrastructure and the network advantages of being part of an industrial cluster, common to the maker movement (Doussard et al., 2018), will be suffered. While motivators as a shared purpose, collaborative learning, and the fun of discovering drive the making process, pioneering teams may turn into lone wolves when prosperous eco-innovations call for the furthering of an industry.

Conclusion

The Textile and Clothing industry is increasingly characterized by sustainable entrepreneurship and local production networks that seek innovations in order to disrupt the conventional production processes and address the environmental and societal challenges that the industry faces (Schaltegger et al., 2016). Novel and innovative design ideas for reshaping the T&C industry and its practices have been popping up as part of "our generational design challenge" (Raworth, 2017, p. 246), in which designers and other pioneers are ever more warranted the roles of problem-solvers (Hussain, 2018). Especially small, experimental practices that would scale up if successful, could make a difference (Beinhocker, 2012). The global maker movement encompasses many of those "potentially emergent manufacturers" (Doussard et al., 2018, p. 652) who, loose from a firm, cooperate and use technology (including craft methods and simple machinery) to learn and create the knowledge that could turn into an entrepreneurial solution (Browder et al., 2019). Those pioneers operating in niche markets are inventing practices and searching for new business models to introduce their innovative products to the market and eventually scale up (Schaltegger et al., 2016). When they adhere to the values of the circular economy, the search for an adequate business model becomes particularly challenging, because a transition to a radically new economic system that slows, narrows or closes resource loops, requires novel ways of value creation and distribution between the different stakeholders involved (Bocken et al., 2016; Ellen MacArthur Foundation, 2021; Ghisellini et al., 2016; Linder & Williander, 2017; Nußholz, 2017).

As an eco-innovation that seeks to integrate CE goals and values into a technological innovation with market potential, the Tomato Textile project is a learning process by an interdisciplinary team that faces several, intertwined challenges. First is the technological challenge that entails overcoming a knowledge gap and numerous decisions on trade-offs, affordable losses (Sarasvathy, 2001) and the open access to intermediate innovations. While the technology absorbs much of the attention and resources in the upfront processes of eco-innovation, the market is considered as well, with particular questions about how to achieve sustainable consumption (Tunn et al., 2019) and a circular product-service system. Even if cost leadership in a broad market is by far the aim of the TT-project, typical marketing questions about value propositions and value capturing (Manninen et al., 2018) came up, as to how the final product would be able to engage consumers who have many alternatives, and which brand/consumer segment combination would be able to succeed at the local level (in line with the Blue Economy principles). Additionally, major circular and collaborative challenges relate to how consumers will be involved in closing the loop, and to new partnerships, particularly when the eco-innovation urges B2B solutions. Fifth, the TT-project is confronted with a complex two-tier institutional environment, with on the one hand a global T&C industry that is unprepared yet to embrace radical changes, and on the other hand, a local policy climate that is supportive of a circular maker movement. Regardless of the current favourability in the environment, eco-innovation that includes making is about the "action of coordinating resources for

commercial projects under uncertainty" (cf. Browder et al., 2019, p. 2). It always runs the risk of lagging, because the velocity of the technology development is unpredictable. Governments may be willing to support eco-innovations because of their potential to catalyze a system-wide change ranging from optimal land usage to the reduction of plastic. This, however, makes the case at stake vulnerable, because as long as there is no market demand for tomato textile, it is replaceable. The last challenge is very existential and questions the purpose of the eco-innovation, which converges with the installation of a new industry. Even if the team is ambitious and strongly committed to the project, the realization that an eventual shift from a prototype to a process will propel a new industry is intimidating.

In conclusion, entrepreneurial circular eco-innovation practices imply making fast and slow decisions under uncertainty, propelled by the volatility that industries experience in terms of consumer demand, but also by environmental trends such as changes in policy and technology. Therefore, it has been suggested that innovations need experimentation, also in terms of business modeling (Antikainen & Bocken, 2019; Bocken et al., 2019; Linder & Williander, 2017), in line with the premises of the lean start-up movement (Ries, 2012). It can be expected that circular business models will emerge in convergence with the trial and error methods that characterize so many of the circular product-making practices of today. Only a critical mass of eco-innovation experiments like the TT-project will provide deeper insight into how those experiments can, at a micro-level, be eventually transferred from pilots in scale-ups (cf. Antikainen & Bocken, 2019). At the macro-level, replication is needed to scale up solutions to lead to sustainable transitions. The more the aforementioned challenges in eco-innovation will become addressed, the more it is expected that they turn into practices based on a shared understanding of how things should go (cf. Thompson et al., 2020) to move toward a Circular Economy.

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The Influence of Affects on Workaholism in Teleworking During the COVID-19 Pandemic: A Partial Least Squares Model

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Abstract Human beings need to feel affects and to work, so it is important to balance personal and professional life. In the context of the COVID-19 pandemic, workers that are unable to disconnect from work and respect rest and leisure hours while teleworking can become workaholics. The present study aims to analyze the levels of workaholism and to study the influence of affects on workaholism in the teleworking context. A quantitative methodology was used, based on data obtained from 365 Portuguese workers who responded to a questionnaire survey that analyzes workaholism levels in workers who were teleworking from home, their affects and some sociodemographic variables. In general, being involved in telecommuting increases levels of workaholism. The results of the application of the structural equation modeling with partial least squares revealed that affects influence workaholism. In teleworking practice, the influence of affects on the workaholism condition is very important and can provide organizational managers with information to help those employees become more productive. On the other hand, it is important to ensure a balance in the use of time between teleworking and everyday life. This study contributes to the scientific knowledge in the teleworking field more specifically, for the relationship between workaholism and the affects when telecommuting. This study is also important for organizations and workers to define strategies to maintain a balance between affects and work.

Keywords Emotional labor · Health and wellness · Workaholism · Positive affects · Negative affects · Teleworking

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Introduction

Teleworking has shown to be a strong trend in the labor market (Rocha & Amador, 2018), being considered an alternative for flexible work (Tavares, 2017), involving work that can be carried out anywhere, anytime, using technological resources (Charalampous et al., 2019). This trend increased with the advent of the COVID-19 pandemic, because in several countries, some companies, as a measure of financial survival and prevention to prevent the spread of the virus, adopted the teleworking regime (Lizote et al., 2021). Thus, in addition to companies keeping their activities running, they ensure the health of their employees (Santos et al., 2020).

To perform telework, workers must first have a trial and training period and then must adapt to new terms or clauses of the employment contract and pay special attention to their internet connection and the communication and information technologies (Beauregard et al., 2019). It is evidenced, in this way, the need for the companies to give an all prior and well-defined preparation to ensure their workers' well-being (Tavares et al., 2020). However, given the sudden situation of the COVID-19 pandemic, the decisions to move workers to telework from their own homes happened overnight. Many workers had never experienced this type of work before, nor the technologies used in this scope. This lack of skills to work with the sophisticated communication technologies can be a disadvantage in teleworking (Tavares, 2017).

In the COVID-19 pandemic context, teleworking is considered safe,as people in their homes feel protected (Santos et al., 2020). On the other hand, the practice of teleworking can provide employees with the flexibility to better manage their private lives and become more productive (Beauregard et al., 2019). Control and balance in the use of time between teleworking and everyday life are vital for the quality of life and social sustainability (Thulin et al., 2019). Family has an important role in respecting privacy and the focus of the family members who are teleworking (Santos et al., 2020).

The sudden changes caused by the COVID-19 pandemic have made employees intensify and increase the amount of effort to be able to do their work (Avanzi et al., 2020). There is also a risk that, in teleworking, the person is always available, anywhere and at any time, and may be requested by the organization at any time (Thulin et al., 2019). Thus, teleworkers may not be able to disconnect from work, not even during what should be their rest and leisure time, so it is essential to study the levels of workaholism of workers who are teleworking.

Workaholism represents an excessive irrational involvement with work, with potential detriment to the well-being and health of employees (Avanzi et al., 2020). In the Strapasson et al. (2020) study, it was found that the more an individual works compulsively, the greater the interference of work in the family, the lesser the interference of the family in the work process and, in both cases, negative affects, which have a negative relationship with life satisfaction, predominate. Therefore, the predominance of positive aspects in the individual's lives is important and can contribute to the sustainability of the exercise of work functions (Strapasson et al., 2020).

The present investigation becomes relevant given the COVID-19 pandemic situation, where negative affects were experienced with greater intensity compared to positive affects (Santos et al., 2021). Such situation also brought a need for greater autonomy at work, which can be related to emotional exhaustion and negative emotions (Spagnoli & Molinaro, 2020). In the Van den Bulck and Custers (2009) study, carried out in the context of the avian pandemic outbreak of the H5N1 virus, it was found that the fear of contracting the disease increases when people watch television. Faced with a new and totally unknown disease, the concern with the situation leads individuals to greater exposure to information and social communication media. Sometimes the information transmitted in the media is contradictory and can even increase the levels of negative affects. Due to this scenario, some telecommuters take refuge at work as a way of forgetting the situation they are experiencing and end up turning work into an addiction that, in this case, is influenced and reinforced by the context (Molino et al., 2016). However, given all the changes that the pandemic has brought and may still bring to the labor market and how work is carried out, organizations must be attentive to their workers' behavior, both in terms of affects and in terms of the workaholism phenomenon. Bearing these arguments in mind, the present study is pertinent. This article aims to analyze the workaholism levels of a sample of teleworking workers and to study the influence of affects on the workaholism condition during the COVID-19 pandemic period.

As for the structure of the present article, after this introduction, the literature review begins, where the themes of workaholism, affects and the influence of affects on workaholism are approached. In the next section, the method is presented, where the population and the sample are defined, and the data collection instruments and the procedures used throughout the investigation are described. In the results and discussion section, the statistical analysis is carried out and is accompanied by the respective discussion, considering the literature review carried out. Finally, the conclusions of the investigation are presented, as well as their limitations and implications, and suggestions are made for future investigations.

Literature Review

Workaholism

The workaholism construct derives from the word "alcoholism", which designates an addiction to alcohol, and was developed to refer to an uncontrollable need to work (Oates, 1968). Generally, the concept of workaholism is understood as a need to work excessively and compulsively (Van Wijhe et al., 2014). The tendency to overwork has to do with the fact that workaholics provide an exceptionally lot of time to their work; they even work more hours than is expected of them to meet organizational and economic demands. The compulsion to work is inherent to workaholics' obsession with their work and to the fact that they often have their minds focused on work

(Schaufeli et al., 2008a, 2008b). This compulsion to work can be seen not as a stable individual trait, but as an addiction that can, like any other addiction, be influenced and reinforced by the context (Molino et al., 2016). Modern organizational culture is widespread in long working hours, in which the phenomenon of workaholism is reinforced through tangible rewards (e.g., salaries, incentives, promotions) and intangible rewards (e.g., praise) (Balducci et al., 2020). According to Scott et al. (1997), workaholism is also seen as a behavioral pattern, with workaholics being individuals who spend many hours of their time on work activities and abdicate many important aspects of life (family, friends, and leisure). Workaholics persist in thinking frequently about work even when they are not working and work far beyond what is imposed and expected from them, both in terms of their role in the organization and in terms of their economic needs (Schaufeli et al., 2008a, 2008b). We emphasize that the amount of worked hours should not be a determining factor in defining a workaholic, even though it is associated with overwork. Thus, besides for addictive issues, people can work a lot because of financial problems, unstable marriages, social pressure, or the desire for career advancement (Schaufeli et al., 2008a, 2008b, 2009). It is pertinent to highlight this point, because conceptualizing workaholism solely by the number of working hours and neglecting its addictive nature would not be correct. Workaholics are then motivated by an obsessive internal urge they cannot resist, rather than external factors (Schaufeli et al., 2008a, 2008b).

