

# Contemporary Perspectives for Technological Entrepreneurship in the Age of Change: Between Success and Resilience

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## Abstract

**Problem:** why are some technology entrepreneurship projects successfully, resilient and others not when they are executed in the same ecosystem?

**Research objectives:** to revise conceptual and theoretical portraits of the process of technological entrepreneurship; propose a model that incorporates multidimensional factors that can effectively contribute to the success and resilience of technology entrepreneurship.

**Methodology:** we used the inductive approach and a qualitative exploratory strategy. Private and public companies are our sample for convenience.

**Results:** at the *design* stage, human capital and relationship capital identify market issues and opportunities. at the *implementation and development* stage, human, relational, structural, and technological capital are effective levers to generate performance and resilience. Finally, at the marketing and *consolidation* stage, human, structural, relational, financial, and technological capital have an undeniable contribution. But it is above all the integration of all these factors that generates success and resilience.

**Implications and limitations:** the chapter is useful for researchers, entrepreneurs and governments who will find strategies to enhance the success and resilience of technological entrepreneurship. This research is part of the theory of artificial science. The adoption of an inductive approach and a qualitative strategy is one of its limitations. Future research could use the mixed strategy to extrapolate results.

**Keywords:** entrepreneurship, technology, success, resilience, intellectual capital

## 1. Introduction

Technological entrepreneurship plays a crucial role in economic development in the 21<sup>st</sup> century (Mignenan, 2021a). It contributes to the creation of industries and the safeguarding of those in decline (Mignenan, 2021b). For several years, research on entrepreneurship has been interested in the discovery and exploitation of advantageous opportunities (DANJOU, 2019). The know-how and creativity of individuals who are called entrepreneurs make it possible to exploit these opportunities. Among the latter, some require the mastery of advanced technologies. However, more and more entrepreneurs are developing technological innovations (Mignenan, 2022d). Thus, technological entrepreneurship represents a new trend within the entrepreneurial ecosystem. It is distinguished by the importance of technological and scientific knowledge, but also by its less linear and predictable aspect (Mignenan, 2022d; Zhang, Rong, & Ji, 2019). Indeed, this type of entrepreneurship is often poorly planned and emerges in an unpredictable way. It is often the result of exchanges between several stakeholders. It plays a key role in competitiveness and socio-economic growth. Despite its importance, technological entrepreneurship is not foolproof. Several technology projects are successful, and others are not, even though they were implemented in the same environment (Mignenan, 2021c, 2022c).

Unfortunately, the literature review revealed that few authors have studied the success and resilience of technology entrepreneurship. In this sense, given its novelty, technological entrepreneurship requires a better understanding, particularly about its success and resilience.

Thus, this research will answer the following question: why are some technology entrepreneurship projects

successfully and resilient and others are not, when they are executed in the same ecosystem?

This chapter has two objectives:

- ✓ devise conceptual and theoretical portraits of technological entrepreneurship.
- ✓ Propose a model integrating multidimensional factors that can effectively contribute to the success and resilience of the different phases of technological entrepreneurship.

As a first step, the theoretical framework, including new perspectives, will be addressed. Second, the conceptual model will be presented through the different success and resilience factors, followed by discussion and implications.

## 2. Theoretical Context

In the context, it will shed light on the notions of entrepreneurship, technology, and technological entrepreneurship. Next, we will analyze the paradigm of artificial sciences as a new perspective of technological entrepreneurship, we will develop the model of success and resilience of technological entrepreneurship.

*Definitional elements: entrepreneurship, technology, and technology entrepreneurship*

### 2.1.1 Entrepreneurship

From the outset, entrepreneurship is a fragmented discipline approached from different angles, including economic, sociological, psychological and managerial (DANJOU, 2019; Mignenan & Meddeb, 2022b). From an economic point of view, entrepreneurship is part of a functional posture. From the perspective of the culture and sociology, entrepreneurship is based on a list of individual posture. From the manager's perspective, entrepreneurship is part of a process approach. Figure 1, developed for synthesis purposes, presents the interaction of entrepreneurship with other disciplines.

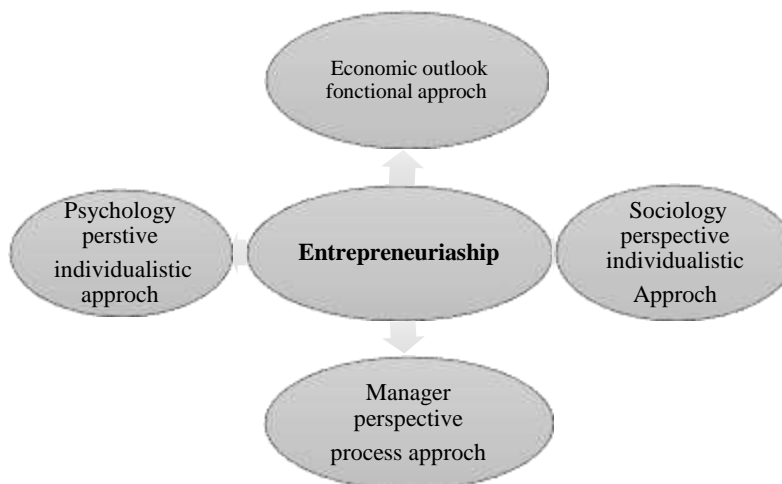


Figure 1. Entrepreneurship and Other Disciplines

Source: author, November 2022

For researchers in the field (Gasse, 2011; Mignenan, 2021a, 2022d; Verstraete & Fayolle, 2005) entrepreneurship is a concept including several types of activities: identification of opportunities, creation or takeover, implementation of a project, etc.

