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Innovation key success drivers of industrial companies in mature technology segments

Doctoral Thesis

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To my wonderful wife Marta.

For her love and continuous support to my work.

And to my daughters and son,

Maria, Imma and Pol, to whom I wish happiness and wisdom.

Joseph Alois Schumpeter

„Kapitalismus ist Chaos“

„Wachstum ist ein Prozess schöpferischer Zerstörung“

"We choose to go to the moon. We choose to go to the moon in this decade and do the other things, not because they are easy, but because they are hard."

John F. Kennedy

September 12, 1962

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List of abbreviations and acronyms:

CEO	Chief executive officer
CIDEM	Centre for Innovation and business development Catalonia
CIO	Chief innovation officer
CIS	Community innovation survey
COTEC	Fundación Cotec para la Innovación tecnológica, Spain
CPAS	Comparative performance assessment study
EBIT	Earnings before interest and taxes
EBITDA	Earnings before interest, taxes, depreciation, and amortization
IESE	IESE business school
IMS	Innovation management standard
LMT	Low-medium technology
NDA	Non-disclosure agreement
NPD	New product development
OECD	Organization for economic co-operation and development
PDMA	Product development and management association
PILOT	Policy and innovation in low-tech industries in Europe
R&D	Research & Development
SME	Small and medium-sized enterprises
TIM	Total innovation management foundation
UPC	Universitat Politècnica de Catalunya

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Joan Badrinas

Foreword

A Friday late afternoon, thirty years ago, I was getting into my car to drive home. I had been recently promoted and my successor as R&D Director peered out from the window of his office. I had an obliging question. How did the last tests go? This was a new product competition, to which our customer had invited all the players in the branch. A set of impossible component specifications to solve an unexpected major issue before the imminent market launch. The car was unsellable! "No progress", he answered. "Let's throw the customer specifications into the bin and think for a minute what the real problem of the car is". We both convened. We changed the game and used a novel concept in an unconventional way. We won. The car was launched on time, and we learned a lesson that I have kept applying. Bold innovation requires reframing the problem. After finalizing the writing of the present doctoral thesis, I realize that, in its essence, I have re-encountered the same conclusion.

Simultaneously to finalizing this manuscript, the publication of a paper, related to the findings of this doctoral thesis, in the *International Journal of Innovation Science* has been accepted. It is expected to be published in the December 2015 edition with the title "An Innovation Management System to Create Growth in Mature Industrial Technology Firms". Authors, Joan Badrinas and Joaquim Vilà.

Abstract

In business terms, the ultimate purpose of innovation is to generate profitable growth, however for mature industrial technology firms (LMTs), operating in mature markets, endeavors of innovation often result in the maintenance of the market share and rarely in creating growth streams. This doctoral thesis intends to shed light on the management practices that makes LMTs in mature markets successful in the creation of innovation driven growth.

On the basis of existent literature in related topics, a conceptual framework describing the business environment influencing the innovation behavior of LMTs in mature markets is proposed, and contrasted to the conditions of companies operating in fast moving business environments.

To collect knowledge on the subject, a multi-case research is undertaken. The selected cases are six LMT companies, headquartered in three European countries, operating in mature markets. To carry out the research, an innovation management analysis framework, made up of twenty factors classified under chapters of Culture, Leadership, Resources & Competence and Processes, is developed. The outcome of applying the innovation management analysis to the six cases is then compared to the success of every company in creating growth streams.

The findings of the multi-case research identify the key factors and its distinctive characteristics contributing to success in the creation of innovation driven growth. Interrelation across factors are also observed and analyzed. Insights into the cases explaining their innovation practices linked to success are presented.

An inductive process and the cross comparison of the cases finally lead to the identification of an innovation system construct, defined as a top management process that proves to contribute towards creating new growth streams in LMTs in mature markets.

SECTION I

Problem definition and research objectives

SECTION I

1. The research problem and objectives

The world is changing faster than it ever did before, globalization, technology, environmental sustainability and easy communications mean the needs and wishes of the market are continuously moving. If firms only react to the obvious market changes, and do not take a proactive innovative role, not only does growth not take place, but quite often competitiveness is seriously deteriorated.

The theory of creative destruction of Joseph A. Schumpeter (1942) and his vision of entrepreneurial innovation as a direct cause effect of economy long term growth, gives him the merits of being often considered the prophet of Innovation. Today, his view has re-gained a high relevance. Innovation is one of the topics and focus more often mentioned and discussed by politicians, authors and business leaders. In the 80s, a good portion of the business management papers were published under titles including the buzzwords of the time, such as Lean Manufacturing, Total Quality Management, kaizen or Six Sigma. In the 90s, entrepreneurship and Innovation started gaining more attention; today, Innovation is at the center of most business projects. The reason seems obvious, in today's fast changing world, innovation is the single matter having the highest impact on the profit & loss bottom line.

The spectacular fast success and billionaire sales turnover and profits generated by companies like Apple, Google, Face-Book, or even Black Berry, have greatly contributed to divulge the benefits of being innovative. The latter having experienced a fast growth phase followed by a dramatic decline, which re-enacts Schumpeter's theory and the fast pace of today's business environment. Managers like Steve Jobs, Larry Page, Bill Gates, and Mark Elliot Zuckerberg, just to mention a few that among others have built empires literally from scratch, have become the new heroes and set the model that all business leaders, managers and investors try to emulate. However, most of the well-known innovation cases have emerged in new technology and highly dynamics business environments. Silicon Valley, which is associated with new technologies, has been the breeding ground of many of the big business innovation successes.

This doctoral thesis on innovation management intends to contribute to the knowledge of the key success factors and its interrelations that make mature technology firms operating in mature markets successful in the creation of innovation driven growth. In this context, mature technology firms are understood as companies within the characteristics of LMTs (Low- or Medium-Technology) industries referred to in the Oslo Manual (2005). This includes the Low-technology, the Medium-low and the Medium-high technology industries according to the classification of the OECD (Hatzichronoglou, 1997).