Several definitions of the workaholism concept can be found in the literature that, have been developed over the years, without a consensus on its definition. Some perspectives see this phenomenon as an addiction, while others defend it as a behavioral tendency (Andreassen et al., 2012). More recently, Andreassen et al. (2014) characterized workaholism as being overly concerned about work, being driven by an uncontrollable work motivation, and investing a lot of energy and effort into work, damaging personal relationships and free time activities and/or health, a definition adopted in the present study.

The phenomenon of workaholism is, increasingly, a reality in contemporary societies, so companies must assess the impact of the trend of workaholism on their workers, and the knowledge of the factors that influence the decision to work in excess can be a competitive advantage in the implementation of human resources policies (Dospinescu & Dospinescu, 2020). A strong investment in work can be good for both the employer and the employee if it is directed towards enticement for work and for the balanced use of working time, leading to an increase in professional performance by the employee (Tecău et al., 2020). Thus, it is crucial to explore the workaholics' positive psychological mechanism and provide them with the necessary organizational support (Zhang et al., 2020). Furthermore, workaholism has very few advantages for individuals and organizations, and should be avoided as much as possible, despite of the added difficulty that this avoidance represents in a context of globalized competition (Balducci et al., 2020).

Avanzi et al. (2020) consider that workaholics work excessively mainly motivated by internal pressures instead of external factors. Their obsession and internal urge to work and constant thoughts about work (even when they are not working) can have negative effects on their mental and physical health, and promote high levels of stress,

exhaustion, burnout and anxiety, as well as foster depressive states (Andreassen et al., 2018; Tahir & Aziz, 2019; Yang et al., 2020).

Some authors (Oates, 1968; Schaufeli et al., 2008a, 2008b; Vazquez et al., 2018) consider that workaholism is composed of two dimensions: behavioral and cognitive. The behavioral dimension refers to overwork, and the cognitive dimension refers to the compulsive way of working. Ng et al. (2007) propose three dimensions of workaholism: affective, cognitive, and behavioral. The affective dimension is related to the passion for work, the cognitive one addresses the issue of obsession with work and the behavioral one refers to excessive involvement with work, whether related to the number of hours or the non-separation of work from personal life. Other studies also considered three dimensions to measure workaholism, namely: involvement with work, drive to work and pleasure in work (Andreassen et al., 2010; Spence & Robbins, 1992; Tahir & Aziz, 2019). The involvement with work dimension examines the need for individuals to use their time efficiently, whether at work or in personal life. The drive to work dimension provides information on internal motivation and the frequency with which individuals think about work. On the other hand, the pleasure in work dimension evaluates the degree of satisfaction that work provides (Andreassen et al., 2010).

Affects

A work context is a privileged place for emotions and, fundamentally, for the realization and construction of personal happiness (Paschoal & Tamayo, 2008). Happiness is closely related to the individual's subjective well-being, revealing how they are or are not satisfied with their jobs and their lives, being a key aspect in improving the productivity of any type of organization (Wesarat et al., 2015).

The affects are the affective dimension of the subjective well-being concept (Diener & Larsen, 1984). This dimension presupposes the occurrence of frequent experiences of positive and infrequent negative affects (Noronha et al., 2014). Positive affects involve fun and satisfaction with life, and negative affects involve feelings such as anger and worry, which can lead to depression (Diener et al., 2017). Of course, people more satisfied with life have lower levels of depression, anxiety, and stress (Zanon, 2017).

The affect is considered a source of job and life satisfaction (Zhai et al., 2009). More precisely, high levels of positive affect improve job satisfaction (Naragon & Watson, 2009; Satuf et al., 2018), physical health and marital satisfaction (Naragon & Watson, 2009), and allow solutions to be found for problems that occur in organizations (Orita & Hattori, 2019).

Ferreira et al. (2008) study showed that positive emotions improve satisfaction with the leadership, salary, colleagues, promotions, and the nature of work, and correlate negatively with emotional exhaustion. Negative affects are negatively correlated with all dimensions of job satisfaction and positively correlated with emotional exhaustion.

At work, it is expected that individuals experience high levels of satisfaction with life and positive affects. On the other hand, it is expected they experience low levels of negative affects (Carvalho et al., 2019).

Galinha et al. (2014), in their study of the Portuguese population, concluded that the affects of enthusiasm, inspiration, delight, warmth and determination have greater weight in determining positive affects, and that the affects of scariness, fear, torment, disturbance and nervousness contribute with a greater weight to negative affects. Worry, stress, despair, depression, anxiety, nervousness, and restlessness are aspects that predominate during the COVID-19 pandemic (Sandín et al., 2020).

Influence of Affects on Workaholism

Studies on the relationship between workaholism and affects have revealed different results (Aziz et al., 2020). According to Avanzi et al. (2020), workaholism has a small positive relationship with job satisfaction, even if not significant. For these authors, this relationship does not mean that workaholism fosters positive emotions at work, being, therefore, explained by the fluctuating experiences that characterize workaholics. Clark et al. (2010) study showed that both negative and positive affects are significantly related to workaholism. Negative affects showed a positive relationship with the three dimensions of workaholism (impatience, compulsion to work, and polychronic control), and positive affects have a negative relationship with the compulsion to work dimension and a positive relationship with the polychronic control dimension. Strapasson et al. (2020) also found a significant relationship between workaholism and positive and negative affects. More specifically, the compulsive work dimension influences positive and negative affects. In the study by Zhang et al. (2020), it was found that competence plays a mediating role between workaholism and well-being, where the direct effect of pleasure at work on well-being is more evident than the impulse to work.

On the other hand, investigations by Bovornusvakool et al. (2012) and by Mazzetti et al. (2016) conclude that only negative affects significantly influence workaholism. Other studies found significant and positive relationships between workaholism and negative affects (e.g., Aziz et al., 2020; Clark et al., 2016).

In further research, the results obtained by Balducci et al. (2016) revealed that workaholism is associated with work-related negative affects (e.g., anger, disgust and pessimism) and is not associated with positive affects (e.g., enthusiasm, satisfaction and energy). Similarly, Clark et al. (2013) examined the mediating role of positive and negative emotions in the relationship between workaholism, work engagement and work-at-home results. Researchers concluded that negative emotions, such as anxiety, anger, and disgust, mediate the relationship between workaholism and work-home conflicts, while positive emotions, such as joviality and self-confidence, mediate the relationship between work engagement and enrichment work-home (Clark et al., 2013).

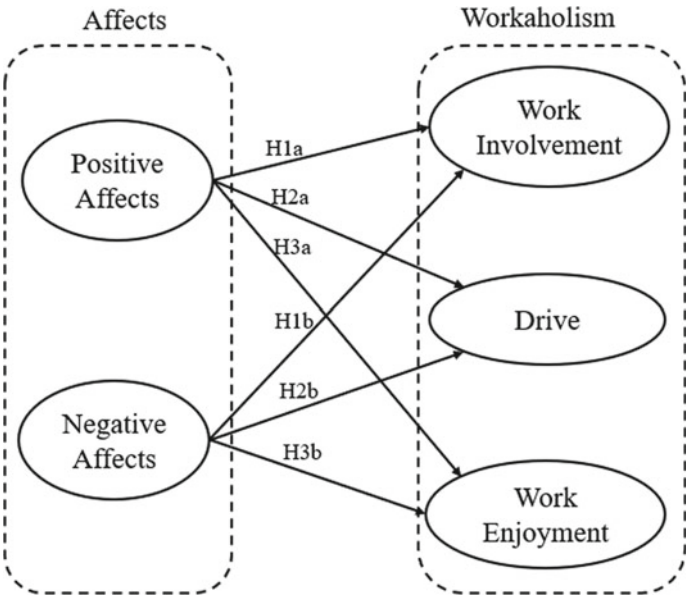

Fig. 1 Conceptual model (*Source* Author's own)

In short, in some studies, workaholism has played the role of a dependent variable (e.g., Clark et al., 2010; Mazzetti et al., 2016), while in others it assumes the role of an independent variable (e.g., Aziz et al., 2020; Strapasson et al., 2020). Thus, in the present study, it is analyzed the influence of affects on workaholism in the telework context, as to according to Molino et al. (2016) workaholism can be influenced and reinforced by the context. In more detail, the hypotheses to be tested are as follows:

Hypothesis 1: Positive affects (H1a) and negative affects (H1b) positively influence the work involvement of teleworking individuals.

Hypothesis 2: Positive affects (H2a) and negative affects (H2b) positively influence drive in teleworking individuals.

Hypothesis 3: Positive affects (H3a) positively influence work enjoyment and negative affects (H3b) negatively influence work enjoyment in teleworking individuals (Fig. 1).

Materials and Methods

Sampling and Data Collection

The target population of the present study are Portuguese individuals aged 18 years or over, who were at home, teleworking during the state of emergency caused by the

situation of the COVID-19 pandemic. To facilitate the operationalization of the data collection process, the non-probabilistic convenience snowball sampling method was used, to include in the sample, the largest number of individuals who were teleworking. The choice of this sampling method was also motivated by the COVID-19 pandemic situation that the country and the world are experiencing.

Research Instrument

In the present study, a three-part questionnaire survey was used. The first part analyses the workaholism in telework, the second analyzes the positive and negative affects, and the third characterizes the sociodemographic, namely personal data (gender, age, educational qualifications, marital status, if the participants have children, and the number of household members), and professional data (service time in the organization, public or private sector, number of hours teleworked per day), and two questions directed to telework involvement.

To measure workaholism in telework, an adaptation of the Workaholism Battery (WorkBAT) by Spence and Robbins (1992) to the telework context was made. That is, after the translation of the items into Portuguese, the term *work* was replaced by *telework*. The WorkBAT consists of 25 items assessed on a Likert agreement scale that ranges from 1—*Strongly disagree* to 5—*Strongly agree*. The 25 items (Table 2) were divided into the three dimensions that were originally proposed by Spence and Robbins (1992): Work Involvement (items 1, 6, 8, 12, 13, 15, 21 and 24), Drive to Work (items 3, 5, 14, 18, 20, 22 and 25) and Work Enjoyment (items 2, 4, 7, 9, 10, 11, 16, 17, 19 and 23). Note that items 1, 6, 8 and 11 have inverted punctuation.

