Università degli Studi di Urbino Carlo Bo

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MANAGING EUROPEAN R&D PROJECTS IN THE INDUSTRY 4.0 CONTEXT: THE PERSPECTIVE OF A SMALL CONSULTING FIRM

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Coordinator: Prof. Antonello Zanfei

Supervisor: Prof. Alessandro Pagano

Co-Supervisor: Prof. Andrea Perna

Ph.D. student: Luigi Mersico

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Abstract

The purpose of this thesis is to examine the processes and key factors that characterize the management of European projects related to Industry 4.0 (I4.0) by small consulting firms. The topics small firms, European projects and I4.0 are inter-related at the light of the growing interest of both towards a broader understanding of the role of small consulting firms in helping industrial clients in I4.0 related projects and, of the European Framework Programmes (FPs) for Research and Development which fund projects related to Industry 4.0 enabling technologies.

Therefore, the motivation for this study stems from a research gap in literature on projects regards the role played by other key business actors, such as small consulting firms, in I4.0 projects funded by the European community, also considering the challenging scenario in which they have to develop their competencies. Notably, given the explorative nature of the research project, this study used a qualitative methodology based on longitudinal single case study (Chapter III) aimed to investigate the resource development process implemented by consulting firms in order to offer their services to customers in the I4.0 domain and, a multiple case study (Chapter IV) in order to gain a deeper understanding of the development process of European funding projects related to Industry 4.0 enabling technologies. Notably, the empirical analysis relies on the Industrial Marketing and Purchasing (IMP) approach as the main conceptual framework and in particular on the 4Rs and ARA models as they can guide research on both the processes of resource development and assembly, offering a useful perspective in understanding the process of combining different organizational, knowledge and technological resources in the development of new offerings, as well as exploring the nature of multiple networks and the interactive processes in which the focal firm is embedded.

This thesis takes the form of a collection of papers and is structured into five chapters. Chapter I introduce the topics, sets the theoretical framework, and describe the research methodology. Chapter II analyzes the state of art of research on topic “Project management and SMEs” with the aim of map the knowledge base, the conceptual structure, and the main themes for outline future lines of investigation. Chapter III is aimed to investigate the resource development processes implemented by consulting firms pursuing the innovation path to develop solutions within I4.0 domain. Chapter IV investigates how interaction SMEs – small consulting firm affected the development process of Industry 4.0 related EU funding project focusing on projects undertaken between SMEs and a consulting firm as they cooperate to get funds from FPs. Chapter V summarizes the findings of the chapters and discusses them by relating them to each other and then concluding with observations, managerial and policy implications, and finally highlighting the limitations of the study.

This study contributes to a) literature on innovation processes related to I4.0 considering the case of the small consulting firm trying to reposition itself as a solution provider by undertaking innovative projects; b) IMP research tradition on projects trying to conceptualize the phenomenon of interaction within projects; c) the literature on SMEs and European Projects showing as the limits to innovation could be overcome leveraging the ad hoc calls for proposals.

Keywords: SMEs, Project management, Innovation, Networks, European Project, Industry 4.0, small consulting firm.

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CHAPTER I

Introduction

SMEs defined, according to the European Union, as enterprise that have revenue of less than € 50 Million and no more than 250 employees, account the 99.8% of all firms in the EU-28 non-financial business sector (European Commission, 2020) contributing to economic activity in terms of employment, innovation and growth although constrained by some characteristics such as shortage of financial resources, including fund raising ability.

European community within the European Framework Programmes (FPs) for research and technological development such as Horizon 2020 in 2014-2020 has created numerous ad-hoc calls for proposals for SMEs (Muscio and Ciffolilli, 2020) wishing to develop product, process or business model innovations (European Commission, 2016) to increase the competitiveness in the international market since the most critical factor for the sustainability of innovation projects is the financial aspects (Vrchota et al., 2020).

Thus, international innovation projects represent an opportunity and a challenge for SMEs as they are, from one side, more flexible (Narula, 2004; Cecere et al. 2020), more willing to take risks (Hall, 1995) and tend to have a higher R&D productivity with respect to MNEs due to their ability to innovate by exploiting knowledge created outside the firm (Audretsch and Vivarelli, 1996; Barajas et al. 2016). From the other, SMEs are affected by limited resources in terms of financial, skills and knowledge resources (Radas and Bozic, 2012; Marcelino Sadaba et al. 2014; Arbussa, Bikfalvi & Marquès, 2017).

This is the case of projects related to the enabling technologies of Industry 4.0 (I4.0). I4.0 represents both one of the main emerging technological and organizational challenges for SMEs (Moeuf et al., 2020; Müller et al., 2018), which often have limited knowledge about digitalization, and area for investment by both the European Union and various national governments (Smit et al., 2016), supported by FPs for research and technological development (Muscio and Ciffolilli, 2020).

The concept of I4.0, *"often referred to as the fourth industrial revolution [...] embraces a set of technological advances that are having a high impact in the current industrial landscape"* (Pereira and Romero, 2017: 1208) according to Rüßmann et al. (2015) relies on emerging technologies (Moeuf et al. 2020) such as: a) Big data and analytics, b) simulation, c) Autonomous Robot, d) internet of Things, e) Cyber-Physical system, f) cloud computing, g) virtual reality, h) Machine-to-Machine communication and i) Cyber security.

With respect to this, Economic and managerial literature from one side have provided some empirical evidence on the impact and effectiveness of public innovation policy measures on innovation of SMEs as policy interventions need to be sensitive to the differences between SMEs (Gambardella et al., 2009; Paier and Scherngell 2011; Cecere and Corrocher 2015; Barajas et al., 2016). From the other, the growing literature on I4.0 has highlighted two main inter-related topics. Various studies have attempted to explore the introduction of advanced digitalization processes (Frank et al., 2019) while other contributions have placed attention on the business and institutional context of I4.0 diffusion, in terms of public support and knowledge dissemination processes (Hervas-Oliver et al., 2019; Pagano et al., 2021), showing at the same time the existence of a lack in literature regarding the role played by other key business actors such as small consulting firms in I4.0 projects fund by the European community.

Existing literature on innovation conceptualizes consulting firms as Knowledge Intensive Business services (KIBS) (Toivonen, 2006) as they not only represent a qualified provider of knowledge-intensive services aimed at promoting and facilitating innovation in economic sectors such as industry and manufacturing (Ciriaci et al., 2012) but, also innovation agents in public policy framework (Czarnitzki and Spielkamp, 2003) whom undertake complex projects of an intellectual nature where human capital is the most critical factor (Muller and Doloreux, 2009).

EU funding projects related to Industry 4.0 are characterized by high complexity (Arsic et al., 2015) due to the skills and knowledge required in their development process (Bougrain and Haudeville, 2002) and therefore are undertaken in partnership between several countries/companies/institutions involving a large number of stakeholders and are constrained by the call (Project Management Institute Italy Chapters, 2019).

Thus, as well as existing literature on Project Management and European Funding is limited only to few studies' practitioner oriented such as Arsic et al. (2015) aimed to disentangle the numerous technical details regarding the project proposal. Literature on I4.0 and solution providers such as IT and consulting firms focuses on technical aspects of those projects (Lopez-Robles et al., 2020) suffering a lack in provide a more in-depth examination of the role played by other key business actors such as small sized consulting firms since that the ability of consulting firms in providing adequate consulting services regarding I4.0 should not be taken for granted. Therefore, also knowledge providers/brokers - as small consulting firms - have been facing a challenging scenario while they undertake resource development processes on their own to become trusted and capable partners for customer firms considering I4.0 projects.

Thus, the overall aim of the present dissertation is to investigate the processes and key factors that characterize the management of European I4.0 projects by consulting SMEs. Notably, in order

to achieve the main aim, the empirical part analyzes the path pursued by a specific actor – a small consulting firm - to become a key player and trusted partner in European Projects related to Industry 4.0. Particularly, the research questions have been formulated as follows:

RQ1: How do small consulting firms develop resources in their innovation path in the I4.0 domain?

RQ2: How is the European Funding application for I4.0 Projects affected by the interaction between SMEs and the consultancy firm?

In order to address these RQs, the present study considers the Project Management perspective to understand the typology of the projects (Barth, 2003), practices, procedures adopted (Turner et al. 2010, 2012) and the Industrial Marketing and Purchasing (IMP) approach as main conceptual framework for the empirical analysis.

Given the exploratory nature of the research work, this dissertation adopts a qualitative methodology based on longitudinal case study concerning the consulting firm Sinergia Consulenze (Sinergia), a small-sized consulting firm based in Pesaro (Marche region, Italy) and providing services on European Projects, Systems for Managerial Control and Risk Management and Lean Technology.

Sinergia has been chosen on four grounds: 1) it is a small consulting firm; 2) it provides the perspective of a services, solutions and I4.0-related knowledge provider (Hervas-Oliver et al., 2019); 3) it is involved in the development of European I4.0 related projects; 4) the chance of follow part of the process during its implementation (timespan 2019-2021).

The reminder of the present dissertation is articulated as follows (figure 1). Chapter I, *"Introduction"* sets the theoretical framework and describe the research methodology. Chapter II *"Project Management and SMEs: a review of the literature and a framework for future research"* represents the conceptual paper that analyzes the state of art of research on topic "Project management and SMEs" using bibliometric methodology and science mapping techniques on the content of the past 30 years of PM research published in the scientific journals in all the different Web of Science and Scopus subject areas, with the aim of map the knowledge base, the conceptual structure and the main themes for both outline future lines of investigation and addressing scholars in positioning their future research work. Chapter III *"From knowledge broker to solution provider in the Industry 4.0 setting: the innovation journey of a small consulting firm"* concerns the first empirical paper, aims to investigate the resource development processes implemented by consulting firms pursuing the innovation path to develop solutions within I4.0 domain. Chapter IV "*The role of SMEs – consultant*

interaction in industry 4.0 related European project" concerns the second empirical paper aims to give a contribution on SMEs and EU funding projects with particular reference to I4.0 related projects literature by exploring how interaction SMEs – consulting firm affected the development process of Industry 4.0 related EU funding project focusing on projects undertaken between SMEs and a consultancy company as they cooperate to get funds from European Funding Programmes.

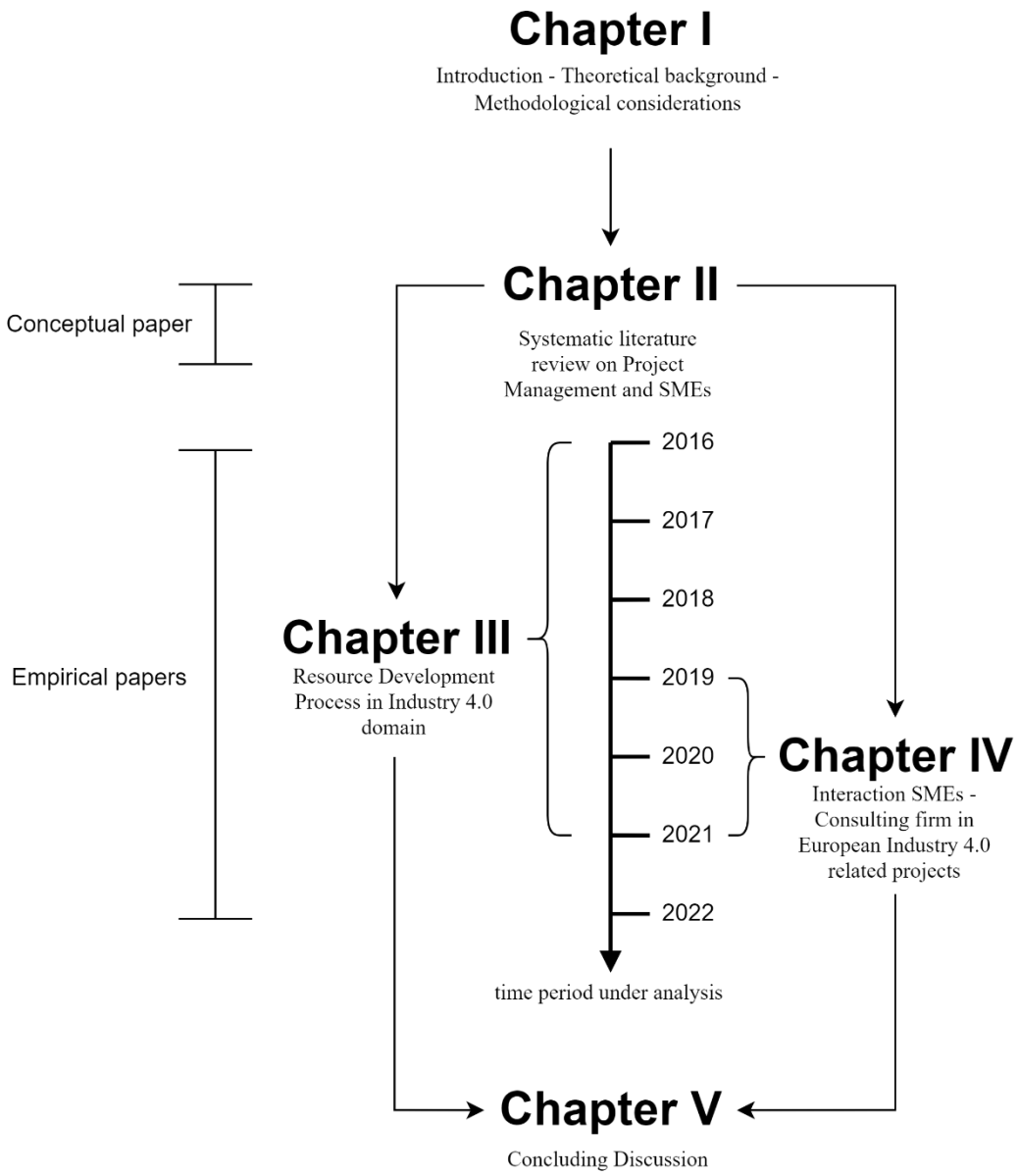

Figure 1. Summary of the outputs of the thesis

1. Theoretical Background

This section of the first chapter, by reviewing relevant literature, presents and discusses the theoretical background and the analytical framework that have guided this study.

1.1. Project Management and SMEs

Project Management (PM) represents an expanding field of research in management and organization studies (Söderlund, 2011) that has its roots in practice-oriented contributions (Geraldi and Söderlund, 2018) on how to manage large engineering and construction projects (Morris, 1994; Turner et al., 2010).

While organizations have been systematically using methodologies, tools, and techniques for complex projects since the 1950s, it is only with the publication of the PMBOK and PRINCE2 that these procedures and techniques have been standardized (Seymour & Hussein, 2014).

By according to the definition provided by the PMBOK, PM is *"the application of knowledge, skills, tools and techniques to project activities to meet project requirements"* (Project Management Institute, 2017: 10), where project is defined as *"a temporary endeavor undertaken to create a unique product or service"* (Project Management Institute, 2017: 4).

However, PM as a discipline presents a high level of fragmentation (Pollack and Adler, 2015) possessing a rich body of literature characterized by a steady growth in the number of published articles and a greater variety in terms of investigations, domains, and methods (Padalkar and Gopinath, 2016). In fact, Soderlund (2011) in his seminal work *"Pluralism in Project management: navigating the Crossroads of Specialization and fragmentation"* identified seven different schools of thought, each of them varying in terms of main focus and use of the project concept, main research questions, methodological approaches and type of theorizing: a) Optimization school - whose contributions generally is devoted to the optimization and evaluation of project implementation using mathematics, optimization theory and management science; b) Factor school - which investigates the criteria for project success and the factors that lead to either success or failure in projects and project management; c) Contingency school - focuses on the comparative analyses of projects and project management discussing the advantages and disadvantages of organizing by projects and identifies the various forms of project organization ranging from individual to project organization; d) Behaviour school - focuses on the organizational behavior of projects, the processes of organizing, and the nature and organization of social interaction in projects; e) Governance school – which use an economics

approach on projects and project management, mainly articulated around the applications of agency theory and transaction cost theory; f) Relationship school - which draws on alternative theories taken primarily from the research field of inter-organizational relations and marketing and focused on themes such as network formation and development, stakeholder interaction, project networks and project marketing; g) The Decision School whose investigating the early stage of projects places emphasis on decision making processes and their influence on the interruption or continuation of projects.

The variety of schools of thought in PM supports the idea of theoretical pluralism, which is also reflected in the increased attention gained by a wide range of disciplines, including operations research, organization theory, economics, psychology, and industrial marketing (Söderlund 2002; 2011).

In recent years, the relevance of the PM approach in companies and organizations has increased (Project management Institute, 2013; Morris & Jamieson, 2005) since on the one hand, projects are becoming increasingly multifaceted, involving stakeholders with different interests, rapidly developing technologies, and distributed knowledge bases. On the other hand, it is beginning to be discussed how corporate strategy can be implemented by projects and programmes and translated into project strategies as many companies adopt project-oriented working methods in their operations (Artto and Kujala, 2008).

As highlighted by the results of a Survey conducted by Turner, Ledwith and Kelly (2010) on European and North American SMEs about a third of the turnover in the former and half in the latter is generated by projects. Thus, the adoption of efficient and effective PM practices became relevant as it is a factor affecting their performance (Barth, 2003).

However, Turner et.al (2010, 2012) reported that although there is a *"wide use of project management for innovation and growth projects",* the adoption of both PM practices and the dedicated organizational structure is influenced by factors such as the size and age (Sane, 2019) of the company and the type of project undertaken since the introduction of Project Management requires the involvement of specific resources (Jugdev and Mathur, 2012).

In this regard, a scarcity of publications exists in the literature on the topic: "Project management and SMEs" (Tezel et al., 2018), although there is a growing interest both from policy makers, such as the European Community (Ciarmatori et al., 2018), and from companies and organizations that consider the use of the project management approach as relevant (Morris & Jamieson, 2005; Sane 2018).

Thus, the research path delineated by a series of articles of Turner, Ledwith and Kelly (2010, 2012) in response to the calls of Murphy & Ledwith (2007), started from a series of empirical studies

aimed to identify the best practices already used and the needs of European SMEs. Authors highlighted the importance of investigate to what extent SMEs undertake projects employing PM techniques placing emphasis both, on the nature of the projects they do and on categorization of SME.

Main findings highlight as SMEs tend to undertake smaller projects than larger firms thus, requiring less bureaucratic practices (Payne and Turner, 1999), tend to be more people oriented (Turner ad Moussault, 2014) and are more likely to be contractors of large firms.

Existing literature indeed is mainly articulated from on hand, around factors that affects productivity and costs in Project-based firm as Masurel and van Montfort (2006) that looked at how labor productivity and differentiation depends by the size and stage of development of project-based firms or Barth (2003) that investigates relationships between organizational structure and competitive strategy on SMEs performance suggesting as project-based firm need to adopt practices and structures on the nature of projects they undertake.

Moreover, Kozlowski and Matejun (2016) analyze how the use of PM practices is associated to cost reduction facilitating the introduction of new products and/or services to the market (Larson, Gobeli & Gray, 1991) in response to individual and changing client requirements (Allocca & Kessler, 2006). From the other, to topic related to Project risk Management (PRM) such as the adoption of PRM tools and techniques in SMEs. As stated in Ferreira de Araujo Lima and Verbano (2019) the contribution of PRM in both the detection of project objectives, improvement of monitoring and facilitation of decision making, increases the chances of project success. In fact, the adoption of PRM for SMEs is more important than larger enterprises since due to their size the failure of a project can have a significant impact on its results Marcelino-Sádaba et al. (2014). Thus, SMEs need appropriate methodologies and tools to minimize the possible negative consequences (Leopoulos et al., 2006).

However, traditional PM approach relies on set of models, tools and techniques for planning and control of projects seem not to represent a valid theoretical and practical framework for SMEs, which on the one hand need "lite" tools as argued in Turner et al. (2010) in order to manage the various phases of the project including initiation, planning, execution, monitoring, and closeout. On the other hand, starts inter-organizational initiatives limited in time but immersed in pre-existing environments (Geraldi and Söderlund, 2018) undertaken to the fulfillment of strategic goals of the firms. Moreover, it seems that in terms of topics covered, PM and SMEs literature suffers some lack of studies with regard to Industry 4.0 (Lopez-Robles et al., 2020), nontraditional project-based sectors such as European project (Ciarmatori et al. 2018), consulting and professional services (Kerzner, 2001; Adesi et al., 2015)

Therefore, the joint use of PM as a lens and the analytical frameworks provided by the IMP seems to represent a useful approach to investigate processes and key factors characterizing the management of complex projects such as, EU projects related to Industry 4.0, undertaken by SMEs.

1.2. European Projects and SMEs

The European Union (EU) with the aim of financially supporting SMEs wishing to develop product, process, or business model innovations (European Commission, 2016) to increase the competitiveness in the international markets has created within the Framework Programmes (FPs) ad-hoc financing schemes for SMEs (Aster, 2016).

Since 1984, FPs have been the main policy instrument of the European Union to support the implementation of innovation projects in SMEs, evolving towards increasing budgets, different models of participation and broader research priorities during the 8 editions (Barajas et al., 2008).

In fact, during the 8th FP, called Horizon 2020 (H2020), the European Union introduced a break with the past (Young 2015) by making important changes in the distribution mechanisms of the FP moving from the coverage of the entire innovation cycle to funding innovations closer to the market and addressing significant societal challenges.

This shift has been motivated by political and economic conditions hampered by the latest economic crisis (see European Commission 2017) and has had a twofold impact on patterns of participation in H2020 (Ukrainski et al, 2018). On the one hand, European national governments have made participation in EU research funding schemes a central point in their R&D policy agendas. On the other hand, the submission of applications by private actors grew by more than 130% between FP7 and H2020 (European Commission 2017).

Thus, the program had to be simplified since Horizon 2020 was a Competitiveness and Innovation Framework Program (CIP) that supports the innovation activities of SMEs in the EU (Kim and Yoo, 2019).

European SMEs play a crucial role in generating knowledge and innovation (Moller, Partanene, Rajala, & Westerlund, 2007). However due to both the characteristics that affect the quantity and quality of its resources compared to larger companies (Arbussa, Bikfalvi, & Marquès, 2017) the development of innovation represents a challenge (Ciarmatori et al., 2018).

In fact, as well as *"Program activities take often the form of projects, which comprise tasks and goals in multiyear plans involving companies, institutions and other organizations based in a*

variety of countries" (Ciarmatori et al., 2018: 1) also the firms' innovation activity with the support of public intervention usually takes the form of projects (Arranz and Fdez de Arroyabe, 2009).

European funded projects represent complex projects usually undertaken in partnership and constrained by the call for tender (Project Management Institute Italy Chapters, 2019). This is particularly true in the case of SMEs undertaking innovation projects (Ciarmatori et al., 2018). In fact, in Narula (2004) has been highlighted the increasingly involvement of SMEs in R&D agreements and alliances.

However, current literature dealing with the topic European Projects and SMEs is focused on economic and technological benefits of participation of SMEs in EU-funded activities (Radicic and Pugh, 2017; Ciarmatori et al., 2018) aiming to examine the impact and effectiveness of public policy measures on innovation of SMEs as policy interventions need to be sensitive to the differences between SMEs, rather than adopting a one-size-fits-all approach (Juergensen et al., 2020).

Existing contributions on the impact of European R&D policies on firms' innovation behavior is articulated around concepts such as input additionality and crowding out effects of subsided R&D (Radicic and Pugh, 2017), as in Czarnitzki and Delanote (2015) which analyzed the effect of subsidies on both R&D input and R&D output is compared between different types of SMEs or in Barajas et al. (2012, 2016) that analyze whether R&D consortia supported by the SME-specific measures under the FPs have a positive impact on SME economic performance and, in Čučković and Vučković (2018) examine the impact that integrated financial support programmes and instruments under Horizon 2020 have on promoting research and innovation in the SME sector.

Despite the increasing interests on European Projects and SMEs existing managerial literature is limited only to few reports and practitioner-oriented studies such as European Commission (2004) and Arsić et al. (2015) aimed to disentangle the numerous technical details regarding the project proposal neglecting that due to their complexity they are undertaken in partnership and thus are exposed to the effects of interaction with external organization (Baraldi and Ingemansson Havenvid, 2013).

Therefore, although there is increasing evidence on the participation of SMEs in innovation projects within FPs (Vossen, 1998) less is known about the methodologies and practices they employ to manage them (Ciarmatori et al., 2018).

1.3. Industry 4.0 and SMEs

Industry 4.0 (I4.0), also called the fourth industrial revolution (Ciffolilli & Muscio, 2018; Gudanowska, 2017) is a double-faced concept coined in Germany in 2011 (Kagermann et al., 2011) indicating from one side, the *"comprehensive transformation of the whole sphere of industrial production through the merging of digital technology and the Internet with conventional industry"* (Merkel, 2014). From the other identifies a government's economic policy strategy for reinforcing the competitiveness of German and, more in general European, manufacturing industry (Santos et al., 2017; Piccarozzi et al., 2018).

Although there is no unique definition of I4.0, the term has been widely used both in the field of engineering and economics and management domains to define the radically changes in which both several emerging technologies are converging to provide digital solutions (Frank et al., 2019) and firms are structured and managed.

Moreover, the recent and current debate – in academia and industrial society - about innovation in industrial sectors is shaped by the diffusion of Industry 4.0 model of organization of production processes, as it is shaped by innovative and pervasive advanced digital technologies in a variety of technological fields (Roblek et al., 2016; Oztemel and Gursev, 2020; Larrea and Estensoro, 2021) but as well as *"academic research focuses on understanding and defining the concept and trying to develop related systems, business models and respective methodologies, the industry, focuses its attention on the change of industrial machine suits and intelligent products as well as potential customers on this progress"* (Oztemel and Gursev, 2020: 127).

Thus, I4.0 represents with this respect both a great technological and organizational challenge for firms, especially SMEs (Moeuf et al., 2020; Müller et al., 2018) since they are affected by limited resources in terms of skills, funding (Matt et al., 2018; Müller and Däschle, 2018) and knowledge (Radas and Bozic, 2012; Marcelino Sadaba et al. 2014; Arbussa, Bikfalvi & Marquès, 2017) that are essential to transform inventions into products/solutions or processes (Salerno et al., 2015) and, a key area for investment by the European Union and various governments in Europe (Smit, 2016), as they have promoted many policy measures to provide financial support and set up knowledge transfer mechanisms to the benefit of SMEs operating in both traditional and high-tech sectors (Muscio and Ciffolilli, 2020).

Several studies have been conducted trying to explore the managerial side of the phenomenon (Piccarozzi et al., 2018; Schneider, 2018; Mariani and Borghi, 2019), highlighting the close link between management and engineering and thus, the interdisciplinary nature of the phenomenon.

These studies from one side, focusing on internal changes investigating the implications of adoption of I4.0 technologies on operations (Frank et al., 2019), production methods and the creation and/or adaptation of business models (Müller and Däschle, 2018). From the other, are devoted to exploring the existence of firm's awareness in the implementation of appropriate strategies for the application of I4.0 related technologies. By considering in both cases the introduction and management of I4.0 related technologies by SMEs both, as a potential opportunity to be seized and, as a threat due to the difficulties that SMEs might face in implementing them, with results lower than expected.

However, as well as literature shows a growing attention on the internal change and thus, the "user" side of I4.0, according with Mariani and Borghi (2019), another related stream of research regarding the service domain is still in its infancy state. In fact, service and solution providers within the I4.0 paradigm represent companies that offer *"complete solutions in which products and services are integrated"* (Müller and Däschle, 2018: 263), i.e., the offering side.

Few existing studies have attempted to understand the role of new subjects, as supporting actors (Vuksanovic Herceg et al., 2020), able to provide a contribution in terms of I4.0 knowledge dissemination and transfer in the process of digital transformation. In fact, seems that I4.0 due to its complexity it couldn't be managed by a single firm (Brunswicker and van de Vrande, 2014), but relevant knowledge is distributed among various public organizations such as local institutions, universities, formal clusters and innovation agencies and knowledge providers and/or brokers (Hervas-Oliver et al., 2019; Götz and Jankowska, 2017; Pagano et al., 2021).

However, while Onar et al. (2017) investigated the characteristics of knowledge and skills provided by Engineering departments of Universities regarding I4.0 and, Müller and Hopf (2017) analyzed the support provided by competence centers to SMEs in the transfer of knowledge from research into practical usage, less attention has been paid to I4.0 business partners such as IT and consulting firms. In the case of I4.0, the ability of consulting firms to provide adequate consulting services should not be taken for granted; on the contrary, it could be argued that consulting firms-especially small-to-medium sized ones-may face a difficult challenge when undertaking I4.0 projects since they require to meet several requirements, in terms of data analytics, organizational structures, and integration, communication, and cooperation between business processes (Brousell et al., 2014; Macaulay et al., 2015).

Furthermore, despite the increasing interests in I4.0 related projects by SMEs (Moeuf et al., 2020), the role of PM, as critical success factor (Subramanian et al., 2020; Moeuf et al., 2020; Marnewick and Marnewick, 2020), in their development has been underweighted. In fact, according to Lopez-Robles et al. (2020) existing literature on PM and I4.0 is focused on technical aspects

suffering a lack in provide a more in-depth examination of the use of PM methods and techniques in I4.0 related project (Marnewick and Marnewick, 2019). although they represent one of the key factors for the success of I4.0 related projects.