In light of the above, it is accepted that the entrepreneurial is a polysemic concept: different meanings have been associated with it (Castonguay, Durand, Hamouti, & Cayrol, 2019; DANJOU, 2019; Gasse, 2011; Mignenan, 2021a, 2021b, 2021c, 2022a, 2022c, 2022d; Mignenan & Meddeb, 2022a). Several terms such as value creation, innovation, continuity, recovery, solvability have been used to designate this phenomenon (Bailetti, 2012; Capdevila, 2015). Some authors (Chabaud & Sammut, 2016; Mignenan, 2021a) judge it from the continuity of the new company. Others assess it on the basis of the performance, success and economic resilience of the emerging firm (Astebro, 2004; Mignenan, 2021a, 2021b). Despite the conceptual diversity, the most widespread meaning in both theory and practice is that which equates entrepreneurship with the new creation of social and economic value (Astebro, 2004; Mignenan, 2021a, 2021b). In this perspective, the success of the entrepreneur is

assessed on the basis of economic success criteria , thus favoring a multi-dimensional analysis of the phenomenon. Figure 2 is developed for summary purposes.

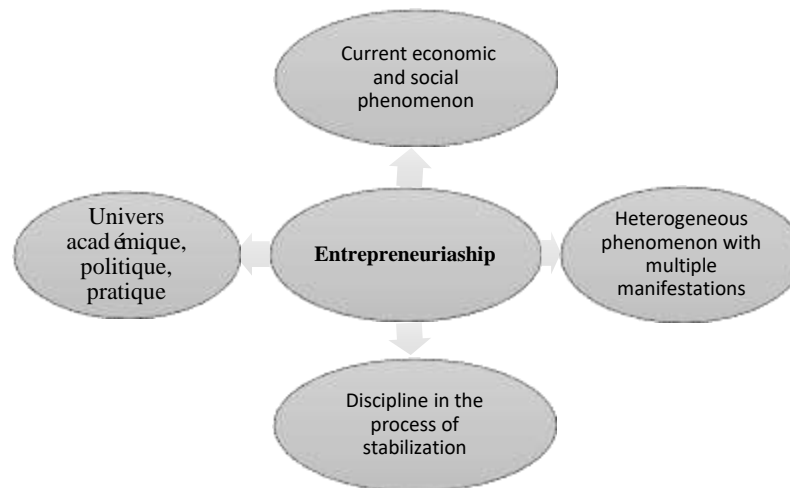


Figure 2. Different dimensions of entrepreneurship

Source: author, 2022

### 2.1.2 Technology

"Technology" is a captivating but confusing concept. It favors a variety of acceptances and is ready to be equivocal. Many definitions have been proposed by theorists and practitioners (Mignenan, 2019). Indeed, according to theorists, technology is a body of knowledge with concrete applications. It is based on the results of basic and applied sciences and the cumulative process of experiential learning (Friedman, Roberts, & Linton, 2008; Gonod, 1972; Heinzl, Kor, Orange, & Kaufmann, 2012; November, 1990; Prud'homme, Doray, & Bouchard, 2015). According to these authors, technology is a multidimensional whole. It consists of equipment, methods and techniques, skills, and knowledge. It concerns basic and applied science outcomes and the experiential learning process (Friedman et al., 2008; Gonod, 1972; Mignenan, 2019; November, 1990; Prud'homme et al., 2015; Roy, Guidon, & Fortier, 1995). This definition, relevant, neglects the stakeholders and therefore the network of actors involved in the production of said technology. In contrast, practitioners view technology as the skill needed to identify, create new knowledge in a collaborative and cooperative process, and improve techniques (Allen & O'Shea, 2014; November, 1990; Prud'homme et al., 2015; Roy et al., 1995; Thibaut, 2010).

The difficulty of explicitly defining the concept of technology stems from the very historical evolution of the term because it is intimately linked to human activities. Thus, among the ancient Greeks, "technè" understood "technology" has been metamorphosed several times to designate respectively (i) "manufacture and production", (ii) "all transformative activities carried out by men" (November, 1990; Prud'homme et al., 2015; Riccio, Bonnet, & Dekorsy, 2009; Roy et al., 1995; Thibaut, 2010). Moreover, still in Greek antiquity, technology or "technè" was divided into two parts, namely "praxi" which refers to purely utilitarian activities, but also "poiesis", which means activities requiring creative talent in the use of instruments. Finally, "technè" consists of these two dimensions and means both "art and craftsman" (Bernard & Fluckiger, 2019; Giones & Brem, 2017; Mignenan, 2019, 2021a; November, 1990; Thibaut, 2010) [1, 18, 22, 25, 28, 29].