The affects (Table 3) were measured using the dimensions of positive affect and negative affect of the Well-Being at Work Scale, by Paschoal and Tamayo (2008). Given the COVID-19 pandemic situation, the *scared* item was included, as this item presented the greatest weight in negative affects in the study of Galinha et al. (2014). The 22 items of the affects scale were assessed using a 5-point Likert frequency scale (1-*Not a little*, 2-*A little*, 3-*Moderately*, 4-*A lot,* and 5-*Extremely*).

To complete the questionnaire, participants were asked, on a 5-point Likert scale of agreement (1-*Strongly disagree* to 5-*Strongly agree),* if their involvement in teleworking made them forget about the pandemic situation, and if they felt that they work more, at this stage, in telework when comparing with the work they previously performed at the office.

Procedures

After conducting an extensive literature review and identifying the constructs to be used, the WorkBAT instrument was translated into Portuguese for the teleworking context and some items of affects were changed to Portuguese in Portugal. Then,

the questionnaire survey was built with the help of the Google Forms tool and a pre-test was applied to five people who were already teleworking before the COVID-19 pandemic. Note that the questionnaire contained an open question so that the participants in the pre-test were able to share their suggestions. After the pre-test some items were changed in terms of semantics to improve their understanding.

Data statistical treatment was carried out using the IBM SPSS Statistics 26 software, and R software version 4.02 (R Core Team, 2020). The descriptive statistics technique was used to characterize the sample. The grouping of the individuals into homogeneous groups regarding their telework involvement was performed through a technical cluster analysis. The clusters' definition used hierarchical analysis with the squared Euclidean distance as a dissimilarity measure, and the Ward method to group individuals with homogeneous characteristics (Marôco, 2018). To investigate if there are differences in the workaholism levels and in the affects between groups in the telework involvement groups, Student's *t*-test was applied for independent samples comparison (Marôco, 2018). Finally, structural modeling equations with partial least squares (Partial Least Squares SEM—PLS-SEM) were applied to test the proposed model.

According to Henseler et al. (2009), to evaluate a model it is necessary to follow a process composed of two stages: (1) validation of the external model, and (2) validation of the internal model. First, it is guaranteed that the measurements of the constructs are reliable, and, for this, the loadings are analyzed. These must have values greater than 0.708 to indicate that the construct explains more than 50% of the variance of the item (Hair et al., 2019). According to Hair et al. (2011), if there are items with external loads between 0.40 and 0.70 they should be eliminated only if they increase the composite reliability above the value considered adequate. Reliability was analyzed by calculating Cronbach's alpha and composite reliability values, the latter indicator producing higher values than Cronbach's alpha. If these measures have values from 0.7 to 0.9, they are considered satisfactory to good (Hair et al., 2019).

Then, the validity (convergent and discriminant) of the model was evaluated. Convergent validity was assessed by the value of the AVE (Average Variance Extracted), which must have values greater than 0.5. Discriminant validity was assessed using the Fornell-Larcker criterion and cross-loadings. The Fornell-Larcker criterion analyzes whether the correlations between latent variables are less than the square root of the AVE. In cross-loadings between indicators and constructs, the loading of each indicator must be higher than all of its cross-loadings in this case (Hair et al., 2017).

To assess the structural model, five aspects are considered: (1) evaluation of collinearity, (2) evaluation of the signal, magnitude and statistical significance of the path coefficients, (3) evaluation of the determination coefficients (R^2), (4) evaluation of the effect size f^2, (5) evaluation of predictive relevance (Q^2) and size of the effects q^2. To assess collinearity, VIF (Variance Inflation Factor) values are calculated. These values must be close to 3 or less (Hair et al., 2019). In the analysis of path coefficients, one can study the nature of the relationships between the constructs and test the formulated hypotheses. To analyse R^2 (percentage of variance explained

by the dependent variables in the structural model), Cohen's criteria (1988) for the area of social and behavioral sciences are used: 2% small effect, 13% medium effect and 26% large effect. In assessing the quality of the prediction of the adjusted model, Q^2 values greater than zero indicate that the exogenous construct has predictive relevance for the considered endogenous construct, and values of f^2 and q^2 below 0.02 indicate that there is no effect (Hair et al., 2017).

Results and Discussion

Sample Characterization

The sample is composed of 365 Portuguese individuals who were teleworking from their homes. Most participants are female ($n = 214$, 58.6%). Their ages range from 18 to 70 years old, with approximately 39 years old mean ($SD = 11.21$). Regarding education, predominates the university education ($n = 292$, 80%). About the marital status, 57.3% ($n = 209$) of individuals are married or living together in a common-law relationship, 34.5% ($n = 126$) are single and 8.2% ($n = 30$) are divorced, separated, or widowed. The average number of household members is approximately three ($SD = 1.16$) and 44.4% of the respondents have children ($n = 162$).

Regarding professional data, 50.1% ($n = 183$) work in the organization for less than 5 years, 31.2% ($n = 114$) work in the organization for more than 10 years, and the remaining 18.6% ($n = 68$) are working from 5 to 10 years in the organization. Regarding the activity sector, 72.1% ($n = 263$) work in the private sector and 27.9% ($n = 102$) work in the public sector.

The analysis of Table 1 tells us that 36.46% ($n = 144$) of the individuals consider that their telework involvement makes them forget about the current pandemic situation, and 45.06% ($n = 178$) feel that they are working more since telecommuting. Regarding telework, on average, workers dedicate 8.32 h per day ($SD = 5.18$) to telework, with a tendency to work many hours a day, since the distribution is positively asymmetric ($Sk = 10.25$).

Analysis of the Levels of Workaholism and Affects

After applying the cluster analysis, with the aim of grouping individuals into homogeneous groups regarding their involvement in telework, that is, regarding the issues presented in Table 1, appears that individuals are divided into two groups. One group is called the Group with High Telework Involvement and is characterized by considering that their involvement in telework makes them forget about the pandemic situation and, at the same time, they feel that they work more when telecommuting

Table 1 Descriptive analysis of the telework involvement

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
My telework involvement makes me forget the current situation	57	70	94	100	44
I feel that, at this stage, I work more in telework than I used to work at the office	54	55	78	69	109

Source Own elaboration

than they used to work before at the office. The other group is called Group with Low Involvement in Telework and has the opposite characteristics to the previous group.

In Table 2, Student's *t*-test was applied to compare the levels of workaholism in the two groups of the telework involvement and it was found that, although the levels of workaholism are higher in almost all items in the group with high telework involvement, there were also statistically significant differences in 15 items, so it can be inferred that, in general, telework involvement increases workaholism levels. It can also be said that the average levels of workaholism only showed higher values in items W12, W15, W16 and W21, and in the remaining items the average levels are not high, so it is considered that teleworking can provide workers with the autonomy and the flexibility during telework, and facilitate their private lives management, increasing productivity, as evidenced by Beauregard et al. (2019).

Table 3 reveals the results of the Student's *t*-test application to compare the levels of affects in the two groups of telework involvement. We found that, although the levels of affects in almost all items are higher in the group with high telework involvement, there are only statistically significant differences in the affects cheerful, content, proud and frightened. The highest affects levels occur in the worry and anxiety affects. But, the low levels of positive affects are what is most worrisome.

Measurement Model Assessment

Table 4 shows that only the loadings of the observed variables W23 and W25 are less than 0.708, with the remaining loadings above 0.708. The Cronbach's alpha values and composite reliability of the Positive Affects, Negative Affects, Impulse to Work and Work Enjoyment constructs exhibited adequate reliability (Table 4). The Work Involvement dimension obtained a very low Cronbach's alpha (0.5), which is due to the reduced number of items in this dimension. However, the value of the composite reliability is considered adequate (0.8), confirming its consistency. Note that in some studies (e.g., Andreassen et al., 2011; Tahir & Aziz, 2019), the

Table 2 Student's t-test results according to the workaholism levels for the two groups of telework involvement

	Low telework involvement group ($n = 182$)		High telework involvement group ($n = 183$)		
	M	*SD*	*M*	*SD*	*t*
W1. When I have free time from telecommuting, I like to relax and do nothing important	3.40	1.29	3.69	1.23	-2.18^{*}
W2. I like my telecommuting more than most people do	2.89	1.15	3.13	1.24	-1.88
W3. I feel guilty when I'm not teleworking	2.71	1.28	3.31	1.39	-4.27^{***}
W4. My telecommuting is more like fun than real work	1.54	0.93	1.50	0.92	0.43
W5. I often wish I wasn't so committed to my telecommuting	2.61	1.25	3.33	1.36	-5.24^{***}
W6. I like to relax and have fun whenever possible, doing home chores	3.32	1.21	3.48	1.15	-1.27
W7. My telecommuting is so interesting that it often doesn't feel like work	2.83	1.19	2.89	1.21	-0.44
W8. I'm really looking forward to the weekend, no telework, just rest	2.88	1.25	3.27	1.36	-2.85^{**}
W9. I telecommute more than is expected of me, strictly for the fun of it	2.42	1.03	2.79	1.18	-3.14^{**}
W10. Most of the time, my telecommuting is very cheerful	2.82	1.08	2.85	1.15	-0.24
W11. I rarely find something I appreciate about my telecommuting	2.09	1.04	2.18	1.05	-0.85
W12. Wasting time is just as bad as losing money	3.53	1.28	3.73	1.20	-1.58
W13. I spend my free time on projects and other activities	3.48	1.07	3.71	1.13	-2.02^{*}
W14. I feel obligated to work hard, even when telecommuting is not pleasant	2.93	1.19	3.54	1.21	-4.87^{***}
W15. I like to use my time constructively, both when telecommuting and at home	4.09	0.96	4.28	0.79	-2.01^{*}
W16. I lose track of time when I'm involved in a project	4.01	0.95	4.25	0.87	-2.52^{*}

(continued)

Table 2 (continued)

	Low telework involvement group ($n = 182$)		High telework involvement group ($n = 183$)		
	M	*SD*	*M*	*SD*	*t*
W17. Sometimes when I get up in the morning, I can't wait to start telecommuting	2.62	0.94	2.72	1.11	−0.93
W18. It's important for me to telework hard, even when I don't like what I'm doing	3.08	1.16	3.52	1.10	−3.73***
W19. When I get involved in an interesting project, I have a hard time describing how excited I feel	3.09	1.11	3.22	1.12	−1.08
W20. I find myself thinking about telecommuting often, even when I want to get away	2.86	1.13	3.54	1.20	−5.59***
W21. Between my telecommuting and other activities I'm involved in, I don't have a lot of free time	3.20	1.21	4.11	1.08	−7.67***
W22. I often feel that there is something inside of me that drives me to telework hard	2.86	1.11	3.57	1.18	−5.88***
W23. Sometimes I enjoy my telecommuting so much that it's hard for me to stop	2.58	1.08	3.01	1.14	−3.68***
W24. I get bored and agitated when I have nothing productive to do	3.51	1.25	3.40	1.32	0.79
W25. I seem to have an inner compulsion to telework hard	2.49	1.12	3.03	1.21	−4.42***

Source Own elaboration
*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

Table 3 Student's t-test results according to the affects levels for the two groups of telework involvement