Thus, since the implementation of I4.0 related projects represents a very broad and complex process that crosses organizational boundaries (Shroeder et al. 2019), requiring the mobilization and combination of resources possessed by various actors, in the present dissertation it is considered that adopting a business network perspective, such as the Industrial Network approach, allows to analyze and understand a phenomenon across three closely interconnected levels of analysis (Håkansson and Snehota, 1995): the firm level, the relational level, and the network level. This is particularly true in settings such as I4.0 which requires highly complex knowledge and, thus the engagement of actors in time-limited projects, partnerships or programs, involving external partners and external sources launching the project. In fact, external resources and partners are key within innovation processes and can be accessed through inter-organizational relationships not only with other firms but also with research centers, universities, consulting agencies (Lind et al., 2012).

1.4. The Industrial Network Approach

The Industrial Marketing and Purchasing (IMP) approach also known as the Industrial Network Approach (INA) (Håkansson, 1982; Håkansson and Snehota, 1995; Håkansson et al., 2009) was born as a critique of the microeconomic thinking providing an atomistic view of the business landscape with emphasis on costs and production functions.

IMP group focusing on the notion that an organization depends on other organizations to develops its business due to the impossibility to possess all the necessary resources within the boundaries of a single firm, theorize how the 'incompleteness' of individual organizations leads to the creation of an inter-organizational business network (Håkansson and Snehota, 1995) in which actors are active in interaction with counterparts.

To support this novel understanding of the business landscape, the IMP Group started in 1976 its first research project (Håkansson and Snehota, 2017) based on empirical observations of the interactional processes that occur between companies of different European Countries (Turnbull, Ford and Cunningham, 1996) in international marketing and Purchasing of Industrial goods. The results, by emphasizing the role of the relationship developed over time between the parties involved in a purchasing process, reject the idea of an atomistic market structure and thus reject the basic assumptions of mainstream economic thinking.

These results, in fact, within the second research project undertaken by the IMP Group in the mid-1980s, shifted the focus from dyadic relations to networks (Håkansson and Snehota, 1995) and then, from a theoretical point of view, flowed into the elaboration of the concept of business network defined as *"a set of two or more connected business relationships, in which each exchange relation is between business firms that are conceptualized as collective actors"* (Anderson et al., 1994: 2) or a complex network of actors, working together to accomplish certain objectives (Ford et al., 2003).

It is central to IMP's thinking the idea of interaction as a *"essential analytical concept at the heart of the relationship and network perspective of business markets"* (Medlin, 2004: 185). In fact, according to the IMP approach the inter-organizational relationships are built *on "mutually oriented interaction between two reciprocally committed parties"* (Håkansson and Snehota, 1995: 25).

Thus, with the aim of turn visible *"Adaptations, mutual orientations, as well as interdependencies"* (Kronlid and Baraldi, 2020: 1039), Håkansson and Snehota (1995) developed the Actor-Resources-Activities (ARA) framework (Håkansson and Snehota, 1995; Håkansson et al., 2009) summarized in figure 2.

ARA representing the most relevant IMP framework for investigating inter-organizational business relationships and their consequences, helps to analyze inter-organizational network of actors with interconnected activities and resources (Håkansson & Snehota, 1995) with the aim of turning visible characteristics of business relationships as adaptations, mutual orientations, and interdependencies between two reciprocally committed parties over time and across three interacting

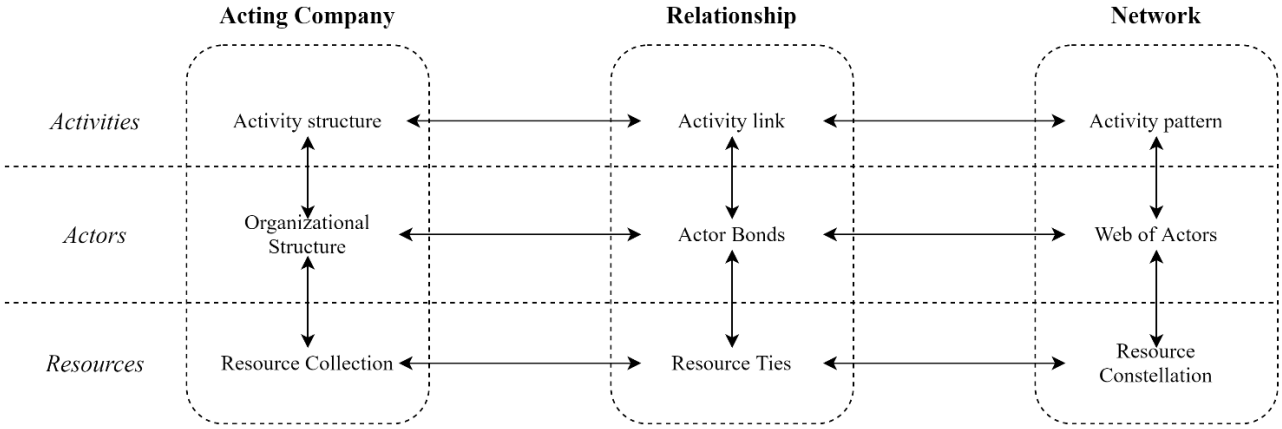

Figure 2. ARA Framework as represented in Hakansson and Snehota (1995)

layers of activity link, resource ties and actor's bond (La Rocca et al.,2017). The first level (Actor bonds) relates to inter-organizational ties characterized by economic, technological, and social aspects within the network and developed through episodes of interaction aimed at developing common problem-solving processes despite differences in interests and objectives. The second layer (Resource ties) The second layer relates to the extent different tangible and intangibles elements

(resources) of the two actors can be tied together through interaction episodes. Resources sustain activities and are heterogeneous by their very nature. The third layer (Activity links) regard technical, administrative, commercial and other activities of a company that can be connected in different ways to those of another company as a relationship develops.

The ARA framework has been adopted within the Chapter IV of the present study with the aim of analyze inter-organizational interactions focusing on actors' bonds, resources ties and activity link (Håkansson & Snehota, 1995), structured along different temporal stages in order to highlight the key steps and the evolution of the relationship among SMEs and the small consulting firms within I4.0 related EU projects.

Recent IMP studies investigating the phenomenon of inter-organizational interaction within innovation processes (La Rocca and Snehota, 2014; Lind, 2015; Gadde and Lind, 2016) highlight that one of the most relevant forces underlying these processes are represented by the *"the heaviness of related resources, their spatial characteristics and their journey"* (Håkansson and Waluszewski, 2018: 259). In fact, several scholars *"have embraced the idea that the development of new solutions occurs by recombining resource elements existing in the network of the innovating business"* (La Rocca and Snehota, 2014: 442).

Thus, comprehension of how resources are combined and re-combined represents a central issue, as highlighted in Pardo (2012), since *"the potential of a resource to generate economic value depends on how it can be integrated with other resources"* (Cantu, Corsaro & Snehota, 2012: 140).

Moreover, as argued in Baraldi et al. (2012), in the IMP view "resources are not given" but depend on the other resources with which they are combined (Håkansson & Waluszewski, 2002; Håkansson & Snehota, 1995). Thus, the development of resources into combinations occurs interactively in business relationships, and it requires co-specialization and learning over time (Håkansson & Snehota, 1995).

In IMP related studies the mobilization and combination of resources through interaction is investigated by a model developed by within the Resource Interaction Approach (RIA) named 4R (figure 3) (Hakansson and Waluszewski, 2002).

The rationale underlying the 4R model is to be found in the seminal works of Penrose (1959) and Alchain and Demsetz (1972) where the notion of resource heterogeneity and co-production is foregrounded. The 4R model in its original formulation (Håkansson and Waluszewski, 2002) classifies resources into physical (products and facilities), having material properties, and organizational/social resources (business units and business relationships), characterized by social features and displaying intangible characteristics (Håkansson and Waluszewski, 2002).

Facilities (PF) concern interdependent technical resources and equipment (plants, logistics, infrastructures, information systems) used to create products (P). Business units (BU) include individuals, internal units or firms and represent key resources encompassing various intangible elements, such as procedures, skills, experience, knowledge and reputation. Business relationships (BR), represent the ties and links created by actors in interaction and mobilized by organizational unit resources (Baraldi et al., 2012).

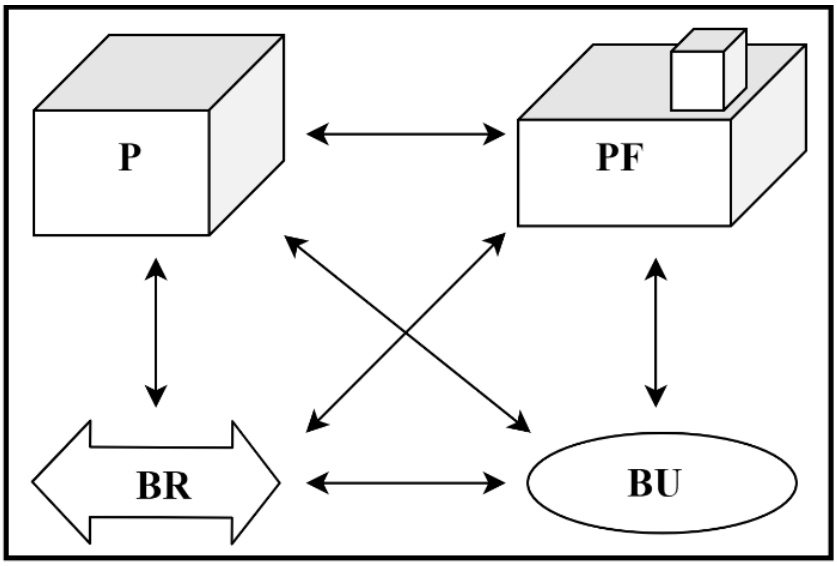

Figure 3. 4R model, interaction between the four basic resource types. Source: Author's elaboration on Baraldi and Bocconcelli (2001) and Baraldi et al. (2012)

In the present work the 4R model has been used in Chapter III as suitable framework to analyze innovation processes (Baraldi and Ingemansson Havenvid, 2013; Baraldi et al., 2012) undertaken through involvement in inter-organizational projects.

Inter-organizational projects representing a time constrained context in which the dynamic combination and interaction of resources happens (Baraldi, 2008; Lind et al., 2012), are characterized by the presence of actors with different goals that need to match to engage in effective resource combining (Corsaro and Cantù, 2015). This is particularly true in settings such as I4.0 which requires highly complex knowledge and, thus the engagement of actors in time-limited projects, partnerships or programs, involving external partners and external sources launching the project. In fact, external resources and partners are key within innovation processes and can be accessed through inter-organizational relationships not only with other firms but also with research centers, universities, consulting agencies (Lind et al., 2012).

IMP related studies defining projects as *"temporary resource constellation and activity pattern in which the actors form a distinct logic in how to learn and develop new solutions in relation to each other"* (Baraldi and Ingemansson Havenvid et al., 2016: 86), conceptualizes them mainly at the light of the interaction processes that occur both within and across their boundaries with the aim of combining resources (Baraldi, 2008).

As a consequence, the IMP perspective recognizes each existing project as part of an inter-organizational network that influences and is influenced by the individual project (Baraldi and Ingemansson Havenvid, 2013; Ingemansson Havenvid et al., 2019), highlighting in this sense the role of the historical "inter-organizational embeddedness" of the project. Thus, whatever two interacting parties can achieve in a specific project is largely determined by their previous interaction, the efforts they have undertaken together, and the learning they have experienced (Gadde and Lind, 2016). In this sense, the innovation process, in the form of projects, not only influences, but is itself influenced, by a series of direct and indirect interfaces between social and material resources established in a context of use, production, and development (Håkansson and Waluszewski, 2002; Eklinder-Frick et al., 2018).

Moreover, within the IMP approach, time represent a central concept (Kronlid and Baraldi, 2020) due that long-term relationship emerges from continuous interaction in time. The ARA model although summarizes the importance of long-term relationships and their effect on business development (Håkansson, 1982; Håkansson and Snehota, 1995), has been used in recent works to analyze inter-organizational interactions within time constrained relationship. Such as projects involving industry and public actors such as the case of ENABLE (Kronlid and Baraldi, 2020) and within the construction Industry to investigate both the relationship continuity across projects among actors (Ingemansson Havenvid et al., 2017) and the development and implementation of a particular innovation within certain industry (Davies et al.,2015).

2. Methodological Notes

The following section presents the methodology used for this study, outlining the rationale underlying and the steps followed in the research project's development.

By drawing on the concepts developed in Industrial Network Approach, this research aims at providing an examination of the path undertaken by a small consulting firm to becoming a key player and a trusted partner in European projects related to Industry 4.0. Notably, the empirical part analyzes the case of European projects related to Industry 4.0 domain managed by Sinergia.

As aforementioned, the theoretical and methodological point of departure of this study is the frameworks developed within IMP network approach as 4R (Håkansson and Waluszewski, 2002) and ARA (Håkansson and Snehota, 1995) as analytical tools.

The use of these two analytical frameworks can help from one side to deal with the complexity underlying the resource development processes (Baraldi et al., 2012; Bocconcelli et al., 2020), offering a useful perspective in understanding the combining process of different knowledge-related and technological resources and in assessing complementary changes in the organizational setting supporting the innovation process. From the other to analyze inter-organizational interactions focusing on actors' bonds, resources ties and activity link (Håkansson & Snehota, 1995), structured along different temporal stages in order to highlight the key steps and the evolution of time constrained relationship among two partners, as already adopted in other IMP studies (e.g., Kronlid and Baraldi, 2020).

Given the explorative nature of the research project, this study used a qualitative methodology based on longitudinal case study analysis, following an abductive approach for coding information and elaborating results (Yin, 1994; Dubois and Gadde, 2002). The qualitative research approach has been chosen to gain an in-depth understanding of the chosen phenomenon within real-life context in absence of clearly defined boundaries between the phenomenon, object of the empirical inquiry, and its context (Yin, 1994).

Moreover, the case study method is deemed suitable to catch both the complexity related to the process of development of the focal company while trying to evolve within a fast changing and challenging scenario (Halinen and Törnroos, 2005) as the one represented by I4.0 technologies, relationships among all actors involved (Dubois and Gadde, 2002) and, in uncovering the main interaction processes within projects.

Data, supporting the development of this study, has been collected through three main sources: participant observation; semi-structured interviews; archival documents such as report, and draft of the project proposals as outlined in table I.

As mentioned above, data collection is primarily based on participant observations. Two years and four months were spent within Sinergia by the author, of which one year as part of activities of the Ph.D. Programme and one year and four months as a part of the DeepReality project team. The use of this data gathering method has allowed to observe part of the process as well as it has happened (Hoholm and Olsen, 2012). Moreover, participant observation has always been possible to contact informants to complement information, as well as to ask for clarification on gathered data. In this sense, various conversations and e-mail exchanges have been carried out to address specific relevant themes and updates. Participating observations amount to 1520 hours in the timeframe April 2019 -

August 2021, including project coordination tools and activities (Kronlid and Baraldi, 2020) such as meetings and discussions.

The second source of data used is semi-structured interviews (Kvale and Brinkmann, 2009). This typology of inquiry has been widely used in the IMP tradition to understand the complexity of relationships, and it has been described as *"the most effective means of gathering data"* (Lindgreen et al., 2020: 2). To guide the direction of the discussed topics, similar questions were raised to all respondents, even though adapted for each specific role in order to understand the background of the various projects and their dynamics over time. Key figures – CEO and consultants in Sinergia, external partners and SMEs involved in specific I4.0 projects - have been identified as informants for the interviews conducted in the timeframe April 2019 – November 2021. The number of semi-structured interviews is 12. Every interview had an average duration of 1 hour and all of them have been recorded and transcribed verbatim.

Over the period, additional data in form of reports and drafts of the project proposals have been collected with regard to the activities conducted within the projects. Those data are however not public due the non-disclosure agreement signed between the parties.

Activities	**Period**
1. Participant Observation	
Internship	April 2019 – September 2019 September 2020 – March 2021
Project management activities within XR4ALL project	March 2021 - August 2021

2. In-depth Interviews

Respondents	**Company/Institution**	**Nr. of interviews/ year**
Founder and Senior partner	Sinergia Consulenze	3/ 2019 and 2021
Senior consultant	Sinergia Consulenze	4/ 2019, 2020, 2021
Professor of Computer Science (PUM) - Supervisor of Industrial PhD student in Artificial Intelligence	Polytechnic University of Marche	1/ 2020
Sales Manager	Alfa	2/ 2019
R&D Engineer and PostDoc Researcher in Bioengineering	Beta	1/ 2021
Tourist Consultant	Epsilon	1/ 2021

3. Archival Document

ID	Company/Institution	Type of Document
Project 1	Alfa	Drafts of the Project proposal
	Sinergia Consulenze	EU evaluation Report
Project 2	Beta	Drafts of the project proposal
	Sinergia Consulenze	EU evaluation Report
Project 3	Epsilon	Drafts of the project proposal
	Sinergia Consulenze	EU evaluation Report
XR4ALL Project	Sinergia Consulenze	Drafts of the Project Proposal
		Evaluation report
	PUM	Grant Agreement
	Ubisive	Technical Deliverables
		Business concept Deliverable
Document 1	Sinergia Consulenze	Company Website
Document 2	XR4ALL	Consortium Website
Document 3	Fondazione Cluster Marche	Association Website
Document 4	Osservatorio Open Innovation and Corporate Venture capital	Report

Table I. Data Collection Process

By considering data analysis, the interviews have been transcribed verbatim and reviewed with the aim of identifying significant sections and finally reconstructing the overall context. The recorded interviews and the secondary data gathered have been triangulated with the aim of examine the consistency of the different data sources. In fact, the use of triangulation supports the qualitative research strategy testing validity through the convergence of information from different sources (Patton, 1999).

Thus, the frameworks provided by the IMP approach are chosen in order to analyze data. Notably the 4R model is adopted in chapter 3 with a processual perspective in order to identify resource development and combination process, while the ARA model is adopted in chapter IV to analyze inter-organizational interactions at actor's, resources, and activities levels along different temporal stages of the projects, with the aim of highlighting the interactive dynamics and the development of the relationship between the different partners. Both the models have been adapted according to the aims of the present work. Table II summarizes the methodology adopted and data material used.

Chapter	II	III	IV
Type of study	Systematic literature review	Single Case study	Multiple case study
Unit of analysis	Documents indexed in Scopus and WoS DBs	Firm	International EU Project related to I4.0
Data material	170 selected articles	7 semi-structured interviews Archivial document	5 semi- structured interviews Official documentations of the projects

Table II. Overview of the methodology and data material

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CHAPTER II

Project Management and SMEs: a review of the literature and framework for future research[1]

Abstract

This paper aims to develops a holistic perspective on research stream Project Management (PM) and Small and Medium sized enterprises (SMEs) by re-examining the PM research agenda extending the scope to the category of enterprise where PM knowledge and practices are used, therefore across industries, countries, and areas of application. For these purposes, the present paper analyzes the content of the past 30 years of PM research published in the scientific journals and proceedings of conference in all the different Web of Science and Scopus subject areas using both quantitative and qualitative methodology to map the knowledge base, the conceptual structure, and the main themes of the research stream.

Keywords: SMEs, Project Management, Systematic literature review, bibliometric analysis, Science mapping

1. Introduction

Project management (PM) and SMEs represents, in the recent years, an emerging stream of research within the field of Project Management (e.g., Meister, 2006; Murphy and Ledwith, 2007; Turner et al., 2009; 2010; 2012) due that, from one side PM is a well-established approach in the definition of tools and techniques required to plan and implement projects (Turner et al., 2009), from the other by the importance of SMEs as economic actor (Bocconcelli and Pagano, 2015). As highlighted by European Commission (2020) SMEs account for 99.8% of all firms in the EU-28 non-financial business sector, contributing both to the execution of larger projects and more commonly to smaller projects (Pollack and Adler, 2016) while constrained by the scarcity of resources available, which leads them to leverage relationships with a variety of external actors (Ciarmatori et al., 2018).

[1] Please note that this chapter largely presents extract from the following Conference Paper: Mersico L. (2021, August 26-27). *Project Management and SMEs: A Review of the literature and a framework for future research.* 37th Annual IMP Conference 2021, Cork, Ireland.

However, as the PM was initially developed for large companies operating in the engineering, defence, aerospace, and shipbuilding sectors (Morris, 1994), the main research focused on project management issues within large companies (Turner et al., 2009; 2010) targeted to specific industries or areas of application (Betts and Lansley, 1995; Themistocleous and Wearne,2000; Pollack and Adler, 2015).

Moreover, as highlighted in Padalkar and Gopinath (2016), although the interest of research in PM in recent years has led both to a steady growth in the number of articles published and to a greater variety in terms of enquiries, domains, and methods, issues relating to the relationship between PM and SMEs remain open.

In fact, as suggest in Turner et al. (2009) and De Almeida Parizotto et.al. (2020) little has been published about the PM and SMEs although the Project Management Institute is interested in SME-focused studies with the aim of tailor the PM body of knowledge/practices to the needs of SMEs, which, by their very nature, have different characteristics from larger organisations in terms of processes, procedures, structure and people, as illustrated in Ghobadian and Gallear (1997).

Thus, with the aim of developing an integrated view on PM and SMEs research, this paper aims to re-examines the research agenda (Padalkar and Gopinath, 2016) by extending the scope to the category of enterprise where PM knowledge and practices are used, therefore across industries, countries, and areas of application (Crawford et al., 2006; Pollack and Adler, 2015).

In fact, since the stream of research is still in its infancy and thus presents a high level of fragmentation (Turner et al., 2011), the contribution of this paper is to detect and analyze within the existing literature on Project Management contributions that deal with the topic PM and SMEs. The aim is delimiting the research area, providing insights about the main themes covered, and thus identificate the future direction of the research area as already attempted in De Almeida Parizotto et al. (2020). Notably, the present paper tries to answer the following research questions:

RQ1: What is the knowledge base of the Project Management and SMEs research stream?

RQ2: What are the main and emerging themes?

Therefore, this paper will be of particular interest to both researchers and practitioners interested in understanding how research in the field of Project Management and SMEs is evolving.

Notably, to pursue the research objectives this paper adopts bibliometrics and science mapping techniques in order to overcome limitations tied to employing a priori classification (Pollack and Adler, 2015) of Project Management publications used in other literature review studies such as

Betts and Lansley (1995), Themistocleous and Wearne (2000), Zobel and Wearne (2000), Crawford et al. (2006).

To this end, the paper is articulated as follows. The research methodology is described in section 2, while section 3 deals with the identification of the relevant paper. Thus, in section 4 results of co-citation analysis will be provided and section 5 presents the main theme identified. Finally, section 6 provides a summary of the main future line of research identified.

2. Research methodology and data

In order to answer to the RQs the present paper adopts a variant of the Systematic Literature Network Analysis (SLNA) (figure 4) methodology (Colicchia and Strozzi, 2012). This methodology, combining the Systematic literature review with the co-citation network analysis and content analysis is articulated in three stages:

- Data collection and pre-processing, aimed to build the bibliographic data frame (document*attribute matrix).
- Identification and selection of relevant paper trough the adoption of an evidence-based approach approach having characteristics of transparency, inclusivity, explanatory and heuristic by nature, (Denyer and Tranfield, 2009) articulated around a 3 step sub-process namely, a) evaluation of abstract, b) descriptive analysis, c) citation analysis.
- Investigation of the "*knowledge creation, transfer and development"* (Colicchia and Strozzi, 2012) through the implementation of a 2 steps sub-process based on co-citation analysis and content analysis.

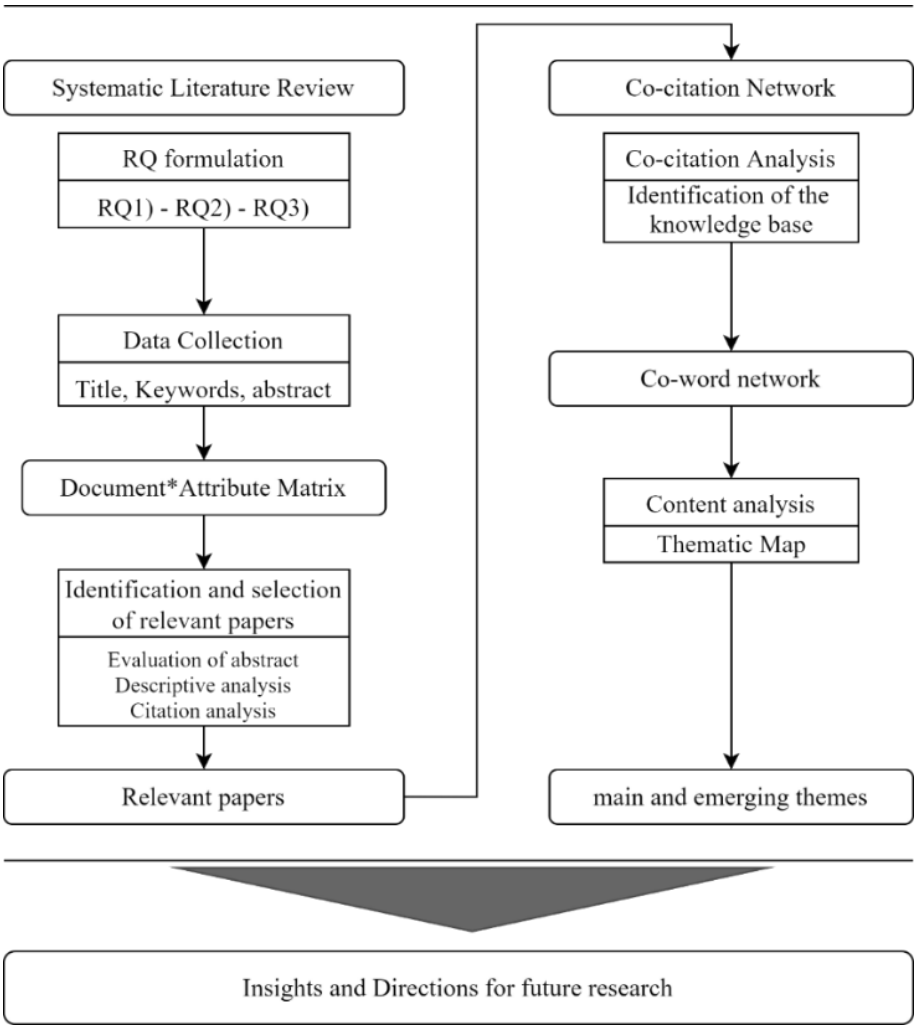

Figure 4 Research Methodology. Source: Author's elaboration on Colicchia and Strozzi (2012)

Co-citation analysis (figure 5), employing co-citations counts as a measure of similarity between documents represents a valid tool for exploring the knowledge base and the intellectual structure of a scientific field i.e., the set of articles most cited by the current research and its disciplinary composition and the pattern of their interrelationships (Shafique, 2013) as well as demonstrated in numerous studies (White and Griffith, 1981) and it is increasingly being used in all disciplines, including in the management field (Zupic and Cater, 2015; Marsilio et al., 2011; Ramos-Rodriguez and Ruiz-Navarro, 2004).

The Two documents cited together therefore are assumed to be conceptually close (Small, 1973; Trujillo and Long, 2018). As citations accumulate over time, this method identifies classical works that are frequently, and often ceremonially rather than substantively, cited together. This makes co-citation analysis particularly suitable for the detection of high-impact publications that represent the intellectual history and origins of a particular research field (Trujillo and Long, 2018).

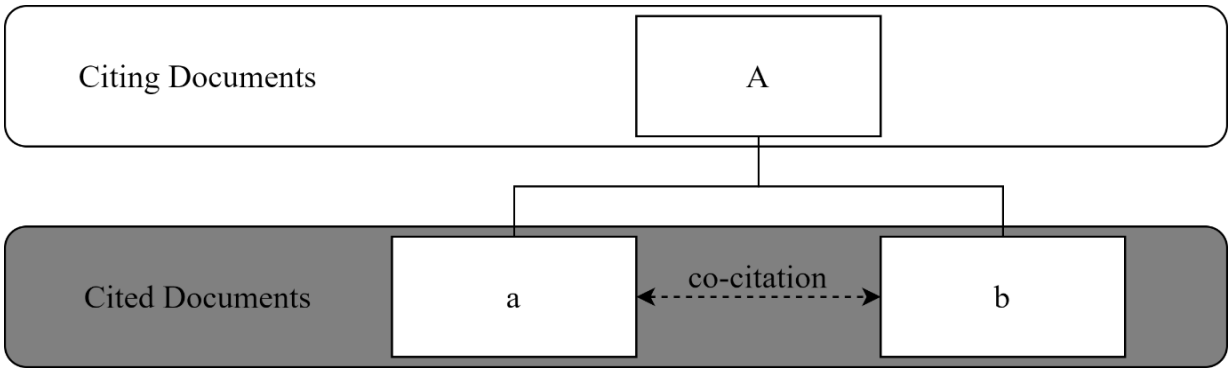

Figure 5 Co-citation analysis. Source: Author's elaboration on Vogel and Guttel (2013)

Moreover, in the clustering derived from this analysis, the network nodes represent cited documents, whose size depends on the number of citations. The edges represent the co-citation relationship, and their weights depend on the number of times that two documents have been cited jointly (Small, 1973; Aria and Cuccurullo, 2017).