The diversity of definitions often leads to confusion and does not allow the technology to be accurately located in relation to other scientific disciplines. It is sometimes located in the "science" sector, "computer science" the field of programming language, software or simply in the technical description of computers. These are the limiting apprehensions of the concept (Bernard & Fluckiger, 2019; Giones & Brem, 2017; Mignenan, 2019; November, 1990; Treglia & Mynard, 2013; Zhang et al., 2019) [5, 18, 22, 28-30], because it goes beyond the technical field in the strict sense of the expression. In the context of this chapter, it is at the same time science, technology, and art, as shown in Figure 3.

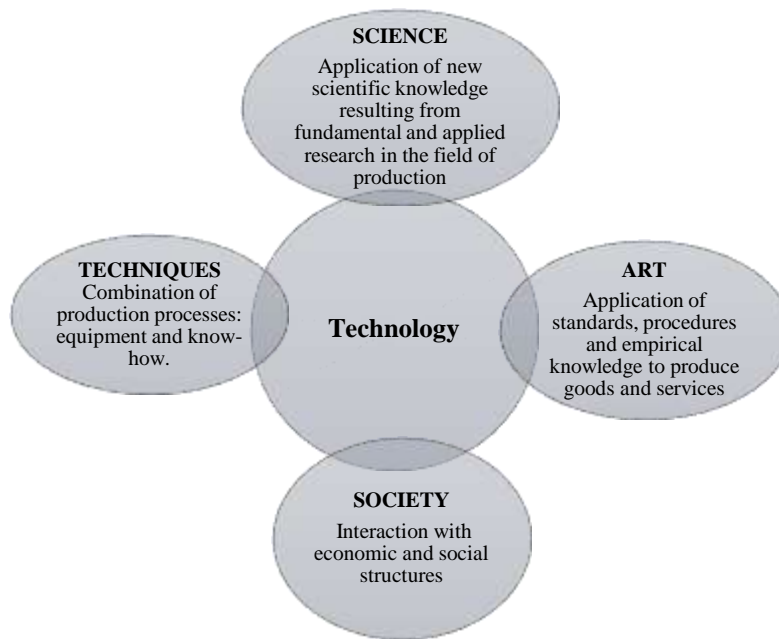


Figure 3. Technology Components

Source: inspired by November, 1990

In the light of Figure 3, technology is defined, in chapter frameworks, as:

*"a body of scientific, technical, know-how and actionable knowledge, necessary guidelines, generated by the individual, group of individuals, interacting according to an elaborate approach that can be used to meet a specific need of a given organization or community."*

This definition highlights four dimensions of technology: science, art, technology, and society. It is a springboard for understanding technological entrepreneurship in its new perspectives. This is the subject of the sequence below.

### 2.1.3 Technology Entrepreneurship

Several authors (Bailetti, 2012; DANJOU, 2019) defines technological entrepreneurship as the mechanism for translating technical and artistic knowledge and knowledge into marketable products . The entrepreneurial opportunity is characterized by this conversion and the search for new relationships between the means offered by technology, and the end, characterized by the satisfaction of needs in the market (Astebro, 2004; Mignenan, 2021a) However, the function of transforming technology into a commodity is central to its success and resilience (Astebro, 2004; Mignenan, 2021a) The inherent value of a technology remains latent until the technology is commercialized. According to several authors (Castonguay et al., 2019) entrepreneurship is the creation of a new technological company. For some authors (Etzkowitz, 2011; Mignenan, 2021b) that these are the coordination efforts needed to achieve technological change. In any case, most of the work (Albert, 2000; Astebro, 2004; Bailetti, 2012; Castonguay et al., 2019; Etzkowitz, 2011; Mignenan, 2021b) reveals that technology entrepreneurship is the search for solutions to problems often related to technology.

Based on the above definitions, technology entrepreneurship is defined as:

*"the design and deployment of a project that brings together and deploys specialized individuals and heterogeneous assets closely linked to advances in scientific knowledge, artistic techniques with the aim of creating and generating sustainable and resilient value for a company whose mission is to satisfy the needs of society."*

This definition highlights art, science, and technology. It thus projects the new perspective of technological entrepreneurship. This is the subject of the sequence below.

### 2.2 New Perspective Technological Entrepreneurship: Artificial Sciences

The science of the artificial is concerned with theories dealing with "artificial" or "synthetic" phenomena. These are phenomena that are located at the meeting point of nature and culture, including technical culture (Avenier & Schmitt, 2008) These artificial phenomena range from tools and machines to languages and the arts. Thus,

artificial sciences offer new bases for analysis and interpretation in the field of technological entrepreneurship.