Innovation activities in LMT's in mature markets are predominately focused on incremental performance projects, and strong focus on operational excellence. The introduction of break

through innovations, with the power of creating strong differentiation, and not only the preservation of the current business competitiveness, is rare. In mature markets, the consequence of this behavior is that companies often manage to maintain their relative status quo in the market, but seldom generate long term net growth. Marginal market share shifts, driven by value associated to incremental innovation, are rapidly counteracted by competitors. The competitive advantage is lost and the market shares tend to come back to the original equilibrium. Only more innovative new products and businesses that cannot be easily contested by competitors can provide durable competitive advantage and therefore growth.

Although the production value of the Low-medium-technology manufacturing industry in the European economy more than triples the production value of the High-technology manufacturing sector[1], innovation in LMTs has received less attention from scholars than the high-technology businesses. Likewise, rapid changing market environments tend to attract more attention in the literature than mature markets, probably because, in the last two decades, this is where the big billionaire innovation cases have emerged. Yet, innovation in mature technology segments confronts greater difficulties than in high technology and rapid changing environments. The technology and business environment changes significantly more slowly than in high technology and rapid changing segments, thus offering fewer opportunities and lever support points to drive innovation. In LMT's operating in mature markets, growth driven innovation is a real challenge.

This doctoral thesis tries to shed light on the relation between the innovation practices of LMT's (= mature technology) firms operating in mature markets and the achievement of growth. The analysis of the innovation practices has been structured under four chapters headlined: Culture, Leadership, Resources & Competence, and Processes.

1.1. Innovation driven growth

The achievement of profitable growth is the single most influencing factor to create shareholder value and to stimulate the equity markets into increasing the value of a firm. This is one of the highest rang objectives on the agenda of most executives, yet in established firms in mature segments it can be a very challenging one.

Executives have two non-excluding paths to achieve profitable growth, organically and through acquisitions. Both have different business implications and both are not at all exempt of risk. This doctoral thesis focuses on the achievement of organic growth through innovation.

[1] Source: Eurostat. Annual enterprise statistics for special aggregates of activities. 2015

The creation of innovation driven organic growth requires the concurrence of two basic components:

- A novel product or service that satisfies market unmet needs or wishes
- A business model capable to convey the value of the innovation to the market and to capture the economic value for the company

The intersection of these two dimensions with the market creates the space for business innovation. Changes in Business model and Products & Services have to be smart and fast enough, to gain innovation space and generate growth (See Figure 1).

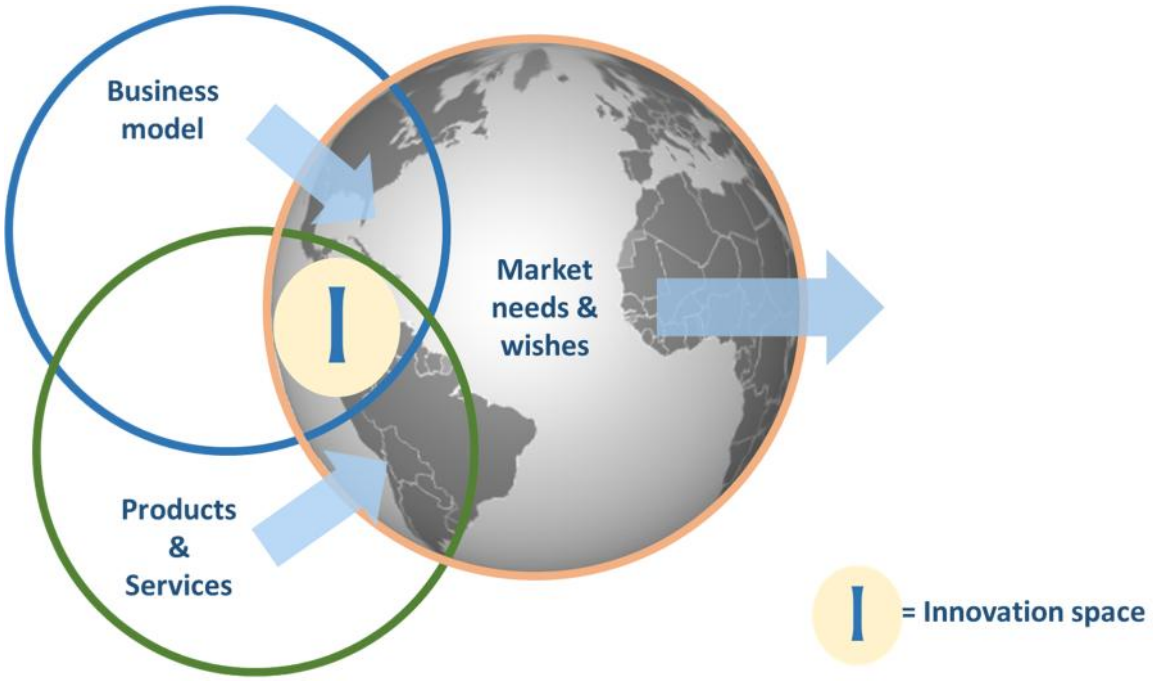


Figure 1: Innovation: A novel Product or Service and a Business model

The involvement of a business model entails the concept that innovation is a company-wide undertaking. This means that Innovation is not synonymous with New Product Development, and it cannot be an exclusive task of the R&D department. What is generally accepted by scholars is surprisingly not always consequently applied by practitioners. The reality is that an investment in the R&D department, or hiring the best engineers and scientist to create novel products is not enough to be successful. A novel product cannot be exclusively created by the R&D department,

all the company stakeholders play a role in selecting the market unmet needs that are to be addressed by the firm, and the way to address them.