Content analysis, employing co-word analysis to identifies the major research themes detecting keyword co-occurrence using the methodology developed by Callon et al. (1991) and visualizing particular themes or general thematic areas (Callon et al.,1991; Cobo et al., 2011) through the use of a thematic map built upon the keyword co-occurrence clusters to highlight the conceptual structure of PM and SMEs.

Groups of frequently co-occurring keywords are identified by the use of the equivalence index (Callon et al., 1991; van Eck and Waltman, 2009).

Thus, the detected clusters are plotted on a two-dimensional diagram called Strategical Diagram (Callon et al., 1991) (figure 6) in which the x-axis reflects the centrality of the themes namely, the strength of interaction of a specific theme with others, while the y-axis shows the internal cohesion of a specific theme (i.e., density). While the size of the cluster depends by the number of occurrences of the keywords it contains, and the label is chosen by the software correspond to the predominant keyword. By using this method, it is then possible to reveal the existence of:

- Motor themes in quadrant I (high centrality and density). They are both well developed and essential for the structuring of a research field, showing strong centrality (high degree of external interaction) and high density (high internal strength of the network).
- Basic themes in quadrant II (high centrality and low density), are important for a research field due to their high centrality. The characteristics of these clusters are transversal, general, and essential.

- Developed but isolated themes (Niche) in quadrant III (low centrality and high density), are internally well-developed, but lack external interaction with other themes, so they are very specialized and peripheral in character.
- Emerging themes in quadrant IV (low centrality and density), are both undeveloped and marginal because of their low centrality and density.

The rationale underlying the use of this methodology can be traced back, from one side to the impossibility to validate a priori the sample consistency as in the work of Vieira and Brito (2015) due the nonexistence of other exhaustive literature review on Project Management and SMEs. From the other to the need of delimitating the research field in both structural and conceptual ways (Cobo et al., 2011; Cuccurullo and Aria, 2017).

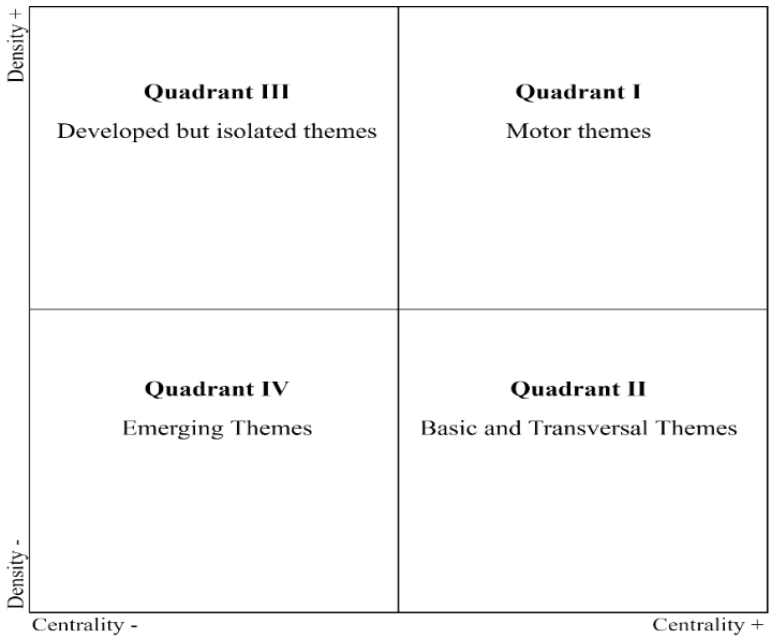

Figure 6. Strategic Diagram. Source: Author's elaboration on Callon et.al. (1991)

2.1. Data collection and pre-processing

Documents were retrieved from Scopus (2020) and ISI Web of Science Core Collection (2020) databases, since they have specific search engines and allows the extraction of metadata using the search query (De Almeida Parizotto et al., 2018): "Project Management" AND ("SME*" OR "small enterprise*" OR "medium enterprise*" OR "small and medium enterprise*" OR "small company" OR "medium company" OR "small and medium compan*" OR "small and medium sized enterprise*"), in the categories title, abstract and keyword.

Thus, the search is refined considering all the published documents in peer-reviewed journals, books and conference proceedings in English language indexed in all the subject areas, given the multidisciplinary of the PM research field, in the timespan 1990-2020. A summary of the results of these searches are showed in table III.

Database	Number of Records
Scopus	879
Web of Science	233
Duplicated Values	152
Total	960

Table III. Summary of the documents extracted.

The rationale underlying these choices can be summarized in three points: i) to considers documents published in the last 30 years, in fact, although the PM has existed as a discipline for 60 years, it is only in the last 20 years that there has been a growing interest in research in this field (Padalkar and Gopinath, 2016); ii) expand as much as possible the width of the research as in Pollack and Adler (2015); iii) data availability: the 1990 is the first year in which data from both the International Journal of Project Management and the Project Management Journal (Themistocleous and Wearne, 200), two of the leading journals in the field, are available.

Successively the results of research were loaded and converted into a bibliographic data frame (Table IV) with cases corresponding to documents and variables to tag as reported in Aria and Cuccurullo (2017). It represents a suitable format for the tool used for the analysis, namely R programming language and Bibliometrix package.

Lastly, authors keyword has been jointed to keywords Plus associated by WOS or Scopus and a normalization process has been carried out in order to merge the singular and plural forms (Cobo et al., 2011) and where possible merge the keywords to their respective acronyms (e.g., Small and Medium Enterprise to SMEs). Moreover, differently from Pollack and Adler (2015), for the aims of present work the phrase “Project Management” has not been removed from the keywords as it is useful to validate the sample.

Field Tag	Description
UT	Unique Article Identifier
AU	Authors
TI	Document Title
SO	Publication Name (or Source)
JI	ISO Source Abbreviation
DT	Document Type
DE	Authors' Keywords
ID	Keywords Plus
AB	Abstract
C1	Author Address
RP	Reprint Address
CR	Cited References
TC	Times Cited
CY	Yearly average number of citations
PY	Year
DB	Bibliographic Database

Table IV. Bibliographic dataframe

3. Identification and selection of relevant paper

The stage of identification and selection of relevant documents following the flowchart illustrated in figure 7.

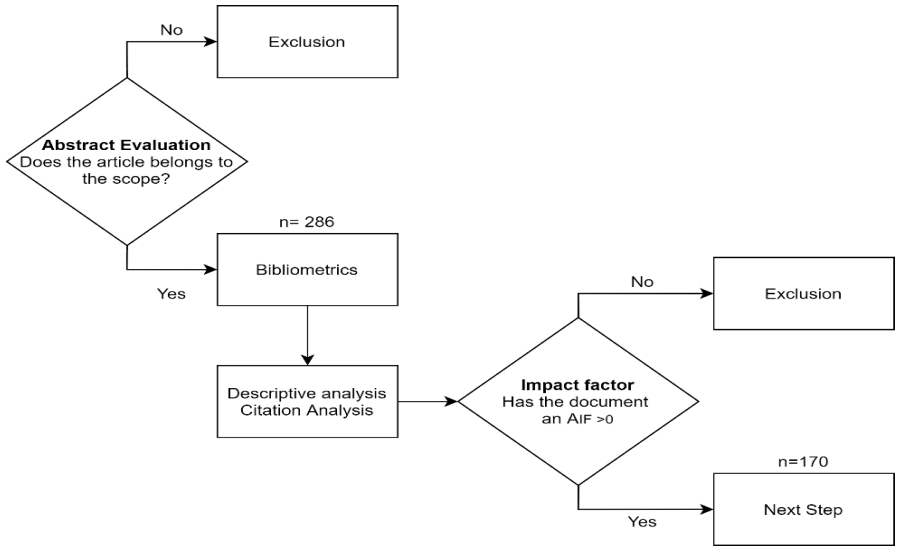

Figure 7. Flowchart illustrating the process of identification and selection of relevant paper.

3.1. Abstract evaluation

Abstracts of documents have been assessed separately, and those considered outside the scope of the research have been discarded. Thus, 674 documents have been excluded from the sample as they did not approach the topic Project Management and SMEs (table V).

Typology of Document	N. of records
Journal articles	129
Conference papers	157
Total	286

Table V. Number and typology of documents

3.2. Descriptive analysis

By according to Aria and Cuccurullo (2017) descriptive analysis has been conducted using documents as units of analysis with the aim of providing an overview on the research field. Table VI provides a summary of main sample information.

Description	Results
Documents	286
Sources	210
Period	1998 - 2020
Authors	742
Author Appearances	836
Single-authored documents	35
Collaboration Index	2.8

Table VI. Main sample information

The period considered in this bibliometric analysis begins in 1990. However, the first document identified in the sample was published in 1998 and although the publications present an annual growth rate of 11.03% it is only since 2003 that there has been an incremental increase in the number of papers with a peak in 2019 (Figure 8).

Authorship presents an elevated level of fragmentation with 742 authors who have contributed to 286 articles, of which 35 (12%) signed by a single author. Thus, multi authored contributions dominate the research field of PM and SMEs since 251 (88%) articles presents a collaboration index[2] of 2.8 (Elango and Rajendran, 2012).

[2] The Collaboration Index (CI) is calculated as Total Authors of Multi-Authored Articles/Total Multi-Authored Articles (Elango and Rajendran, 2012). In other word, the Collaboration Index is a Co-authors per Article index calculated only using the multi-authored article set (Aria and Cuccurullo, 2017).

Figure 8. Annual Scientific Production

The 286 documents in the dataset were published by 210 different sources (journals and proceedings of conference) in typical Project Management areas such as business management and accounting, computer science, engineering, decision science, with an average of 1.36 documents per source. However only ten journals have published more than 3 articles. In fact, the most productive journals represent approximately 20% of the total number of documents retrieved.

The top 2 journals are the International Journal of Project Management (IJPM) and Advances in intelligent system and computing. The former, represents one of leading world journal in Project Management (Themistocleous and Wearne, 2000) published by the International Project Management Association (IPMA) and admitted to the Social Science Citation Index only in 2009 (Turner et al., 2010). The latter contains publications on the theory, applications and design methods of intelligent systems and intelligent computing. The publications within "Advances in Intelligent Systems and Computing" are mainly proceedings of important conferences, symposia, and congresses on recent developments in areas such as engineering, natural sciences, computer science, ICT, economics, e-commerce, environment, health, life sciences (Springer, 2020). Proceedings of Association of Researchers in Construction Management (ARCOM) conferences is the third, while the fourth place is occupied by the International Journal of Managing Project in Business.

It is relevant to note the absence in the list of most productive journal of the Project Management Journal (PMJ). Table VII summarizes the most productive journals.

Source	N. of documents	Subject area
International Journal of Project Management	11	Business Management and Accounting
Advances in Intelligent Systems and Computing	7	Computer Science Engineering
Proceedings of Association of Researchers in Construction Management (Arcom) Conferences	7	Engineering
International Journal of Managing Projects in Business	6	Business management and Accounting
Proceedings of Americas Conference on Information Systems (AMCIS)	6	Engineerin
International Conference on Industrial Engineering and Engineering Management	4	Business management and Accounting Engineering
Proceedings of The International Conferences on Enterprise Information Systems ICEIS	4	Computer Science
Journal of modern project management	4	Business Management and Accounting
Production planning and control	4	Business Management and Accounting Decision Sciences
Procedia of computer science	4	Engineerin

Table VII. Most productive Journals. Source: Author's elaboration on Scopus and Web of Science data (2020)

3.3. Citation analysis

Table VIII lists the top 10 most cited articles in the examined area. Citations represent a measure of influence under the assumption that authors cite papers they consider important to their work (Zupic and Cater, 2015).

In our sample, the average number of global citations (TC), defined as the total citations that an article included in the sample has received from a document indexed on a bibliographic database, for each article, is 7.70 with a standard deviation of 20.73 and the median of 1. The top 10 % has an average number of global citations of 51.86 and the top 5 % has an average global citation of 73.8.

However, although citation analysis provides information about the relative influence of publications newer publications had less time to be cited, therefore citation count as a measure of influence is biased toward older publications (Zupic and Cater, 2015).

Thus, with aim of identify the most influential documents an impact index was constructed following the work of Carvalho et al. (2013) and De Almeida Parizotto (2020). The article impact

index (A_{IF}) was calculated according to equation (1) considering the number of citations per year (C_N) and the journal impact factor (JCR_{IF}) obtained from the Scimago Journal Citation Index.

$$A_{IF} = C_N \times (1 + JCR_{IF}) \quad (1)$$

170 articles that show values of $A_{IF} > 0$ are identified for the next step of analysis. Table IX lists 10 papers with the highest level of A_{IF}. It is relevant to note that, exists slightly differences between the 10 most cited articles and the top 10 high impactful articles identified.

Table VIII. Most cited articles

Authors	Year	Source	Title
Okamuro	2007	Research Policy	Determinants of Successful R&D Cooperation in Japanese Small Businesses the Impact of Organizational and Contractual Characteristics
Malhotra, Temponi	2010	International Journal of Information Management	Critical Decisions for ERP Integration Small Business Issues
Marcelino-Sadaba, Perez-Ezcurdia, Echeverria, Villanueva	2014	International Journal of Project Management	Project Risk Management Methodology for Small Firms
Huin	2004	International Journal of Project Management	Managing Deployment of ERP Systems in SMEs Using Multiagents
Federici	2009	Journal of Enterprise Information Management	Factors Influencing ERP Outcomes in Smes a Postintroduction Assessment
Turner, Ledwith, Kelly	2010	International Journal of Project Management	Project Management in Small to Medium sized Enterprises Matching Processes to the Nature of the Firm
Sexton, Barrett	2004	Engineering, Construction and Architectural Management	The Role of Technology Transfer in Innovation Within Small Construction Firms
Lawson, Longhurst, Ivey	2004	Technovation	The Application of a New Research and Development Project Selection Model in SMEs
Ahuja, Yang, Shankar	2009	Automation In Construction	Study of ICT Adoption for Building Project Management in the Indian Construction Industry

A_{IF}	Citation per year	Authors	Title
1446.4	10.7	Marcelino-Sadaba, Perez-Ezcurdia, Echeverria, Villanueva (2014)	project risk management methodology for small firms
1317.8	5.8	Okamuro (2007)	Determinants of successful r&d cooperation in japanese small businesses the impact of organizational and contractual characteristics
797.7	5.9	Turner, Ledwith and Kelly. (2010)	Project management in small to medium sized enterprises matching processes to the nature of the firm
793.1	5.8	Voss and Kock (2013)	Impact of relationship value on project portfolio success investigating the moderating effects of portfolio characteristics and external turbulence
690.9	6.9	Malhotra and Temponi (2010)	Critical decisions for erp integration small business issues
585	4.3	Tezel, koskela and Aziz (2018)	Current condition and future directions for lean construction in highways projects a small and medium sized enterprises smes perspective
571.7	4.2	Huin (2004)	Managing deployment of erp systems in smes using multiagents
477	4.4	Ahuja, Yang and Shankar (2009)	Study of ict adoption for building project management in the indian construction industry
447.3	3.6	Lawson, Longhurst and Ivey (2006)	The application of a new research and development project selection model in smes
432.5	2.5	Chien, Hu, Reimers and Lin (2007)	The influence of centrifugal and centripetal forces on ERP project success in small and medium sized enterprises in China and Taiwan

Table IX. Most impactful articles

4. Co-citation analysis: the knowledge base of PM and SMEs

Co-citation analysis (Figure 9) conducted on the bibliographic references of the 170 articles identified as relevant, was performed with a minimum degree of co-citation equal to 2 and a threshold of 230 network nodes. It shows originally the existence of 8 clusters (Table X) of which 2 containing seminal works of managerial and methodological literature that so are considered as outlier. Also, findings show as the network of documents presents several structural holes (Burt, 2000) except for clusters 3 (green) and 4 (purple) in which it's relevant to highlight the brokerage role of the articles of Turner et al. (2009). Moreover, Turner et al. (2009) shows the highest level of centrality and are also included in the list of most impactful documents.

Number /color	Cluster	Label Assigned
1 (red)	Eadie et al. (2013); The American Institute of Architects (2007)	PM methodology in Construction Industry
2 (blu)	Ghassemi (2011); Farmer (2016); Smyth (2010) Hardie, Newell (2011); Egan (1998); Porier (2015)	Building Engineering
3 (green)	Gledson (2017); Turner (2009); Turner (2010); Marcelino-Sadaba (2014); Beck (2005); Ayyagari (2007); Hudson (2001); Thomas (2008)	PM general practice and SMEs context
4 (Purple)	Prencipe2001; Scarbrough et al. (2004); Hobday (2000); Engwall 2003; Jörg Sydow et al. (2004); Grabher (2004); Cacciatori (2008); Brady and Davies (2004)	Project Environment
5 (pink)	Nah et al. (2001); Barker and Frolick (2003); Al-Mashari and Al-Mudimigh (2003); Hsu et al. (2006); Achanga et al. (2006); Finney and Corbett (2007); Remus (2007); Deep et al. (2008); Winkelmann and Leyh (2010)	Industrial Engineering
6 (brown)	Leopoulos et al. (200; Aloini et al. (2007)	Risk Management

Table X. Co-citations cluster

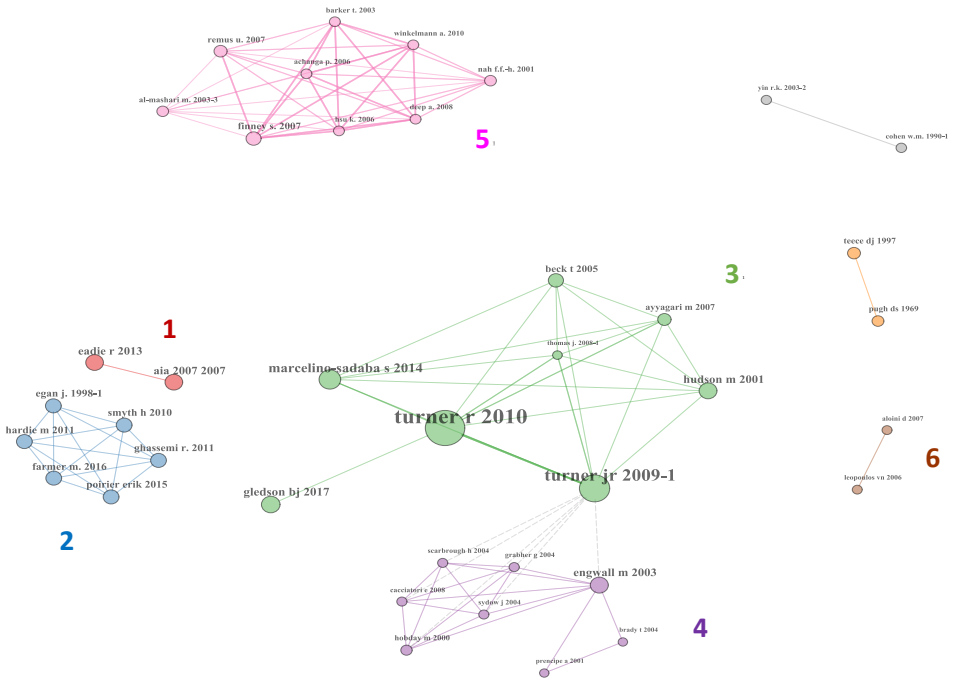

Figure 9. Co-Citation Network

Documents embedded within the first two cluster labeled "*PM methodology in Building Engineering"* and *"Building Engineering"* consider the rising interest in Building Information Modelling (BIM) namely, the process of generating, storing, managing, exchanging, and sharing building information in an interoperable and reusable way in conjunction with new PM framework

(Bryde et al., 2013) as the Integrated Project Delivery (IPD) (American Institute of Architects and AIA California Council, 2007). Thus, in Eadie (2013) is highlighted as the size of the organizations implementing BIM represents a significant factor.

The third cluster, *"Project Management general practices and SMEs context"* consists in documents articulated around two literatures: economics and project management related studies, showing in this way the existence of a crossover between the two disciplines.

Notably, the paper articulated around economics investigate the contribution of SMEs on the economic activity across countries (Ayyagari et al., 2007; Beck et al., 2005) and across specific sector (Hudson et al., 2001) while the high centrality of the contribute of Thomas and Mullay (2008), *"Researching the value of Project Management"*, confirm how the creation of value through projects, analyzed by the authors along 5 dimensions: satisfaction, alignment, process outcomes, business outcomes, and return on investment; shows substantial differences within different economic, people, cultural, project, organizational attribute, and strategic contexts requiring a bridge to the implementation (Thomas and Mullay, 2008).

With this respect, the works of Turner et al. (2009; 2010) represent seminal contributes aimed to understand the nature of PM practices required by SMEs.

The authors, starting from a series of empirical studies of a qualitative and quantitative nature, highlighted the extent to which SMEs undertake projects using PM methodology with an emphasis on both the nature of the projects they do and the categorization of SMEs. They have found in this regard how *"Smaller and younger firms will be less likely to employ dedicated project managers, and less likely to adopt identifiable project management practices"* (Turner, 2010) arguing that firms adopt PM practices that fit the type of projects they do and theorizing the need of lite versions of PM methodologies.

Thus, Marcelino Sadaba et al. (2014) completes the framework by building a proposal based on risk management, tailor made for the SMEs that considers the factors that are usually neglected by SMEs, i.e., project alignment with the company's strategy and results management.

The fourth cluster labeled *"Project Environment*" includes some contributions articulated within organizational studies but not focused on SMEs. These studies, mainly focused on the project-based firm and multi-project management, conceptualize projects as open systems embedded within an organizational and historical context (Engwall, 2003) called "project environment".

They discuss the ability of the project-based firm of both capitalize knowledge gained during the execution of a project and the ability to transfer it to other projects or parts of the organization (Prencipe and Tell, 2001) investigating how organizations can learn from projects, focusing on the

relationship between projects and their organizational context (Scarbrough et. al, 2004, Brady and Davies, 2004).

In this regard, Grabhner (2002) starting from the assumption that the essential processes of knowledge creation and sedimentation occur at the interface between projects and organizations, communities and networks in which and through projects are undertaken, has attempted to develop a framework built around the notion of project ecology in order to analyze the learning processes based on the project, by disarticulating its constituent layers namely: the core team, the firm, the epistemic community, and personal networks. In Grabhner (2004) this architecture is then employed as a theoretical model to explore the learning process in two ecologies with different logics.

Numerous empirical studies, in fact, investigate the importance of systems integration, software, and project management as fundamental capabilities in the production of complex products and systems (Hobday, 2000) or the use of projects to achieve strategic and operational goals and to adapt to a rapidly changing technological and market environment (Brady and Davies, 2004).

Project-based learning can thus be understood as a dynamic process of building capacity over time using what Cacciatori (2008) calls the "metaphor of remembering" i.e., a process of 'storage' and 'retrieval' that allows for the timely retrieval and adaptation to new contexts of relevant knowledge.

The fifth, "*Industrial engineering"* contains mainly articles focused on topic critical success factors in Enterprise Resource Planning (ERP) project development in manufacturing and process industry.

In fact, there are many potential risks associated with the introduction of ERP that management should consider (Hsu et al., 2006) in order to avoid losing significant personnel and system functionality (Barker and Frolick, 2003) due to the fact that ERP implementation requires the re-engineering of the company's business processes.

In this sense, the documents contained in this cluster, place particular emphasis on three "phases" of the development of an ERP project and its introduction, namely: model selection (Deep et al., 2008), implementation of the project (Nah et al., 2001; Remus, 2007; Finney and Corbett, 2007) and diffusion of related knowledge (Winkelmann and Leyh, 2010).

For instances, Deep et al. (2008) present the findings of research carried out as part of an industrial project for selection of an enterprise resource planning (ERP), while Nah et al. (2001) identify CSFs in ERP implementation, categorizes them into their respective stages of the ERP life cycle model proposed by Markus and Tanis (2000) discussing the importance of these factors in ERP implementation. Thus, Finney and Corbett (2007) provide an extensive overview on the literature on CSFs in ERP implementation.

The sixth cluster related to *"Risk Management"* provides a practitioner-oriented overview on the key features of the basic risk management tools that can be used by the project managers of SMEs who are looking for the suitable tools for a specific risk management function (Leopoulos et al., 2006) with particular reference on the classification of project risk factors that affect the ERP project implementation (Aloini et al., 2007).

Thus, to answer to RQ1, considering the examined knowledge base, in terms of a) disciplinary composition, b) topics addressed and c) the pattern of interrelationships (Zupic and Čater, 2015), is possible to assert that although exist several structural holes between different research lines at the basis of the research stream, large part of the discussion in articulated around R&D and innovation projects related to two industries such as Construction and Manufacturing.

The former, more focused on methodological and managerial innovations, while the latter more focused on providing insights into critical success factors within innovation projects. However, in both cases the SME actor is left in the background.

In fact, SME represents a central actor only in the cluster 3 in which the existence of a crossover between Economics and Management highlights the role of the Project as a vehicle for value creation in SMEs and the linkage with organizational studies makes it possible to hypothesize how research is orienting itself towards the development of PM methodologies in SMEs considering organizational context and external environment.

5. Content analysis: main and emerging themes

After an overview of the first results obtained and having discussed the articulation of the knowledge base of the research stream it is appropriate, in order to answer RQ2, to study the strategic diagram generated on the basis of the co-word analysis. The analysis conducted using the keyword, with at least 4 co-occurrences, of the 170-article identified as relevant is shown in figure 10 while the detailed results are illustrated in table XI. From this map emerges a wealth of knowledge that is sometimes difficult to translate except by using a mix of quantitative and qualitative approaches to analyze it (Bredillet, 2006)

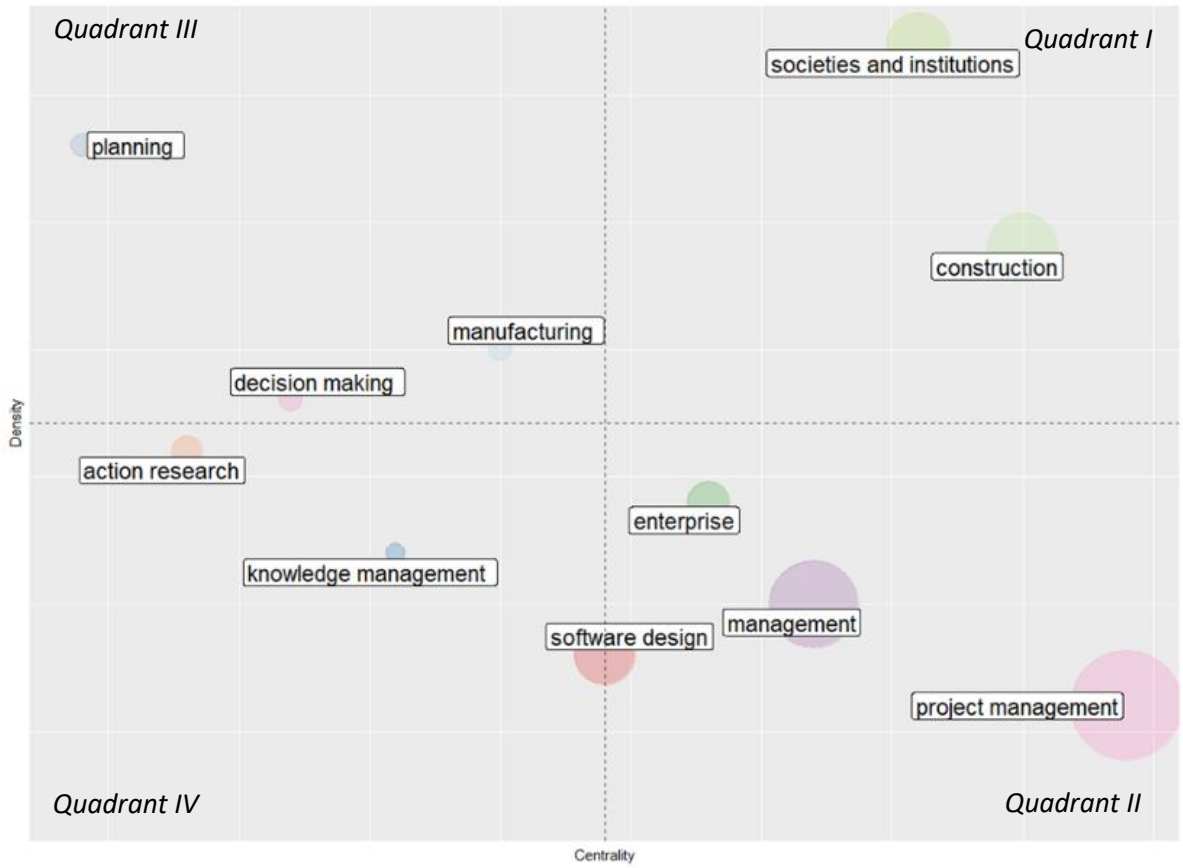

Figure 10. Strategic Diagram

Name	Centrality	Density	Frequency	Keywords
Management	639,44	568,06	103	Management, System, Performance, Design, Product Development, Innovation, Software Engineering, Implementation, Agile, Success
Project Management	1128,22	503,69	286	Project Management, Sme, Information System, Erp, Risk Management, Risks, Risk Assessment, Managers, Project Managers, Critical Success Factor
Action Research	225,02	826,06	9	Action Research, Software Project Management
Planning	212,975	1107,75	6	Planning
Decision Making	264,47	873,87	6	Decision Making
Societies And Institutions	711,47	1808,13	35	Societies and Institutions, Information Technology, Information Dissemination, Supply Chain Management, Information Management, Communication
Manufacturing	341,63	950,85	6	Manufacturing
Knowledge Management	286,00	727,35	5	Knowledge Management
Construction	815,170	979,36	47	Construction, Research, Construction Projects, Productivity, Contractors
Enterprise	560,90	740,62	14	Enterprise, Investments
Software Design	552,61	553,07	30	Software Design, Costs, Research and Development Management, Software Process Improvement, Computer Software

Table XI. Co-words clusters

Quadrant I: Motor Themes. These themes represent the heart of the research stream. The analysis of theme embedded within quadrant I revealed how, although there is a heavy influence of engineering on the research stream, we are seeing a shift in the themes covered towards the interpersonal aspects of project management and a broader role of the organizational context. In fact, unlike the PM field of research overall (e.g., Pollack and Adler, 2015) within the PM and SMEs research stream, issues associated with the adoption of collaborative technologies (Ahuja et al., 2010; Duffy et al., 2007) that enable effective communication and information exchange among project participants show a strong centrality and a high degree of internal cohesion (quadrant I, clusters Societies and Institutions and construction). This is mainly due to the involvement of SMEs in inter-organizational projects, as in the case of the construction industry, whose participants are often geographically decentralized, and processes fragmented.