Indeed, the paradigm of artificial sciences highlights the process of technological entrepreneurship as an object to be conceived (*Conception* stage). This paradigm offers an interesting crucible for the operationalization of this stage (Avenier, 2019) It symbolizes an entrepreneurial situation shaped by man. In other words, it is the fruit of a relationship that the buyer maintains with the world through his acts of design. The entrepreneur, like any person, cannot dissociate himself from the situation or from his action. This could be called to act located and finalized (Avenier, 2019; Avenier & Schmitt, 2008) The design brings out, at the same time, the subject and the artefact by a focus on the development of the action of the entrepreneur. In this respect, Simon points out that "*design is a process which is concerned with how phenomena might achieve goals*(Simon, 2015). In addition, artificial science also provides a theoretical foundation for *implementing* entrepreneurship as contingent rules. These are linked to the objectives that have been assigned to the design phase. They also enable the implementation phase to achieve its goal and to develop. Second, they promote understanding of *how*, *when*, and *why* implementation should be carried out. Moreover, the paradigm of artificial sciences considers that technological entrepreneurship is not designed to be static, but dynamic through recursive adaptation. Finally, the paradigm of artificial sciences considers the *consolidation* phase (*Marketing*), as the ability of a project leader to acquire all the skills and to implement the actions that guarantee the strategic, economic viability and sustainable development of the product.

Considering the above, the new perspectives of technology entrepreneurship are akin to a process, consisting of the design, implementation, and consolidation (marketing) phase as shown in Figure 4. They are based on the foundations of artificial science. Consequently, in the rest of this chapter, technological entrepreneurship is *the design and implementation of an evolving situation, adapting, recursively, to its ecosystem.*



Figure 4. Technology Entrepreneurship Process

Source: author, 2022

### 2.3 Technology Entrepreneurship Success and Resilience Model

The success of technological entrepreneurship is manifested by the acquisition of artistic and technical advantages, the level of user satisfaction and the use of new knowledge (Mignenan, 2021a, 2021d; Mignenan & Meddeb, 2022b) It also addresses the added value that manifests itself through new products, processes, and organizational behavior. It is usually broken down into management success and investment/organizational success (Astebro, 2004; Mignenan, 2021d) In contrast, entrepreneurial resilience manifests itself in overcoming adversities and adapting to uncertainty (Mignenan, 2021a) Similarly, it involves the ability to bounce back from an adverse event; the ability to cope with major disruptive events; the ability to adapt to a challenging environment; the tenacity to survive and succeed(Mignenan, 2021a, 2021c).

In the light of the above, several authors (Astebro, 2004; DANJOU, 2019; Mignenan, 2021a, 2022b) reveal that the success and resilience of entrepreneurship are the result of intellectual capital (Delgado-Verde, Amores-Salvadó Castro, & Navas-López, 2017; Mignenan, 2021e)

Specifically, several authors (Delgado-Verde et al., 2017; Mignenan, 2020, 2021e) find a direct relationship between human capital (business experience, training, and motivation) and positive outcomes of technology firms. For structural capital (adaptability to change and the implementation of correct strategies), the author suggests that this factor is associated with the growth and survival of the firm. Other authors point out that the development of business networks, the creation of contacts and knowledge of customers promote marketing operations and resistance to competitive shocks and therefore to the success and resilience of an entrepreneurial project.

Several authors (Cappelletti, 2010; Lacoursière, Raymond, Fabi, & St-Pierre, 2014; Mignenan, 2020, 2021e) argue that the strategic positioning of the technology company in a competitive environment result from its intellectual capital, as it is a better lever for innovation. In their study of several companies in the Turkish

automotive industry, a large number of authors found that technological innovation has a positive relationship with human, technological, financial, structural and relational capital (Cappelletti, 2010; Delgado-Verde et al., 2017; Lacoursière et al., 2014; Mignenan, 2020, 2021e) According to the results of some studies (Cappelletti, 2010; Chen, 2008; Delgado-Verde et al., 2017; Lacoursière et al., 2014; Mignenan, 2021e) accumulated knowledge from customers, suppliers, other stakeholders, processes, etc. increases the success and resilience of the business. This knowledge is part of a company's intellectual capital, including financial capital, that it must exploit and explore to improve its performance.

Considering the above analysis, Figure 5, developed for synthesis purposes, serves as a model for the success and resilience of technological entrepreneurship.