	Low telework involvement group ($n = 182$)		High telework involvement group ($n = 183$)		
	M	*SD*	*M*	*SD*	*t*
1. Cheerful	2.66	1.02	2.92	1.06	−2.38*
2. Worried	3.90	0.93	4.05	1.00	−1.52
3. Good-natured	3.26	0.93	3.33	0.96	−0.76
4. Content	2.73	1.01	2.94	1.02	−1.97*
5. Annoyed	2.65	1.17	2.88	1.19	−1.83
6. Depressed	2.26	1.11	2.41	1.24	−1.23
7. With boredom	2.59	1.09	2.59	1.17	0.03
8. Animated	2.74	0.91	2.90	1.00	−1.65
9. Upset	2.46	1.11	2.63	1.17	−1.40
10. Impatient	2.93	1.16	2.98	1.31	−0.42
11. Enthusiastic	2.50	1.00	2.69	1.06	−1.80
12. Anxious	3.12	1.18	3.27	1.22	−1.21
13. Happy	2.75	1.07	2.96	1.03	−1.91
14. Frustrated	2.55	1.14	2.61	1.30	−0.40
15. Troubled	2.87	1.22	2.85	1.23	0.12
16. Nervous	2.63	1.13	2.85	1.22	−1.79
17. Excited	2.34	1.02	2.52	1.00	−1.79
18. Tense	2.76	1.13	2.90	1.25	−1.11
19. Proud	2.39	1.08	2.70	1.14	−2.66**
20. Angry	1.99	1.17	2.10	1.28	−0.85
21. Quiet	2.91	1.02	3.03	1.11	−1.03
22. Frightened	2.60	1.11	2.88	1.27	−2.24*

Source Own elaboration
*$p < 0.05$, **$p < 0.01$

involvement dimension also had low Cronbach's alpha values. Concerning the AVE values, they are greater than 0.5, which indicates adequate convergent validity.

Table 5 shows that the values of the square root of the AVE (diagonal of the matrix in bold) are higher than the correlations between the constructs. Note that when analyzing the model's discriminant validity through cross-loadings, it was found that the loading of each indicator is greater than all of its cross-loadings. Thus, it is concluded that the reliability, convergent validity and discriminating validity of the external model are adequate. Then the proposed model is evaluated.

Table 4 Estimation of the measurement model parameters

Construct	Items	Loadings	Cronbach's alpha	Composite reliability	AVE
Positive affects	A1	0.843	0.918	0.937	0.712
	A4	0.881			
	A8	0.866			
	A11	0.845			
	A13	0.873			
	A17	0.749			
Negative affects	A5	0.793	0.933	0.944	0.653
	A6	0.817			
	A9	0.846			
	A10	0.816			
	A12	0.744			
	A14	0.809			
	A15	0.738			
	A16	0.867			
	A18	0.831			
Work involvement	W12	0.761	0.500	0.800	0.664
	W24	0.865			
Drive	W14	0.852	0.766	0.851	0.562
	W18	0.776			
	W22	0.711			
	W25	0.645			
Work enjoyment	W7	0.818	0.775	0.856	0.591
	W10	0.815			
	W17	0.751			
	W23	0.684			

Source Own elaboration

Table 5 Discriminant validity: Fornell–Larcker criterion test

	PA	NA	WI	D	WE
PA	**0.844**				
NA	−0.252	**0.808**			
WI	0.054	0.266	**0.815**		
D	−0.062	0.281	0.332	**0.750**	
WE	0.337	−0.181	0.257	0.122	**0.769**

Source Own elaboration
PA, Positive Affects; NA, Negative Affects; WI, Work Involvement; D, Drive; WE, Work Enjoyment

Evaluation of the Structural Model

The VIF value was 1.069, that is, less than 3 as recommended by Hair et al. (2019). Concerning the coefficient of determination (R^2) it was found that the affects explain 6.4% of the variance of the work involvement, 7.9% of the variance of the drive and 12.4% of the variance of the work enjoyment, which according to Cohen (1988), are considered small effects. Regarding the values of Q^2 (0.043, 0.045 and 0.073, respectively for work involvement, drive, and work enjoyment), these are higher than zero which shows that the affects have predictive relevance to the model in relation to the three Workaholism dimensions.

Table 6 shows that negative affects have a significant and positive influence on work involvement ($\beta = 0.256$, $t = 4.86$, $p < 0.001$, $f^2 = 0.065$, $q^2 = 0.042$), which empirically supports the hypothesis H1b. Negative affects has a significant and positive influence on drive ($\beta = 0.284$, $t = 5.45$, $p < 0.001$, $f^2 = 0.054$, $q^2 = 0.040$), which supports the H2b hypothesis empirically. Positive affects have a significant and positive influence on work enjoyment ($\beta = 0.312$, $t = 6.13$, $p < 0.001$, $f^2 = 0.0.097$, $q^2 = 0.055$), which empirically supports the H3a hypothesis. Thus, it can be said that work enjoyment is influenced by positive affects, and it is the only dimension that is not influenced by negative affects.

In short, the results show that positive affects influence the work enjoyment dimension, and negative affects influence the work involvement and drive dimensions. Such results agree with those obtained by Clark et al. (2010), who showed significant relationships between negative and positive affects and workaholism. The fact that positive affects influence the work enjoyment dimension contradicts Bovornusvakool et al. (2012) and Mazzetti et al. (2016) studies, who concluded that only negative affects significantly influence workaholism. In the context of the COVID-19 pandemic, teleworking gave workers more work flexibility. On the other hand, affectivity at work seems to be a source of job satisfaction, with only high levels of positive affects truly improving job satisfaction.

Table 6 Results of the Structural Model Analysis

Path	Path coefficients	*t*-values	*p*	95% confidence intervals	Significance[a] ($p < 0.05$)?
H1a: PA → WI	0.119	2.26	0.024	[−0.015, 0.236]	No
H1b: NA → WI	0.256	4.86	0.000	[0.160, 0.358]	Yes
H2a: PA → D	0.010	0.19	0.848	[−0.110, 0.193]	No
H2b: NA → D	0.284	5.45	0.000	[0.184, 0.387]	Yes
H3a: PA → WE	0.312	6.13	0.000	[0.202, 0.419]	Yes
H3b: NA → WE	−0.103	−2.02	0.044	[−0.212, −0.004]	No

Source Own elaboration

WI, Work Involvement; D, Drive; WE, Work Enjoyment; PA, Positive Affects; NA: Negative Affects. [a]The confidence intervals were obtained with bootstrapping procedure (5000 samples)

Conclusions

The teleworking regime adopted in several countries, in addition to being an important measure for the financial survival of companies, also prevented the spread of the virus, ensuring the health of the workers so that they can continue to exercise their positions in their companies because companies cannot survive without the human strength that workers are.

Workaholism is the excessive and compulsive need to work, not being a stable individual trait, but rather an addiction. Workaholism can also be seen as a behavioral pattern, which is increasingly a reality in contemporary societies. Knowing the factors that lead workers to overwork can be a competitive advantage for the company, in the implementation of its human resources policies. A work context is a privileged place for emotions, achievements and the construction of personal happiness, and affections are the affective dimension of the concept of subjective well-being.

The main objectives of this article were to analyze the workaholism levels and to study the influence of the affects on workaholism in the context of telework. To analyze the levels of workaholism, two groups were analyzed: one considered as a group with high involvement in telework - characterized by individuals who consider their involvement in telework makes them forget about the pandemic situation and, at the same time, feel that they work more in teleworking than previously used to work when at the office -, and the other group, called the group with low involvement in teleworking, with contrary characteristics to the first group. From this analysis, it was possible to infer that, in general, telework involvement increases workaholism levels. It was also concluded that teleworking allows for the workers' autonomy and flexibility, which can facilitate their life management and increase productivity.

The external model showed adequate evidence of reliability, convergent and discriminant validity. Regarding the proposed structural model, it is concluded that negative affects have a significant positive influence on work involvement and work drive. Positive affects, on the other hand, only positively and significantly influence work enjoyment. The group with greater involvement in teleworking, has higher levels of affects such as worry and anxiety and extremely low levels of positive affects.

One of the limitations of this study is because the dimension Work Involvement of the Workaholism Scale consists of only two items and obtained a low Cronbach's alpha value. It should be noted that in other studies in the literature, the Work Involvement dimension was also composed of a reduced number of items and also obtained a low Cronbach's alpha value. On the other hand, it was also necessary to exclude some items from the analysis of the Drive to Work and Work Enjoyment dimensions. Because of these facts, it is recommended that in future studies the items of the Workaholism scale be analyzed, in the sense of a reformulation to improve the scale psychometric qualities.

This study, in academic terms, contributes to the increase of the scientific knowledge workaholism field, affects and teleworking. In the organizational aspect, knowledge on this topic is important as it helps to understand the influence of affects on the

workaholism condition during teleworking practice, which can provide information to the organizations' managers and to the human resources managers that can help workers to become more productive and to promote a healthier relationship with work. This study is also of interest to workers in organizations, as it helps them to realize that control and balance in the use of time between teleworking and everyday life is vital for their quality of life and social sustainability. Thus, it is perceived that happiness is closely related to the individual's subjective well-being, revealing how they are or are not satisfied with their work and with their life, being fundamental for the improvement of the productivity of any individual in the organization. It is expected that the results presented here will motivate companies to adopt strategies that optimize their resources and reduce costs, obtaining advantages in terms of competitiveness and productivity that do not affect the health and well-being of their workers.

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Is the Impact of Sustainability Exploration on Firm Economic Return so Obvious? The Case of Internationalized Spanish Firms Operating in High-Tech and Low-Tech Industries

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Abstract This study aims to help to bridge the innovation and sustainability literature by assessing the impact of sustainability exploration on the economic return of internationalized Spanish firms. We apply partial least squares structural equation modeling (PLS-SEM) to data from a sample of 156 internationalized Spanish firms. The results suggest that sustainability exploration by itself does not have a positive impact on economic return, which suggests that integration between sustainability exploration and sustainability exploitation might be the key to achieve the potential of sustainable innovation fully. In this line, the impact of sustainability exploration on economic return is not more significant for firms operating in high-technology industries compared to those operating in low-technology industries, which sheds some light into the debate on trade-offs in corporate sustainability.

Keywords Sustainability exploration · Corporate sustainability · Economic return · Performance · Internationalization · Innovation

Introduction

Global initiatives of all kinds, both public and private, support the reduction of environmental risks and the negative impacts of resource-use through the application of innovation policies centered on sustainability. Thus, the growing interest in developing sustainable innovations highlights the relevance of studies that address this

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issue for both practical and academic purposes (Gianni et al., 2017; Hernández-Vivanco et al., 2018). Due to the increasing awareness and interest in sustainability, organizations are accountable for embracing core strategies to become more sustainability-oriented (Kennedy et al., 2017). As such, corporate sustainability (CS) has been analyzed from different angles in the literature. More specifically, the impact of CS on firm performance has caught the attention of researchers from different sustainability related fields such as corporate social responsibility (e.g., López et al., 2007; Mohr et al., 2001; Prado-Lorenzo et al., 2008; Weber, 2008), environmental performance (e.g., Koo et al., 2014; Wagner & Schaltegger, 2004), sustainability performance (e.g., Wagner, 2010), and sustainable entrepreneurship (e.g., Schaltegger & Wagner, 2011), among others.