Quadrant II: Basic Themes. Analysis of the theme embedded within this quadrant supports the hypothesis of the unbiased nature of the sample since it incorporates themes which represent "umbrella themes" that concur in the creation of knowledge within the research stream and are very widespread such as theories of firm, management, and Project Management.

Quadrant III: Niche themes. Themes related to "planning", "decision making", and "manufacturing" industry represent niche themes. In fact, if on the one hand the "planning" and "decision making" are long established themes in PM research field they are closely related to the nature of the practices adopted, range from ad hoc tools to procedures and software systems, typically less formalized in SMEs. On the other hand, the isolation of topics related to the manufacturing industry is in line with the results of the analysis of co-citations that shows how the focus of these studies are the critical success factors in ERP projects and marginally industry 4.0 (Ahmad, 2018) partly neglecting the SME actor.

Quadrant IV: Emerging themes. Here we find 3 emerging themes namely, Action research (AR), knowledge management and Software design. The latter is a theme in transition to the third quadrant.

Action research represents the youngest research methodology in PM and is becoming popular because it appeals to both researchers and organizations intent on understanding the impact and use of scientific results in practice (Staron, 2020) especially in the context of SMEs. Although through the use of Action Research project activities can be explored to identify problems and ways to improve (Davey, 2006; Caffyn and Grantham 2003) unfortunately AR has not yet gained wide acceptance within the project management community (Whitehead, 2005). Its effectiveness has been validated by some empirical work mainly in the literature related to the Scandinavian school (Paisan, 2015). It, contemplating the projects as temporary organizations (Kronlid and Baraldi, 2020) benefits

from the use of this methodology, which manages to be a flexible method solve the problems caused by time constraints and the emergent nature of the temporary organization by investigating the variables in real time.

This issue has been discussed within several empirical works covering various case studies. On the one hand software development in SMEs (Ruiz Castilla et al., 2016) in which it is treated at the light of the turnover of the various actors within the different phases of the project. On the other hand, in construction industry in which they highlight the key benefits arising from the introduction of knowledge management practices in terms of increase in efficiency, quality, productivity and decision-making processes (Yap and Lock, 2017) highlighting how difficulties exist in SMEs in sharing knowledge within projects, due to the implementation of informal practices rather than formal project management systems, to manage their projects (Tang et al., 2005).

Thus, the last theme, "software design," incorporates methodological work centered on agile methodology, which developed in the software industry (O'sheedy, 2014), is spreading to other typically project-based industries such as construction. In line with the shift in this cluster from emerging to basic and transversal themes. Since PM methodologies have reached maturity in large organizations, SMEs struggle to implement the best practices contained in internally accepted standards and frameworks such as PMBOK, because they lack economic and human resources, skills, tools, and techniques based on the implementation of best practices (Garca et al., 2018).

However, despite these advances, small software teams have often found these project methods to be too bureaucratic and cumbersome. this has therefore led to the style of software development methods known collectively as "agile" (O'sheedy, 2014) which in line with the shift of this cluster from emerging to cross-cutting issues has begun to spread to other typically project based industries such as construction (Nowotarksi and Paslawski, 2015).

6. Direction for future research

The analysis of the knowledge base and the thematic analysis allow to better understand how the research stream is structured and thus at this stage is possible to formulate a few research directions for practitioners and researchers interested in PM and SMEs.

From an operational point of view, as also highlighted by the work of Turner et al. (2009, 2010, 2012) and Tezel et al. (2018), SMEs need "lite" tools to manage the various phases of the project including initiation, planning, execution, monitoring, and closeout. In fact, as shown in quadrant IV of the strategic diagram, the set of PM methods deriving directly or indirectly from the

principles of the *"Manifesto for Agile Software Development"* (Beck et al., 2001) represents one of the emerging themes that is consolidating within the research stream as the agile methodology has started to spread to other typically project-based sectors (i.e., Nowotarksi, 2015).

In this sense, contributions may consider the adoption of comparative case studies covering different types of projects and/or enterprises or, the use of mixed methods aimed at investigating managerial aspects and also their diffusion through surveys in different sectors or categories of enterprises, starting from the detailed explanation of the methodological aspect contained in Turner et al. (2010, 2012).

However, traditional PM approaches that conceptualize the project as an isolated phenomenon and focus on a set of planning and control models and techniques do not, on their own, seem to represent a valid theoretical and analytical framework for the study of projects undertaken by SMEs, as is evident from both the analysis of the knowledge base and the clusters contained in Quadrant I. These show the involvement of SMEs in inter-organizational projects, as in the case of the construction sector, whose participants are often geographically decentralized, and processes fragmented.

In fact, SMEs not only adopt project-oriented working methods in their businesses (Tikkanen et al., 2007; Artto and Wikström, 2005) but also, initiate inter-organisational projects that are limited in time but immersed in pre-existing environments (Söderlund, 2002). The existence of both a business network and a project network defined as an inter-organisational form that simultaneously influences and affects individual projects (Baraldi and Havenvid-Ingemansson, 2013) makes the issue of managing multiple business relationships and multiple projects central. Therefore, the network perspective when considering multiple projects and multiple firms or organizations is most relevant.

Thus, a second line of research can be traced back to the various issues that deserve further investigation at theoretical level and in terms of analytical tools used in order to investigate the *"part of the business that relates directly or indirectly to projects"* (Arrto and Wikström, 2005) in SMEs, in relation, on the one hand to the processes of interaction and alignment of practices among the actors involved (La Rocca and Perna, 2014) within projects. On the other, to the governance of network of projects managed by project-based SMEs embedded in business network. By considering that resources are provided by more than one socio-cultural system and/or geographical setting and coordinated by various actors, operating with different logics, also involved in other projects, with different and variable roles that can join the project at different stages and are embedded in permanent networks.

With this respect, at theoretical level, results provided by Artto and Kujala (2008) can represent a good point of departure to future research oriented to investigate the relationships between

the management of project network and business network since as highlighted in Aaltonen and Sivonen (2009) they take into account both the interplay between temporary and permanent networks and, the interaction within the project network of various actors (Artto and Kujala, 2008).

Moreover, in terms of analytical tools useful for analyzing projects in their inter-organizational dimension, focusing on the role of interactions and resources, framework provided by the Industrial Marketing and Purchasing (IMP), with its emphasis on relationship and interaction pattern between actors, resources and activities, and their view of a project as a *"temporary resource constellation and activity pattern in which the actors form a distinct logic in how to learn and develop new solutions in relation to each other"* (Havenvid-Ingemansson et al., 2016: 86) represent useful tools such as the ARA Model (Håkansson and Snehota, 1995) and the 4R model (Håkansson and Waluszewski, 2007) to analyze both the historical background and the organizational context of project stressing the role of interconnectedness between actors.

However, as well as the research tradition summarized by the expression *"project business"* (Artto and Wikström, 2005; Artto and Kujala, 2008) also the mainstream IMP literature partly neglects topics related to SMEs (Bocconcelli & Pagano, 2015).

Finally, in terms of topics covered, research stream suffers some lack of studies with regard to PM methodology for manufacturing SMEs (Carden and Egan, 2008), Industry 4.0 (Lopez-Robles et al., 2020), nontraditional project-based sectors such as European project (Ciarmatori et al. 2018), consulting and professional services (Kerzner, 2001; Adesi et al., 2015), cultural industries (e.g., Uriarte et al., 2018) showing at the same time a scarce representation of strategy research (Artto e Wikström,2005) although projects are usually delivered to satisfy broader strategic priorities (Too and Weaver, 2014).

7. Conclusion

This paper represents a first attempt to provide empirical evidence on the state of the art of Project management and SMEs as a research stream and provide insights on the future lines of research using bibliometric and science mapping techniques jointly with qualitative analysis.

The survey of publications on PM and SMEs allowed to answer the RQs contributing to the PM literature in understanding the common knowledge base and the main and emerging themes in the SME-related research stream.

As aforementioned, PM and SMEs represents in recent years an emerging stream of research within the field of Project Management. However, the high number of publications in leading journals

have not led to the development of shared theoretical, analytical, and operational frameworks, thus favoring the high fragmentation of the stream of research. Moreover, the research stream is focused on very narrow topics and on few traditionally project-based industries that have partly neglected the environmental and contextual variables with the aim of enabling efficiency improvements in project management by SMEs.

Finally, this paper has some limitations. First, the analysis presented in the present work is restricted to the published documents indexed in Scopus and Web of Science databases. Second, due to the methodology used, interesting articles may have been excluded from sampling, although the bases chosen are very inclusive. Third, the level of details of qualitative analysis conducted on articles embedded within the various cluster identified should be completed by in-depth research.

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CHAPTER III

From knowledge broker to solution provider in the industry 4.0 setting: the innovation path of a small consulting firm[3]

Abstract

This paper examines the resource development process implemented by Sinergia, a small consulting firm active in a traditional industrial context, pursuing the innovation path to develop solutions within the industry 4.0 (I4.0) domain. By using a qualitative case study, the innovation path of Sinergia has been analyzed through critical events and adopting the 4R model, developed within the Industrial Marketing and Purchasing (IMP) approach. The analysis highlights a transition from knowledge broker to solution provider, based on a process of networking, with a relevant strategizing effort, and of assembling internal, external, and shared resources. Three patterns in the evolution of the company's innovation path emerge: i) resource-oriented networking; ii) hybrid resource development and iii) resource assembly. The empirical study provides novel evidence over localized innovation processes in I4.0 by exploring the innovation path pursued by a small consulting firm in connection with the local business. The study represents a theoretical development in terms of the 4R model as it suggests the need to further conceptualize the category of technical resources - including products and facilities - in the increasingly complex I4.0 domain and provides insights on the changing role of actors in networks underpinned by emerging resource structures.

Keywords - Industry 4.0, Consulting firms, SMEs, resources, innovation

1. Introduction

Industry 4.0 (I4.0) represents one of the main emerging technological and organisational challenges for firms across sectors (Bellandi et al., 2019; Matthyssens, 2019). I4.0 represents a multifaceted concept. On the one hand, it refers to an emerging paradigm of digital-based manufacturing and industrial inter-firm connected value and embraces a set of technologies having an impact on the business landscape (Kagermann et al., 2013). I4.0 implies substantial investments

[3] Please note that this chapter largely presents extract from the following Conference Paper: Mersico, L., Carloni, E., Pagano, A., Bocconcelli, R. (2021, May 19-20). *Upgrading resources in the Industry 4.0 context: the case of a small consulting firm.* IMP Forum Seminar, Uppsala, Sweden.

in equipment and technologies for companies, the development of competences and an organizational context ready to support the transformation process (Agostini and Nosella, 2019). The implementation of I4.0 also requires taking a differentiated perspective on varying company sizes, industry sectors, and the company's role as an Industry 4.0 provider or user (Müller et al., 2018). Notably, for small and medium-sized enterprises (SMEs), exploiting the potential of I4.0 is challenging due to the increased dynamism and the complexity of the SMEs' market and technological environment (Neirotti and Raguseo, 2017). On the other hand, I4.0 implies an economic policy strategy aimed at accelerating digital transformation technologies to reinforce the competitiveness through the continuing convergence between the real and the virtual world (Kagermann, 2015) of the manufacturing industry (Kagermann et al., 2011; Piccarozzi et al., 2018; Reischauer, 2018). As a policy-driven innovation discourse, I4.0 aims to institutionalize innovation systems embedding business, academia, and politics (Reischauer, 2018) mobilizing actors to innovate collaboratively in a logic of open innovation (Schepis et al., 2021) in which value creation occurs through combining resources and capabilities across organizational boundaries. Governments are thus increasingly enacting policy measures aimed to foster innovation processes by providing funding and an institutional system enhancing collaboration among businesses, universities, institutions, knowledge providers and innovative firms (Ciffolilli and Muscio, 2018).

The growing literature on I4.0 has placed emphasis on two main interrelated topics. On the one hand, various studies have attempted to explore the introduction of advanced digitalization processes having a substantial impact in terms of organisational change and innovation, requiring new organisational settings, procedures, and routines (Frank et al., 2019). On the other hand, other recent contributions have placed attention on the business and institutional context of I4.0 diffusion, in terms of public support and knowledge dissemination processes (Hervas-Oliver et al., 2019; Pagano et al., 2021). While most of these studies have been concerned with the implementation of I4.0 in industrial firms in both high-tech and traditional sectors, less emphasis has been placed on the role played by other key business actors supporting industrial customers in I4.0 projects, such as consulting firms. Within I4.0, the literature has described their role as "first movers", being promoters of the adoption of I4.0 and having produced some of the incipient seminal works on the topic (Trotta and Garengo, 2019). While large IT consulting firms have resources and capabilities to explore and provide services in the I4.0 domain (McKinsey, 2016), it could be argued that small consulting firms have been facing a challenging scenario while they undertake resource development processes on their own to become trusted and capable partners for customers considering I4.0 projects. SMEs – often in traditional sectors – tend to involve small consulting firms in digitalization projects – rather than large IT firms – as they offer more customized solutions and adequate assistance in terms of

training and continuous feedback. Thus, small consulting firms are called upon for developing new skills and know-how both on the business and on the IT side (Bensberg et al., 2019; Oesterle et al., 2020; Benitez et al., 2021) to provide I4.0 solutions for SMEs. However, how this process evolves and the main factors shaping it have not been explored in depth yet.

Therefore, this paper aims to explore the resource development process implemented by small consulting firms pursuing the innovation path to develop solutions within the I4.0 domain. The idea of innovation path reflects the spatial and temporal dimension of innovation (Purchase et al., 2016) and the "muddling through" characterizing such processes (Makkonen et al., 2012). The main research question to be addressed is the following:

> *RQ:* How do small consulting firms develop resources in their innovation path in the I4.0 domain?

This paper attempts to answer this research question by conducting an explorative case study concerning the consulting firm *Sinergia*, a small-sized consulting company based in Centre Italy and providing services on European Projects, Systems for Managerial Control and Risk Management and Lean Technology. The company is based within a region characterized by a dense network of SMEs active in various industrial districts – furniture, yachts, footwear – and operating in both high-tech and traditional industrial sectors. Sinergia has been chosen to provide the perspective of a service and solution provider operating in a context characterized by firms active in traditional industries, in an area where over the years an effort has been made by the local government for promoting the technological and digital upgrading, as the region has been among the first in Italy to adopt the S3 strategy (Eklinder-Frick et al., 2020a).

The case analysis follows a longitudinal approach (Halinen and Törnroos, 2005) to highlight the main events (Purchase et al., 2016) occurring in identified temporal phases (Quintens and Matthyssens, 2010) and the development of resources related to innovation in the I4.0 context.

The empirical analysis relies on the IMP approach as the main conceptual and analytical framework and, notably, on the 4Rs model as it can guide research over resource development processes (Baraldi et al., 2012; Bocconcelli et al., 2020). Specifically, it is argued that the 4Rs model offers a useful perspective on three different grounds. Firstly, it helps in understanding the combining process of different knowledge-related and technological resources in the development of new offerings; secondly, it allows for assessing complementary changes in the organizational setting supporting the innovation process; thirdly, it conceives "business relationships" as resources and thus allows to explore the nature of multiple networks where the focal company is embedded (Håkansson and Waluszewski, 2002).

The paper is structured in five main sections, besides the introduction. In the second section, we analyze the emergence of I4.0 as a policy and management concept and the main technological and organisational challenges for firms, with a focus on SMEs and IT providers; then, the resource interaction approach in innovation processes is discussed. Section three presents the methodology adopted in the study and the analytical framework used for analyzing data. The fourth section concerns the case study analysis, focusing on the different phases of Sinergia's innovation path for I4.0. Section five discusses the main results of the empirical analysis and answers the research question. The last section draws conceptual, managerial and policy implications, and outlines the main limitations of the study along with main future developments of the research.

2. Background

2.1. Industry 4.0, SMEs, and IT providers

The recent debate – in academia and the business world - about innovation in industrial sectors is shaped by the diffusion of Industry 4.0 model of organisation of production processes, involving innovative and pervasive advanced digital technologies in a variety of technological fields (Roblek et al., 2016). The concept of I4.0 *"is often referred to as the fourth industrial revolution and embraces a set of technological advances that are having a high impact in the current industrial landscape"* (Pereira and Romero, 2017, p. 1208) or the *"comprehensive transformation of the whole sphere of industrial production through the merging of digital technology and the Internet with conventional industry"* (Merkel, 2014).

I4.0 represents both one of the main emerging technological and organizational challenges for SMEs (Moeuf et al., 2020; Müller et al., 2018), and a key area for investment by the European Union and various governments in Europe (Smit, 2016) that have promoted many policy measures to provide financial support and enhance knowledge transfer mechanisms to the benefit of SMEs operating in both traditional and high-tech sectors (Muscio and Ciffolilli, 2020). SMEs are, in fact, affected by limited resources in terms of skills, funding (Matt et al., 2018; Müller and Däschle, 2018) and knowledge (Radas and Bozic, 2012; Marcelino-Sádaba et al., 2014; Arbussa et al., 2017) that are essential to transform inventions into products/solutions or processes (Salerno et al., 2015). Therefore, facilitating innovation in SMEs has become a cornerstone of policy initiatives to stimulate economic development at local, regional, and even national levels (Jones and Tilley, 2003).

As technology becomes so complex, as in the case of I4.0, that it cannot be managed by a single firm, and relevant knowledge is distributed among various firms and institutions (Brunswicker and van de Vrande, 2014), collaboration among firms and between firms and institutions is acknowledged as a key factor for success (Lee et al., 2010). A stream of studies indeed has started to explore the role of supporting actors, able to provide a contribution in terms of I4.0 knowledge dissemination and transfer. A few existing studies have attempted to understand the role of public organizations such as local institutions, universities, formal clusters and innovation agencies, placing emphasis on their role as promoters of awareness about the value of I4.0 technologies and as knowledge providers and/or brokers, even though with mix effects due to the complexity of I4.0 technologies and the fragmentation of the overall institutional effort (Hervas-Oliver et al., 2019; Götz and Jankowska, 2017; Pagano et al., 2021). It is apparent that the development of the I4.0 and the growing recognition of universities as drivers of regional development (Benneworth and Hospers, 2007) have led to a growing awareness of the role of these non-business actors not only as producers of knowledge and innovation (Wolfe, 2005), but also as one of the main agents of economic growth. Thus, cooperation between firms, especially SMEs, and universities became essential to foster innovation (Babkin et al., 2013).

While there is a growing attention on "user" industrial firms - in terms of technology selection, implementation processes and effects on relationships with suppliers and customers (Szalavetz, 2019; Schroeder et al., 2019; da Silva et al., 2018) - and on the role played by universities (Onar et al., 2017) and technology centers (Müller and Hopf, 2017), less attention has been paid to the "provider" side and notably to I4.0 business partners such as IT and consulting firms. Service and solution providers within the I4.0 paradigm represent companies that offer *"complete solutions in which products and services are integrated"* (Müller and Däschle, 2018, p. 263), i.e., the offering side. Studies have contributed to the definition of architectural frameworks that can support the creation of supplier solutions, sometimes of Open-source nature, within the industry 4.0 paradigm (Batista et al., 2017). It is well-known in the innovation literature the role of consulting firms in partnering with local manufacturing firms to spread innovations in local networks, including IT-based knowledge and resources (Seclen and Barrutia, 2018). However, in the case of I4.0, the ability of consulting firms in providing adequate consulting services should not be taken for granted; on the contrary, it could be argued that consulting firms - especially those having a small-medium size - could face a tough challenge while undertaking I4.0 projects, which might require a complex development process in terms of adequate technological and organisational resources. In fact, the implementation of I4.0 requires meeting several requirements, in terms of data analysis, organizational structures and integration, communication and cooperation between business processes (Brousell et al., 2014;

Macaulay et al., 2015). We thus argue that in-depth research is needed for understanding how small consulting firms have engaged in their resource development processes for becoming recognized I4.0 providers.

2.2. A Resource Interaction Approach on innovation processes

Firms are increasingly relying on inter-organizational interaction to pursue innovation processes (Lind, 2015; Gadde and Lind, 2016). When it comes to highly complex knowledge, such as in the I4.0 setting, actors often engage in time-limited projects, partnerships, or programs, involving external partners and external sources of knowledge (Schumacher et al., 2016). In fact, external resources and partners are key within innovation processes and can be accessed through inter-organizational relationships with other firms but also with research centers, universities, consulting agencies (Lind et al., 2012).

Recently, within IMP, there has been an increasing focus on projects dealing with innovation and digitalization (i.e., Rubach et al., 2017; Håkansson and Waluszewski, 2018; Eklinder-Frick et al., 2020b). Studies have shown the importance of managing organizational intangible aspects, such as competences and organisational practices, when dealing with changes brought up by technological development projects (Fremont et al., 2019). Innovation processes require spanning between and beyond firms' and network boundaries; the stimulation of innovative processes is spurred by interactions and overlaps between innovation network initiatives and previously established industrial networks (Rubach et al., 2017). The major forces behind innovation projects are represented by "the heaviness of related resources, their spatial characteristics and their journey" (Håkansson and Waluszewski, 2018, p. 259).

In line with previous IMP studies (Gadde and Lind, 2016; La Rocca and Snehota, 2014; Hoholm and Olsen, 2012), we argue that the networked nature of innovation processes and projects can be understood in terms of resource interaction and development. The link between innovation processes and resources has been explicitly touched on by La Rocca and Snehota (2014), who argue that innovation processes in the forms of new solutions and offerings are developed by means of combining and recombining resources. In fact, innovation is generated through interaction between specific companies' constellations of existing socio-material resources (Håkansson and Waluszewski, 2018; Eklinder-Frick and Åge, 2017; Gadde and Lind, 2016). Resource interaction has been defined within IMP as "the processes of combination, recombination, and co-development of resources that happen through the interaction among organizations" (Baraldi et al., 2012, p. 266).

In fact, by engaging in innovation processes, firms need to introduce new resources and competences, which affect existing interfaces and must, in turn, become embedded with them (Håkansson and Waluszewski, 2018). Resource embeddedness requires creating new resource structures and could lead to clashes with established business models (Eklinder-Frick et al., 2020b). Arising frictions might be mitigated by developing partnerships and ensuring continuity across projects (Crespin-Mazet et al., 2015).

The 4R model, developed within the Resource Interaction Approach (RIA), appears a suitable lens for investigating innovation processes (Baraldi and Ingemansson, 2013; Baraldi et al., 2012) since, as mentioned above, projects provide the context for the dynamic combination and interaction of resources (Baraldi, 2008; Lind et al., 2012) and because actors taking part in inter-organizational projects have different goals that need to match to engage in effective resource combining (Corsaro and Cantù, 2015). Within the 4R model, resource development processes are analyzed as the interplay between physical (or technical) resources and organizational (or social) resources (Håkansson and Waluszewski, 2002). The 4R model classifies resources into physical (products and facilities), having material properties, and organizational/social resources (business units and business relationships), characterized by social features and displaying intangible characteristics (Håkansson and Waluszewski, 2002). Products can be described as artifacts, goods, and services. Products, according to the 4R model, are the result of historical and future interaction patterns (Strömsten and Waluszewski, 2012). Facilities concern interdependent technical resources and equipment (plants, logistics, infrastructures, information systems) used to create products. Products and facilities are conceptually connected since facilities are needed to produce products (Waluszewski and Wagrell, 2013). Business units include individuals, internal units or firms and represent key resources encompassing various intangible elements, such as procedures, skills, experience, knowledge, and reputation. The interaction among units benefits the involved parties which gain imprints from interaction and develop specific social features (Håkansson and Waluszewski, 2002). The last class of resources is business relationships, that is the ties and links created by actors in interaction and mobilized by organizational unit resources (Baraldi et al., 2012).

The focus on resource interaction in inter-organizational networks arose from empirical studies on technological development and innovation (Baraldi et al., 2012). Such studies depart from the assumption of resource heterogeneity, which implies that resources are dynamic and can be used in existing and new combinations in business relationships. More in detail, IMP studies have used the 4R model to classify, map and analyze the process of resource interaction (Baraldi et al., 2012), the variability of resources in use by actors in innovation processes and the relevance of leveraging resources in the network (Ostendorf et al., 2014).

Understanding how internal and external resources are combined and recombined represent a central issue in the development of I4.0 enabling technologies. In fact, digitalization implies extensive reconfiguration of products creating considerable risk for suppliers who may not have control over critical external resources and who tend to link each other through "weakly manageable" non-hierarchical relationships, fostering the development of emerging business networks (Shroeder et al., 2019; Davis and Cobb, 2010; Agrifoglio et al., 2017). For the aim of this paper, namely exploring resource development processes implemented by consulting firms active in I4.0 projects, the 4R model is employed to guide the research on three grounds: i) to help understanding the combining process of different pieces of knowledge and technologies in the development of new offerings; ii) to allow for assessing complementary changes in the organizational setting supporting the innovation process; iii) to conceive "business relationships" as resources and thus allows to explore the nature of multiple networks where the focal company is embedded (Håkansson and Waluszewski, 2002).

3. Methodology

This research aims to explore the resource development processes implemented by small consulting firms trying to innovate to develop solutions related to the enabling technologies of I4.0. Given the explorative nature of the RQ and in line with existing studies on resource development processes for innovation (Håkansson and Waluszewski, 2002; Baraldi et al., 2012), this research follows a qualitative approach and is based on a single case study, following an abductive approach for coding information and elaborating results (Yin, 2003; Dubois and Gadde, 2002). The single case study method is deemed suitable to both catch the complexity related to the process of development of the focal company while trying to evolve within a fast changing and challenging scenario (Halinen and Törnroos, 2005) as the one represented by I4.0 technologies, relationships among all actors involved (Dubois and Gadde, 2002) and, in understanding dynamic interaction processes.

The case firm in focus is an innovative small-sized consulting company - Sinergia - established in 2005 by two co-founders that over the years developed its business and that currently offers a broad range of services (i.e., European Projects, Systems for Managerial control and Risk Management, Lean Technology) mainly addressed to local SMEs active in different sectors - furniture, mechatronics, shipbuilding, footwear - and often co-located within industrial districts in the region. Sinergia has been chosen on two grounds: 1) it provides the perspective of a services, solutions and I4.0-related knowledge provider (Hervas-Oliver et al., 2019) to the benefit of local businesses and institutions; 2) it has developed a novel application in the I4.0 domain which is the result of an

innovation path. The case analysis thus follows a processual approach (Halinen and Törnroos, 2005) based on the event and innovation path analysis (Van de Ven et al., 2008; Halinen et al., 2013; Purchase et al., 2016) to highlight the key events related to the development of resources within the I4.0 context that occurred in the last five years. Notably, the firm has been under observation for a period of five years (2016-ongoing). The active observation has been realized from April 2019 until August 2021, while the previous years have been analyzed retrospectively.

Data has been collected through three main sources (table XII): direct semi-structured interviews and participating observation conducted by one of the co-authors (Hoholm and Olsen, 2012) as primary sources, and company's websites, projects official documentation, sectorial magazines and editorials, press briefings and corporate reports as secondary sources.