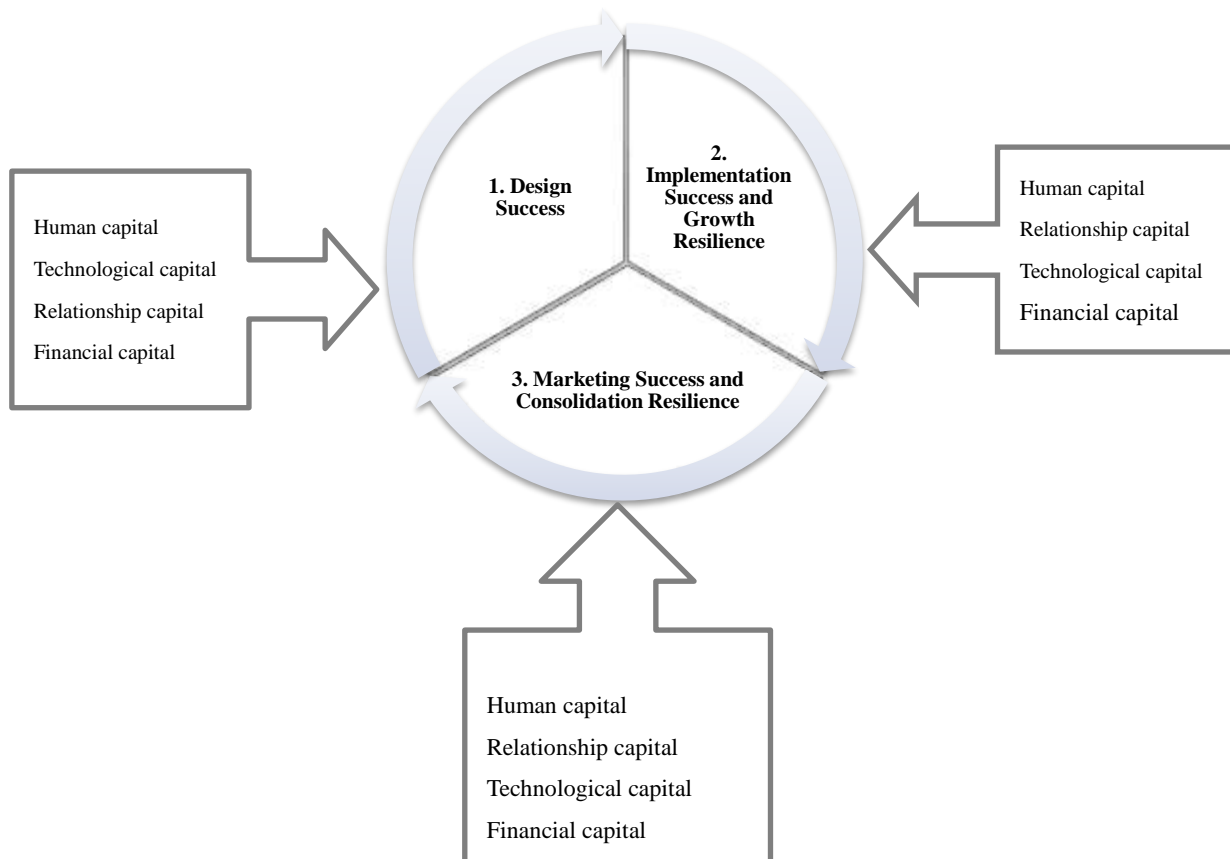


Figure 5. Technology Components

Source: author, 2022

### 3. Methodology

Technological entrepreneurship is a phenomenon less well known to researchers. We have deployed a qualitative exploratory approach. Inductive in nature, it has made it possible to grasp technological entrepreneurship in its finest manifestation. The field of maneuver is for private and public companies. Sampling by convenience was adopted because the goal is not to generalize the results to all contractors. The objective pursued in this research is to construct theoretically, to guarantee internal validity (Evrard, Pras, Roux, & Desmet, 2009) With the use of a small sample (12 technology entrepreneurs) too large biases would emerge. Data production began with the validation of the interview guide following a pre-test and the consultation of three experts. Then, we sent a letter explaining the research project to each of the 12 identified entrepreneurs. Similarly, a telephone call was made in the same week. A total of 12 semi-structured interviews were conducted by a four-member team between September and November 20 22. Interviews average one hour in length. They were recorded on a digital medium and then transcribed. The *verbatim*s were then codified and analyzed thematically (Igalens & Roussel, 1998) via the NVivo software version 14 by the author of the chapter.

Portrait of companies that responded to interviews.

In this research project, several technology companies of different ages, sizes and sectors were studied, as shown in Table 1 below.

Table 1. Technology Companies Interviewed

Maintenance	Sector	Age	Waist	Process phase
1	Health	6	51	Implementation and growth
2	Energy	8	54	Development and Marketing
3	Water	4	23	Conception
4	Technology	3	62	Development and Marketing
5	Media	14	14	Development and Marketing
6	Bank	6	8	Implementation and growth
7	Energy	8	14	Marketing and consolidation
8	Electricity	6	24	Conception
9	Breeding	5	7	Marketing and consolidation
10	Academic and industrial research	18	90	Development and Marketing
11	Energy	14	42	Implementation and growth
12	Energy	20	34	Implementation and growth

An examination of Table 1 reveals that five companies work in the sectors in which they work.

## 4. Results

### 4.1 Design Phase of Technology Entrepreneurship

Eleven of the twelve companies studied have experimented with the design stage of technology entrepreneurship. The twelfth is still in this phase.

#### Design Phase Success and Resilience Factors

Success factors and related barriers are classified into five dimensions: Human Capital, Technological Capital, Structural Capital, and Relationship Capital.

#### Contributing human capital to success and resilience

During this phase, it is important to consider the following success factor: human capital. To develop a good business plan, the entrepreneur must have a good skill of the trade. In addition, he must know «what customers need or will want" according to interviews #1, #2 and #3. Other interviews (#4, #5, #6) illustrated understanding the evolution of the market to offer, at the right time, the product that will respond to the problem faced by the user. This is consistent with several authors (Lacoursière et al., 2014; Mignenan, 2020, 2021e) that highlight the importance of using your human capital to know the user of your product. The authors then insist on the fact that it is as much a priority to understand your customer as to know your market in a global way.