The launch of innovative new products and services to the market might require changes in the business model. For instance, a more complex product might require offering installation service assistance, different distribution channels or extended repair warranty conditions. The business model can also be the locus of innovative concepts, which can eventually imply product changes. Renting instead of selling, or moving from components supplier to solutions provider are business model changes that will probably require product and service modifications. Incremental product innovation does not necessarily force business model adjustments, but more radical product innovations require a review of the business model. This involves questioning the distribution channels, service, partnerships, internal resources and processes (Johnson, Christensen, & Kagermann, 2008).

The market, at a higher or lower pace is constantly moving, even in mature markets new needs and wishes emerge, generating new business opportunities. For a firm to generate growth, the creation of new Products and Services and the adaptation of the Business model to new business opportunities have to move faster than the market; faster than the old business declines and faster than competitors occupy the new space. Only then does the firm's addressed market become bigger and generate growth. Easy to be said, but in stagnant and low growth markets this is a challenging task.

1.2. Industrial mature technology versus fast moving markets and new economy firms

Firms in industrial mature segments operate in a market environment with quite different conditions than firms in fast moving markets or the new economy. Contrast, for instance, companies operating in manufacturing industries such as buildings and construction, elastomeric goods or automobile with companies operating in fast moving markets such as online retailers, consumer electronic goods, communication or social media. The market conditions in each group force executives to engage a different set of priorities in their management agendas, and therefore innovation management priorities are also different.

This section includes a review of the differences in these two business environments (see Table 1). Industrial firms in mature technologies typically operate in low growth, well-known established markets, with a value chain having strong interdependencies. The automobile industry is a typical example, where the car manufacturers together with a multi-tier level supplier network, have developed progressively over almost a century. A broad spectrum of

alliances and agreements shape a well-known and relatively stable automotive industrial business. In Western economies, car sales are stagnant, and global market growth is moderate.

Yet, for incumbents the market to defend is big, up to one hundred million vehicles per year. The paper industry is another typical example of a mature market, with established firms and a strong network of relationships along value chains. Here also there is no growth potential in Western economies and the overall global growth is moderate, with graphical paper and newspaper consumption in decline, as a consequence of advances in tablets and new electronic information technologies.

New economy and fast moving markets experience higher growth potential and the environment is more turbulent, changes in the market occur much faster, disruptive technologies create fresh opportunities, new consumer trends and new market needs. For instance in consumer electronics, the high quality MEMS microphones (micro-electro-mechanical system) used to cancel ambient sounds, which is critical for voice recognition and command systems, have generated in four years a new business exceeding $1 Billion [2], with yearly growth compound rates up to 50% since 2010. This new technology has made irrelevant the manufacturing of old technology microphones. Such strong growing markets generate attractive opportunities, where new players, short term strategic moves and novel commercial schemes impose totally new mindsets. A highly dynamic business landscape.

In industrial mature segments, technology progresses at low pace, with only incremental improvements for long periods of time. In the absence of disruptions with the strength to question and shake the dominant design (Tushman & Anderson, 1990) (Tushman, Anderson, & O'Reilly, 1997), companies enter into long periods of fermentation with frequent design changes, until a new dominant design emerges and sets a new industrial regime. Even in that case, the transition between dominant designs is slow and smooth. For instance, nobody questions that the automobile is moving towards plug in hybrids and electrical cars, but a dominant design around plug in stations, recharge options, battery range versus cost, has not yet been resolved since the new introduction of hybrid cars in 1997. Despite the fact that the development of electrical cars started in the ‘90’s, more than two decades later, the global production of plug in hybrids and electrical cars account for less than 0,5% of the total global light vehicle production. Mature established industrial technologies tend to entail big inertia, making the transformation of businesses progressive and long, thus protecting the business exploitation from abrupt fast disruptive changes.

[2]Source IHS 2014

Table 1: Differences in business environments affecting innovation

Industrial mature technology	Fast moving and new economy
Established markets. Known players. Intertwined dependencies	New markets, rapid changing environment, start-ups
Low growth or stagnant markets In Western economies, often declining	Big growth opportunities. Fast growing, yet short cycled product markets.
Technology improvements are incremental, cycles between disruptive technologies are long and transitions tend to be smooth	Technology changes rapidly and in big steps, disruption risk management is a key executive activity
Historical regional differences and regional customer relationships hinder growth opportunities	Regional barriers are small or inexistent. There is no legacy history. In many fields, like the new internet economy, markets are open, with no borders.
Operational excellence and the ability to manage a balanced price-cost relationship is a must to remain competitive	Dynamic capabilities to adapt to a rapidly changing environment are key to stay in business

Source: Own elaboration

In mature markets, regional differences tend to be significant, with roots in a long legacy history prior to globalization. As a result, in the automotive market, car preferences are still significantly different in America, Europe and Japan. Quite simply it is the consequence of cross-cultural differences. In new economy and fast moving markets, regional differences are much smaller; there is no legacy to respect. Consider the smart phones, tablets, computers or consumer electronics goods. Products are basically equal in all regions, only with exception of the electrical plug and voltage, which are, of course, tied to a mature technology. Regional differences in mature technologies are an additional burden when it comes to generating growth from new products.

In fast moving markets and the new economy, technology disruptions and frequent fast market changes are inherent to the business landscape. The status quo does not hold long, and executives, attentive to the market, feel the need to be constantly open to changes. To perform and survive, firms in this context require flexible processes to continuously adapt to fast changes. Dynamic capabilities (Teece & Pisano, 1994) become part of the business as usual activities. The market sets the pace.