Activities	**Company/Institution**	**Period**
1. Participant Observation		
Internship	Sinergia Consulenze	April 2019 – September 2019 September 2020 – March 2021
Project management activities within XR4ALL project	Sinergia Consulenze	March 2021 - August 2021
2. In-depth Interviews		
Respondents		
Founder and Senior partner	Sinergia Consulenze	2019 and 2021
Senior consultant	Sinergia Consulenze	2019, 2020, 2021
Professor of Computer Science (PUM) - Supervisor of Industrial PhD student in Artificial Intelligence	Polytechnic University of Marche	2020
Industrial PhD Student	University of Urbino	2021
3. Archival Document		
Company Website	Sinergia Consulenze	2021
Consortium Website	XR4ALL	2021
Association Website	Fondazione Cluster Marche	2021
Report	Osservatorio Open Innovation and Corporate Venture capital	2021
XR4ALL Official Project documentation	Sinergia Consulenze, PUM, Ubisive	2021

Table XII. Data Collection Process

The first source of data used is one-to-one semi-structured interviews (Kvale and Brinkmann, 2009). This typology of inquiry has been widely used in the IMP tradition to understand the complexity of relationships, and it has been described as *"the most effective means of gathering data"* (Lindgreen et al., 2020: 2). To guide the direction of the discussed topics, similar questions were raised to all respondents, even though adapted for each specific role. Key figures - consultants in Sinergia and external partners involved in specific I4.0 projects - have been identified as informants for the interviews conducted in the timeframe April 2019 – October 2021. The number of semi-structured interviews is 8. Every interview had an average duration of 1 hour and all of them have been recorded and transcribed verbatim. Table XIII details the number, duration, and information about interviewees.

Moreover, thanks to the involvement of one of the co-authors in the participating observation, it has always been possible to contact informants to complement information, as well as to ask for clarification on gathered data. In this sense, various conversations and e-mail exchanges have been carried out to address specific relevant themes and updates. Participating observation has allowed us to observe part of the process as well as it has happened (Hoholm and Olsen, 2012). Participating observations amount to 1520 hours in the timeframe April 2019 - August 2021, including project coordination tools and activities (Kronlid and Baraldi, 2020) such as meetings and discussions.

Analyzing data, in line with existing studies (Halinen et al., 2013; Purchase et al., 2016), a timeline of the innovation path has been developed to support the identification of a series of events coded in three categories: a) critical, b) related, and c) background. *Critical events* are used as checkpoints (Halinen et al., 2013) in delineating the various phases of the survey period and are coded as such if they meet the following criterion: respondents mentioned the event as important during their narrative (Makkonen et al., 2012). *Related events* are actions or activities that directly trigger or arise from the critical events but are not significant to the innovation process on their own (Purchase et al., 2016). *Background events* concern the context in which the innovation is embedded, such as the macro-environmental context and institutional forces (Purchase et al., 2016).

The resulting process has been analyzed in depth using the 4R model (Håkansson and Waluszewski, 2002, 2007; Strömsten and Waluszewski, 2012). Thus, the 4R model is employed as a framing mechanism (Strömsten and Waluszewski, 2012) to match the insights arising from the interviewees' knowledge and the identified critical events. In particular, *products* and *facilities*, *business units* and *business relationships* and their interaction have been analyzed for each critical event. This helped reconstruct the entire resource development and combination process regarding I4.0 enabling technologies whose value eventually emerges during their utilization applied to specific tasks involving other resources.

Existing studies on the model (Baraldi, 2003; Baraldi et al., 2001; Baraldi and Waluszewski, 2005) have been conceptualized in the innovation and IT context. These studies have shown the interplay between IT and other resources in business networks (Baraldi, 2003) due to the embeddedness of computerized systems, as facilities that process information *"into other resources implies that their effects seldom turn out to be as expected or simply defined by their technical potentials"* (Baraldi and Waluszewski, 2005: 1251).

Considering data analysis, the recorded interviews and the secondary data gathered have been triangulated with the aim of examining the consistency of the different data sources. In fact, the use of triangulation supports the qualitative research strategy testing validity through the convergence of information from different sources (Patton, 1999).

Company/Institution	Interviewees	Number of interviews	Duration	Period
Sinergia Consulenze	Founder and Senior Partner	3	54 min	November 2019
			1.20 h	April 2021
			25 min	December 2021
Sinergia Consulenze	Senior Consultant	4	45 min	July 2019
			1 h	February 2020
			27 min	April 2021
			40 min	October 2021
Polytechnic University of Marche	Professor of Computer Science (PUM) – Supervisor of Industrial PhD student in Artificial Intelligence	1	30 min	March 2020
University of Urbino	Industrial PhD Student (Sinergia)	1	1h	May 2021

Table XIII. Interviews' information

4. Case analysis

This section is devoted to the case analysis. In the following paragraphs a brief profile of Sinergia is provided. Afterwards the evolution of the process of resource development in Sinergia will be analyzed in a processual perspective, highlighting critical events happening throughout the innovation path.

4.1. Company profile

Sinergia was established in January 2005 as a small sized management consulting company active in two main advanced service areas: European projects design and software development for managerial control, managed respectively by two different business units, EP and SGIA (Software for Accelerating the Integrated Management System).

The founding team was composed by 2 co-founders with heterogeneous background: Flavio, a Physicist and Massimiliano, a Chemist, with more than ten years of experience in managerial consultancy and IT systems, which leveraged their expertise in 2008 developing and patenting a cloud-based software called "Integrated Enterprise Management System", specifically designed to organize the management system in compliance with the government regulations. Thus, in order to better manage future developments of the software, SGIA was split into two distinct business units: the Systems for Managerial control and Risk Management (SCI) business unit, which deals with the implementation of management systems and regulatory compliance; the Lean technology (LT) business unit, which develops customized software solutions. In addition, in 2013, a senior consultant, currently a member of the board of directors, was hired to manage the EP business unit.

Sinergia during the years has gained experience in European project management, process efficiency and software development with both large and SMEs customer firms in a variety of sectors, thus positioning itself as a partner able to offer private companies and public administration support throughout the project life cycle and within the business operations. The company has grown from 4 employees and a turnover of 100,000 Euro to 24 employees and one million Euro turnover in 2020. Sinergia is active in a region of central Italy (Marche Region) well-known for being part of the so-called "third Italy" due to its industrial structure made of micro enterprises and SMEs (Potter et al., 2010), most of which are located in industrial districts. Recently the most dynamic firms – including Sinergia - have promoted the establishment of four formal clusters: Agri-food, E-living, In-Marche, Marche Manufacturing (Fondazione Cluster Marche). The region represents one of the 15 most industrialized regions in Europe and is characterized by a significant presence of the manufacturing industry, with a marked incidence of traditional sectors (Cucculelli and Lena, 2017). The company thus appears to be located in a context that can be considered "peripheral" if compared to larger and more high-tech specialized hubs and technological poles.

4.2. The innovation path in the I4.0 domain

In 2016, Sinergia founders started to participate in fairs and exhibitions on I4.0 and have been invited to a trip to Germany with Benelli Armi, a local large company active in the gun sector. The trip was aimed at carrying out a study tour at the Fraunhofer Institute in Stuttgart for Benelli to understand the advantages offered by the new I4.0 paradigm and the best ways to apply it to the Benelli Armi plant (Fabbrica Futuro, 2018). After this business trip Flavio became aware of the relevance of Industry 4.0 for Sinergia. Given the limited size of the company and the lack of knowledge about I4.0 technologies, Flavio started to interact with other organisations - i.e., universities and companies - to explore I4.0 opportunities.

CRITICAL EVENT 1: A framework agreement with Marche Polytechnic University (PUM) for I4.0 activities

Sinergia clearly felt that being perceived by customers as a "simple" software house was no longer sufficient to catch the market opportunities offered by these evolving technologies and the company recognized the urgency to reposition itself as an I4.0 solution provider mainly in the area of prototyping and proof of concept development. Undertaking this path is perceived as a tough challenge. On the one hand, as highlighted by the Senior EP Consultant, "*many of the emerging technologies still need research, including applied research, and unfortunately the high-tech industry is going much faster because competition is so high".* On the other hand, Sinergia is active within an industrial district in the furniture industry where *"finding I4.0 applications that can be actually used […] is not really so simple..."* (Founder and Senior Partner).

The head of Lean Technology Department of Sinergia initially began to discuss the potential developments of I4.0 with the local Polytechnic University of Marche (PUM), already partner of the EP business unit for European R&D projects within the Smart Specialization Strategy (S3), a policy implemented in the Marche Region since February 2014. PUM is a university located in Ancona and focused mainly on technical-scientific disciplines, such as Engineering, Economics, Medicines and Agriculture.

Since the beginning Sinergia displayed a strong interest specifically on three of the keys enabling technologies of I4.0 - augmented reality (including vision systems), advanced manufacturing solutions (robotics) and big data and analytics - as they were fully mastered by a research team named Vision Robotics and Artificial Intelligence (VRAI) belonging to the PUM and coordinated by a PUM professor. However, in this initial phase for Sinergia the evaluation of technological opportunities was not an easy task. The PUM professor proposed to Sinergia a project

concerning the development of artificial intelligence algorithms for the recognition of the qualities of legumes. The project was financed several years later through EU funds but without the participation of Sinergia. As pointed out by the head of the LT department: *"I was not yet ready to catch this opportunity, and this must be the last time […]"*. This event pushed Sinergia to develop a key relationship with PUM university, which then became the main source of knowledge and insights driving Sinergia in its innovation process. Participation within the project in the context of S3 has therefore directly influenced Sinergia's strategy for the development of competencies related to I4.0.

Afterwards, Sinergia started participating in dissemination activities concerning I4.0 and organized by local partners. This is the case of initiatives promoted by the local business association, where the senior partners of Sinergia were invited to discuss digital technologies and opportunities brought up by I4.0.

As part of the strategy to strengthen its local network, Sinergia started to make agreements with local firms and institutions to grow and acquire the required expertise in I4.0. A framework agreement based on I4.0 themes with PUM is formalized in 2017 in order to enhance and boost the creation of ad-hoc collaborations:

"It's not a contract but it's a document that basically says you have skills that I like, and that I have skills that you like, let's make an agreement because there are conditions to be able to collaborate when opportunities arise". (Senior EP Consultant)

Then Sinergia organized in 2018 an event on I4.0 with the collaboration of PUM Professor and of a professor of computer science of University of Urbino (UU) to make visible to local firms and institutions the interest and commitment of Sinergia for R&D activities in Industry 4.0.

Since 2018 Sinergia has been transformed into an *Innovative SME* (in accordance with the Italian law), which allowed it to set up formalized research contracts with universities also in the light of fiscal benefits provided by Italian legislation and develop good practices on R&D activities following the Frascati manual guidelines (OECD, 2015). In 2018 Sinergia signed a formal agreement with PUM to undertake a project entitled "Advanced Systems in Industry 4.0 Scenarios".

This critical event contributed to the development of resources from both an organizational and technical perspective. The project resulted in the development of a Prototype of an Advanced system of I4.0 solutions for proximity visualization of technical product sheets, and of facilities in the form of software, cloud, and computational technologies. Sinergia also strengthened relationships for its innovation process and created a new inter-organizational business unit with PUM as a qualified supplier for the aim of the project. The new business unit is defined as a qualified supplier within an "off-site" R&D research contract (according to the Italian law). PUM was aiming to develop

a localized "ecosystem" of young skilled researchers, and Sinergia aimed to create a network of firms able to host such skilled staff. In terms of technical resources, partners developed a prototype App for product localization and technical sheet visualization.

CRITICAL EVENT 2: Opening to Universities collaborations through the setup of PhD positions

The collaboration with local universities continued and upgraded in the following years as a result of the benefits of becoming an Innovative SMEs by the Italian law and thanks to its embeddedness in the Marche manufacturing cluster.

In this sense, Sinergia has made a two-fold effort in collaborating with two local universities in both its core business units. Therefore, two PhDs have been set up thanks to scholarships provided by the European Union through the Marche Region, one related to the EP Department and the other one to the LT Department. In 2018, the Marche Region launched and financed an innovative PhD, within the activities of "Marche Cluster Association", with the Department of Economics, Society and Politics (DESP) of UU to develop research activities on the topic of project management and SMEs. Sinergia, being a member of Marche Manufacturing Cluster, has hosted a PhD student for two internship periods (12 months) within the EP business unit, with the goal of supporting the development of proposals for European funding on I4.0 projects. In 2019, within the framework program with PUM an industrial PhD position has been created. The PhD scholarship is financed with European funding collected by the EP unit with the technical support of the LT unit:

"The EP business units currently manages the technical-financial aspects of the project that finances a research activity within which there is the Lean Technology service that performs activities from the point of view of computer engineering". (Senior Consultant)

The main area of the PhD research project is in the Embedded Automation and Edge Computing for I4.0, which has led to the development of an AI application for Augmented Reality (AR). The key business partner in the project is Benelli Armi, which is a long-standing partner and introduced Sinergia to I4.0:

"Although (Benelli) is not a company of the furniture industrial district, it is perceived as a reference point. It is clear that when you start doing scientific research of this kind, especially at the beginning, where costs are high it is clear that if you want to be the first you have to be willing to pay more and Benelli, we know, has a very high profitability and therefore can afford to do research and invest money". (Founder and senior partner)

In parallel Sinergia continues with dissemination activities related to I4.0. Two key events have been organized: an International Winter School *BigDat2020* with PUM and other international partners such as the Institute for Research Development, Training and Advice (IRDTA), with the goal of presenting the latest advances in the developing area of big data on a broad spectrum of academic and industrial application; the workshop *"The challenge of digitization in the processes of SMEs"* as part of the activities of CyberChallenge.IT 2020, a nationally relevant event for the training and selection of the National Cyberdefender Team, where Sinergia served as an industrial partner for the PUM team coordinated by a PUM Professor. Regarding the *BigDat2020* event, the former participation of the head of the LT department to a Summer School on Deep Learning, organized by the IRDTA Committee, led to a collaboration within the 2020 event, also involving the local business association and PUM, thanks to the personal ties of Flavio. The event combined the scientific competences of PUM and the industrial ones of Sinergia, that participated as industrial chair.

In this phase, in 2019, the company collaborated for the creation of Overlux, a national network of companies with complementary expertise in digitalization processes and I4.0. The goal of this network is to satisfy - through the EP business units - the need for support of start-ups and SMEs in identifying and applying for SME-Instrument European calls for proposals on topics related to I4.0.

The two PhD projects, established in the previous phase, continued with the two PhD students developing more advanced skills and competences in their respective domains. In the words of the PhD student of UU:

"Having gained experience during the first period, I felt more confident in the activities I carry out […] I saw my contribution growing especially in the activities related to this last project, where I have been more involved also in different activities than before […] I could work in a team composed of other PhD students. We had a supervisor, but we were allowed freedom in our activities with increasing responsibilities".

This critical event contributed to the development of resources from both an organizational and technical perspective. Sinergia, in fact, has created at the same time two new inter-organizational business units, the first with UU on Project Management and the second with PUM and Benelli on Artificial Intelligence. The features of such inter-organizational units represented a novelty in terms of management of research projects. While the university usually undertakes research projects autonomously or in partnership with firms, the inter-organizational business units provided a heterogenous team. The critical event also played a role in the development of other organizational resources in the form of trustworthiness towards Sinergia. In terms of technical resources, the event resulted in the development of products as the prototype of an AI based workbench for quality control and of facilities, for the management of the full data lifecycle such as the RGB high resolution camera,

industrial lamps, pre-trained neural net, and object-oriented database leveraging physical computational technologies and labs.

CRITICAL EVENT 3: The DeepReality Project

A key turning point is represented by the XI edition of the *SMEs Day* (November 2020). The SMEs day is an event organized by the Small Industry Committee of the local business association (Marche Nord), headed by one of the founders of Sinergia since 2019, and PUM with the aim of allowing local SMEs to interact with local high schools through company tours. Within the 2020 edition, to overcome the problems related to the Covid pandemic, virtual tours of companies were created by Sinergia in collaboration with Ubisive, a local software house experienced in Unity3D programming and development of mobile App. This experience *"motivated us and pushed us to turn this service into something structural. Our customer will be able to create virtual tours of their production environments or products using immersive technologies"* (Web site Sinergia Consulenze, 2020).

Another related event in which the company participated in collaboration with one of the local universities is the Open Day at PUM. Sinergia together with Ubisive and PUM have attempted to develop a standard data layer as a baseline to develop serialized virtual tours. Moreover, they presented an analytic tool able to evaluate the performance of a specific virtual tour (Pierdicca et al., 2021).

The resources developed within this critical event are both organizational and technical. In terms of organizational resources, we acknowledge the emergence of business relationships and the creation of an inter-organizational business unit with Ubisive and PUM dedicated to the development of virtual tours. This has enabled the development of technical resources such as the data layer that can be used for the serialization of the production of virtual tours and the AR viewer. This critical event, in the words of one of the founders of Sinergia *"allowed to integrate, get to know better and create harmony among the team in terms of competences"* leading to the later participation in the Extended Reality for all (XR4ALL) call for projects proposal.

In Fall 2020 the EP business unit started scouting activities on EU call for proposals for SMEs and informed the LT department and PUM about a call for proposals in the field of AR. The call for proposal was launched as part of the activities of the XR4ALL project, an initiative funded by the European Commission through Horizon 2020 to strengthen the European Extended Reality (XR) industry (**https://xr4all.eu/about/**). The call aimed to attract, select, and provide financial support in

two sequential phases (phase 1, feasibility study; phase 2 development of the innovation) to third parties to develop new XR solutions[4].

Sinergia, acting as a project coordinator, PUM and Ubisive developed the project proposal named "DeepReality, automatic Content Generation for eXtended Reality Applications", later submitted at the end of 2020 to the XR4ALL consortium. DeepReality project, by implementing a Unity Plug-in, specifically designed to enable an integration of Deep Learning algorithms within AR applications, was aimed at addressing two complex issues related to AR applications development, namely robustness of environmental tracking and generalizability of content creation.

Sinergia won the grant with both the scientific and technical support of PUM and Ubisive, leveraging both the EP expertise in Project Management of EU projects for SMEs and LT know-how in IT, and then developed the innovation embedded within the DeepReality Project. The project started officially started at the beginning of February 2021 and in August 2021 Sinergia released under MIT License the version 1.0 of a Software development kit (SDK) for Unity3D environment aimed at simplifying and optimizing the use of Deep learning models in the development process of augmented reality (AR) applications mainly for industrial, while still implementing a Software as a Service (SaaS) for paid licenses based on cloud. Figure 11 depicts the network of the project.

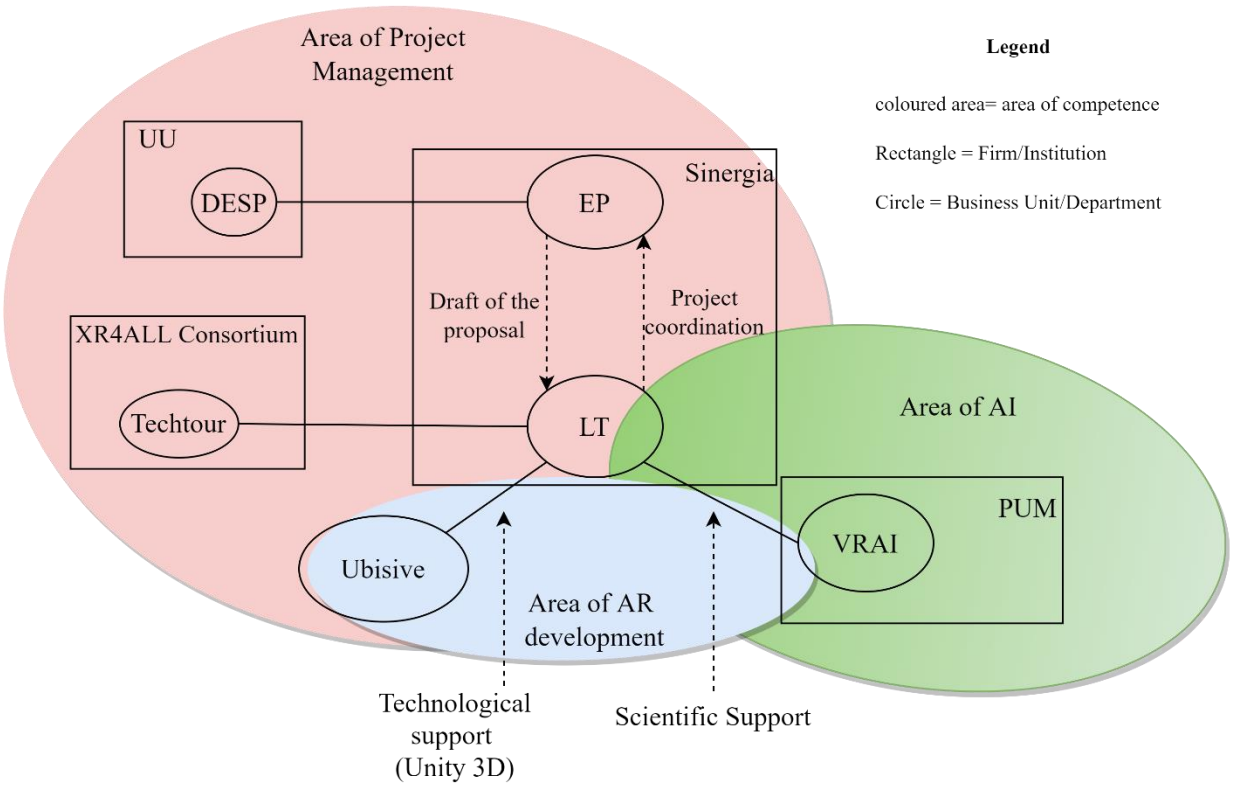

Figure 11. Sinergia's network and competence areas around the European Project XR4ALL

[4] "XR" - is the umbrella term used for Virtual Reality (VR), Augmented Reality (AR), and Mixed Reality (MR)

Winning the competition for the European project allowed Sinergia to rethink its positioning within the regional business landscape as a technological partner – and not only as a broker or mediator - in I4.0 projects. Before *"in the 4.0 part, thus far our historical customers did not perceive us as potential partners because we haven't even proposed to them with all the 4.0 activities."* (Founder and Senior partner). After winning this project initial contacts have been launched with leading local industrial firms in traditional sectors for possible technological consultancies in the I4.0 domain.

In the words of one of Sinergia founders, the company has been able to *"achieve the creation of an ecosystem of collaboration with universities"* that has fostered, at the beginning, the integration of internal and external competences of the company creating stable links with business/non-business actors, in a logic of open innovation. The open innovation approach adopted by the company has also been recognized as a best practice in the business community (Website Osservatorio Open Innovation e Corporate Venture Capital, 2021 **https://osservatorio-openinnovation.it/**).

Becoming a I4.0 technology provider has been a difficult and complex process for Sinergia. A key role has been played by the strategic partnership with PUM. In the words of the Sinergia founder: *"[...]there is a special empathy and feeling with PUM Professor. Without that I would not have been able to accomplish this.* Sinergia perceives the Polytechnic of Milan – recently partnering with local industrial firms - as a main competitor, due to its *"large structure, also with an ecosystem of company spin-offs"* (Founder and Senior Partner). Therefore, Sinergia has recently reorganized its corporate governance and is planning to setup an *ad-hoc* start-up jointly with PUM (Website Osservatorio Open Innovation e Corporate Venture Capital, 2021 **https://osservatorio-openinnovation.it/**) to effectively manage current and future projects related to Industry 4.0.

The critical event DeepReality project represents the synthesis of both organizational and technical resources previously developed and assembled by Sinergia (figure 12 depicts Sinergia's innovation path). In fact, leveraging on business units and relationships previously created, Sinergia has developed technical resources such as the SDK for AR applications and programming languages, equipment, computational technologies, and clouds.

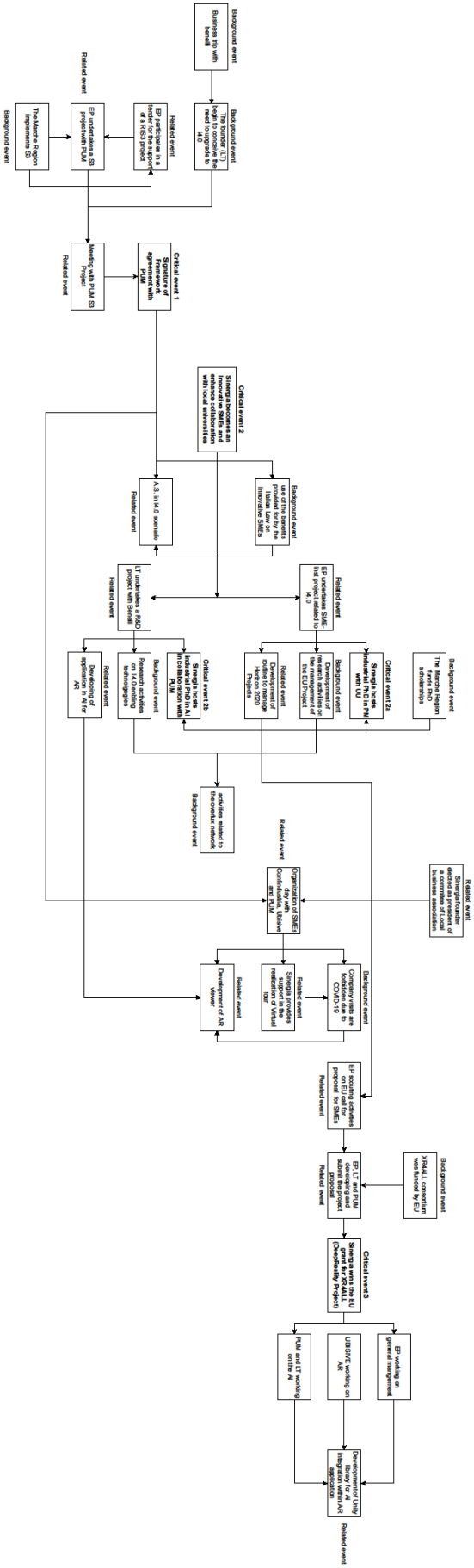

Figure 12. Event based innovation path.

5. Discussion

5.1. Event based Analysis

The case analysis provides useful evidence and insights to address the research question and allows to discuss resource development processes in the innovation path of a small consulting firm in the I4.0 setting. Drawing on Purchase et al. (2016), the coding of critical events highlights the embedded and temporal nature of the innovation path undertaken by Sinergia – in connection with the development of the network around them (Hedaa and Törnroos, 2008). The use of the 4Rs shows how the innovation path followed by Sinergia has led to a process of resource assembly (Håkansson and Waluszewski 2002; Arthur and Polak, 2006). Table XIV details the resources developed along the identified stages.

The innovation path begins with the recognition by Sinergia of the need of searching partners and activating business relationships for the purpose of developing resources in the I4.0 setting. It is apparent the emergence of a strategizing approach (Freytag et al., 2016) related to a new pursued positioning in the local/regional networks where Sinergia is embedded (Gadde et al., 2003). The company founder Flavio has become aware of the need to adopt and implement an "open innovation" logic in order to achieve this goal, through making new contacts and "re-activating" relationships established in other contexts (Hurmelinna, 2018).

This phase is characterized by the critical event related to the establishment of a framework agreement (Mouzas and Ford, 2012) with PUM for the purpose of I4.0 cooperation. Business relationships with local selected actors in the local academic and business setting - already familiar and active in the I4.0 trajectory - allowed to tap into valuable technological and managerial resources. In terms of technical resources, the critical event led to the development of new products, such as the Prototype of an Advanced system of I4.0 solutions for proximity visualization of technical product sheets, and of facilities in the form of software, cloud, and computational technologies. The first critical event had a major implication also in terms of organizational resources. The relationship developed with PUM in the I4.0 domain led to the establishment of an off-site business unit between LT and PUM devoted to R&D activities. Therefore, this initial phase shows the emergence of *"resource-oriented networking"*, as Sinergia has been keen on searching and activating business relationships with key local actors in the I4.0 setting.

The second critical event is related to the strengthening of collaboration of the company with local universities, following its new status of Innovative SMEs. Notably, new partnerships emerge with local universities, PUM and UU, through the launch and implementation of industrial PhD projects. Two main patterns emerge in this phase. Firstly, the PhD students involved in the joint

industrial projects started to play a main role in terms of technological and managerial competences thanks to the learning process implemented in their universities and in the companies where they have been involved (Fremont et al., 2019; Ciarmatori et al., 2018). Secondly, within Sinergia there has been an effort in integrating technological expertise and project management skills developed in two internal Business Units (LT and EP) to better address I4.0 projects. The second critical event resulted also in the development of products as the prototype of an AI based workbench for quality control and of facilities for the management of the full data lifecycle (i.e., RGB high resolution camera, industrial lamps, pre-trained neural net, and object-oriented database).

In terms of organizational resources this event has allowed for the establishment of joint PhD positions in Artificial Intelligence and Project Management, reinforcing the already existing relationships with PUM and UU, leading to the development of shared organizational routines for carrying out projects. The newly developed industrial PhD positions represent channels for stronger interaction and knowledge exchange between academia and business (Rubach et al., 2017). Therefore, the second phase is characterized by *"hybrid resource development"*, as the joint technical resources development is shaped by the emergence and consolidation of inter-organizational resources represented by the PhD positions.