In addition, according to respondents, "the entrepreneur who has a good knowledge of his customers and who puts forward the characteristics of his product" (interviews #7, #8, #9 #11) plays a major role in the success of the design of the innovation. Respondents also emphasized the importance of having a good team to be able to succeed in the design phase. In addition, "Having good collaborators you trust and who are more competent than you" will determine the success of the technology entrepreneurship project (interview #6). Thus, one of the success factors of R&D projects is human capital (Delgado-Verde et al., 2017; Lacoursière et al., 2014; Mignenan, 2020, 2021e) since it is necessary to "have the right people to complete the project" (interview #4).

Since the employees of the technology entrepreneur have a decisive influence on his project, it is relevant to focus on the relational capital including stakeholders and their contributions during the design phase of the technological product.

#### Contribution of relational capital in the success of the design phase

This research project identified several components of the relationship capital that provide support to the technology entrepreneur in his project. Several contributions were identified: technical contributions, structuring of the project, building a network of contacts, and seeking funding.

In terms of technical contribution, several stakeholders supported the technology entrepreneur, including, among others: research firms, suppliers, and university research laboratories, etc. These different organizations have provided the necessary knowledge, information, and skills to support technological innovation. The entrepreneur in interview #8 mentions the role of investors in access to equipment and infrastructure: "Our financial partners have given us access to workspaces, facilities and other equipment, etc. » Other stakeholders, such as future customers, voluntarily lent themselves to technical tests to validate the idea of technological innovation: "This company allowed us to experiment, knowing that it would regenerate energy savings for them" (Interview #11). This statement corroborates the opinion of two authors (Astebro, 2004; Mignenan, 2020, 2021e) that highlight the need to work with the client, to generate the success of his entrepreneurship and foster his resilience.

As part of the structuring of the project, the technology entrepreneur can call on an entrepreneurship advisor who can accompany him in his project (interview #4). He can use patent agents to provide him with the necessary information and feedback: "I contacted my patent agent to verify the existence of such a project" (interview #6). The technology entrepreneur can call on incubators (interview #9) or university development companies (interview #11). Finally, the protection of the technological project requires a good lawyer from the beginning of the project: "A good lawyer, from the beginning. Just because it's cheap doesn't mean it's good" (Interview #10). Finally, many issues force entrepreneurs to call on lawyers from the beginning: intellectual property, procedures to separate from former employers, etc.

With a view to building a network of contacts to validate the idea of innovation, respondents mentioned several possible trajectories: professional organizations (interviews #3 #5 #7 and #10), trade clubs (interview #2, and #9), incubators (interview #11), accounting managers (interviews #4, #9 and #10). These leads corroborate the literature. Indeed, professional associations and trade groups are opportunities to identify new opportunities. They are also a source of relevant information. Accountancy managers can help the entrepreneur by giving him the benefit of their network of contacts and thus giving him access to clients. As a result, actors involved in financing can become accessible through this network of contacts.

Finally, during the design phase, the search for funding is necessary. Several respondents mentioned using bank managers, microfinance institutions (interviews #4, #8 and #9), or private investors (interview #7). The contribution of managers is also mentioned in the literature. Other opportunities identified by respondents included government grants (interviews #2, #3, #4, #5, #6, #7, #8, #9 and #11) and incubators (interviews #4 and #9). These possibilities are in line with the words of some authors (Astebro, 2004; Bailetti, 2012; Mignenau, 2021e) According to this author, government grants provide funds to entrepreneurs who help them with their projects.

#### *Contribution of technological capital to design success*

Respondents agreed that technological capital is the successor factor to technological entrepreneurship. They stress the positive correlation between the availability, quantity and quality of technological resources and the successful design of technological innovation. This is the case for respondents #5, #6, #7 and #12. According to them, it is necessary to make "a marriage between knowledge of the market and the need, and knowledge of the technology available to meet this need". In addition, some respondents insisted that one should not "be married to technology", but rather choose technology appropriated and equated and evolve, if necessary, "technically strong people, to analyze technological choices" (interview #10), technical skills being key success factors.

Ultimately, there is general agreement that the success of the design phase of technological entrepreneurship is strongly due to the quality of human capital (level of training, experience, business/technical competence, management, trust, etc.). Then comes relational capital (business network, customer relations, technical and financial partners). Finally, technology, structure and finances also play a significant role in the success of entrepreneurship. On the other hand, the resilience of the design phase is the subject of little comment for reasons of its limitations in time.

#### *4.2 Implementation and Development Phase*

This phase, considered simplified (Tiwari, 2007) includes development and was carried out by 9 of the twelve companies studied. While the other companies are still in this stage.

Success factors of the implementation and development phase

The various dimensions (Relational Capital, Human Capital, Financial Capital, Structural Capital, Technological Capital) will be addressed in this phase.

Contributions of relational capital (market and users) to success and resilience

According to the respondents, the mastery of relational capital (customer relationship, knowledge of the market and the user, stakeholder management) remains important in the implementation and development of technological innovation (interview #3, #5#7, #8). In addition, for some respondents (interview #3, #5#7, #9), the goal is not to understand the need, but to find a solution (appropriate technology) to the problem detected. Understanding the market is then one of the success factors of the technological project: the relevance of the solution to the identified problem. The mobilization of the first customers to test the product is then necessary: "It takes first customers who will try." (Interview # 9). This ties in with another success factor of this phase, which is to "be 'challenged' as quickly as possible" (interview #6).