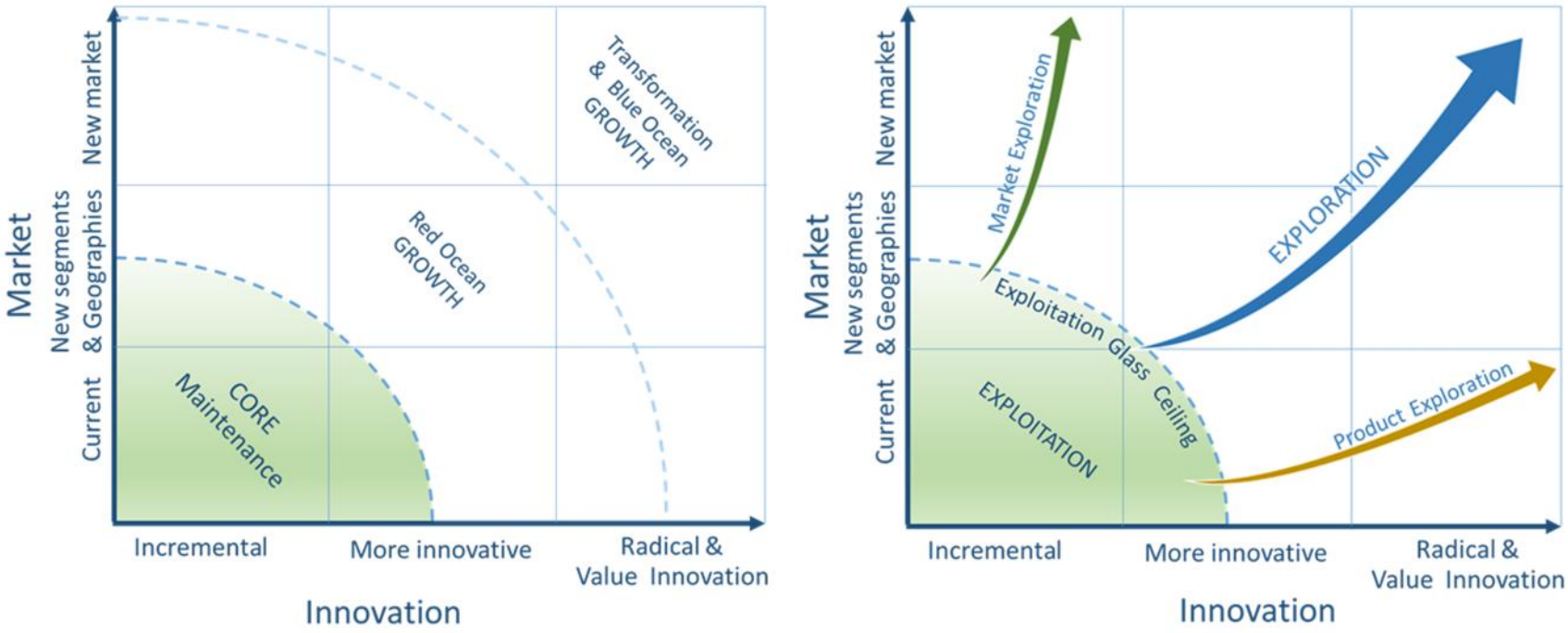


Figure 2: Innovation – Market matrix: Growth Streams

In Industrial mature markets, the executive's priorities have a different focus, the defense of the competitiveness and status quo in a market that will not radically change in the short term. Whilst prices are under pressure and there is a constant risk of falling into a commoditization spiral, these threats can be counteracted with strong focus on operational excellence, cost reductions and a continuous flow of incremental innovation. That's all what markets and stakeholders require.

In summary, industrial market environments induce industrial companies to be naturally focused on defending the status quo. To deliver the yearly results, strategic actions are more focused to strengthen core competences, to maintain or improve the product portfolio competitiveness through incremental innovation and to reduce costs rather than to create new competences. In other words, in most cases, operational excellence will lead, in the short term, to satisfactory financial results. If the market is quiet, there are no clearly compelling reasons to undertake drastic moves. Radical changes involve high risk and commitments with uncertain pay-offs. Why then embark on major changes? Still the achievement of profitable growth remains the single most influencing factor to create value. This permanently stands as one of the highest ranked objectives in the agenda of most executives. Yet in established firms operating in mature markets, it is also an outstanding challenging target.

1.3. Growth streams beyond exploitation

The majority of industrial firms in mature markets, despite offering a continuous flow of incremental innovation to their clients, barely generate organic growth. They just defend their market share against competitive forces. In stagnant markets, growth can only be achieved through market share gain or entry into new markets. In both cases, other players will have to lose ground. Even though marginal growth is possible, if the competitive advantage gained is based on incremental innovation, it will not take long until the competitors catch up, or pricing tradeoffs offset the relative advantage. Incremental innovation hardly generates sustainable growth.

The matrices in Figure 2 show the space and directions to create growth along two dimensions: Innovation and Market. The matrix has been adapted from a map of innovation utilized by Tushman, O'Reilly (2004) and also Anderson (1997), in which the authors compare Innovation (primarily related to technology) and current and new customers (or markets). The innovation types in the Innovation axis are the generally accepted categories used in the literature. The term "More Innovative" has been taken from the PDMA CPAS study (Markham & Lee, 2013), which comprehend architectural (Henderson & Clark, 1990) and generational innovation (Gatignon , Tushman, Smith, & Anderson, 2002). "Value Innovation" (Kim & Mauborgne, 1999) relates to innovation involving a drastic review of the company value proposition, which can lead to the creation of a Blue Ocean uncontested space (Kim & Mauborgne, 2005). Value innovation can also be achieved by a transformation of the business model (Johnson, Christensen, & Kagermann, 2008) (Teece D. J., 2010), changing the business canvas (Osterwalder & Pigneur, 2010). The measure of the Innovation axis, beside the innovation type, can be seen in terms of price/performance (Gatignon , Tushman, Smith, & Anderson, 2002), Innovation types

more to the right of the scale involve higher risk and, therefore, a more favorable price/performance is expected.

Most industrial companies in mature markets are mainly focused on maintaining their core business and remaining inside the Exploitation space. They are concerned mainly with launching incremental innovations in their current markets, and only occasionally do they develop more innovative products or enter in new segments or geographies. Yet, competitors carry out very similar kind of activities and, therefore, very often, all innovation efforts end up in maintaining the market share and not generating net growth. To grow, it is necessary to undertake more innovative or radical innovations, to implement a new value proposition canvas or enter into new markets. These movements cannot be easily replicated by competitors. The more radical the innovation goes, the higher the associated risk is, but also more distance from competitive red oceans will be generated. The upright corner of the matrix involves a real transformation, aiming at introducing totally new products in a new market; a true challenging task in terms of management demands and risk.