Sustainable entrepreneurship is the driving force of technological-niche disruptive innovations used for accelerating sustainability transitions (Kuokkanen et al., 2019). Disruptive innovations born from the 'think-out-of-the-box' strategy and creative thinking, open new growth paths for firms, which benefit stakeholders, especially shareholders. This is the main idea behind sustainability exploration (SER), which is concerned with challenging existing solutions with innovative concepts, whereas the other main dimension of CS, namely sustainability exploitation (SEI), is characterized by practices closely tied to improving firm efficiency (Maletič et al., 2015). Being sustainability exploration the most challenging dimension of CS, managers should be aware of SER's capacity of leveraging firm performance and transfer this notion efficiently through different firm levels.

All in all, even if sustainability attracts managers' attention due to its potential presence in all kind of activities and organizational systems (Lozano, 2012), researchers and managers still struggle to understand how sustainability practices can enhance firm performance. Within this framework, we try to address recent calls of analyzing the corporate sustainability-performance link (Maletič et al., 2014) by focusing on sustainability exploration practices as essential mechanisms to explain the economic performance of internationalized firms, for which innovation constitutes an important learning mechanism (Kyläheiko et al., 2011).

The rest of this chapter is organized as follows. After the introduction, we provide the theoretical background for the sustainability exploration in the context of Spanish firms operating in high-tech and low-tech industries. Then, we explain the methodology we follow, and we report the results of the data analysis. Finally, we present our conclusions and list both some limitations and further lines of research.

Theoretical Background

Innovation and sustainability are two concepts that separately impact the competitive position of organizations and, together, act synergistically by generating both new markets for environmentally benign products as well as a new field of academic study in sustainable innovation (Delmas & Pekovic, 2018). The term sustainable innovation (i.e., environmental innovation, ecological innovation, green innovation,

or eco-innovation) has been used to identify innovations that contribute to a sustainable environment through the development of ecological improvements (Xavier et al., 2017). Sustainable innovation reduces environmental burdens and helps improve a situation under given sustainable objectives. Following this definition, the concept of sustainable innovation is intrinsically linked to green competitiveness and the ecological approach of the economy. In this sense, Faucheux and Nicolaï (2011) claim that the integration of all those management elements that make up a sustainable innovation system is required, considered as management, business method, or strategy for the organization.

Corporate Sustainability

Research on corporate sustainability (CS) has significantly increased during the last decade. The most highly ranked journals and prestigious book publishers are now including CS in their research agendas (see for example the review of Meuer et al., 2019) since CS is becoming more critical for firms (Landrum & Ohsowski, 2018). Interest in CS develops from practical applications for firms to adopt it as a core business strategy promoting long-term growth (Bhattacharya & Polman, 2016). Generally speaking, CS has been linked to financial performance (Bodhanwala & Bodhanwala, 2018; Flammer, 2015).

Nonetheless, the authors agree that never before have the theory and practice been wider apart, mainly due to the limited understanding of the meaning of CS (Bansal & Song, 2017; Landrum, 2018). Such lack of clarity in the definition is demonstrated by the 33 definitions of CS (from 1997 to 2016) found in a recent literature review (Meuer et al., 2019). Thus, the several research efforts on this topic during the past two decades have offered us insights into particular aspects of CS, for example, the pursuit of sustainability (e.g., Baumgartner & Rauter, 2017) or the integration of sustainability into firms' operations (e.g., Hahn et al., 2014).

As a result, instead of embracing a comprehensive perspective on CS (e.g., including notions such as CSR), this study aims to develop further how specific sustainability practices can be linked to economic returns by addressing the role of sustainability exploration (SER) activities. Further, this study also offers an opportunity to reconsider the adoption of different approaches to target setting based on contextual attributes derived from low and high-technology industries.

Sustainability Exploration

Focusing on SER dimension, the literature suggests that sustainability exploration practices have a positive impact on firm performance (Maletič et al., 2016a, 2016b). Even when organizations can sustainably develop and improve efficiency by reducing

costs -closely tied to SEI-, betting on increasing innovation rate is risky (Leal-Rodríguez & Albort-Morant, 2016; Leal-Rodríguez et al., 2015) but essential (Schaltegger & Wagner, 2017).

Sustainability exploration practices can be conceived in the context of finding new solutions both in terms of products and processes (Maletič et al., 2014, 2015). Transformation towards sustainability requires innovation (Edwards, 2009), which is the essence of SER. By performing (radical) sustainability innovations, firms can outperform their peers (Rosenbusch et al., 2011; Sok & O'Cass, 2015).

Based on the arguments mentioned above, we believe that challenging existing sustainability solutions and focusing in the long term is a way of enhancing firm economic return. Hence, we hypothesize:

H1: Sustainability exploration has a positive impact on firm economic return.

Research on the relationships between innovation and economic returns at the national and regional levels has been broadly developed in the last two decades. The literature has primarily focused on high-tech industries (e.g., Chai et al., 2011), with little attention to low-tech ones (Law et al., 2019). Previous studies established that high-tech firms are different from low-tech in terms of innovation practices and investments. For example, Heidenreich (2009) uncovered that low-tech firms in European countries prioritize the acquisition of assets, such as equipment and software, while high-tech firms mostly devote their resources on R&D.

Furthermore, high-tech industries depend on R&D external knowledge than low-tech ones in their internal innovation activities (Serrano-Bedia et al., 2012); as a result, devoting a more significant portion of their budget to R&D expenses (Bartos, 2007). Given the nature of their industry, firms must advance strategies oriented towards innovation, as well as capabilities developed particularly for innovation (Yu et al., 2019). This is in line with Chan et al. (1990) who found that high-tech firms compete on innovation and, thus, are unwilling to cut R&D expenses or innovation projects expressively. Hence, these firms competing in high-tech industries will have access to unique external resources which facilitate the internationalization process (Jones, 1999).

Even when firms operating in low high-tech industries also benefit from innovation (Laforet, 2009), we believe that high technology-based industries are the ones in which an innovation-related strategy would have more potential. Based on the above discussion and some works (e.g., Wagner, 2010), we believe that firms operating in high-tech industries are the ones which would most benefit from challenging existing sustainability solutions. Therefore, we hypothesize:

H2: The positive impact of sustainability exploration on firm economic return is stronger for firms operating in high-tech industries compared to one of the firms operating in low-tech industries.

Methodology

Sample

Our population comprises Spanish firms internationalized to two culturally very different countries, namely Mexico and Morocco. The sample was refined, obtaining 730 companies. Then, CEOs were asked to answer a short questionnaire via e-mail. One hundred fifty-six responses from CEOs were obtained (21%), which is a high response rate for this type of research (Brettel & Rottenberger, 2013).

Data Analysis

We tested our model (Fig. 1) using partial least squares structural equation modeling (PLS-SEM) technique, which is a useful method in management (Hair et al., 2011, 2012a, 2012b, 2012c, 2019). Furthermore, PLS-SEM is especially suitable due to the early phase of theorizing within the innovation-sustainability interplay (Richter et al., 2016; Rigdon, 2016). Concretely, we used the SmartPLS 3 (Ringle et al., 2015) software.

Measurement of the Model Variables

We based our research on a well-known scale to measure exploration at the international level. Precisely, we based on Cui et al. (2014) to measure SER by means of multiple items on a 7-point Likert scale (1 = 'Completely disagree' to 7 = 'Completely agree'). The technology was included in the analyses based on the classification of Van Beers and Zand (2014). Economic return is a single-item factor.

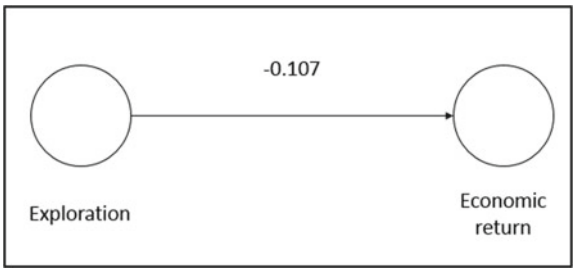

Fig. 1 Path loading and hypothesized structural model (*Source* The authors)

Results

The Validity of the Scales

First, we assessed the measurement model (Table 1). Factor loadings of sustainability exploration are 0.913 and 0.919; that is, latent variables explain a substantial part of the variance of each indicator (Henseler et al., 2009). The assessment of the reliability of internal consistency showed that composite reliability (CR) value (0.912) and Cronbach's α values are well above the threshold (Hair et al., 2019; Nunnally & Bernstein, 1994). We assessed the discriminant validity using the Heterotrai-monotrait (HTMT) ratio (Hair et al., 2019; Henseler et al., 2015; Voorhees et al., 2016), which is 0.119. Hence, discriminant validity has been established. Table 1 provides an overview of the results for the measurement model.

Table 2 provides an overview of the results for the inner model. Besides the path coefficients, it provides the coefficient of determination (R^2), the variance inflation factor (VIF), and the effect size. The R^2 value is small, which suggests that SER—at least on its own—cannot explain much of the variance of the endogenous variable, namely firm economic return.

To assess H2, we conducted a multi-group analysis (MGA). The difference in the path coefficient between firms operating in high-tech industries and firms operating in low-tech industries is only 0.051 ($p = 0.641$).

Table 1 Evaluation results: Measurement model

Constructs/items	Loading	Composite reliability (Cronbach's α)	AVE
Exploration strategy (international)		0.912 (0.808)	0.839
• New approaches to developing products and processes	0.913		
• Engage in developing new products	0.919		

Source Author's own
Note AVE = Average variance extracted

Table 2 PLS-SEM analysis

Relationship	Path coefficient	*p*-value	VIF	f^2	*Bias corrected 95% CI*
Exploration (international) → Economic return	−0.107	0.164	1.000	0.011	[−0.220;0.095]
R^2	0.011				

*** p < 0.01. VIF = Variance inflation factor. CI = Confidence interval

Discussion, Conclusions and Implications

First, we aim to explain to what extent sustainability exploration impacts on firm economic return. By trying to transfer the notion of sustainability to the business level, our findings reveal that sustainability exploration does not have a significant positive impact on firm economic return. Furthermore, the relationship mentioned above is absent, which suggests that further studies could build on this work by adding –at least– the other dimension of corporate sustainability, namely sustainability exploitation, in order to capture the whole domain of corporate sustainability and assess whether the simultaneous interplay between both dimensions is relevant.

Second, we cannot demonstrate that the positive impact of sustainability exploration on performance is stronger for firms operating in high-tech industries compared to those firms operating in low-tech industries. The explanation behind might be that we have only been able to capture a part of the domain of corporate sustainability, which again reflects the need of bringing sustainability exploitation into the analysis, which would, in turn, increase the in-sample predictive power. The ability to simultaneously pursue explorative and exploitative activities might be crucial for sustainable innovations (Maletič et al., 2014). Furthermore, analyzing the interplay between both dimensions could also shed some light into the debate on trade-offs in corporate sustainability. As acknowledged by Wagner (2010), innovation activities do not per se improve the effect of corporate sustainability. Accordingly, by increasing the scope of sustainability objectives and by analytically reviewing targets, managers may find new and successful means of integrating corporate sustainability across the organization.