The third critical event is represented by Sinergia successfully participating in a highly competitive European call for proposal on I4.0 related technologies, which has led to the implementation of the DeepReality project. In terms of product offerings, the innovation path undertaken by Sinergia has led to the development of an SDK specifically designed to allow a smart and agile integration of Artificial Intelligence and Deep Learning algorithms within AR applications. This development allowed the autonomous execution of two types of tasks: object detection and generation of 3D content directly within Unity3D (for testing) or in near-real time within the AR application using Deep Learning. Facilities in the form of programming languages, equipment, computational technologies, and clouds have been key in this critical event. Sinergia has been active in exploiting unexpected opportunities – as the start of a collaboration with the software company Ubisive, in order to integrate valuable technological expertise. The result of this initial collaboration has been the development of an application for smartphones connected to an AR viewer arising from the need to realize a virtual tour within the SMEs Day, as in-person visits were forbidden due to COVID-19. Success in the DeepReality project has been based on the further integration of the EP and LT business units within Sinergia and on the strengthening of relationships with both the scientific (PUM) and technological (Ubisive) partners. On the one hand, the LT business unit was rich in technical skills in its sector of reference, however it lacked the knowledge to autonomously monitor, identify, and eventually respond to the European calls for proposals which represent one of

the main sources of funding for innovation projects undertaken by SMEs. Therefore, stronger cooperation in this field with EP and PUM has been crucial. On the other hand, the interaction between the company and its network of partners composed by universities and specialized software houses (Tödtling et al., 2006) has made it possible to develop a set of tools for software development. In relation to the DeepReality Project, a new tailored organizational unit has been established for the project lifetime (February 2021 - August 2021) in the form of Project Management Office (PMO) of the consortium, involving the company, the University and Ubisive. This third phase is thus characterized by *"resource assembly"* within both intra and inter-organizational settings, building on the resource structure developed across the two previous critical events.

5.2. Resources in Industry 4.0 Domain

Therefore the empirical analysis highlights how continuous interaction fostered the development of technical resources in terms of prototypes of I4.0 solutions (i.e., creation of a structured service on digitalization and I4.0), of facilities (software, tools for software development and computational technologies held by Sinergia and University partners) and organizational resources such as PhD positions, European project management expertise, company and individual reputation and of key business relationships (with PUM, UU and selected business partners and local institutions).

It is worthy to notice that within the I4.0 domain, the link between physical resources - products and facilities - and intangible resources is as close and interdependent as ever in the light of the concepts underlying I4.0 paradigm such as Cyber Physical Systems (Lee, 2015; Xu and Duan, 2018) and Internet of Things (Falkenreck and Wagner, 2018) that refer to systems that combine physical dynamics with computational procedures, also described as an orchestration of computers and physical systems. In fact, differently from "traditional" IT systems defined as artefacts used to create or transform products and information (Baraldi 2003; Baraldi and Waluszewski 2005) - within the I4.0 domain developers have to manage physical aspects and computational and organizational processes in a completely new integrated way, in order to fully enhance the potential of the enabling I4.0 technologies (Lee, 2008). Computational procedures - defined as blocks of code that perform a specific task without human intervention - constitute the so called *"behind the curtain"* elements (Baraldi, 2003: 3) that affect a wide range of physical structures or devices through feedback loops (Falkenreck and Wagner, 2018). From the provider/developer perspective, computational procedures represent products developed by organizational units using facilities - such as physical computer technology and software - to create or reconfigure a facility in the house of the user, who, in turn can

affect both the physical and organizational resources of the provider by making use of it. If we consider products and facilities in the I4.0 context as “cyber resources” as defined in the computer science domain (Ross et al., 2021), eventually these resources show different characteristics compared to the IT systems and physical resources in more traditional settings. With respect to the former, computational procedures represent the procedures or routines inscribed in IT systems that allow them to mimic the behavior of a business unit (Baraldi and Waluszewski, 2005) with higher standard of reliability and predictability; with reference to the latter, computational procedures require low investments also in the light of their open-source nature, being therefore more suitable for SMEs. Such computing procedures are not physical items and have not very clear physical properties (Håkansson and Waluszewski, 2002).

In synthesis, Sinergia’s innovation path is characterized by three patterns in terms of resource development: i) resource-oriented networking, ii) hybrid resource development and iii) resource assembly. Resource-oriented networking was initiated by Sinergia to connect with the technological frontier in I4.0 and it is characterized by the development of strong organizational resources and by the internal technical expertise of the company. Hybrid resource development allowed for setting up a joint resource structure with key partners, based on a system of relationships with actors from business and academia to explore and exploit the opportunities of I4.0 (Sjöö and Hellström, 2021) by leveraging managerial skills and pooling the know-how of all partners. Lastly, resource assembly resulted in achieving the ability of effectively combining internal and external resources in new configurations with a strategizing view (Lind et al., 2012; Ciabuschi et al., 2012). Sinergia has pursued an innovation path where the development of organizational resources represented the setting where scientific and technological resources could be accessed, developed, and then assembled in key projects.

It can be argued that the result of this path is the shift in the role played by Sinergia from *knowledge broker* to *solution provider* in the highly competitive I4.0 setting. This process is characterized by a strong networked nature, as shown by the building up of a “local inner network coalition” composed by Sinergia and its local business and non-business partners – perceived as an “ecosystem of collaborations”. Sinergia has implemented a localized open innovation approach involving key partners recognized for their expertise in the I4.0 context.

Becoming a solution provider has meant – in the perception of Sinergia – a rethinking of its positioning within its business landscape as a technological partner, pursuing a distinct "identity" in the I4.0 context at the local/regional level (Hervas-Oliver et al., 2019; Baraldi et al., 2020; Huemer, 2013). The identity building process has been shaped over time by the strategic alignment of the

company with its key partner - the PUM research group on robotic vision and artificial intelligence - in the innovation path.

It should be highlighted that this key business relationship has been shaped by the strengthening of personal ties (Granovetter, 1973; Halinen and Salmi, 2001) between the head of the LT department and the PUM Professor. The existence of personal trust and esteem – leading to stronger reputation (Musiolik et al., 2012) - has been itself a key resource (Baraldi et al., 2012), which allowed for the mobilization of valuable technological and organizational resources.

Critical event	**Technical resources**		**Organizational resources**	
	Products	Facilities	Business units	Business relationships
1	Prototype of an Advanced system of I4.0 solutions for proximity visualization of technical product datasheet	Software for Mobile application development (Xamarin - AltBeacon) Microsoft Azure cloud (Microsoft AppCenter) Computational physical Technologies (Beacon BLE)	Sinergia: LT department PUM LT and PUM: Off-site BU devoted to R&D activities	PUM
2	Prototype of an AI based workbench for quality control	RGB high resolution camera Industrial lamps Pre-trained neural net Object oriented Database Computational technologies Labs	Sinergia: LT department Benelli: QC PUM: PhD position in AI UU: PhD in PM Local Business Association PUM UU	Benelli PUM Ubisive Local Business Association Overlux UU
3	AR Viewer for Virtual tour (Application for smartphone and physical product) Software Development Kit	Software for mobile application development Physical viewer Unity3D environment, Python programming language Google Colab, Microsoft Azure Android and iOS Smartphones Computational technologies	Sinergia: LT, EP departments Ubisive PUM: PUM PhD position in AI UU: PhD position in PM PMO of the XR4ALL consortium	Ubisive PUM UU XR4ALL consortium

Table XIV. resource Development along the identified stage

6. Conclusions

This study aims to explore the resource development process implemented by a small consulting firm, active in a traditional industrial context, in its I4.0-related innovation path. Through critical event analysis (Purchase et al., 2016) and the adoption of the 4Rs model (Baraldi et al., 2012), the case study analysis highlights a transition from knowledge broker to solution provider, based on a process of networking, with a relevant strategizing effort, and of assembling internal, external, and shared resources. Notably, this research shows the emergence of three main patterns in the evolution of the innovation path: resource-oriented networking, hybrid resource development and resource assembly. Within this process, having a strong networked nature, the development of key organizational resources – business relationships with local leading actors, hybrid organizational units, a corporate identity increasingly related to I4.0 - provide the context for the development and combination through interaction of technological knowledge and resources with the contribution of key scientific and technological partners.

This research provides a contribution to the growing literature on adoption of I4.0 solutions (Frank et al., 2019; Hervas-Oliver et al., 2019) analyzing the perspective of the solution provider and notably of small consulting firms active in traditional industrial contexts. Undertaking I4.0 projects could be a challenging task for those firms and organizations supposed to help and support industrial firms and notably SMEs. Specifically, this study contributes to previous studies on localized innovation processes in I4.0 (Pagano et al., 2021; Götz and Jankowska, 2017) by exploring the innovation path pursued by a specific actor – a small consulting firm – in connection with the local business networks.

The case analysis also contributes to IMP literature in the context of Resource Interaction both from a methodological perspective and from a theoretical standpoint.

For what concerns the methodological contribution, by adopting a processual perspective (Halinen and Törnroos, 2005) over the resource development process within the innovation path by means of events (Purchase et al., 2016), has represented a useful research tool to capture processes and dynamics in the context of business networks evolution. Notably, the critical event analysis allows to effectively develop the resource interaction model by highlighting how technical and organizational resources have been developed and assembled in the key identified events. Events do not only allow to reconstruct the innovation path pursued by Sinergia but especially to focus on the entire resource development and combination process regarding I4.0 enabling technologies whose value eventually emerges during their utilization applied to specific tasks involving other resources.

Taking the second point, the paper sheds light over two interrelated issues as called by Bocconcelli et al., 2020. Firstly, the study adopts the 4R model in a highly complex technological context, characterized by fast-paced changes. Building on existing IMP studies dealing with resources in the IT context (Baraldi, 2003; Baraldi and Waluszewski, 2005), this research contributes by showing how the increasing technological complexity of these systems brought about by I4.0, and characterized by a collaborative and open-source nature, requires a much stronger interaction between technical and organizational resources. While the category of organizational resources has been further conceptualized, encompassing a wide range of elements as trust, reputation, identity, the category of technical resources, in terms of products and facilities, calls for an additional theorization since, as shown by the present empirical analysis, its boundaries appear as blurred in the I4.0 domain. In fact, at the light of both fast technological changing and, I4.0 paradigm which allows a greater interdependence between physical and computer systems/computational procedures, some technical resources appear difficult to be categorized exclusively as products or artifacts, as they can be considered as products developed by organizational units, using facilities to create or reconfigure a facility through its deployment made by the users, thus changing the way value is generated within interactive business relationships.

Secondly, the new emerging resource structure in the I4.0 domain, characterized by a process of networking and assembly of internal, external, and shared resources following an open innovation logic, leads to changing roles of actors within the network in which they operate (Hedaa and Törnroos, 2008). The changing role of actors in the network is apparent in the second and third critical event and it is closely related to emerging technical resources related to I4.0, which resulted in both the achievement of the DeepReality project coordination of Sinergia and, in the new positioning as a provider of I4.0 solutions within the local context.

6.1. Implications and limitations

The empirical research undertaken in this paper has various managerial implications for small consulting firms active in the I4.0 setting. The first one concerns the key role of "business networking" activities (Rusanen et al., 2014) in order to effectively navigate into multiple networks, shaped by different logics - business, University and European institutions - and embedded in a regional context which is not "core" in the IT and I4.0 context. For a small consulting firm pursuing a I4.0 positioning in the market represents a great challenge requiring managerial vision and capabilities. Secondly, this effort requires setting up an appropriate organizational configuration for developing I4.0 projects in order to maintain over time control and access to key technological

expertise, in a context where there is a strong competition for this type of resources, by both large industrial and service firms and by leading Universities and Research centers. Thirdly, participation in small-scale I4.0 projects funded by the European community with the objective of producing open-source software could represent one of the most suitable models for smaller consulting firms to verify both the commercial viability of a product and the possible support of the community of developers, while ensuring a stronger control over intellectual property rights of the innovation proposed.

This research also entails relevant policy implications. The diffusion of I4.0 technologies is shaped by the involvement of industrial firms – often operating in traditional and medium-technology sectors – in dynamic innovation networks where a variety of knowledge brokers and providers are active. Local small/medium consulting firms in the last decade have been increasingly partnering with industrial firms in their technological and organizational upgrading processes. It could be useful to devise appropriate policy mechanisms to make this cooperation more stable and oriented towards innovative technologies as those related to I4.0, with the involvement of universities and research centers. As the Sinergia case shows, joint Industrial PhD projects could represent key mechanisms to transfer and combine knowledge in these industrial settings.

Moreover, this study emphasizes that the I4.0 setting is much more than what is assumed from a policymaking perspective. The general policy interpretation of this phenomenon is strictly connected to its tangible dimension, seeing I4.0 as a process of technology transfer and adoption. Recently, there has been a shift towards the intangible features of I4.0 implementation, in terms of enhanced collaboration among "triple helix actors" (Reischauer, 2018). We argue that a resource interaction view could provide a useful perspective of the business and institutional context where I4.0 projects – often having an inter-organizational dimension – and their localized learning processes are implemented.

This study does not come without limitations. The present research accounts for the perspective of the small solution provider in the I4.0 context and for its network of partners in the innovation process. Thus, while the focus is on the producing and developing settings, the main limitation of the study is that it does not investigate in depth the using setting. A future interesting research avenue could be adopting a full DPU lens, focusing on the three embedding settings of "developing", "producing" and "using" (Håkansson and Waluszewski, 2007; Ingemansson and Waluszewski, 2009).

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CHAPTER IV

The role of SMEs – consultant relationship in Industry 4.0 related European project[5]

Abstract

The purpose of the present paper is to give a contribution in SMEs and Euroepan Projects literature by exploring how interaction between SMEs – consultancy company affected the development process of European funding projects related to Industry 4.0 enabling technologies. In line with the explorative nature of the research question, a multiple case study analysis is performed by taking into consideration three SME-Instrument projects undertaken by SMEs with the support of consulting firm Sinergia, adopting the actor-resource-activity (ARA) model as theoretical framework.

Keywords: Project management, SMEs, European Project, Network, Industry 4.0

1. Introduction

Small and Medium Sized Enterprises (SMEs) account for 99.8% of all firms in the EU-28 non-financial business sector (European Commission, 2020) contributing to economic activity in terms of employment, innovation and growth although constrained by some characteristics such as limited financial capability and fund-raising ability. Thus, they constitute the most relevant target for European Union's effort to create competitive entrepreneurial structure (Floyd & McManus, 2005) through the implementation within framework programmes, such as Horizon 2020 of ad-hoc financing scheme.

One of the main investment areas for the European community (Smit et al., 2016), supported by FPs for research and technological development (Muscio and Ciffolilli, 2020), concerns the adoption of Industry 4.0 (I4.0) enabling technologies by SMEs. In fact, the difficulties related to the exploitation of the potential of I4.0 by SMEs (Neirotti and Raguseo, 2017), have imposed European policymakers to adopt an economic policy strategy aimed at accelerating technologies and digital transformation with the aim of strengthening competitiveness through the continuous convergence of real and virtual world (Kagermann, 2015) in different industries.

[5] Please note that this chapter largely presents extract from the following Conference Paper: Mersico L., La Rocca, A., Perna, A., Pagano, A. (2020, September 3-4). Startup-Consultant relationship in European funding application. 36th Annual IMP Conference 2020, Örebro, Norway.

Over past years, FPs have been extensively discussed in academic and policy maker literature mainly from an economic perspective assessing their impact on innovations and economic performance of SMEs (Barajas et al., 2012; Blažková, 2016; Čučković and Vučković, 2018). While recent contributions on I4.0 have placed attention on I4.0 diffusion, in terms of public support and knowledge dissemination processes (Hervas-Oliver et al., 2019; Pagano et al., 2021).

According to EuroPM, a jointly initiative of the three Project Management Institute Italian chapters aimed to develop best practices of Project/Program/Portfolio Management in the European Project Design, the process characterizing the access to European funding is complex and quantitative relevant in terms of funds granted. SMEs although are generally rich of technical skills in their sector of reference present a lack in knowledge and skills to autonomously monitor, identify, and eventually respond to the announced calls for proposals. In fact, EU funding projects representing in this sense resource-intensive activities as they are (sometimes) undertaken in partnership between several countries or companies involving a large number of stakeholders and are constrained by the call (Project Management Institute Italy Chapters, 2019).

The need for support of SMEs in finding out and responding to these calls has been noted by consultancy companies specialized in helping the companies' potential applicants, in different activities, from identifying EU funding opportunities, finding partners and developing the project application for EU funding. However, also these consultants depend on SMEs in carrying on their work as they have only limited knowledge of the specific content and context of SMEs' projects. As argued by Nikolova et al. (2009), quality and intensity of client-consultant interaction is one of the factors that has the greatest impact on the success of projects. Interaction between SMEs and consultant is thus key for the application to take shape, but we have limited knowledge on how this happens in practice and how this affects the EU funding application process and its outcomes.

This paper aims to give a contribution in the literature on SMEs and EU funding projects with particular reference to I4.0 related projects by exploring how interaction between SMEs – consultancy company affected the development process of EU funding projects related to Industry 4.0 enabling technologies. Notably, focus is on three projects undertaken between SMEs and a consultancy company as they cooperate to get funds from European Funding Programmes (FPs) since these represent an increasingly attractive source of funding for SMEs. Particularly, the research question has been formulated as follows:

> *RQ:* How is the European Funding application for I4.0 Projects affected by the interaction between SMEs and the consultancy firm?

In order to address this RQ, this paper adopts the Industrial Marketing and Purchasing (IMP) perspective, which stresses the role of business relationship and interactions at actors, activities and resource level (Håkansson, 2009). Within the IMP approach the analysis of inter-organizational business relationship and their consequences is conducted by the use of the ARA model (Håkansson and Snehota, 1995; Håkansson, 2009; La Rocca et al.,2017). The ARA model highlighting the role of a) actors, as interconnected nodes embedded in a network; b) activities implemented by actors; c) resources activated and combined is aimed to turn visible adaptations, mutual orientations, and interdependencies across three interacting layers of activity link, resource ties and actor's bond. The ARA models allow to understand the consequences of interaction between SMEs and consulting firm within complex projects such as I4.0 related, as in recent studies of interaction in time-constrained relationships (Kronlid and Baraldi, 2020).

Thus, the analysis of the emergence and development of the relationship between SMEs and a small consulting firm within European funding Projects provides a contribution to the IMP literature on SMEs and European funding projects regarding the specific case of SMEs European funding projects related to I4.0.

Given the explorative nature of the research question, this paper adopts a qualitative methodology based on a longitudinal multiple case study (Yin, 2009, Aaboen et al., 2012). The empirical investigation concerns three SME-Instrument phase I project related to Industry 4.0 enabling technologies undertaken by SMEs with the support of the consulting firm Sinergia. Empirical data were gathered through both participant observation and the conduction of semi-structured individual in-depth interviews with relevant stakeholder involved in the projects under analysis.

The paper is articulated as follows. In section 2 the background literature is discussed analyzing contributions on SMES and European Funding and Project management, SMEs, and network. Section 3 addresses the research methodology, while in section 4 the multiple case analysis is provided following a processual perspective in order to highlight the key steps and the evolution of the relationship among the partners. Section 5 discusses the case by addressing the research question. Finally, Section 6 presents the conclusion.

2. Theoretical background

2.1. SMEs and European funding

Recent studies on SMEs and European funding recognized that financial constraints play a crucial role in the development of innovation by SMEs (Cecere et al., 2020; De Marco et al., 2020). In fact, while theoretical economic principles consider the decisions of the firm as unaffected by its financial structures and its financial policies, there are some institutional and normative conditions, or simply operational practices, that lead SMEs to make different financial choices from large enterprises, due the existence of constrains in terms of financial resources (Freel, 1999).

Many empirical studies have been validated that the factors most frequently mentioned as limiting innovation (Radas and Bozic, 2012) are financial constraints and the high innovation development costs (Canepa and Stoneman, 2008; Mohnen et al. 2008; Hall & Lerner, 2010)

However, innovation is more important for SMEs due that in their effort to become and remain competitive, SMEs rely on innovation to a greater extent than large firms (Sweeney, 1983; Fritz, 1989) and thus become a strategical players in the process of innovation development (Floyd and McManus, 2005; Heimonen, 2012; Cecere et al., 2020) since they are more willingness to take risks (Hall et al., 2009), flexible, dynamics, efficient and close to market (Hewitt-Dundas, 2006) than their larger counterparts.

As a consequence, the European Union has put in place several policy measures to address these perceived 'market failures' in the provision of finance for R&D activities by SMEs (Storey, 1994) such as the Research Framework Programmes (FPs).

FPs started in 1984 with the aim of ensuring the technological competitiveness of European industry, especially high-tech industry (Roediger-Schluga and Barber, 2007) have evolved considerably in terms of objectives and design to become the main policy instrument for coordinating R&D activities funded by the European Commission (Barajas and Huergo, 2008).

To date, there have been 8 editions, the last of which, called Horizon 2020, with a budget of € 80 billion (Kim and Yoo, 2019) is the largest R&D program of the EU (Arsić et al., 2015) aimed at promoting research excellence in Europe and to achieve this ambitious goal, it supports high-risk basic and applied research (Ciffolilli and Muscio, 2019) representing in this sense the policy instrument designed to overcome the logic of market failure (Radicic and Pugh, 2017) i.e. to lower the costs of private R&D and innovation activities and/or to increase the payoff from knowledge creation (Smith 2000).

As highlighted in both Radicic and Pugh (2017) and Ciarmatori et al. (2018) existing studies on SMEs and European Funding highlight economic and technological benefits of participation of SMEs in EU-funded activities aiming to examine the impact and effectiveness of public policy measures on innovation of SMEs as policy interventions need to be sensitive to the differences between SMEs, rather than adopting a one-size-fits-all approach (Juergensen et al., 2020). In fact, as empirically verified EU support yields indirect behavioral benefits on the long run favoring both an increasing cooperation such as the establishment of consortia led by the most reputed SME (Barajas et al., 2016) which favors the management of the intellectual property rights on the innovation resulting from the projects (Barajas et al., 2012) and the promotion of infrastructural matters such as improvement of skills and training of personnel (Luukkonen, 1998).

Thus, literature on the impact of European R&D policies on firms' innovation behavior mainly focused on input additionality and crowding out effects of subsided R&D (Radicic and Pugh, 2017) as in Czarnitzki and Delanote (2015) which analyzed the effect of subsidies on both R&D input and R&D output is compared between different types of SMEs or in Barajas et al. (2012, 2016) that analyze whether R&D consortia supported by the SME-specific measures under the FPs have a positive impact on SME economic performance and, in Čučković and Vučković (2018) examine the impact that integrated financial support programmes and instruments under Horizon 2020 have on promoting research and innovation in the SME sector.

Moreover, also reports provided by the policy maker, in line with the results provided by Radicic and Pugh (2017) are mainly focused both on the assessment of the FPs based on criteria of effectiveness and efficiency (European Commission, 2016, 2019; Executive Agency for Small and Medium-sized Enterprises, 2015, 2018) and on policy implication (Padilla et al., 2018) neglecting the managerial aspects.

However, as well as *"Program activities take often the form of projects, which comprise tasks and goals in multiyear plans involving companies, institutions and other organizations based in a variety of countries"* (Ciarmatori et al., 2018: 1) also the firms' innovation activity with the support of public intervention usually takes the form of projects (Arranz and Fdez de Arroyabe, 2009).

As already mentioned, European projects are complex projects as they are undertaken in partnership involving a large number of actors as well as being constrained by the tender (Project Management Institute Italy Chapters, 2019) and although there are increasing evidence on SMEs participation in projects within FPs (Vossen, 1998) less is known on the methodologies and practices that they adopt in order to manage it.

2.2. Project Management, SMEs and Networks

Despite the increasing interests on SMEs in managerial and policy maker literature and the relevance of the Project management approach in companies and organization (Morris & Jamieson, 2005), few publications on Project management and SMEs existing in literature (Turner, 2010; De Almeida Parizotto et.al, 2020). In fact, results of a bibliometric analysis conducted by De Almeida Parizotto et.al (2020) on a sample of 235 published articles from 1996 to 2016, shows the presence of 17 articles receiving the 47% of the total citations. Those articles referable to studies on the adoption of PM practices in SMEs, lying outside of the overall pattern of distribution represent outliers, which according to Fanelli and Glanzel (2013) provide insight on the high-end of research performance and thus deserve special attention.

Thus, the research path delineated by a series of articles of Turner, Ledwith and Kelly (2010, 2012) in response to the calls of Murphy & Ledwith (2007), started from a series of empirical studies aimed to identify the best practices already used and the needs of European SMEs. Authors highlighted the importance of investigate to what extent SMEs undertake projects employing PM techniques placing emphasis both, on the nature of the projects they do and on categorization of SMEs.

Turner et.al (2010,2012) found that, although exists a *"wide use of project management for innovation and growth projects"* (Turner et al., 2010: 754), the adoption of both PM practices and dedicated organizational structure is affected by factors such as the typology of project undertaken, the size and the age of the firm. Thus, they highlighted as *"Smaller and younger companies will be less likely to employ dedicated project managers, and less likely to adopt identifiable project management practices"* (Turner et al., 2012: 954) arguing that firms adopt PM practices that fit the typology of projects they do (Barth, 2003). One of the misconceptions about projects is, indeed, that all projects are the same or using a common expression *"one size fit all"* (Shenhar, 2002). For instance, the case of innovation projects undertaken with the aim of increase competitiveness, while representing one of the most important growth factors (Carvalho et al., 2018) in the case of SMEs, at the same time represents a challenge due the various constrained they are affected. In fact, as mentioned in the previous sections, SMEs to make different financial choices from large enterprises with respect to R&D projects and in the case of the European SMEs, one of the first resource available are provided by the European funding programme such as Horizon 2020.

In this sense the limitation underlying the recurrent pattern in "traditional" PM literature that conceptualize project as an isolated phenomenon, has led to some fundamental changes spreading its

scope of analysis to the historical and organizational context merging into the stream of research summarized in the expression "no project is an island" (Engwall, 2003).

In fact, "traditional" PM literature and PM body of knowledge considering the project as unit of analysis seldom discuss it in relation to surrounding organizational structures and routines and thus does not provide a useful way of framing projects in their inter-organizational setting. In fact, as highlighted in Aaltonen & Sivonen (2009) not take into account the interaction within the project network of various actors which should be causes uncertainties due to *"network effects such as dependence on other actors; interest asymmetries; different identities; missing information; information asymmetry within the network; social and institutional risks, network risks; trying to behave rationally, and; risk management procedures that do not fit into a networked context"* (Artto and Kujala, 2008: 478).

By the way, the IMP-related studies, such as Ciarmatori et al. (2018) and Kronlid and Baraldi (2020), with both their emphasis on relationship and interaction pattern between actors, resources and activities, and their view of a project as *a "temporary resource constellation and activity pattern in which the actors form a distinct logic in how to learn and develop new solutions in relation to each other"* (Havenvid Ingemansson et al., 2016: 86) provide a useful framework in which analyze both the historical background and the organizational context of project stressing the role of interconnectedness between actors, in line with the ideas underlying the definition of project network provided by Hellgren and Stjemberg (1995) namely*, "1) a set of relations where no single actor may act as legitimate authority for the network as a whole, 2) where the network is open in the sense that there are no definite criteria by which the boundary of the network may be identified and controlled, and 3) where the network is temporally limited, dynamically changing and (partially) reconstructed from one project to the next"* (Hellgren and Stjemberg, 1995: 379). In fact, within the IMP approach, interactions at actors, activities and resource layers occurring within and across the single project shows the existence of two connected levels namely, temporary network and permanent network (Ciarmatori et.al., 2018).

Thus, the project network can be viewed as an inter-organizational form at the same time influenced and influencing individual projects (Baraldi and Ingemansson Havenvid, 2013). In Manning (2010) is highlighted as project network raises from the application of relational practices that serve as building block to develop and maintain project-based relations with partners over time.

Based on those theoretical backgrounds, this study aims to exploring how interaction SMEs–consultancy company affected the development process of EU funding projects related to I4.0 using the ARA model to analyze inter-organizational interactions by focusing on activity links, resource ties and actor bonds with the aim of understand the pattern of interaction at relationship level as

already adopted in other IMP studies such as Kronlid & Baraldi (2020). The ARA model has been applied to in order to understand a) activity links that emerge when the organization are involved in the changeset of their activities to improving efficiency (Håkansson and Snehota, 1995); b) resource ties emerging form the resource combination process in order to address the specific needs of both parties (Baraldi et al., 2012; c) actor bonds that connect single individuals or subunits of the organizations involved (Håkansson and Snehota, 1995). Thus, the use of ARA model in the process of development of EU projects related to I4.0 allows to disentangle interaction and its consequences on the outcome of the projects.

3. Research Methodology

In this section, methodology used in the empirical study is discussed. Given the explorative nature of the study, this paper adopts a qualitative research methodology based on a multiple case study approach (Yin, 2009) aiming to uncover the main interaction processes in EU funding projects undertaken between three SMEs and a consultancy company.

The multiple case study methodology is chosen because it represents a strategy *"particularly suitable when dealing with research questions that try to identify some behavioral aspects of companies' actions"* (Tunisini et al., 2011: 1014). In fact, it is particularly relevant to understand "actors, interactions, sentiments and behavior occurring for a specific process through time" (Woodside and Wilson, 2003) within real-life context in absence of clearly defined boundaries between the phenomenon, object of the empirical inquiry, and its context (Yin, 1994).

In this way, multiple case study is emerged as one of the most suitable methodologies in Industrial Marketing approach (Aaboen et al., 2012) due to the nature of phenomena investigated, namely, the consequence of continuous business relationship between organization (La Rocca et al., 2017) embedded in complex reticular structure.