As reported by Cooper (Cooper, 2005) (Cooper, 2011), a comparative analysis of development projects launched by industrial firms, between mid-1990s and the first years of this century, shows a dramatic reduction of "New–to-world, new-to-market innovations" (20,4% down to 11,5%) in favor of "Improvements & modifications to existing company products" (20,4% up to 36,7%). The wish or ability to launch radical innovative products in mature markets seems to have slowed down over recent years. Is the trend driven by the firm's stakeholders requiring more exploitative low risk and short term projects, in prejudice of uncertain more long term oriented radical innovation projects? The question is open.

Growth can be generated along distinctive streams, Product Leadership, Market Exploration or a combination of both (see Figure 2). Product Leadership is primarily focused on product innovation, it creates innovation streams (Tushman, Anderson, & O'Reilly, 1997) driving new architectures, technologies and/or new business concepts to generate and lead change in the currently served customers and markets. It aims at developing and applying the potential of an internally generated technology, process or design to the well-known markets, with the objective of becoming the uncontested leader and expanding the gap to competitors. Market Exploration is focused on new market development. It aims at directing core competences to adapt products to satisfy the needs of customers in related and especially in new markets. While technical competences will go through relatively minor changes, new marketing approaches will be necessary. Despite mastering the technology, entering a new market poses new challenges in terms of management, commercial assets and risk.

The combination of both will set a balanced Exploration path, focused on developing product-business model innovation with the objective to serve new markets. This compounds and magnifies the complexities and risks of both paths in isolation, reaching its maximum difficulty in the up-right corner of Figure 2, with radical innovation in newly created markets (Colarelli O'Connor & Rice, 2012).

1.4. The research questions

Mature technology firms appear to be hostage to their exploitation intense and highly demanding activities, trapped under a virtual exploitation glass ceiling (see Figure 2). Breaking through it to generate profitable growth is a true management challenge. This entails to gain trust and confidence in navigating in exploration unknown waters, to energize the organization to move out of the comfort zone, to drive progress and finally deliver positive growth results. As discussed, in mature markets, there are few, if any, incentives to move away from the exploitation regime. Even in the event of a huge storm coming in, management team's assessment of risks and unknowns surpass the uncertain payoffs (Christensen, 1997). The exploitation glass ceiling keeps firms away from growth. The thrust to free from the exploitation glass ceiling has to be built from inside out.

This doctoral thesis aims to shed light on the mechanisms that make an LMT, operating in mature markets, successful in breaking through the exploitation glass ceiling[3], and creating innovation growth streams, in any of the directions defined in the previous paragraph (§1.3). It tries to contribute towards understanding the key innovation factors and practices that drive a company to create innovation driven growth, outside the exploitation arena.

The research questions are:

1. What are the factors and attributes of the innovation practice of industrial LMTs operating in mature markets that make a company successful, in creating innovation growth streams beyond the exploitation maintenance activities?

2. Are there interrelated factors and attributes forming an innovation driven growth construct?

The first question entails breaking through the glass ceiling. It tries to understand the mechanisms that drive a company to start a journey outside the exploitation space. The question is not about incremental innovation in current markets, which would be inherent to the exploitation activities. The question relates to going beyond that, creating bold innovations or moving into new markets to generate growth. Why do some LMTs remain busy always doing the same things, while others, despite not being asked by the market, try and succeed in creating growth?

[3]The metaphor of „Breaking the Glass Ceiling" was introduced first time at the National Press Club in July 1979 to describe invisible barriers through which women can see elite positions but cannot reach them.

The second question is an expansion of the first. It tries to determine whether, in addition to single independent key factors, there is a relation between them. A construct or gestalt that drives the company to create innovation growth streams.

SECTION II

The State of the art

SECTION II

2. Literature review and state of the art

The research questions implicitly involve a wide spectrum of innovation management disciplines. They are not targeting to improve the knowledge of a single aspect of innovation management, delimitated by a set of very restricting boundary conditions, or a specific innovation factor within an innovation scenario. The wide formulation of the research questions requires looking at all the possible innovation management factors that potentially can influence growth. The boundaries of the research relate to the type of companies, must be mature technology industrial companies operating in mature markets, and the effect of innovation in the generation of growth.

The literature search has been structured in areas covering the central concepts that the research questions entail. This relates to the success of innovation beyond exploitation, technology effect on innovation, and specifics related to mature markets. In addition, a research of models to structure the analysis of the factors influencing innovation success has also been carried out. The literature search and review of the state of the art knowledge have been structured under the following areas:

- Exploration, exploitation and technology cycles: To identify the state of the art in managing innovation beyond exploitation boundaries and the effect of technology
- Innovation in mature markets and LMTs, versus rapid changing environments: To identify specific knowledge and idiosyncrasy on innovation in mature markets and LMTs
- Innovation best practices and growth: To find out the state of the art on key success innovation factors
- Innovation models: To select a structure of the innovation factors to be used in the research process
- Innovation culture and leadership: To complement the state of the art on topics that are less developed in the traditional innovation models

In the following paragraphs, a summary of the literature research under every one of the above areas is presented and discussed.

2.1. Exploration, exploitation and technology cycles

Several scholars have studied the exploitation-exploration tradeoff, following the seminal contribution of March (1991). Tushman and O'Reilly (1996) argue on the benefits of the ambidextrous organization. They suggest an organizational split of responsibilities between exploitation and exploration as shown in Figure 3. Exploration activities are protected and free to focus on future business growth opportunities, while exploitation takes care of daily tasks, with a focus on short term business performance. This separation permits to foster exploratory activities isolated from the negative effects of the efficiency oriented discipline that dominates exploitative settings (Benner & Tushman, 2003). This line of work sheds light on a critical phenomenon and helps practitioners to set up organizational choices to overcome some of the pitfalls associated with innovation. The exploitation–exploration approach in the literature offers an excellent framework to analyze the subject which has already been utilized in the formulation of the problem, however it does not provide a comprehensive answer to the research questions.