Besides the conclusions mentioned above and further lines of research, some caveats must be made. First, our results are based on cross-sectional data, which in turn opens new opportunities of research by analyzing how results change using longitudinal data. Second, we only focus on Spanish firms internationalizing to two countries: Mexico and Morocco. Hence, even if our selection offers us an excellent benchmarking due to the significant cultural difference between Mexico and Morocco, culture might play a role in this (and further) analyses. In fact, as acknowledged by Maletič et al. (2016a), organizations based in different countries hold different perspectives on the deployment of sustainability exploration practices. Third, our construct can only be considered as a proxy to measure a dimension of corporate sustainability. Future studies could use more in-depth conceptualizations framed (for example, including sustainability-oriented learning) into the full range of existing approaches to conceptualize and measure corporate sustainability, which is a multi-level and multi-faceted construct.

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Digital Transformation of the Quadruple Helix: Technological Management Interrelations for Sustainable Innovation

José Luis Torres-Loredo, Jesús Manuel Palma-Ruiz, and José Manuel Saiz-Álvarez

Abstract Since the 1990s, there is no discussion that information technologies (IT) and the Internet have transformed everything in its path and have reshaped our societies. In the same way, they have changed the economic models in the industrial, academic, and governmental sectors, redefining the behaviors, preferences, and ways of living of our communities. Today, the generation of knowledge is a fundamental part of the development of economies. Information about the application of new knowledge represents the digital transformation of the models and processes carrying out the management of technological and non-technological innovation. Innovation becomes the element that gives companies a competitive advantage, and scientific and technical research becomes the basis for wealth creation and economic development. Hence, when technology, people, and data are connected, transformative, and sustainable innovation occurs. Accelerating the digital transformation and the increase in ICTs investments in the various environments and sectors allows us to be in harmony with the full growth and development that occurs worldwide in the modern fourth industrial revolution. The present chapter aims to integrate the innovation accelerators of the four pillars of technologies of the third platform in the interrelations of technological management among the actors of the quadruple helix for digital transformation.

Keywords Quadruple helix · Technological management · Innovation accelerators · Third platform · Sustainable innovation

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Introduction

The well-being development of societies is embraced by creativity and innovation exhibited within the industrial revolutions throughout history. According to Schwab (2017), the periods in which these industrial revolutions took place spanned from 1760 to 1840s with the first industrial revolution. The second revolution, known as the mass media revolution, elapsed between the late nineteenth and early twentieth centuries. The third revolution began in the 1960s, and it is generally known as the digital or computer revolution because the development of semiconductors catalyzed it, computing using mainframe servers (1960s), personal information (1970s and 1980s) and the Internet (1990s). We are at the dawn of a fourth industrial revolution. This revolution began at the beginning of this century and is based on the digital revolution. A more ubiquitous Internet characterizes it (generalized connectivity of low cost and high speed, primarily through wireless services with and without a license, making almost everything connectable), by mobile (by smaller and more powerful sensors that are increasingly cheaper), and by artificial intelligence and machine learning. As a result, from the late 1760s to the present days, the world has witnessed a five-fold rise in the global population, and a ten-fold increase in GDP (Skilton & Hovsepian, 2018).

The impulse of Industry 4.0 and the generalization of big data is leading to a transformation from current traditional and hybrid business models, to new hybrid and digital models in which STEM professions (Science, Technology, Engineering, Mathematics) will be increasingly in demand, professionals that will use digital entrepreneurship to reach a large number of potential clients with the ease of being able to adapt their products and services offered in the market to each clients' needs (Colvin & Saiz-Álvarez, 2019). Within the relevant technological advances that have been integrated to give rise to and advance the fourth industrial revolution, information and communication technologies (ICTs) play a crucial role in development strategies in the field of governmental public policies, in the business environment in the industrial sector, and in the academic research environment, not only because of their growth potential, but also because of the favorable effect they have on other social areas and the overall competitiveness of the economy.

The expansion of the digital transformation (revolution) on a macroeconomic scale indicates the dawn of a new digital economy. In the digital economy, the digital transformation of the actors: government, industry, academia and civil society of the quadruple helix model (Etzkowitz & Leydesdorff, 2000; Leydesdorff, 2012) will be measured by their ability to reach and overcome an entirely new set of demanding performance benchmarks and correspondences, enabled by the technologies of the third platform with its powerful "innovation accelerators" (IDC, 2017) and ICTs leadership to thrive in the digital ecosystem, based on Katz's conceptualization (Katz, 2015).

Leadership has a crucial task in these technological innovation processes, as leaders force firms and organizations to change in hostile and competitive business environments. Leaders empower people to accomplish their goals in a continuously

nurtured lifelong learning process, as lifelong learning and leadership are indispensable to each other. Changes accelerate in a learning-by-doing process, especially when firms succeed by applying to outsourcing as a strategy for growth (Saiz-Álvarez, 2008). Besides, when sustainable innovation links to additional services for products, firms enhance their product and service profitability (Jiang et al., 2019). This result is stronger on sustainable innovation when firms, organizations, and universities adopt a centralized leadership structure (Xu & Bai, 2019). In addition to one where the interrelations of technology management and innovation systems among the actors of the quadruple helix strive for digital transformation (Leydesdorff & Zawdie, 2010).

Digital Transformation can be widely applied to many principles and ideas. The efforts of the digital transformation of the "world leaders" will no longer be only projects or initiatives, but will be central wills for what is managed, produced, and administered, as well as how they operate collaboratively.

In the information technology (IT) market, 2013 was listed as the year of innovation. Thus, 2014 not only meant an extension of this concept, but it has been extended to a period where the process of digital transformation has been lived with higher intensity in the current decade. Based on the International Data Corporation´s estimates in technology to advance the efforts of digital transformation, global spending on IT products and services will continue to be led by financial services (banking, insurance, securities, and investment services) and by manufacturing industries (Tapper et al., 2018).

One of the strategies to increase the competitiveness of the local, regional, or national environment is through the interrelationships or interactions between the entities participating in the innovation processes. The national innovation system is defined as the productive social structure composed of policies, strategies, programs, and provisions that promote a collaborative culture among companies, consumers, educational institutions, and organizations to obtain technological results (Bruneel et al., 2010; Ioppolo et al., 2016).

The quadruple helix model describes the evolution in the interaction between its main actors, government, industry, academia, and civil society. The links between the actors of the model are influenced by a series of elements that promote or inhibit interrelationships or correspondences. In the context of the technological integration, interest has arisen to discover and take advantage of the opportunity to technologically manage through the innovation accelerators of the third platform (IDC, 2017) the interrelationships or correspondences between the actors of the quadruple helix model (Etzkowitz & Leydesdorff, 2000).

From a technological management perspective, the following research questioned is presented in this chapter: Is the digital transformation of the quadruple helix model established through technical management interrelations between the government, industry, academia, and civil society employing the innovation accelerators of the four pillars of technologies of the third platform?

This chapter aims to develop a documentary investigation by collecting the background and substantiating it through a descriptive research study. From the bibliographic sources, essential topics of the quadruple helix model and the digital transformation were reviewed individually to establish their relationship, and the dispersed elements of interest were rationally gathered to study them in their entirety. The general scenarios of the quadruple helix model were related to the innovation accelerators of the third platform, which were designated through technology management interrelation in the prevailing scenarios of the quadruple helix model.

The Fourth Industrial Revolution 4.0

During the several industrial revolutions that have occurred throughout history, technological, economic, and social transformation processes were presented where creativity and technological innovations took place. From the beginning of the twenty-first century and based on the Digital Revolution, the current Fourth Industrial Revolution or Industry 4.0 (term coined at the Hannover Fair, Germany, 2011) or Intelligent Industry or Cyber Industry is characterized by a more ubiquitous and mobile Internet, by smaller and more powerful sensors that are becoming cheaper, and by artificial intelligence and machine learning. The aim is to reach a large number of intelligent factories capable of greater adaptability to the needs and production processes, as well as to a more efficient allocation of resources (Bloem et al., 2014).

The digital technologies that in their core have hardware for computing, software, and networks are not new, but unlike the third industrial revolution, they are increasingly sophisticated and integrated and are transforming societies and the world economy. This is why professors Brynjolfsson and McAfee of the Massachusetts Institute of Technology referred to this period as the second era of the machines by stating that the world is at a turning point in which the effect of these digital technologies will be manifested with full force through automation and the creation of unprecedented things (Brynjolfsson & McAfee, 2016).

At the dawn of the fourth industrial revolution, general, physical, and biological systems are combined. Schwab on the fourth industrial revolution in the World Economic Forum in 2016 declared that one of the characteristics of this revolution is that it does not change what we do, but what we are. We are a composition of physical and biological systems with stimulations of environmental and digital systems that induce change.

Sustainability is hinged on innovation (Kusi-Sarpong et al., 2019). Thus, regulation is of fundamental importance throughout the innovation process. Institutional and regulatory settings determine the productive and commercial strategies of organizations and avoid dumping practices (social, economic, and ecological) that harm free competition, society, and nature. Also, the regulation grants legal certainty, which encourages the arrival of foreign capital and the implementation of sustainable innovation. As sustainable innovation is a synchronous process defined by co-construction

and parallel association (Aka, 2019), stakeholders' participation must be especially active, especially customers and society.

The disposition of the sectors of society to the development of technological and non-technological innovation represents a definitive cause of progress and well-being. Those responsible for making decisions in public policies and educational institutions, as well as the private sector, must do their part in pursuing innovation management. Besides, it is also essential that citizens perceive the various benefits and challenges in a reasonable period.

An Overview of the Quadruple Helix Model

In the triple helix, unlike other models, there is no reference book in which its foundations and concepts are exposed (Shinn, 2002), as its leading theorists, Loet Leydesdorff and Henry Etzkowitz have been developing this approach in several joint studies and various publications along with different authors. Being consistent with their ideas, both authors act as consultants and as academic staff of various organizations from different countries to design and undertake their innovation policies.

According to Etzkowitz (2003, 2008), the triple helix model has its origin in the entrepreneurial university that emerged in the USA where there is a long tradition of collaborations between academic and industrial environments, between the university and governmental agencies, and between the government and industries. Here the interrelation or correspondence between the sectors that are part of the model is manifested. The triple helix is defined as "a spiral model of innovation that captures multiple reciprocal relationships at different points in the process of knowledge capitalization" (Etzkowitz, 2002). It is a process of knowledge capitalization as well as an internal transformation in each of the helices, such as the "development of lateral ties among companies through strategic alliances or an assumption of an economic development mission by universities" (Etzkowitz, 2003).

The triple helix approach of Government-Industry-Academia relations can be seen as a sociological complement of economic models in the studies of innovation (Albert & Laberge, 2007). This model postulates that the interactions between these actors are the key to improving conditions for innovation in a knowledge-based society.