Contributing Technology Capital to Success and Resilience



According to the respondents, it is relevant to perform several tests and correct errors or overcome technological challenges that come your way. In addition, risks of technology implementations exist, and some respondents point out that they can become significant obstacles when they are not anticipated: "we have not seen the risk of implementation at the level of certain technologies [...] Implement them at the time and in the cost that we had anticipated, on this, we had more difficulties" (interview #6, #9). In addition, respondents noted the splitting of information when interacting with various collaborators, such as suppliers.

#### Contribution of Financial Capital to Success and Resilience

The respondents mentioned the cost and working capital requirement, which is often higher than expected during the implementation phase: "Financing at this stage is very difficult." (Interview # 5). "There is a much greater chance of a failure in terms of funding than in terms of technology." (Interview # 8). Therefore, it is possible to solve these problems through "government grants and aid" (interview #9), for example. The literature also deals extensively with the issue of financing as a cause of success/failure and resilience of technological projects (Astebro, 2004; Bailetti, 2012; Mignenan, 2021a, 2021b, 2021c, 2022c)

#### Contributing Human Capital to Success and Resilience

Many authors (Astebro, 2004; Bailetti, 2012; Fossum, Binder, Madsen, Aarseth, & Andersen, 2019; Lacoursière et al., 2014; Mignenan, 2021a, 2021b) highlight that the success of technology projects is influenced by the entrepreneur's management skills. Respondents point to management obstacles, particularly related to the satisfaction of financial partners and shareholders, which makes this phase "very risky. Shareholders can leave if anything less clear happens (interview #4). In addition, it is communication management, interpersonal management and partner relationship management that is mentioned by respondents as causes of success/failure and resilience. For example, it is necessary to keep the partners informed of the real problems going on and therefore of the real situation. This led one respondent to state that "choosing an experienced financial partner is important, as it will facilitate the management of communications with these partners (interviews #8 and #10). While communications management was an element that emerged from the interviews, so it was interpersonal and time management. It is easy to underestimate the interpersonal conflict and the time required to complete this phase: "it put pressure on the entire organization" (interview #11).

#### 4.3 Marketing Phase and Consolidation

This phase includes production, marketing, and consolidation. Eight of the twelve companies in our sample are in this stage. According to respondents, this is the phase in which entrepreneurs experience enormous cash flow difficulties.

#### Success and resilience factors of the marketing phase and consolidation

The various dimensions (relationship, human/management, technology, finance) will be addressed in this phase.

#### Contribution of relational capital to success and resilience

The importance of relationship capital in the success and resilience of marketing (production and marketing) and sustainability activities was highlighted by respondents: "To produce, market and withstand market shocks, you need to be able to have a good business network, to have people you can count on." (Interview #3, #5, #8). Two other factors of success and resilience were then identified. An SME with limited resources seems to have difficulty accessing the market: "market acceptability is never obvious" (interview #6). In addition, it seems necessary to "have a global presence with certain employees, to have this feedback from the market. I also feel the competition, what is happening, to be able to develop the right products" (interview #11). This then makes it possible to improve the product. In addition, to commercialize innovation, market data is needed to ensure product diffusion, growth, and development.

#### Stakeholder roles in the marketing phase

Several roles have been identified: access resources, access services and finally, access to a network of contacts. With respect to *Access to Resources* (interviews #4 and #9), interviewees emphasized the importance of financial, physical, and informational resources, as they play an important role in the execution of launch activities and thus promote success. For services, responses refer to government departments, standards bodies, lawyers, etc. (interviews #6 and #9). Finally, access to networks of relevant contacts promotes support, pooling and increases resilience (interviews #1 and #3).

#### Contribution of human capital to the success and resilience of the marketing phase and consolidation

Having competent human capital was seen as a factor in success and resilience by many respondents. Thus, two criteria must be considered: "First criteria: someone who knows his target market very well, he must be in the

target market" (interview #2, #5, #8). Second criterion: someone who has sufficient technical knowledge. (Interview #7). Since then, several authors (Astebro, 2004; Bailetti, 2012; Fossum, Binder, Madsen, Aarseth & Andersen, 2019; Lacoursière argue that the most important factor in the success of research and technology development as well as its resilience is human resources. Since the human resources of the technology entrepreneur exert a decisive influence on his project, it may then be relevant to focus on the necessary stakeholders and their roles during the marketing phase of the technological product.

**Contributing Technology Capital to Success and Resilience**

This dimension was addressed by several respondents during this phase. It's necessary that the entrepreneur has state-of-the-art technology to deliver quality products. This will ensure its positioning in the competitive environment and therefore increases its resilience: "but without technology, you cannot be efficient in the process of your project." (Interview #5, #8).