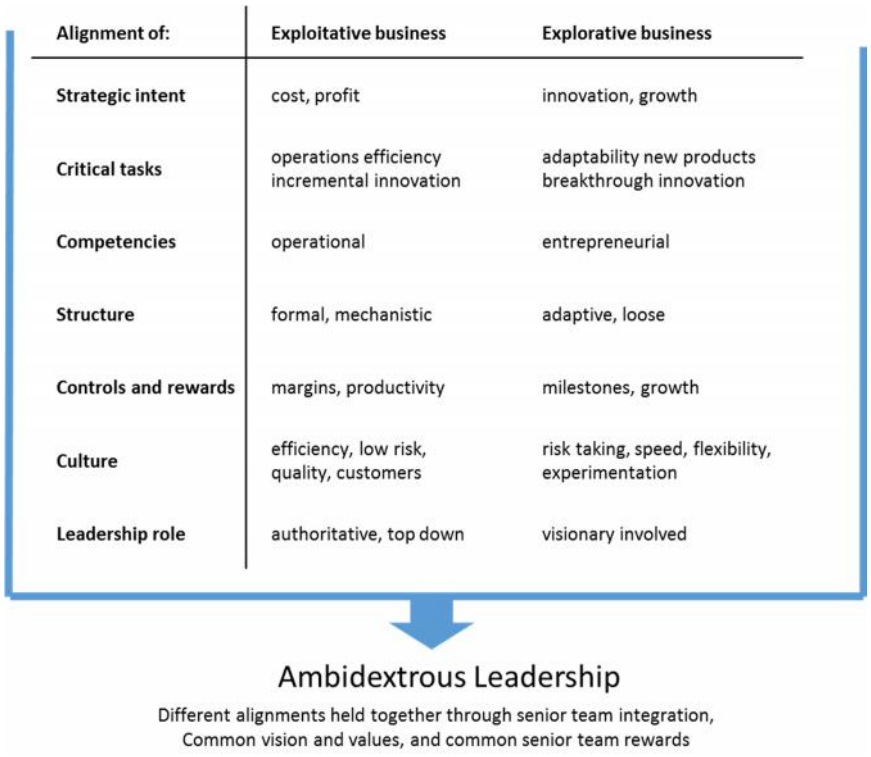


Figure 3: Ambidextrous leadership. *Source: (O'Reilly & Tushman, 2004)*

The development of new technologies introduces changes in the industry. When a new basic technology is discovered, it can be disruptive and cause the substitution of old products or components through new ones. It tends to cause radical innovations, which are initially produced in small scale, introducing changes until the new design becomes accepted. At this point, mass production methods

have been developed, the manufacturing cost goes down and the new products become the new standard (Abernalthy & Utterback, 1978).

Technology discontinuities break established designs, and trigger the start of periods of fermentation, in which competitors attempt to use the new technology to substitute the old designs (see Figure 4). The fermentation period will go on until a dominant design is accepted by the market. At this point, a period of incremental changes will follow until a new technology discontinuity irrupts in the market (Tushman & Anderson, 1986) (Tushman & Anderson, 1990) (Tushman, Anderson, & O'Reilly, 1997).

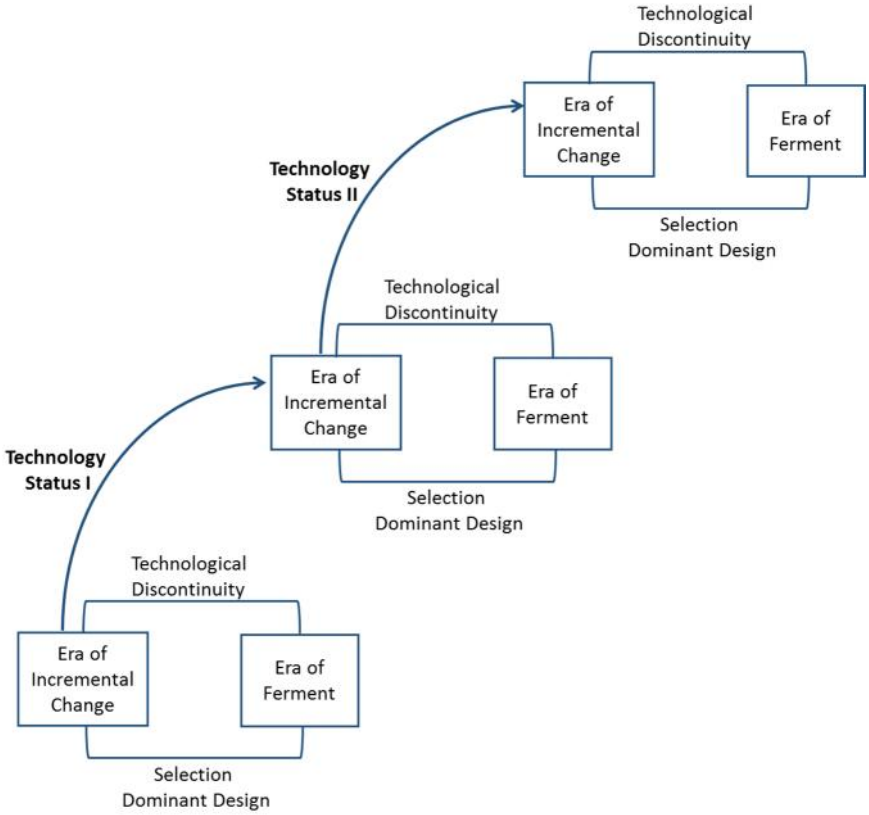


Figure 4: Technology cycles over time. *Source: (Tushman, Anderson, & O'Reilly, 1997)*

As previously discussed in, in mature technology industries, the time between technology discontinuities and also the periods of fermentation tends to be long.