Innovation becomes the element that gives companies competitive advantages, and scientific and technological research becomes the basis for wealth creation and economic development. In the social sciences, models are developed to explain and account for innovation as the main element of a new type of economy, "knowledge-based economy," based on the production, distribution, and use of knowledge and information, made possible by information and communications technology (ICT) and the process of globalization of markets and their relationships.

According to Leydesdorff (2006), the knowledge-based economy becomes the goal of most of the economic policies of post-industrialized countries, as is the case in the European Union with the commitments based on the Lisbon Summit of 2000.

From those dates are considered the generation of knowledge as a fundamental part of the development of the economies of the countries.

To complement the knowledge-based economy, the "capitalization of knowledge" that coincides with the "cognitivization of capital," refers to the creation of new forms of capital, which are created based on social interaction or intellectual activities, and are interchangeable (Etzkowitz, 2003). The contribution of Etzkowitz stands the opportunity to update through interrelations or correspondences of technological management of the digitalization of social interactions. Interrelations that will also positively impact both the intellectual capital of the stakeholders (interest groups), which creates a feedback effect that favors the creation of quadruple helix models (Saiz-Álvarez & Palma-Ruiz, 2019).

The Digital Transformation

The technological platforms that initiate the development of the digital transformation of the various sectors of society were gradually presented with specific technological advances. The first platform is believed to originate from 1950 to the present. The mainframe is shown with a large, powerful, and expensive computer, which performs all the calculation processes and is only accessed through reserved interfaces, from punch cards to keyboards and text screens (Bloem et al., 2014).

The second platform begins from 1980 to the present or from 1986 to 2010. It corresponds to the "client–server" architecture; it is the revolution of personal computers, versions of computers are released along with access to communications networks from places of work, education, and homes. It facilitated communication from more or less "dumb" terminals to servers located in traditional data processing centers. The Internet and the World Wide Web arise. In the technological sector, there is a process of escape from the second IT platform, very handmade, to the so-called third platform, fully industrialized.

The Chinese firm International Data Corporation (IDC) (www.idc.com) is one of the world´s leading providers of market intelligence, consulting, and conference services for information, telecommunications, and consumer technology markets.

IDC defends that the expansion of the digital transformation on a macroeconomic scale marks a new economy of digital transformation. The organizations of the economic sectors must enable digital transformation through the technologies of the third platform to create value and competitive advantages through new offers, new business models or actions, and new relationships. These objects will exist and would be attainable by organizations by using the technological tools of the third platform to innovate the decision-making process and expand the experiences gained.

The technologies of the third platform are fundamental and essential elements in a digital economic association that can evolve the market and successfully adapt to a new economy focused on digital transformation. They are technical and service concepts intertwined, and that, in one way or another, respond to the needs to make business, academic or public information available on any device, time, and place as

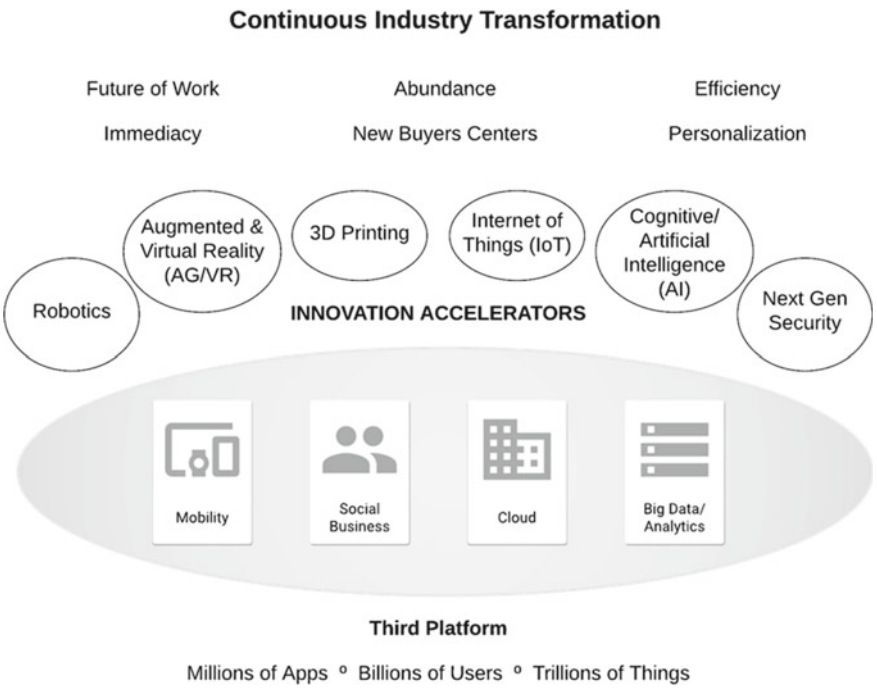

Fig. 1 Third platform and innovation accelerators for digital transformation (*Source* IDC [2017])

the primary imperative. Figure 1 shows the model proposed by IDC for the digital transformation consolidated by the third platform.

The six innovation accelerators support the four technology pillars of the third platform that drive digital transformation: Internet of Things (IoT), Augmented and Virtual Reality (AR/VR), Cognitive/Artificial Intelligence (AI), Next Generation Security, 3D Printing and Robotics.

Figure 2 shows the representation of the digital transformation of the quadruple helix model with technology management interrelations. It is a descriptive model that shows the interrelationships of technological management or correspondence between the Government, Industry, Academia, and Civil Society sectors with the innovation accelerators of the four technology pillars of the third platform.

Table 1 shows the four pillars of technology of the Third Platform that drive the six innovation accelerators. In each of the four pillars, the set of techniques that are gradually integrated into 5G technology are considered a fundamental part of its development and performance. Besides, the six innovation accelerators are further described in this section.

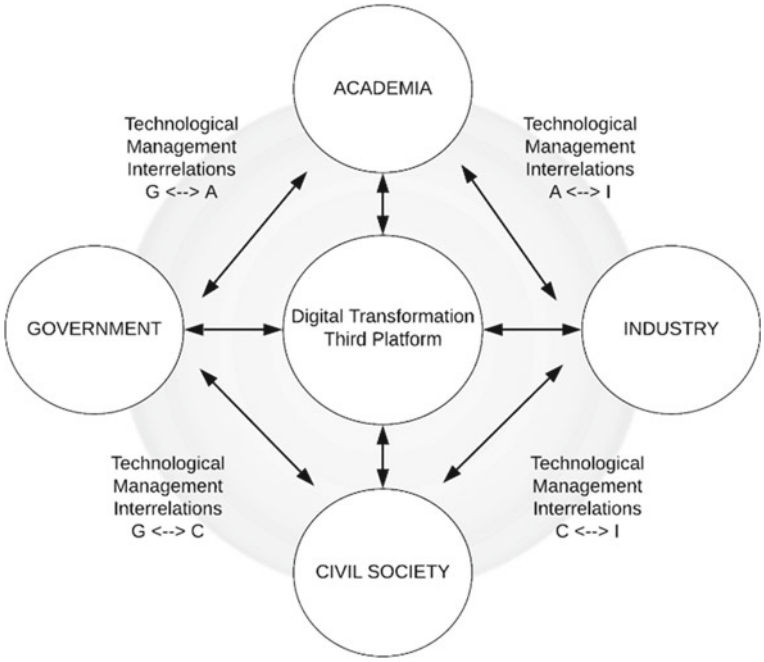

Fig. 2 Digital transformation of the Quadruple Helix Model (*Source* The authors)

Internet of Things (IoT)

It is a strategic innovation accelerator for organizations in various economic sectors. According to Rose et al. (2015), the term "Internet of Things" was first used in 1999 by Kevin Ashton to describe a system in which the objects of the physical world could be connected to the Internet through sensors. Ashton coined this term to illustrate the power of connecting radio-frequency identification (RFID) tags that were used in corporate supply chains to count and track merchandise without the need for human intervention.

There is no single and universally accepted definition of the term IoT. Different meanings are used to describe or promote a particular vision of what IoT means and its most essential attributes. The Oxford Dictionary offers a concise definition that invokes the Internet as an element of IoT: "Interconnection through the Internet of computing devices integrated into everyday objects, which allows them to send and receive data."

Key distribution and critical management control are necessary tools for securing applications in the context of IoT to assure flexible, scalable, and resilient communication tools to guarantee IoT security and performance (Nafi et al., 2020), especially in wearable devices, as they are the latest IoT trend (Bhushan & Agrawal, 2020). Rose et al. (2015) pointed out that IoT in general terms refers to the extension of network

Table 1 Four pillars of technology of the third platform that drive the six innovation accelerators

Mobility	Cloud	Social business	Big data
Smartphones, tablets, portable technologies, and other mobile devices allow economic sectors to interact in new ways with employees, customers, partners, and other stakeholders, creating personalized digital experiences. 5G technology will have a profound impact on ecosystems, mobility, and ICT	The adoption of the cloud continues to expand. The cloud will represent approximately two-thirds of all IT infrastructure and software investments. This growth will be accelerated by the evolution of cloud technologies in case they are better distributed, safe, specialized in various economic sectors, as well as intelligent. Faster and lower latency access to the cloud will be provided by 5G technology	In the connective branch that best aligns the economic sectors with the interested groups, in addition to organizing the internal units of the business with the business lines. The challenges to creating openness and connectivity in their social ecosystems will have to be resolved to transform their actions. 5G adoption and monetization strategies will explore how services can be provided to customers and consumers	The economic sectors are already collecting vast amounts of data and analyzing them to inform and make the best commercial, academic, and public policy decisions. In data collection, 5G adoption, and monetization strategies will recognize the implications of the ecosystem for device manufacturers, software vendors, content providers, and mobile operators

Six Innovation Accelerators					
Internet of Things (IoT)	Augmented Reality/Virtual Reality (AR/VR)	Cognitive/ Artificial Intelligence (AI)	Next-Generation Security	3D Printing	Robotics

Source Adapted from IDC (2017)

connectivity and the ability to compute objects, devices, sensors and elements that are not usually considered computers. Although IoT has many opportunities to foster digital transformation, many organizations now decide to work with external experts to advise them on the use of IoT as a strategic innovation accelerator. Regarding the security problems offered by IoT, a series of questions can be raised, the relevance of the correct answers has increased due to the vast deployment of devices being used.

Augmented Reality and Virtual Reality (AR/VR)

On the background of augmented, virtual and mixed reality, Piña Huesca (2018) highlighted the several "immersive technologies" that have been developed. A term that refers to those digital technologies in which the user plunges into an environment that can be real or fictitious at different levels through tools such as electronic devices, lenses, gloves, headphones and omnidirectional tapes, an outcome of electronic and IT advances.