However, although IMP perspective is focused on long-term business relationship, a project undertaken in collaboration between organizations represents a case of time-constrained inter-organizational interaction, which poses some methodological challenges referable to the temporality and time (Kronlid and Baraldi, 2020). To deal with those question, from one side a processual perspective is followed with the aim of highlight the key steps and the evolution of the relationship among the partners, From the other a data collection method based on participant observation has been used as already adopted in similar IMP studies (e.g., Hoholm and Olsen, 2012).

Notably, the case study is aimed to uncover the main interaction processes within three different European SME-Instrument phase 1 projects related to Industry 4.0 enabling technologies.

SME Instrument is one of the funding schemes of the Horizon 2020 program dedicated to SMEs (Aster, 2016) and/or consortia of SMEs located within the European Union or in countries associated with Horizon 2020 that wish to develop product, process or business model innovations in order to increase competitiveness in international markets. Managed at European level by the Executive Agency for Small and Medium-Sized Enterprises (EASME), it was launched in 2014, having a budget of about €3 billion (European Commission, 2015) and configuring itself as the tool able to fill the gap in innovation financing in the early stages, characterized by greater risk and uncertainty (Čučković & Vučković, 2018). It represents a cross-cutting instrument, in fact the SME Instrument budget is allocated in both "Leadership in Enabling and Industrial Technologies" (Pillar II) and "Societal Challenges" (Pillar III). Since 2018 it has been included in the Work Program 2018-2020 European Innovation Council (EIC) pilot (European Commission, 2018) with a budget of € 1.63299 billion.

These projects have been undertaken between Sinergia, a small local consulting firm also active in the support to the design and management of EU projects and a) Alfa, a small company based in Marche region, active in the development of artificial intelligence systems; b) Beta, a small company based in Marche region, active in the sales and imports of electromedical equipment for diagnostics and monitoring of cardiovascular system; c) Epsilon, a small firm based in Emilia-Romagna operating in the ICT for tourism sector.

These projects have been selected according to the following criteria: a) the complex nature of the product/service, as the three companies were involved in the development of projects related to the enabling technologies of Industry 4.0; b) they are SMEs; c) they have undertaken the project with the support of Sinergia consultancy company; d) the chance of following the entire process of the application.

As mentioned above, data collection (Table XV) is primarily based on participant observations. One year were spent within Sinergia by the author. The use of this data gathering method has allowed to observe the process as well as it has happened (Hoholm and Olsen, 2012). Over the period, secondary data in form of reports, drafts of the proposals and e-mail messages, have been collected with regard to the activities conducted for the duration of the project. Those data are however not public due the non-disclosure agreement signed between the parties. In addition, as shows in table 1, 8 open ended interviews (Table XVI) have been conducted with the Sales Manager in Alfa (2), the R&D Engineer in Beta (1), the tourist consultant in Epsilon (1), the Responsible of EU projects in Sinergia (2) and a University Professor cooperating with the projects (1). All

interviewed people have been involved in the projects from the beginning until the end. The interviews questions are designed in order to understand from one side, the background of the project, from the other its dynamics over time. Each interview has been recorded.

Considering data analysis, the recorded interviews and the secondary data gathered have been triangulated with the aim of examine the consistency of the different data sources. In fact, the use of triangulation supports the qualitative research strategy testing validity through the convergence of information from different sources (Patton, 1999). Thus, data have been analyzed comparing concepts such as actors, activities and resources provided by the ARA model, which was developed with the aim of analyze inter-organizational interactions focusing on actors' bonds, resources ties and activity link (Håkansson & Snehota, 1995), structured along different temporal stages in order to highlight the key steps and the evolution of the relationship among the two partners, as already adopted in other IMP studies (e.g., Aaboen et al., 2012).

Activities	**Company/Institution**	**Period**
1. Participant Observation		
Internship	Sinergia Consulenze	April 2019 – September 2019 September 2020 – March 2021
2. In-depth Interviews		
Respondents		
Senior consultant	Sinergia Consulenze	2019, 2020, 2021
Professor of Computer Science (PUM) - Supervisor of Industrial PhD student in Artificial Intelligence	Polytechnic University of Marche	2020
Sales Manager	Alfa	2019
R&D Engineer and PostDoc Researcher in Bioengineering	Beta	2021
Tourist Consultant	Epsilon	2021
3. Archival Document		
Project ID		**Type of Document**
Project 1	Alfa Sinergia Consulenze	Drafts of the Project proposal EU evaluation Report
Project 2	Beta Sinergia Consulenze	Drafts of the project proposal EU evaluation Report
Project 3	Epsilon Sinergia Consulenze	Drafts of the project proposal EU evaluation Report

Table XV. Data Collection Process

Company/Organization/Institution	Interviewees	Number of Interviewees	Period
Sinergia Consulenze	Senior Consultant	3 (45 min; 1h, 27 min, 35 min)	July 2019/ February 2020/October 2021
Alfa	Sales Manager	2	March 2019
Beta	R&D Engineer and Postdoc researcher in Bioengineering	1	October 2021
Epsilon	Tourist consultant	1	October 2021
Polytechnic University of Marche	Professor of Computer Science (PUM)	1 (30 min)	March 2020

Table XVI. Interviews with key informants

4. Multiple case analysis

This section describes the case study. First a brief Company profile of Sinergia, Alfa, Beta and Epsilon and the background of the project will be provided, then the evolution of the EU Funding projects will be analyzed, distinguishing two sequential stages of the project: a) preliminary interaction; b) submission stage.

Notably, the submission stage consisted of five phases: 1) preliminary draft of the project, 2) development of the project proposal, 3) refinement of the project proposal, 4) submission of the final version of the proposal in the EU portal.

4.1. Sinergia company profile

Sinergia is a small consulting firm established in January 2005 and active in consulting services on EU projects (EP), Systems for Managerial control and Risk Management and Lean Technology (LT). Sinergia has a partnership with PUM for R&D projects in the area of Industry 4.0 and has gained experience in EU project management over the years with both public institutions and, large and small customer firms in a variety of sectors.

In 2013, a senior consultant with previous experience in the international field, currently a member of the board of directors, has been hired to manage the EP business unit.

Between 2018-2019 the incidence of the revenue of EU SME Instrument project design on total revenue for Sinergia was about 2%; thus, the service in itself was not strategically relevant, but it represented a preparatory phase to the actual management of EU projects, as highlighted by the Senior Consultant:

"We don't make money on the project design, but we do with the management of approved projects…therefore you have to help to design well, otherwise you don't win them" (Senior Consultant)

Thus, Sinergia is interested in selecting projects with more chances to be eligible for funding. Moreover, as emerged from the interviews, the senior consultant does not use a traditional PM methodology but has implemented his own method of project management at Sinergia.

"… I employ, I implemented (my) method…" (Senior Consultant)

Currently the EP business unit relies on a multidisciplinary team of 6 collaborators composed of engineers, economists and experts in international relations to support public and private organizations throughout the entire project life cycle (Website Sinergia Consulenze, 2022, https://sinergia.it/pe-progetti-europei-sviluppo-e-innovazione/).

4.2. Project 1: Case of Alfa

4.2.1. Case Context: Origin of Alpha and search for EU funding

Alfa was established in Pesaro (Italy) in 2016 as a small enterprise (innovative startup according to Italian Law), active in novel applications of artificial intelligence (AI) systems.

The founding team was composed by 4 co-founders with heterogeneous background: a Mechanical Engineer (Project Coordinator), an Electronics Engineer (Technical Manager) and two Chartered Accountants (Financial Manager and Legal Manager). In addition, a Sales Manager has been hired to manage the commercialization of the product - in cooperation with the Project Coordinator for the technical aspects – and to raise funds.

Since its origin Alfa has been financially supported by private investors, which were entrepreneurs experienced in the automotive and consumer goods industries oriented to diversify their

personal investment portfolio in AI- related projects. Therefore, it was a kind “Family and Friends" investment, as the investors were acquaintances of two of the co-founders.

The entrepreneurial idea was first developed in the Master Program thesis of the Project Coordinator as a matching platform for engineering services, evolving over time into an AI based service for technical and engineering design.

The main product developed by Alfa is a Design Support System (DesSS), a Software as a Service able to predict the design features in the process of development of new products, with potential applications in the fields of process control or optimization. The novelty in DesSS lies in the predictive approach, as it uses Machine Learning techniques accessing to different types of data. To develop its solution, Alfa implemented informal cooperation - exploiting previous personal contacts of two co-founders - with the Department of Information Engineering (DII) of Polytechnic University of Marche (PUM), for the development of algorithms and of the back end, and with a local high-tech company for the front-end of the software, whose involvement has been suggested by PUM partners.

The first marketable version of the software has been tested to predict the characteristics of new variants of electric motors (Design) with an Italian company operating in the design of electromagnetic devices. Other possible applications are process quality and sales. In this way, the software meets the needs of two main types of customers: manufacturing companies, engineering, and design studios.

A preliminary analysis of demand conducted by Alfa - in cooperation with the local University of Urbino - showed that DesSS might have about 2.5 million potential customers geographically in United States and Europe.

To obtain additional funds to enter the market and to gain an assessment of the economic and technical feasibility of their innovation, the founders, following the advice of a PUM professor partner, started considering funding through the EU program SME-Instrument Phase I,

In the meanwhile, Alfa attempted to collect financial resources - without success - also through “an Acceleration program" in the United Kingdom managed by an Italian business community. Obtaining the EU funding was therefore absolutely necessary to continue the startup activities. The financial support of the Regional Government - the so-called "voucher" for consulting services - to promote EU funding applications has been a key incentive to carry on with this option.

4.2.2. Preliminary Interaction (June-July 2018)

In order to assess the feasibility of the funding proposal within the SMEs Instrument 1 scheme, Alfa contacted a local consulting firm, Sinergia, following the advice of a PUM Professor partner.

The first meeting between Sinergia and Alfa aimed at analysing and discuss the project idea. The SME's aim was to gain access to the EU SME-Instrument to finance the commercialization of the DesSS, since the development of the product had exhausted the available funds.

For the preliminary analysis, two experts were involved: The Head of Lean Technology Department in Sinergia and the PUM Professor who acted as advisor to Alfa. During the meeting, Sinergia expressed some doubts about the innovativeness of Alfa's solution, but the positive assessment of PUM Professor, who plays often the role of EU Referee for Industry 4.0 projects, convinced Sinergia to collaborate with Alfa:

"From the point of view of the technology, I tend to ask the opinion of those who have expertise in the technology, because I cannot have expertise in tourism, health, industry, artificial intelligence …in this case the Professor of the university and he told me that it was a very interesting and innovative thing, certainly to be developed a little more ... [but] beyond the state of the art. Then I saw that they [Alfa] were serious because they had already developed a sort of business plan which in the end is what is needed for the proposal. They showed me numbers on a target market ... that, if it is true what they wrote, was of interest ... these are the evaluations I do [before taking a decision]" (Senior Consultant)

4.2.3. Submission of the proposal (July 2018-November 2018)

The initial phase started after the acceptance of the 'bidding document'. First, the consultant shared the form of the proposal and the work schedule with Alfa, whose Sales Manager was in charge of interacting with Sinergia. The main sections of the proposal are: Impact, Excellence and Implementation. The development phase has been characterized by frequent exchange of e-mails leading to five different drafts of the proposal. This process was iterative, shaped by the timing of the deadlines set up by Sinergia and based on Sinergia's feedback on identified weaknesses. While Alfa's Sales Manager easily followed the procedures - in terms of project management tools and timing of the work process–s - he had some difficulty in collecting data on market and economic feasibility, aspects of the proposal that the Consultant was trying to improve. Another problem concerned the provision of requested data on the technological quality of the project, which implied the involvement of the Alfa's technical managers. The two managers had very limited interaction with Sinergia, while

most of the work of revising and filling the form has been undertaken by the Sales Manager. Sinergia laments a lack of energy in Alfa's team:
"…the relationship was not ... I was not very happy ... [the Project coordinator and the technical manager of Alfa] They came twice to the office at Sinergia, they never gave feedback. They were probably overworked but they let the commercial manager do everything, but he was there to do the commercial part, so he did not have the skills [for the rest]. It was him who made the link between them and us, in my opinion they had to intervene more" (Senior Consultant)

According to Alfa's sales manager, Alfa's confidence in Sinergia has increased over time, strengthened by the initial referral of the PUM Professor as the Sales Manager highlights:
"Maybe there was a bit of diffidence at the beginning to disclose all information about your business idea to a consultant ... but it seemed like a good opportunity, we trusted the Professor, and therefore despite the first meeting [being not satisfactory] …. already from the second [which went better] ... then when you start to collaborate ... things improve" (Sales manager)

Six drafts were created before the proposal was completed. In the final version all the required information for a SME-instrument Phase 1 proposal was included. Although the PUM Professor was included in the proposal as external consultant on AI technology, the local Technical University was not mentioned as a partner due to the absence of formal agreements. The proposal was submitted in November 2018, even though Alfa was pushing for submitting it before to have the feedback earlier in terms of funding. The evaluation report by the EU was sent back on December 2018 with an overall evaluation of 12.11 (minimum threshold to obtain the funds is 13/15) articulated as follows (all with minimum threshold 4): Impact 4.10, Excellence 3.85, Implementation 4.10.

After a follow-up meeting to discuss the outcome, the partners agreed on the re-submission. Sinergia accepted since, according to senior Consultant experience, resubmissions have more chances when the evaluation score is over 12, while Alfa perceived it as an opportunity because the costs were still covered by the Regional voucher.

4.3. Project 2: Case of Beta

4.3.1. Case Context: New Product development and patenting costs: the case of Beta

By Following the publication of "The clinical implications of endothelial dysfunction" (Widlansky et al., 2003), endothelial function began to be defined as a "barometer" for cardiovascular health, and as a result, two foreign multinational enterprises operating in the sector of healthcare developed devices to assess it.

However, Beta an SME based in Marche region (Italy) and operating in the sector of the sales of electromedical devices is beginning to consider such devices as having numerous technical limitations and high costs of purchase and use.

By identifying the limitations of these products as a market opportunity, in 2015 Beta decided to launch project 2 as part of its strategy to expand and renew its product portfolio. The expected output will be an inexpensive, user-friendly device for the endothelial assessment with an integrated Clinical Decision Support System (CDSS) for automated processing of diagnostic data.

Between 2015 and 2019, therefore, the company will co-finance a PhD scholarship in collaboration with the Marche region and the local Polytechnic University with the aim of carrying out research activities related to the project.

During this period Beta won an European Regional Development Fund (ERDF) grant on wellness and health called IOT-INTELLIGENT ONCOLOGY TELECARE and then developed both the algorithm of the CDSS in collaboration with Local Polytechnic University and a foreign University, and the software and the hardware of the device.

Moreover, the first version of the software was released and at the same time Beta subcontracted the prototyping of the hardware to an engineering consultancy firm in the same region. In April 2019, the first prototype of the device was produced and subsequently, the clinical trial necessary for its validation start in June 2019 with the support of a partner company at the local Healthcare Agency (Azienda Sanitaria Unica Regionale - ASUR).

However, as the medical device market is strictly regulated, the commercialization of the product is subject to obtaining the CE mark (Europe) and the FDA mark (USA). Thus, in order to fund the costs of obtaining the certifications, Beta applied for an SME Instrument phase I with the support of Sinergia.

4.3.2. Preliminary Interaction (December 2018)

In order to assess the feasibility of the funding proposal within the SMEs Instrument 1 scheme, Beta contacted Sinergia, following the advice of a PUM Professor who was the supervisor of the PhD research project.

The first meeting between Sinergia and Alfa aimed at analysing and discuss the project idea. Beta's aim was to gain access to the EU SME-instrument to financing patenting and certification costs.

"The SME instrument would have helped us more on that part there, where in fact to date we are still lacking because the expenses are really high." (R&D Engineer)

Although for the preliminary analysis of project proposals the senior consultant tends to consult experts, in this case the senior consultant based the acceptance of the project on his personal experience as highlighted in the interview

"[...] Now all the call for proposal in the health field... of say... the information technology... to me is an area that I like a lot... So, it is clear that I do not have that sensitivity to be able to say: "this is 100% innovative, it is really nice and so on, but let's say that I was convinced. They [Beta] were convinced, telling me that there was no such thing, that the market was really... it was demanding..." (Senior Consultant)

Then he shared the project proposal with the head of the Lean Technology business unit to assess the latter's interest in innovation, since LT had started to deal with enabling technologies related to Industry 4.0.

"I had shared it to assess if it was of interest more to our Lean Technology service since in that year it was starting... let's say the service... to take Industry 4.0 skills, so since the topic didn't particularly interest Flavio, so no, there wasn't a comparison to make the decision of the support of my service to submit the application. I do it more to see if there are additional opportunities for other services... in this case it wasn't of interest to Lean Technology Business unit and I 'don't think it would be interesting in current events as well." (Senior Consultant)

4.3.3. Submission of the proposal (April 2019 – May 2019)

The initial phase started after the acceptance of the 'bidding document'. First, the consultant shared the form of the proposal and the work schedule with Beta, whose R&D engineer of Beta was

in charge of interacting with Sinergia. The main sections of the proposal are Impact, Excellence and Implementation.

The development phase was characterized by interaction *"frequent and concise. all very supportive, that is, not that there was no availability But it always seemed to be all in a hurry and with little concentration... that is, the idea that one has and that the consultant is doing at least 10-15 projects at the same time and knows very well that for my project he dedicates 5 minutes because he has another 10 to devote to another and so this becomes a bit of a nuisance but, for the fact that while the consultant knows what to do, the company does not know so there is just... that is, I felt this great distance."* (R&D Engineer)

This process was iterative, shaped by the timing of the deadlines set up by Sinergia and based on Sinergia's feedback on identified weaknesses. However, while Sinergia followed the procedures usually adopted for the development of these projects - in terms of project management tools and timing of the work processes, Beta found some criticalities both in the scheduling and in the type of activities to be undertaken as highlighted by the R&D Engineer:
"[...] the criticality, maybe not having planned the work in the right time and not having maybe explained to us well what our commitment was really because it was not simply about writing a project it was about thinking... I 'don't know... the commercial optics of the device, what are the criticalities of our device, that is the questions were many were questions to be asked before... maybe yes this". (R&D Engineer)

In fact, Beta found many difficulties in the development of the business model and also identified a problem in the assignment of roles within the project team, as emerged from the interview with the R&D Engineer:
"In my opinion there had to be defined roles there, that is: there is a person who was in charge of the writing part, because the projects like when one participates in a call for proposals have to be written in a certain way and like when one writes a patent, there are specificities that are just of that presentation... well." (R&D Engineer)

As, from Beta's point of view, a small non-project-based company not having a dedicated PM for project development would have needed the consultant to take on that role.
"Maybe a small company where there's not a project manager you expect more that maybe the consultant' I'm not saying he's our project manager but, he's just the one who identifies all the tasks or helps you plan them...so that project becomes linear." (R&D Engineer)

However, Sinergia's senior consultant perceived the development of the project as a smooth *"I honestly 'don't remember any hard times."* (Senior Consultant)

Nineteen different drafts were created before the proposal was completed. In the final version all the required information for a SME-instrument Phase 1 proposal was included and the local Technical University was mentioned as a partner in activities tied to the development of the product as the PhD scholarship.

The proposal was submitted in May 2019, even if Beta would have preferred to wait a few months to reshape the project. The evaluation report by the EU was sent back in June 2019 with an overall evaluation of 10.05 articulated as follows: Impact 3.30, Excellence 3.50, Implementation 3.30.

Thus, in the light of the score obtained, based on its experience Senior consultant considered that there were no conditions for submitting a re-submission of the proposal, even thought:
"On the scope... health [...] I would reason with it because in my opinion potentially if you do it right it could have potential, but it's been a while now and development has changed so it doesn't make sense anymore from my perspective." (Senior Consultant)

In fact, one of the main critical aspects of the proposal found by the R&D Engineer after receiving the negative feedback:
"There really hasn't been any more talk with anyone from the company, no one has pointed out to us that we could resubmit, no one has pointed out to us that we could change anything. Maybe there was some aspect that was treated in a superficial way or however wrong or ... understand if the project that was not interesting. I mean I would have liked to have looked into." (R&D Engineer)

Therefore, the relationship between Sinergia and Beta has ended.

4.4. Project 3: Case of Epsilon

4.4.1. Case Context

Epsilon is a small company based in Emilia-Romagna region (Italy) operating in the ICT sector, established in 2011 with 2 employees and a turnover of € 100,000 per year. The core business is the design and development of information ecosystems (websites, mobile apps, and online advertising campaigns) in particular for the tourism sector and public administration.

Epsilon, finding it difficult to find information on the needs and purchase intentions of tourists during their stay in tourist destinations, launched Project 3 with the aim of increasing the effectiveness of customer communication campaigns.

The company epsilon, using its ICT know-how for the tourism sector and its informal relations with a local and PUM universities as a strategic lever, launched project 3 with the aim of implementing an automation technology that, by applying AI algorithms on 2nd party data from the CRMs of its clients (hotels, public tourism promotion bodies), makes it possible to predict the interest of tourists "on site" and thus recommend events via instant messaging systems.

In order to assess the feasibility of the innovation, the company epsilon applied for an SME Instrument Phase I with the support of the consultancy company Sinergia with which the epsilon tourist consultant collaborates on an ongoing basis.

4.4.2. Preliminary Interaction

Epsilon in order to assess the feasibility of the funding proposal within the SMEs Instrument 1 scheme, contacted Sinergia on the behalf of the tourist consultant with whom there was a long-term relationship.

Epsilon was aimed to gain access to the EU SME-Instrument to finance the set of actions aimed at increasing the number of users of an innovation

"Actually, we arrived with a mockup of the project and a test done on some accommodation facilities in the Rimini area; therefore, we had already done some tests and therefore we also had sales traction". (Tourist Consultant)

During the first meeting there is some doubt as to the innovativeness of the project since the senior consultant, on the basis of his experience in projects funded by the EU, considered epsilon's solution of low interest

"...what can I say a CRM doesn't seem very innovative…." (Senior Consultant)

However, after the convocation of a second preliminary meeting at PUM where both the PUM professor and the head of the LT department were present, it was decided to undertake the project focusing on the AI algorithm, on the advice of the PUM professor

"In short, this discussion with PUM Professor who illustrated to us possible, how to say... areas of product improvement to be included within the project proposal." (Senior Consultant)

4.4.3. Submission (April 2019 – September 2019)

As usual for Sinergia, the initial phase started after the acceptance of the 'bidding document' and the sharing of both the form of the proposal and the work schedule with Epsilon, whose Tourist consultant was in charge of interacting with Sinergia.

Although participation in the Project had been decided 3-4 months earlier, the development phase was characterized initially by a low level of interaction which became very intense close to the deadline as highlighted by the Epsilon Tourist consultant:

"The exchange was very intense close to the delivery, of course, while in the first part was taken for granted by Sinergia that we proceeded with the work when instead ... perhaps we say ... companies like ours that do not make design every day should be followed with a more strict cadence in the sense with tighter deadlines starting from months before the deadline, that is, we found ourselves working at night 3, 4, 5 days before the deadline, when we had decided to participate in the call 3-4 months earlier". (Tourist Consultant)

In fact, as pointed out by the Senior Consultant in this phase there were an high exchange of e-mails in which Sinergia requested information from Epsilon but did not receive feedback or received incorrect information

"No... because you'd ask for things and they'd send them to you either late, after the set deadline, or badly or both." (Senior Consultant)

Although the process was iterative, shaped by the timing of the deadlines set up by Sinergia and based on Sinergia's feedback on identified weaknesses, Epsilon's delays in providing information appear to be attributable, as highlighted during the interview with the tourist consultant:

"a) to find the time to summarize it in the form required by the call, b) to the difficulties tied to write the call, it was also useful just to refocus some ideas we had, change others... that is... so the project changed even while we were writing it according to the call." (Tourist Consultant)

Moreover, another problem concerned the provision of requested data on the technological quality of the project, which implied the involvement of Epsilon technical manager (and CEO of the company), with who there was actually no interaction as emerged from the interview with the senior consultant:

"a relationship with the epsilon CEO had not arisen." (Senior Consultant)

Epsilon from this point of view, however, would have wished for support also from the LT service as argued by the tourist consultant:

"We could have, for example, in these months, I 'don't know, tested, for example, IT solutions, maybe... I 'don't know, made in mockup form or in simplified form [...]". (Tourist Consultant)

However, the tourist consultant discovered the existence of the LT department a few months after the submission.

Ten different drafts were created before the proposal was completed. In the final version all the required information for a SME-instrument Phase 1 proposal was included and PUM and the other university were included as partner in R&D activities.

The proposal was submitted in September 2019, the evaluation report by the EU was sent back in October 2019 with an overall evaluation of 11/15, thus below the threshold of acceptance.

Thus, although the senior consultant tends not to make a resubmission in the presence of ratings below 12/15, he decided, following an informal meeting with the tourist consultant, to involve Epsilon in an European Regional Fund (ERDF) project related to mobility, tourism, and technology platforms in which Sinergia was in charge of technical support.

This is because, as emerged from the interview with the epsilon tourist consultant, the failure to award the grant was not due to the project but to the size of the company.

5. Discussion

The empirical analysis develops from one side a picture of the management of the SME-Instrument project proposal development undertaken with the support of Sinergia. From the other shows interaction occurred between three SMEs and Sinergia in relation to the set of activities within an EU funding project.

Analysis has been conducted considering two different level (Kronlid & Baraldi, 2020) with the aim of: 1) to identify various stages in which the project is articulated, according to the processual perspective; 2) analyze inter-organizational interactions focusing on activities, resources, and actors' layers. Two main stages could be highlighted (Figure 13): a) Preliminary interaction, b) submission.

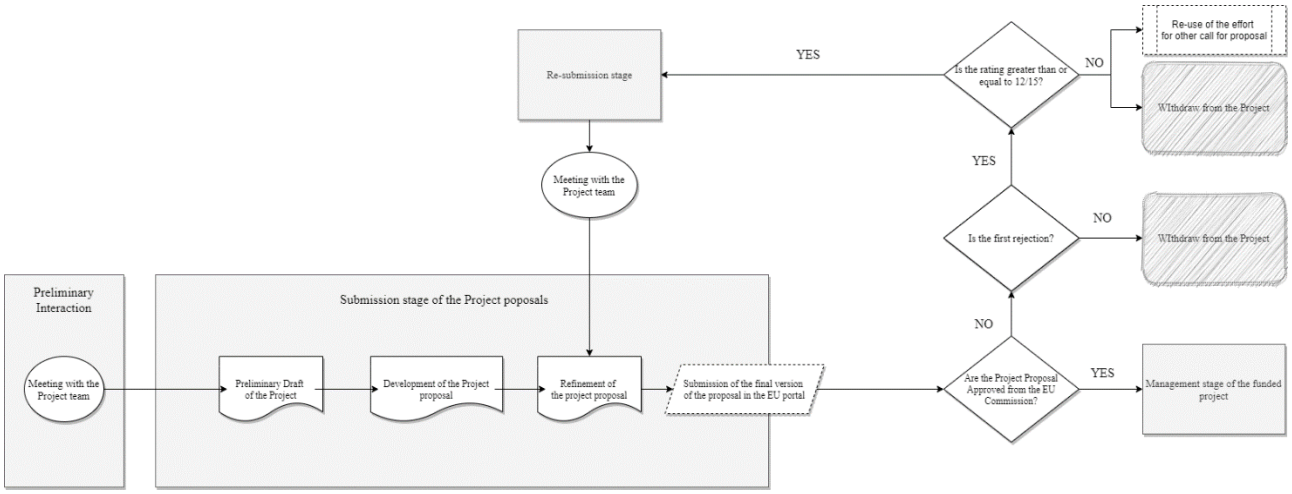

Figure 13. Project proposal development process from the consultant's perspective

5.1. Analysis of process of Project proposal Development

From a processual perspective, in the preliminary interaction stage, analysis shows how in the cases of Alfa and Beta the focal relationship was actually a triad. In fact, a third party belonging to the academic setting (the PUM professor), has made possible the first contact between Alfa and Sinergia. While in the Case of Epsilon, the existence of a long-established relationship with one the project team member but however also a relevant role of the PUM professor. PUM professor represent a key actor in the decision of Sinergia to commit to Alfa and Epsilon project application during the preliminary meeting. Without the PUM Professor's positive assessment of the innovativeness of the Alfa's and epsilon solution, Sinergia would not have started the collaboration, while in the case of Beta he represents both the tie with the consulting firm and the supervisor of the Ph.D. research associated to the project. Thus, although Sinergia requires a non-disclosure agreement to be signed for this kind of projects, the relationship between Alfa and Sinergia started in an ambiguous atmosphere (Aaboen and Aarikka-Stenroos, 2017), in which Alfa was attentive not to disclose sensible data showing limited trust in Sinergia and this latter was trusting the Professor but was doubting on the innovativeness of Alfa's solution and thus of the potential of getting the funds. However, in the cases of Beta and Epsilon the relationship arose in an atmosphere of mutual trust since, on the one hand, Beta was not asked for technical details of its innovation due the high involvement of the R&D engineer in the development of the SME-instrument project. On the other hand, in the case of Epsilon, although Sinergia had many doubts about the innovativeness of the solution, there was a long-standing relationship with the tourist consultant. Moreover, in terms of resources, the financial support provided by the regional government was a fundamental incentive for

Alfa and Beta to undertake the project, while for Epsilon it was not a fundamental lever as the project would have been undertaken regardless of the possibility of public funding.