This paragraph opens up the question on whether the relative position of an industry in the technology cycle, era of fermentation or era of incremental changes, could influence the conclusions of this work. This is matter to consider in the selection of companies in the empirical setting.

2.2. Innovation in mature markets, LMTs and innovation in rapid changing environments

Cooper (2011) (2014) has studied the difficulties of innovating and creating growth in mature markets. Based on his own research, he takes the position that bold innovation break through products is the answer. To be successful he proposes to focus on the five vectors shown in Figure 5. The first vector consists of developing a robust innovation strategy to identify attractive growth areas. The second vector proposes to develop the right climate & culture, organization and leadership that foster innovation. The third proposes to think big, try to develop game changing ideas. The fourth vector is the implementation of a robust idea to launch a project management system, capable of handling risky complex ideas. He, of course, suggests using his proprietary stage gate process. The fifth argues that a solid business case, with a scope beyond financials and including front-end due diligences, has to be built for every idea and invest in the best ones.

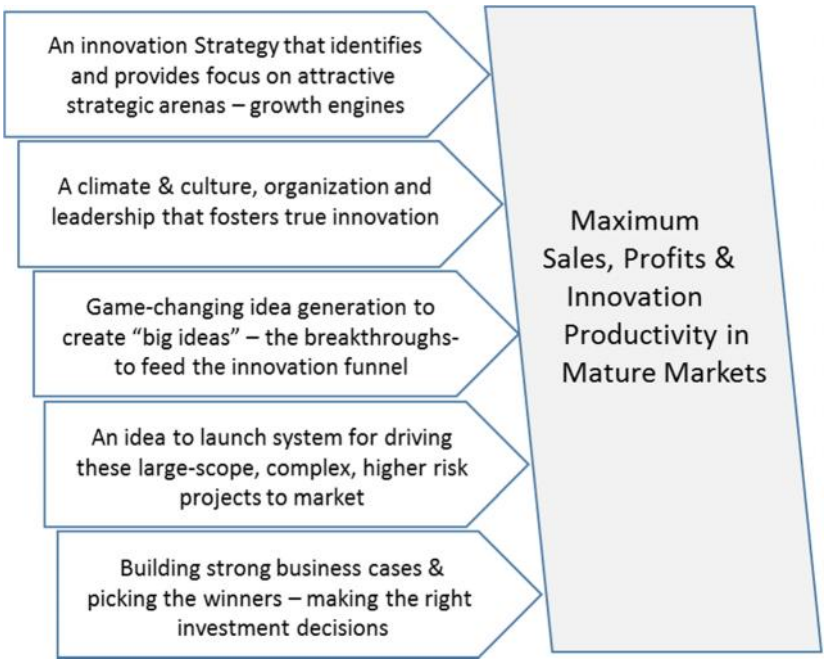


Figure 5: The five innovation vectors that drive bold innovation. *Source: (Cooper, 2011)*

The work of Cooper provides an excellent framework explaining the problematic in mature markets, however it is not specifically focused on Low-Medium Technology industrial firms, and does not deal with the problem at the origin, which is energizing the company to break through the exploitation glass ceiling. To illustrate and justify his arguments, the author often refers to electronic consumer goods, services or health care, which are not companies within the scope of this doctoral thesis.

A study of the binomial innovation/market-success of 59 industrial SMEs, with growth achieved in the prior years of the study, in Catalonia (Solé, et al., 2003), outlines that innovation was considered by the firms interviewed as the factor with the highest influence on their competitiveness. The second competitiveness factor was quality and the rest was considered to have a lower influence. The study is relevant for this thesis, since it is trying to establish a link between innovation and the market success achieved by the companies, which is the same as the growth achieved. The analysis focuses on understanding how technology innovation works in Catalonia and how this could be further supported. The outcome underlines the fundamental role of top management reading the market signals, both formal and informal. The managers interviewed understood that making mistakes in interpreting the signals could be catastrophic. Once the signals are understood, the process of innovating outlined three key factors: the ability to adopt available technologies, capacity to use talented people and prioritize the achievement of customer satisfaction as a main differentiating axis. The study concludes with the suggestion that reinforcing the territorial technology support (Universities, labs, technology sub-contractors) should facilitate a qualitative step change in the technology strategy of the Catalan SMEs.

Research and development and open innovation activities have been of crucial importance to drive progress in LMT sectors in Catalonia. El Rayyes and Valls (2013) advocate that bridges between the university, research centers and LMTs would strengthen open innovation and be beneficial to further develop the industry and the firms. Conclusion aligned with the earlier study of Solé et al for SMEs in the same region.

According the European Union CIS survey 2005 (Heidenreich, 2008), the innovation pattern of LMTs is characterized mainly by process, organizational and marketing innovations, by weak internal innovation capabilities and a strong dependence on the external provision of machines, equipment and software. Suppliers are the most important external source for information and knowledge. Moreover, the aims of innovation activities reflect the primacy of process innovation instead of product innovation. Improved production flexibility and cost reductions are the main focus. The study reveals that regions with a high proportion of LMTs have below average growth rates, which seem consistent with the lack of focus on product innovations. The picture confirms the problem definition drawn in the introduction of this PhD, and Cooper's findings that the profile of innovations in mature segments is low. The study outlines the facts and issues, but does not propose a model on how to address the subject, it just adds on the paradigm, upon which this doctoral thesis intends to shed light.

Drawn on the research results of the development perspectives of low-tech industries funded by the European Commission ("Policy and innovation in low-tech industries in Europe – PILOT), Hirsch-Kreinsen (2008) outlines that a number of different dimensions pertaining to high-tech dynamic capabilities are used in low-tech firms to innovate. They have the possibilities to integrate a new knowledge base or to recombine existing knowledge and apply it to improve products. Based on that, as far as European policy is concerned, the author argues that supporting the diffusion of knowledge should support growth and innovation in low-tech segments.