**Contribution of Financial Capital to Success and Resilience**

An SME has limited financial resources, which can be a significant obstacle during the marketing phase: "Since you are an SME, you cannot make huge marketing efforts." (Interview #8). They can therefore be a factor that determines the success of the commercialization of technological entrepreneurship projects. In addition, inadequate funding is the fundamental barrier to establishing technology companies. This is due to the difficulty of estimating cash flows and the volatility of this type of business (interview #1, #3, #9).

**4.4 Best Practices for the Success and Resilience of the Tech Entrepreneur**

This section presents good practices related to the success and resilience factors identified by the 12 technology entrepreneurs. Each of these good practices covers the different dimensions (relational capital, technological capital, financial capital, management, and people). Moreover, these good practices are different according to the three phases of the entrepreneurial innovation process. Which is in the following table 2.

**Table 2. Best Practices for Success and Resilience**

	Conception	Implementation and development	Marketing and consolidation
Human capital	-Provide business skills -Elaborate the different tasks -Formulate a relevant solution -Ensure the quality of technology	-Provide management skills -Develop the operational plan -Manage operational aspects -Promote compliance with standards and methods	-Stimulate production and competitiveness -Prove the values of technology -Create networks of contacts -Manage the strategic side of the technology.
Relationship capital	-Know the characteristics of the market -Make contacts available -Protect trade secrets -Informing stakeholders.	-Provide contacts in the market -Perform tests and trials -Build partnerships -Provide networks of relationships	-Provide contacts in the market -Perform tests and trials -Build partnerships -Provide networks of relationships
Technological capital	-Use technology in operations -Distribute resources	-Digitize services -Follow-up and control of activities -Automatically manage operations -Ensure quality and productivity	-Promote agility and flexibility. -Produce automatically -Facilitate communication between actors -Improve productivity and quality
Financial capital	-Develop the cash flow plan -Control expenses -Develop the financing plan -Choose the right financial partners.	-Set up financial accounting -Manage expenses with financial partners, -Facilitate the execution of activities -Respect the constraints	-Ensure the execution of operations -Achieve sales targets -Adopt a marketing process -Support all loads

**5. Implications for Research**

In the first place, thanks to its focus on public and private companies, our study goes against the current of the literature above focused only on private companies and, very often large. Therefore, our results demonstrate interest in future research on the human and relational dimensions of an organization, including social practices

to increase opportunities for success and resilience.

Second, our study sheds light on the role of intellectual and social capital in the process of success and resilience of technological entrepreneurship. Indeed, while a few previous studies have examined the role of intellectual capital in the performance of technological innovation projects, little qualitative research has been conducted to date, to our knowledge of the resilience of technological entrepreneurship projects. Our study demonstrates that social practices that include the intellectual capital of the business can be effective for the success and resilience of the design, implementation, consolidation, and marketing of technology entrepreneurship.

Finally, our results confirm that intellectual capital management practices including social and technological capital contribute effectively to the three main phases of technological entrepreneurship. Therefore, it would be relevant to take these dimensions into account in future models on the success and resilience of technological entrepreneurship. Our results shed light on how technology entrepreneurs can successfully run their projects and make them resilient.

## 6. Limitations and Future Research

Some specificities of our sample, related to the size and process of entrepreneurship constitute limitations, but also interesting future research perspectives. We have chosen in this study to focus on small public and private organizations, as all are, by nature, more limited in resources. Similarly, we have adopted the qualitative approach. Therefore, we are not able to generalize our results and say that they apply to all organizations. Therefore, some questions deserve to be explored in future research, including the quantitative method, with a large sample size.

Finally, an ambitious research perspective would be to conduct new empirical studies in three different locations to make comparisons. We could then move closer to a consensus on the question of the contribution of intellectual capital to the success and resilience of the process of technological entrepreneurship in a changing context.

## 7. Conclusion

This study made it possible to identify and understand the factors of success and resilience of technological entrepreneurship in the era of change. It fostered the visibility of intellectual capital as a determining factor in the design, implementation, and marketing of the technology entrepreneur. Nevertheless, given the nature of the qualitative exploratory approach of this study, the aim was to construct theoretically and therefore the results cannot be generalized. In addition, 12 enterprises were the subject of semi-structured interviews. It should also be noted that the Tiwari (2007) innovation process model used was not perfect. The fact that it is simplified has made it easier to analyze the results, but an approximation is then made, since entrepreneurial innovation is not necessarily a linear process. One of the entrepreneurs started his project directly in the implementation phase, for example.

About future research, researchers have several options. It may be relevant to dwell on the different alternative strategies of human capital, relational capital, and financing of technological entrepreneurship projects. A consensus emerged that the financial, human, and relational dimensions were vital for each of the three phases of the model adopted. To seek to generalize the results, a confirmatory approach could be adopted to estimate the effects of the identified factors in the success and resilience of each phase of the innovation process. Several stakeholders and their roles as well as technological capital would also be relevant to deepen. This then makes it possible to present the results of the technological product, but also to detect new avenues for innovation. The mentoring relationship and business network identified by respondents may also be the subject of further study. Finally, the role of public and private support bodies, the relationship between a university external to the project and the latter, are avenues to be explored. From a managerial point of view, future entrepreneurs can use the results of this study as guidelines to adopt good practices based on these success and resilience factors, from the beginning of their projects.

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