In the submission stage, in the case of Alfa at the beginning there was diffidence to disclose information on business idea to the consultant but its confidence in Sinergia has increased over time strengthened by the referral of the PUM Professor (Peters and Pressey, 2016), while in the cases of Beta and Epsilon there seems to have been no difficulty in sharing information. Notably, in the case of Beta, the consultant did not further investigate the technical details of the proposal, while in the case of Epsilon a high level of trust already existed. However, unlike to what claimed in Kronlid and Baraldi (2020), relationship appear characterized by low interaction intensity, despite the tight timing of the application process. Interactions between the three SMEs and Sinergia appear indeed characterized by the use of project coordination tools such as e-mails and meetings, but while the former are most frequent, the latter are only episodic and leave the parties with only partial understanding of the relevant issues. Although the proposal development process has been iterative, shaped by the timing of deadlines and based on Sinergia's feedback on the weaknesses identified, it has some shortcomings perhaps attributable to the partial knowledge that the people in charge of interacting with Sinergia had of the technological (in the cases of Alfa and Epsilon) and commercial (in the case of Beta) aspects of the projects. In fact, although Alfa easily followed the procedures - in terms of project management tools and timing of the work processes, Epsilon and Beta would have preferred a different timing and approach to project management and notably, in the case of Epsilon analysis highlights a low or no interaction with the LT service. The low involvement of the technical managers in the case of Alfa and Epsilon means that the SMEs assumed that the 'technical knowledge' could be transferred internally from the developers to both the sales manager and the tourist consultant and finally to Sinergia but, projects like this needs the involvement of all parties and cannot be delegated to the consultancy firm only (Nikolova et al., 2009). At the same time, in the case of Beta, the low involvement of sales department and the Sinergia's involvement in other parallel projects led to underestimating the business model aspects of the project. Thus, this behaviour seems to be caused also by the parallel involvement of all the actors involved in other activities and projects, requiring time and commitment (Engwall, 2003). Knowledge to be used in the application is not there to be selected and transferred but should be rather created in joint endeavours (Kronlid & Baraldi, 2020). Within this stage, in all three cases, different numbers of drafts were created before the proposal was completed and submitted for the evaluation by the EU commission auditors. In the final version of the proposals, as emerged also during the interviews with Alfa's Sales Manager one of the main weaknesses is represented by exclusion of the local Technical University as a partner due to the absence of formal agreements. Furthermore, in the evaluation report provided by the EU is reflected

the low commitment of the Alfa's technicians since that the Excellence section of the proposal it is the only ones that do not reach the minimum threshold. While in the case of Beta it does not seem to have helped that the company didn't have a patent on the innovation proposed and Epsilon realized that it was not linked to the content of the project, but to the size of the company.

In synthesis, the process of submission of project proposals is characterized by four different phases: a) Preliminary draft of the project proposal b) Development of the project proposal c) refinement of the project proposal d) Submission of the final version of the proposal in the EU portal.

After received the evaluation report, given Sinergia's previous experience in managing this type of project, the senior consultant preferred not to try to re-submit the Beta and Epsilon projects. However, in the case of Epsilon Re-use of the effort for another call for proposal, while in the case of Alfa the resubmission stage, given the coverage provided by the regional voucher, begins subsequently to a meeting between the two parties.

5.2. Cross-Cases discussion applying ARA

With regard to actors, the selected cases highlight the role of business network (Håkansson and Snehota, 1995; Håkansson et al., 2009) on individual projects (Baraldi and Havenvid-Ingemansson, 2013). In fact, in the cases of Alfa and Beta, during the preliminary interaction stage PUM professor represents from one side the "weak ties" for the development of new time-constrained relationships. From the other, in the case of Epsilon, the main channel for the activation of knowledge resources. Moreover, the cases highlight the role of Local regional Government in implementing innovation policy, such as the voucher for consulting services, which is a viable incentive for small businesses, such as Alfa and Beta to undertake innovation projects.

In all three cases, the empirical analysis highlights how one of the most visible aspects, tied to the short time duration of the projects, is the absence of turnover among them (Kronlind and Baraldi, 2020). In fact, actors who join the project generally don't leave it until it concludes. However, in terms of inter-organizational interactions, one of the most important factors that affected the process of development is attributable to le level of commitment and interaction of some actors involved. In the three cases, the involvement of actors in other parallel projects implied a low level of commitment. Furthermore, the absence of interaction with the EU auditors jointly to the scarcity of details about the evaluation criteria made difficult the interpretation of evaluation reports. Finally, although Sinergia has a business unit dedicated to software development (LT), there has been little or no interaction with the latter.

With regard to the managed activities, they are not limited only to the processing of the information and data that Sinergia has requested to the SMEs both for the elaboration of the proposal and for access to the regional voucher but include other project coordination tools such as e-mails and meetings. This latter, for instances, encourage the development of new solutions based on the tacit knowledge of the actors involved (Baraldi et al., 2012). However, in these cases the emphasis has shifted on the specialization and division of tasks within the SMEs and in relations to the consultant. In fact, from the interviews it appears that the main actors assume that most of the knowledge is explicit, codifiable and can thus be transferred.

Furthermore, from the case analysis, it seems that although the activities were defined and scheduled by the consulting firm on the basis of its previous experience, the short time planned for their implementation, as well as the non-fluent and discontinuous participation of the actors, due to the overlap with other projects, made it difficult to achieve the expected efficiency and effectiveness (Kronlid and Baraldi, 2020).

In terms of resources, as also highlighted in Kronlid & Baraldi (2020) the project's resource constellation is constantly evolving due to the iterativity of the process based on the feedbacks provided by Sinergia, by virtue of expertise in European Project design to draft proposals. Thus, the most obvious resource is the various draft of the project proposal developed during the project lifecycle. However, the low level of commitment of actors involved has prevented the activation of knowledge resource (Håkansson and Waluszewski, 2007) that would be incorporated into the proposal, contributing to the creation of the various sections in which the proposal is articulated. Furthermore, it is evident that, in the cases of Alfa and Beta, two resources were relevant for the project undertaking, namely, the regional voucher, which materially has financed the development of the proposal and the knowledge of the PUM Professor about the technical details of the solutions (Ciabuschi et al., 2012). While in the case of Epsilon the business relationship with the tour consultant was the main lever for undertaking the project. However, it seems that Sinergia's internal technological resources are not mobilized in all three cases.

By according to the ARA model, table XVII details the actors, activities and resources involved in the identified stages.

		Preliminary Interaction	Submission
Project 1	**Actors**	Sinergia EP and LT, PUM, Alfa	Sinergia EP, Alfa, Regional Government, European Commission
	Resources	Bidding document, project schedule, Knowledge on technical aspects of the innovation proposed	Project proposal, Evaluation Report, Voucher for consulting services
	Activities	Preliminary meeting, project schedule	Meetings and E-mails, Implementation of routines related to the project proposal development
Project 2	**Actors**	Sinergia EP and LT, Beta, PUM	Sinergia EP, Regional Government, European Commission
	Resources	Bidding document, project schedule	Project proposal, Evaluation Report, Voucher for Consulting service, new knowledge on the business aspects of the proposed innovation, lack of PM resources due the non-project-based nature of the client firm
	Activities	Preliminary Meeting, project schedule	Meeting and E-mails, Implementation of routines related to the project proposal development, Lack in definition of clear roles within the development process of the project proposal
Project 3	**Actors**	Sinergia EP and LT, Epsilon, PUM	Sinergia EP, Epsilon, European Commission
	Resources	Bidding document, project schedule, Knowledge on technical aspects of the innovation proposed	Project proposal, Evaluation Report, Knowledge on business aspects of the innovation proposed, Lack of technological resources due the absence of interaction with Sinergia LT
	Activities	Preliminary meeting, project schedule	Meeting and e-mails, Implementation of routines related to the project proposal development but delayed due the low level of commitment of epsilon

Table XVII. Empirical context under the ARA lens

6. Conclusion

This paper represents a contribution to the literature on SMEs and EU funding projects, focusing on the interaction between SMEs and small consulting firm in the development process of EU funding projects related to I4.0.

This study investigating the main contributions on this topic in Managerial and Economic literature provides insights on the interaction processes within projects at a micro level (La Rocca et al., 2017) using the IMP approach and the ARA model (Hakansson and Snehota, 1995; Hakansson, 2009) as a conceptual guideline.

The empirical analysis indicates how time constraints and project capabilities (Davies and Brady, 2016) affect the joint creation of knowledge in inter-organizational projects (Kronlid and Baraldi, 2020) regardless of the existence of turnover among actors but, being closely related to the level of commitment, the effective use of project coordination tools. Results also reflecting the findings of previous studies that emphasize a) SMEs difficulty in relating with external actors and in becoming intelligible to these especially when technology-driven (e.g., Coviello and Munro, 1995); b) the differences between time-constrained relationships and long-term interaction (Kronlind and Baraldi, 2020).

In fact, the timing constraints to which relationship is subject although providing that the activities are outlined in a precise manner with the aim to avoid delays and bottlenecks also require that resources are combined among the actors in an efficient manner (Kronlid & Baraldi, 2020). However, it seems that in order to achieve this efficiency, the project or non-project-based nature of the SME is relevant as finding the right stakeholder, who employs a high level of commitment within the project and interacts frequently with the consulting firm, it allows the relevant issues of the project proposal to emerge.

Thus, in line with Kronlind and Baraldi (2020) seems that activities designed in a precisely manner by the Consulting firm create some bottlenecks in the process of project proposal development especially when the client is not a project-based firm. This can be due to the existence of asymmetry between the resources and capabilities owned by the parties involved.

Moreover, as well as several scholars have highlighted the continuity of interaction between actors beyond and outside the temporal boundaries of the projects (e.g., Havenvid Ingemansson et al., 2017; Kronlid and Baraldi, 2020) there are no reason to believe that resources developed within these projects cannot be used outside and beyond the boundaries of the project itself. In fact, the development of the project proposal seems to be a moment to rethink some business and technological aspects related to innovation and consequently provide a starting point for the articulation of a more detailed business plan to be used for other projects.

6.1. Implications and limitations

The empirical research undertaken in this paper has some managerial and policy implications. In terms of managerial implications, it seems that fundraising and relationships with concerned actors –as with consultancy firms in our case– requires high involvement and high interaction intensity to be productive as for relationships with other business actors. This is particularly true for EU funding

processes, which require skills in managing the application procedure and high quality and innovativeness in terms of content (Ciarmatori et al., 2018). These joint efforts are missing during the project development since the main actors assumed that most of the knowledge was explicit, codifiable and can thus be transferred.

Moreover, in order to maximize both effectiveness and efficiency it is necessary for consultancies to develop criteria for project selection. Innovation projects evaluation and selection represents a complicated multi criteria decision-making process (Eliat et al., 2008). Thus, the subjective judgment of the experts involved in the selection process could represent a particularly critical and challenging step (Liu et al., 2019) considering both the high variety of innovations proposed and the structured and formalized approach that many funding agencies are adopting for their evaluation (Tavana et al., 2013).

In terms of policy implications, the case study shows as, although the voucher for consulting services and being embedded into a network of public and private actors represent two key drivers to undertake innovative project. Its development is however penalized by the misalignment between the established practices of the embedded actors in the network (La Rocca and Perna, 2014) and by the lack of interaction with the client of the project, namely the European Commssion.

Moreover, as well as SMEs recognize the importance of the EU funding program, it seems that sometimes the objectives of companies differ from those of calls for proposals. In fact, as highlighted by the empirical analysis, it seems that, for SMEs, the financing scheme represents an instrument for sustaining costs directly connected to the development of the product rather than verifying its technical-commercial feasibility.

This paper has some limitations tied to the unsuccessful nature of the EU funding project under investigation. Thus, it was not possible to analyze further aspects related to the management stage of the projects funded. In addition, in order to generalize the results, further studies, may consider the use of mixed methods aimed to investigate in addition to managerial aspects also their diffusion, by means of surveys in different sectors or categories of firm, starting from the detailed explanation of the methodological aspect contained in Turner's work (2010, 2012) or using quantitative methods such as Structural Equation Modelling in order to analyze the influence of project management processes on the outcome of the projects.

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CHAPTER V

Concluding Discussion

This chapter provides the main findings of this thesis. The discussions and conclusions presented at the end of each chapter provide different insights on the International Innovation projects such as European I4.0 projects undertaken by small consulting firms. Therefore, this final chapter aims to recognize, by triangulating, the results provided in the previous chapters. The empirical analysis has allowed to reconstruct the process undertaken by a small consulting firm to becoming a key player and a trusted partner in European projects related to Industry 4.0.

With the aim of achieving this purpose, the main findings of each paper are presented by relating them to each other and then concluding remarks and managerial and policy implications are outlined. Finally, the limitations of the study are highlighted.

1. Projects as a lens to view the process of resource development

As stated in the Introduction, this research has been motivated by an interest in a broader comprehension of the role played by other key business actors such as small sized consulting firms in helping industrial customers in I4.0 related projects also considering the challenging scenario in which they have to develop competencies. The aim was to provide an understanding in how a small sized consulting firm become a key player and trusted partner in European Projects related to I4.0.

This thesis started with a conceptual paper (Chapter II) entitled “Project Management and SMEs: a review of the literature and framework for future research” which was aimed to develop an integrated view on PM and SMEs research stream detecting and analyzing within the existing literature on Project Management contributions that deal with the topic PM and SMEs.

The need for such investigation lies in the “infancy” status of the research stream PM and SMEs (e.g., Meister, 2006; Murphy and Ledwith, 2007; Turner et al., 2010; 2012) concretized in a high level of fragmentation (Turner et al., 2011) and thus in the need of delimiting the research area, providing insights about the main themes covered, and thus identificate future research direction.

In order to achieve these aims 170 articles have been analyzed using bibliometrics and science mapping techniques using an ad-hoc framework developed on the basis of previous studies in management research field (e.g., Colicchia and Strozzi, 2012; Zupic and Cater, 2015).

By addressing the two RQs, findings show large part of the discussion in articulated around innovation projects related to Construction and Manufacturing industries, showing at the same time the development of a new trajectory towards the development of PM methodologies for SMEs (i.e., Nowotarksi, 2015) considering both organizational and historical context (Scarbrough et. al, 2004, Brady and Davies, 2004) and external environment (Engwall, 2003).

Within the two empirical studies conducted, a qualitative approach has been used by adopting both a longitudinal single case study (Chapter III) and a comparative case study (Chapter IV) methodology concerning the consulting firm Sinergia with a focus on European projects related to Industry 4.0 using on the one hand, the 4R model (Håkansson & Waluszewski, 2002) to investigate the resource development processes. On the other, the ARA model (Håkansson and Snehota, 1995) with the aim of examining the interactive dynamics within the projects undertaken during its path for I4.0 in order to develop project capabilities.

In Chapter III "From knowledge broker to solution provider in the Industry 4.0 setting: the innovation path of a small consulting firm" the resource development process implemented by a small consulting firm pursuing the innovation path to develop solutions within the I4.0 domain has been analyzed, highlighting the spatial and temporal dimension of innovation (Purchase et al., 2016) and the "muddling through" characterizing such processes (Makkonen et al., 2012).

Analysis has been conducted following a longitudinal approach (Halinen and Törnroos, 2005) allowing to highlight the main events (Purchase et al., 2016) occurring in the identified temporal phases (Quintens and Matthyssens, 2010) and thus the innovation-related resources developed in the I4.0 context according the 4Rs model (Håkansson and Waluszewski, 2002).

Main findings concern the embedded and temporal nature of the innovation path undertaken by Sinergia – in connection with the development of the network around them (Hedaa and Törnroos, 2008). Then the use of the 4Rs shows how the innovation path followed by Sinergia has led to a process of resource assembly (Håkansson and Waluszewski 2002; Arthur and Polak, 2006).

Chapter IV - "The role of SMEs – consultant interaction in European Projects related to Industry 4.0" – represents the second empirical paper. This paper explores how interaction between SMEs and small consulting firm affect the development process of EU funding projects related to Industry 4.0 with a focus on three projects undertaken between Sinergia, during its innovation path, and three SMEs as they cooperate to get funds from European Funding Programmes (FPs).

Analysis has been conducted following a processual perspective in order to highlight the main stages and the evolution of the relationship among the partners with the aim of uncover the main interaction processes within three different European SME-Instrument phase 1 projects related to Industry 4.0 enabling technologies.

Main findings concern how time constraints and project capabilities affect the joint creation of knowledge in inter-organizational projects (Kronlid and Baraldi, 2020) regardless of the existence of turnover among actors but, being closely related to the level of commitment, the effective use of project coordination tools.

Consistently with the adopted theoretical and analytical framework, the research questions outlined and the findings in the individual chapters address the overall aim of this thesis. Thus, they can be embedded in a broader context and illustrated through the use of a processual perspective in order to explore the process of resource development (Håkansson and Waluszewski, 2007) undertaken to reposition itself locally as a partner in EU projects related to I4.0.

As highlighted in chapter III, the innovation path undertaken by the company develops in 3 different temporal phases (Quintens and Matthyssens, 2010) delimited by main events (Purchase et al., 2016). Notably, investigating innovation through the analysis of events is considered the most suitable approach to conduct an integrated interpretation of the results provided by the previous chapters as it allows to reconstruct the path, or the sequence of serially dependent events, in which actors, activities and resources analyzed with different emphasis and focus on the previous chapters are involved.

PHASE 1

In the initial phase of the innovation process, is highlighted the emergence of "resource-oriented networking" making new contacts and “re-activating” sleeping relationships established in previously undertaken projects (Hurmelinna, 2018) with key local players in the I4.0 context, such as small IT firms, Academia and Business associations.

It seems that discontinuity between projects is embedded within these relationships despite the lack of resource exchange. The cause can be traced back to the partners' knowledge of each other's experience, which leads to the creation of social and technological interdependencies, between the various actors (Hadjikhani, 1996).

In fact, as shown in Chapter II, it is evident within the research stream on PM and SMEs that the presence of a link between the studies of PM focused on general practices and SMEs and the studies mainly focused on the project-based firm and multi-project management. These latter, conceptualizing projects as open systems embedded within an organizational and historical context (Engwall, 2003) called “project environment” highlight the ability of the project-based firm of both capitalize knowledge gained during the execution of a project and the ability to transfer it to other projects or parts of the organization (Prencipe and Tell, 2001) investigating the mechanisms of

learning from projects and, focusing on the relationship between projects and their organizational context (Scarbrough et. al, 2004, Brady and Davies, 2004).

Chapters III and IV provided evidence on the existence of an interplay between time constrained inter-organizational interaction and business relationships shaped by weak ties (Granovetter, 1973; Halinen and Salmi, 2001).

Notably, in chapter III it appears that in order to overcome the degree of uncertainty in relation to future interactions (Kronlid and Baraldi, 2020), the strengthening of collaboration between Sineriga and local universities is realized through the underwriting of contractual arrangements in order to facilitate the resources interaction processes (Mouzas and Ford, 2012) with local selected actors in the academic and business setting. In fact, Contractual agreements such as the "Framework agreements" (Mouzas and Furmston, 2008) representing in this sense a kind of umbrella agreements used as a platform to exploit valuable technological and managerial resources (Mouzas and Ford, 2012), allow the creation of a series of joint initiatives for the strengthening of the ongoing dialogue between business and academic setting for the fulfillment of emerging needs related to the new scenarios of I4.0.

While Chapter IV highlighted as in the SME-Instrument projects the existence of a long-established relationships with business and academic setting made possible the first contacts with SME clients and impacted on the decision to undertake the projects, acting as a selection criterion of the individual projects.

PHASE 2

Concerning the second phase, it is highlighted as the process of innovation has involved both formal and informal forms of organizing and learning (Crespin-Mazet et al., 2021).

On the one hand, legislation on innovative SMEs has enabled the formalization of business-university research agreements aimed to the implementation of industrial Ph.D. projects. On the other hand, Sinergia begins to adopt internal organizational changes, aimed at integrating the technological and PM expertise of the two business units LT and EP with the aim to better address I4.0 projects.

As highlighted in Chapter III, starting industrial PhDs, in AI and PM, allowed the acquisition of technological and managerial skills related to I4.0. In fact, seems that PhDs projects represent mechanisms to transfer and combine knowledge in industrial settings thanks to the learning process implemented in the universities and in the companies where they have been involved (Fremont et al., 2019; Ciarmatori et al., 2018).

This result evidence how small consulting firms tend to innovate by both exploiting and exploring knowledge created outside the firm (Purchase et al., 2016) in a logic of Open innovation.

Notably, although in relation to AI, physical resources have been developed in the form of prototypes leveraging the specific interests on key enabling technologies mastered by both the academic and business partners. The analysis conducted in Chapter 4, focusing on PM resources, highlights how the undertaking of SME-Instrument projects, framed in the H2020 framework, although not quantitatively relevant in terms of revenues for the firm, has allowed the development of intangible resources that can be used outside and beyond the boundaries of the single project (Havenvid Ingemansson et al, 2017; Kronlid and Baraldi, 2020), in terms of project capabilities (Davies and Brady, 2016), to autonomously assess the eligibility of a project proposal and thus respond to European calls related to I4. 0.

This process of capabilities building seems to be oriented towards transferring the knowledge created within the projects undertaken by the LT and EP business units, with their respective partners, not to other parts of the organization (Prencipe and Tell, 2001) but into a new organizational structure with the ability to efficiently exploit resources, both internal and external to the organization, and to perform repeatable and routinized project activities (Davies and Brady, 2006).

PHASE 3

Finally, the third phase, is characterized by "resource assembly" (Ciabuschi et al., 2012) resulted from the ability of effectively combining internal and external resources developed across previously undertaken projects (Lind et al., 2012).

This insight shows how resources can be developed and used only when they cross individual project boundary (Lind et al., 2016) contributing to the creation of value not only for individual actors but, for all organizations involved.

Chapter III findings shows as these resources previously developed have been deployed within a highly competitive and successful European call for proposal on technologies related to I4.0, which led to the development of an SDK for Augmented Reality, allowing Sinergia - in its perception - to rethinks its position within the business landscape as a solution provider in the I4.0 context at the local/regional level (Hervas-Oliver et al., 2019; Baraldi et al., 2020; Huemer, 2013).

However, the case analysis shows that the organizational identity change does not result from a strategic change (e.g., Huemer, 2013) but rather from a process, driven by a strategic vision (Freytag et al., 2016) of the CEO, of aligning the company with its key partners within a broader innovation path based on the development, assembly and use of shared resources.

In this process, although a certain degree of internal control contributes to the creation of a new perceived identity (Crespin-Mazet et al., 2015), the influence of the business network appears to

be central since, the selection of any partner considered suitable for the development of a joint project is influenced by the trust created in antecedent projects (Castro et al., 2009).

In a nutshell, this research offers several insights to interpret the repositioning process of a small consulting firm as a key partner in I4.0 projects. The use of IMP approach helped to analyze both the development of resources and the interaction processes within this context, as it allowed to obtain a more in-depth understanding of the interaction between individual projects and networks, showing the role of formalized relationships between heterogeneous actors, project capabilities, and the creation and combination of resources across project boundaries.

2. Conclusion

This research investigates the processes and key factors that characterize the management of European I4.0 projects by consulting SMEs analyzing how a small consulting firm become trusted and capable partners for customer firms in EU projects related to I4.0.

Notably, this study provides a contribution to literature on the role of consultant in European and Industry 4.0 projects since, to author's knowledge, it is one of the first works that deal with the topic.

By using a Project management perspective and frameworks related to the Industrial Network approach this research strives to contribute to current knowledge and understanding in the field of SMEs and I4.0 projects at theoretical and empirical level.

On a theoretical and empirical level, on the basis of the findings showed in the previous paragraph, this study allows for contributions to various research areas that lie at the core of this work.

The first contribution concerns the enrichment of the literature on innovation processes related to I4.0 (Pagano et al., 2021; Götz and Jankowska, 2017) by exploring the transition process of a small consulting firm from knowledge broker to solution provider, based on a process of networking, with a relevant strategizing effort, and assembling internal, external and shared resources.

As stated in the introductory chapter, the existing literature on innovation conceptualizes consulting firms as Knowledge Intensive Business services (KIBS) (Toivonen, 2006) as they are, on the one hand, a qualified provider of knowledge intensive services aimed at promoting and facilitating innovation (Ciriaci et al, 2012). On the other hand, they operate as agents of innovation in the framework of public policies (Czarnitzki and Spielkamp, 2003) by undertaking intellectually complex projects in which human capital is the most critical factor (Muller and Doloreux, 2009).

However, although literature shows a growing attention on both the introduction of advanced digitalization processes (Frank et al., 2019) and, the business and institutional context of I4.0 diffusion in terms of public support and knowledge dissemination processes (Hervas-Oliver et al., 2019; Pagano et al., 2021), the research stream regarding the service domain is still in its embryonic state.

The present study attempted to understand the role of new actors, which offer "complete solutions in which products and services are integrated" (Müller and Däschle, 2018: 263), as supporting actors (Vuksanovic Herceg et al., 2020), able to provide a contribution in terms of I4.0 knowledge dissemination and transfer in the digital transformation process, starting from the transition of the role played by small consulting firms from knowledge broker to solution provider in the highly competitive context of I4.0.

This process, analyzed through the use of the IMP approach, is characterized by a strong network nature, shaped over time by the implementation of joint projects between business and academic settings that has fostered the development of which is perceived as an "ecosystem of collaborations".

Concerning the interaction within projects, this research contributes to conceptualizing the phenomenon, whose articulation and methodological complexities have only been scarcely addressed (La Rocca et al., 2017). The focus on projects, as time constrained inter-organizational relationships, in which knowledge is developed jointly, raises two key issues. The first concerns the effective use of project coordination tools as an instrument to promote the development of solutions based on tacit knowledge. The second relates to the existence of project capabilities by the parties involved. Project capabilities are developed and mobilized both to explore new and innovative possibilities and address uncertain and rapidly changing conditions, and to exploit existing routines and perform repetitive processes when conditions are stable and predictable (Eisenhardt and Martin, 2000; Davies and Brady, 2016) thus, allowing the efficient combination of resources.

With regard to SMEs and European projects, this study shows that the limits to innovation have been overcome by leveraging one of the various ad hoc calls for SMEs (Muscio and Ciffolilli, 2020) wishing to develop innovations. However, on the basis of the previous discussion it emerges how Small firms, given the scarcity of human resources in terms of technology and PM, in order to manage complex projects and therefore to participate in such calls for proposals must introduce mechanisms of collaboration and cooperation that take the form of a network with the aim of access to external resources in terms of business relationships not only with other companies but also with research centers and universities (Lind et al., 2012).

The empirical research undertaken in this work has some managerial and policy implications.

In terms of managerial implications, the first one concerns the key role of “business networking” activities (Rusanen et al., 2014) and strategizing approach in order to effectively navigate into multiple networks, shaped by different logics - business, University and European institutions - and embedded in a regional context characterized by the presence of traditional industry.

The analysis of the path undertaken by Sinergia could provide useful indications to other small consulting firms that wish to reposition themselves as I4.0 service providers. This study has highlighted the commitment in terms of capabilities, knowledge, and organizational configuration that a repositioning process requires in the I4.0 context in order to maintain control of and access to key PM and technology skills over time. At the light of the strong competition for these types of resources, both from large industrial and service companies and from leading universities and research centers.

Secondly, the participation in small-scale I4.0 projects funded by the European community, with the objective of producing open-source software, may represent the most suitable model for small consulting firms wishing to reposition themselves as I4.0 service providers. However, the case analysis also shows that undertaking EU projects requires membership in multiple networks, such as business and academia, in order to create knowledge through joint projects.

In terms of policy implications. Firstly, this study highlights the usefulness of devising appropriate mechanisms to make cooperation between industrial companies - often operating in traditional and medium technology sectors - and knowledge brokers and providers more stable and oriented towards I4.0-related enabling technologies. Therefore, not limiting itself to the provision of vouchers for consulting services but encouraging the implementation of joint projects, such as industrial doctorates, which could represent key mechanisms to transfer and combine knowledge in these industrial contexts.

Secondly, on the basis of the recent shift towards the characteristics of I4.0 implementation, in terms of an increased collaboration between "triple helix actors" (Reischauer, 2018), this study highlights that in the implementation of public policies to support innovation, policy makers should consider the use of tools aimed to assess the impacts of the SME-consultant relationship given the role of consulting firms as intermediary actors between SMEs, academic and governmental settings as disseminators of best practices.

This study has various limitations that open future research aimed to explore new dimensions related to the main themes addressed in this work.

First, the empirical analysis concerns the transition process from knowledge broker to solution provider of I4.0 services of a small consulting firm, which is still ongoing. Thus, the present study provides insights into an in-progress process without providing an ex-post analysis.

Second, for the purposes of this work, the case of a small consulting firm embedded in a traditional industrial context is considered. Thus, it may be significant to investigate transition processes in other more technology intensive contexts.

Third, the case of a small consulting firm having an internal technology presidium was analyzed. Further studies could investigate the approach taken by small consultancies with no internal technology facilities to operate in European projects related to Industry 4.0.

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