Immersive technologies are then classified into three areas:

(a) Virtual reality (VR): The term was first used in the article "The Ultimate Display" by Ivan Sutherland in 1965. It is a technology that involves a complete immersion of the user to a simulation where he can interact in a fictional environment and even manipulate objects. So, the user´s interaction with reality is low. This VR can be done through different devices such as lenses or visors, with the most prevalent sensory helmets.
(b) Augmented Reality (AR): This term was coined in 1990 by Tom Caudell, a Boeing engineer. It refers to the technology that through the use of a mobile device allows adding digital information to the natural environment, so the interaction between the user and the elements of the environment is high. The most popular tools to make use of this technology are smartphones and tablets. Currently, this technology is in the process of expansive exploration and its applications with other devices, such as lenses that display increased information to the user.
(c) Mixed Reality: It considers elements of both, VR and AR since a digital environment is projected on the real environment utilizing electronic devices, such as the lenses. Nowadays, it is in the phase of experimental evolution. The current dream of AR/VR is to combine the mobility and wireless capacity of a mobile headset with the power of a computer.

Current Virtual Reality Applications

(a) Business Division: Virtual reality allows remote employees to meet in a 3D environment using social avatars. It offers the possibility of designing better products, selling them to customers in a more immersive way, and it is also an excellent tool to train staff more quickly and thoroughly.
(b) Entertainment Division: A combined or mixed reality headset fuses VR with RA. It uses integrated depth sensors and space mapping technology to transform real objects into simulated ones, i.e., a living room into a battlefield.

Sectors in Which Virtual Reality Is Deployed with Intensity

(a) Online sales: Through VR, it is possible to combine the convenience of online shopping with the experience of being in a store.
(b) Real estate: Thanks to VR, it is possible to visit a property remotely regardless of its location.
(c) Health sector: Virtual reality offers the possibility of rehearsing complex surgery operations and can also help treat psychological conditions.
(d) Aerospace industry: Virtual reality is part of the pilots´ training through simulations.

The Future of Virtual Reality

With the arrival of VR comes a new way of seeing the world and involves the revolution of the senses. Technological giants are already tracing the future of VR due to its massive market potential. In 2016, the global augmented, and market size for VR was approximately 1.9 billion USD. In 2019, grew to 16.8 billion USD, and in 2020, it is expected to rise to 22.4 billion, based on Statista (Liu, 2018).

The various immersive technologies are other innovation accelerators that allow the beneficiary to immerse themselves in an environment that can be real or fictional (simulated). At different levels of the digital transformation, VR is being carried out or adopted in governmental, industrial, and academic sectors. There remain many areas of opportunity to study and further develop AR and VR equipment, device prediction, technology training, forecasting, and emerging commercial services, educational purposes, and application cases.

Cognitive Systems/Artificial Intelligence (AI)

According to KPMG International Cooperative (2018a), artificial intelligence is a general term; it encompasses all the technologies that allow a computer to perform tasks that require human intelligence, and that involves four specific capabilities:

- Gather information and structured and unstructured data like human perception.
- Understand and process information reasonably.
- Act accordingly after choosing the most viable answer.
- Learn autonomously and through feedback based on data.

Artificial Intelligence is currently used near to all sectors, including public and private organizations, and has a tremendous economic impact by optimizing the value of many new technologies.

Examples of Artificial Intelligence Application Areas

(a) Consumption: Creation of customized products or services through "chatbots" that analyze customer preferences in social networks.
(b) Manufacturing: Movement of heavy loads through exoskeletons with visual recognition and augmented reality.
(c) Customer service: Machine learning systems to generate automatic improved answers, in the face of the most frequently asked questions from customers.
(d) Human resources: Creating interactive stories autonomously to develop online courses and corporate training.
(e) Marketing: Websites of online stores that change automatically to persuade undecided customers to make a purchase.

Other Artificial Intelligence Application Areas

The term "machine learning" does not refer to the complicated learning processes typical of human beings; it is merely an analogy since these algorithms are only able to evaluate results and, based on them, adjust response variables to optimize future outcomes.

Myths will continue to manifest (that AI will displace almost all jobs) and realities (AI will create 2.3 million jobs in 2020 globally, while 1.8 million will disappear) around the development and application of cognitive systems/AI in addition to the challenges and threats AI brings to change the culture by "reimagine old tasks and create new industries" them to engage in innovation (van der Meulen & Pettey, 2017). Gartner, Inc. predicts such AI integration into organizations by 70% to assist employees and increase productivity (Omale, 2019).

According to KPMG International Cooperative (2018b), away from any controversy, current AI can provide multiple benefits for a company, such as:

(a) Cost-savings: According to some estimates, the cost of a robot is equivalent to one-third of that of a full-time hired human and does not require expensive training plans.
(b) Consistency/permissibility: The implementation of AI can reduce accidents, violations of regulations, and corporate fraud.
(c) Staff satisfaction: Eliminating repetitive and daily work routines can leave time to foster human creativity and innovation.
(d) Productivity/Performance: The machines work 24/7 and perform tasks at superhuman speed.
(e) Quality/Reliability: If the software is configured correctly, its deviation standards are set within permissible ranges, thus avoiding mistakes. Therefore, it eliminates human error and extensive supervision.

Next-Generation Security

Security is an increasingly important issue for all organizations. The various economic sectors can benefit from professional service consultants and cybersecurity providers who understand the technology and can advise on how to use it as an innovation accelerator for digital transformation. It is estimated that by 2020, a large percentage of organizations around the world will invest in "response retainers" (antivirus or firewalls) in incidents to better manage threats and security attacks (Brethenoux et al., 2018).

Data security is a recognition of the link or the direct link between the domain of the data and the ability to protect them. The constant evolution of fraud and identity theft/intellectual property persistently affects a considerable number of people, as well as public and private organizations. Thematic areas of security include the evolution of cryptography as the technology pillars of the third platform are advanced, such as cloud computing and large amounts of data/analytics. Also, the collection of massive amounts of content created by the user and the machines, which is increasingly turning organizations into intermediaries (brokers) of data.

Next-generation security also includes technologies on the verge of disruption of traditional data security models and the transformation of security solutions focused on existing data for both structured and unstructured content. As business data stores grow with the promise of analyzing and using data, it is advisable to include:

- Encryption technologies
- Data loss prevention (DLP)
- User Behavioral Analytics (UBA)
- Supervision and monitoring
- Symbolization (coding) and masking (encryption) of data.

Markets and Issues to Analyze as Innovation Accelerators

- Modern trends in data security (containerization), behavior analysis, cognitive analysis, data plotters, and business rights management.
- Data protection and cryptography (encryption of files and entire disks, key management, and tokenization.
- Security of data storage (prevention of data loss, business rights management, anti-fraud monitoring and remediation, and advanced threat detection and intelligence).

3D Printing

A 3D printer is a machine capable of replicating 3D designs, creating pieces or volumetric models from a computer-made design, downloaded from the Internet, or captured from a 3D scanner. 3D printing developed with the idea of converting 2D files into real or 3D prototypes. It has been commonly used in the prefabrication of parts or components in sectors such as architecture and industrial design. Currently, its use is being extended in the manufacture of all types of objects, models for emptying, complicated parts, food, medical prostheses (since 3D printing allows each manufactured piece to be adapted to the exact characteristics of each patient).

There are multiple commercial models:

- Laser sintering (SLS) involves the depositing of subtle layers of powdered materials (steel, aluminum, titanium) for a laser to fuse each layer with the previous one.
- Stereolithography (SL) involves a photosensitive resin cured with ultraviolet light beams.
- Compaction comprises a mass of powder that is compacted by strata.
- Addition or injection of polymers in which the material itself is added in layers.

Current Uses of 3D Printing

(a) ***Medicine***: This field is one of the most advanced in terms of the use of 3D printers. In the USA, the Food and Drug Administration (FDA) approved in August 2015, the first drug that can be produced by 3D printing. The medicine is called *Spritam* and is used to treat epilepsy. 3D printing of medications can allow specialists to prescribe more precise doses, adjusted to the patient´s needs (Kite-Powell, 2016). Additionally, there are 3D printers that can create prostheses, transplants, organs, and many other applications, even the creation of skin for burned people, as made by the CIEMAT Biomedical Engineering Mixed Unit, one of the leading research centers on biomedicine in Spain.

(b) ***Automotive industry***: Design of vehicles, specifically in the prototype design phase, to save costs.

(c) ***Aerospace industry***: Both the USA space agency (NASA) and the European space agency (ESA or Spacex) are working on the use of 3D printers in space that allow them to create components and tools on-demand, which can be printed when needed, saving on space and weight, by carrying only the impression material, avoiding wasting valuable capacities on objects or tools that may not be used or that once used can be re-melted to create other purposes.

(d) ***Education***: Games for teaching and for learning mathematical concepts for blind or visually impaired students. Also for class gamification (e.g., Kahoot!, Trivinet) and educational cooperation (e.g., G Suite for Education).

(e) ***Robotic industry***: Countless applications are being found to use 3D printing as its development progresses. For example, the case of a printer that designs almost any type of sneaker with different compounds and colors. Also, in robotics. At this respect, the Robot Institute of America (RIA) defines a robot as "a multifunctional and reprogrammable manipulator designed to move materials, parts, tools or special devices through programmed and variable movements that allow various tasks to be carried out" (Freedman, 1996). The robotics learning proposal must contemplate the study of the different elements that make up a robot, and that can be considered as its subsystems (Lam, 2007). During the design, creation, or commissioning process, it is possible to learn robotics themes such as robot manipulation, computer vision, artificial intelligence, and mechatronics (Krotkov, 1996).

Kitts and Quinn (2004) affirm that several robots could be built, such as industrial, air, land, and submarine robots. In the period between 1999 and 2004, in the robot systems laboratory of the University of Santa Clara in Silicon Valley, interdisciplinary teams developed different types of robotics projects and the student groups were made up of young people of different levels, academic programs, and disciplines.

New developments in robotics will have the potential to alter the business or activity ecosystems granted to all economic sectors and will have a significant impact on the functions of IT within organizations. Robotics is an area that is aligned with the other innovation accelerators and can be combined to offer a privileged experience at the managerial or rector level. It is estimated that by 2020, approximately 60% of the robots will depend on cloud-based software to define new skills, artificial intelligence capabilities, and application programs (Brethenoux et al., 2018). Some of the applications of the robots are in medicine, the industrial sector, the military avant-garde, agriculture, education, space exploration, science and technology, the business environment and those that need to be developed in agreement new trends. As a result, the adoption of 3D printing has begun to break the mold of the various economic sectors.

Conclusions

The prospects for correspondence between the governmental, industrial, and academic sectors have been modified and will continue to be altered due to the digital transformation. The pace is accelerating, as is the scale of change and disruption that take place at the individual, organizational, and societal level at the dawn of the fourth industrial revolution.

A descriptive model of the digital transformation of the quadruple helix model with interrelations of technological management between the government, industry, and academia is proposed, integrating the six innovation accelerators of the four pillars of technologies of the third platform.

It is convenient to make a point that, from the third platform, all the four pillars of technologies and the six innovation accelerators can be interrelated and integrated to establish the application of technological management that is projected between the actors of the quadruple helix model.

Strategies focused on technological and non-technological tools that work must integrate the vital component of creativity, in addition to having disruptive and innovative thinking in a multidisciplinary profile. The objective to be fulfilled will be to innovate and reinvent the strategies in the linkage processes with the correspondence and interrelations of technological management between business, academia, and public policies. The expansion of digital transformation into macroeconomics establishes a new scale, the economy of digital transformation.

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