In the high velocity computer industry and rapidly changing environments, where businesses and opportunities are constantly falling out of alignment, Eisenhardt (1989) and Eisenhardt and Brown

(1999) have studied how rapid management decisions are key for success. Based on the same industry type, Eisenhardt and Martin (2000) defend that patterns of dynamic capabilities vary according to market dynamism, in stable industry tend to be detailed, analytic, with linear execution and using existing knowledge. In rapidly changing environments dynamic capabilities tend to be simple, experiential and rely on quickly created new knowledge. Brown and Eisenhardt (1998) introduce the Competing on the Edge Strategy and propose to choose a balance between the ability to move fast and the discipline of structured processes. Figure 6 shows a conceptual behavioral framework of five management dilemmas related to fast moving and structured move. For each one, two possible and opposite choices are proposed, and the resulting consequence of driving each choice to the extreme. The very structured approach side is assumed to be the bias of the management style in mature technology segments, where the strategy tends to be centered on strengthening the company's core competencies. The other side, the fast move, is assumed to be the successful approach in rapid changing environments, where the success depends on the ability to quickly become adapted to new business conditions. The authors argue that the competing on the edge strategy that drives success in companies in rapid changing environments should also help mature industries to lead and embrace change rather than react to it.

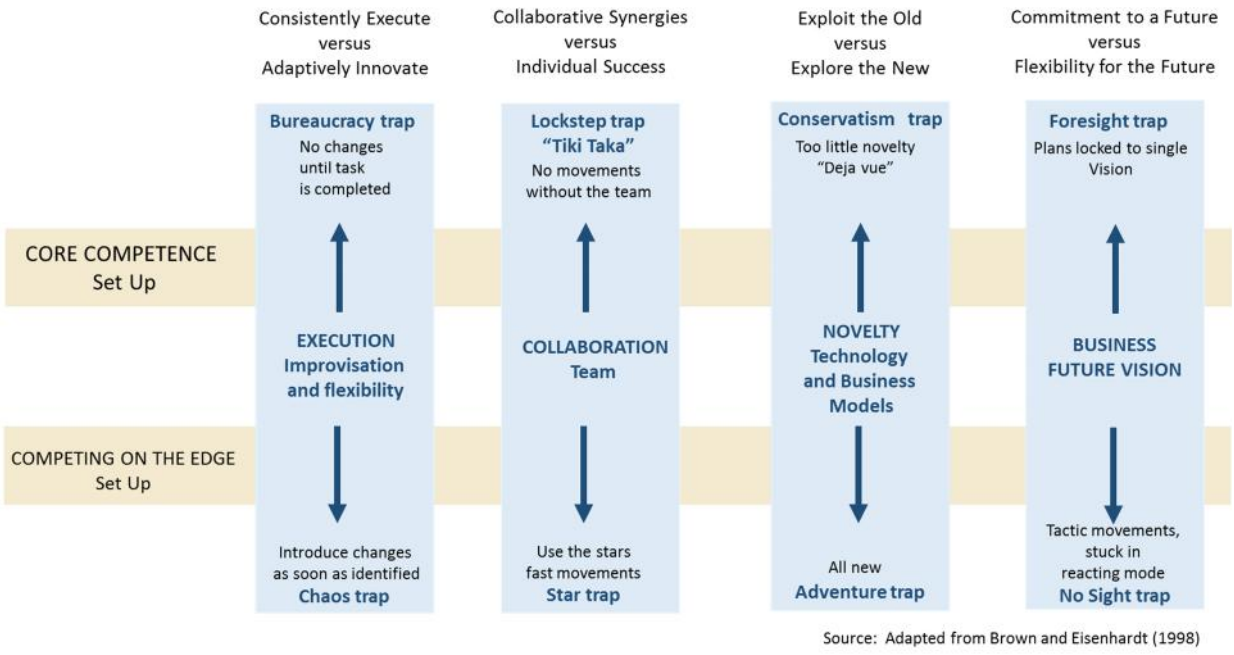


Figure 6: Structured processes versus fast moves

Some authors suggest that the simple rules used by jazz musicians to improvise and create complex new musical structures, without the benefit of a rehearsal or the use of sheet music, provides a good balance between structure and flexibility, which could inspire organizational innovation behaviors in business environments (Bastien & Hostager, 1988) . This proposition is well aligned with

the arguments of Competing on the Edge Strategy and other work done by Eisenhardt et al. (1995) (2001).

In essence, among the scholars, the literature reveals two lines of thinking, an innovation approach based on a very structured process, argued by Cooper, and the Competing on the Edge strategy approach, which advocates for rapid changes. The first, thought for mature markets, consists of a thorough strategy analysis to identify growth opportunities, develop ideas and prioritize them using a structured business case analysis and use a stage gate process to bring the ideas into businesses. The second, originating from observations in firms in fast moving environments, proposes agile processes and strategy, the priority is to continuously move, embrace new ideas, and do it fast. In fact, the two lines of thinking show some parallelism to the dilemma between exploitation and exploration, this time observed from a strategical approach rather than from an organizational perspective, as was done by the authors reviewed in the previous paragraph. Both approaches will be later contrasted with the findings and construct exposed in this thesis.

The public administrations, in Europe and Catalonia, view the problem from a different perspective. Based on the relevance of LMTs in the economy of the regions, studies have been funded, with the objective to understand the needs of companies with regard to innovation support. Here the firms are analyzed with the objective of answering the question on what can be done by the institutions to support innovation, and therefore economic growth. It differs from the perspective of this thesis, which is to understand what has to be done inside the company. The administration-funded studies seem to pursue technology innovation, aiming to enhance the technology profile of the region, and therefore the pre-eminent answers lead to a reinforcement of technology diffusion by improving the links between the technology and scientific institutions and LMTs.

2.3.Innovation key success factors and best practices

The objective of the literature review in this area is to identify previous research work and industry analysis shedding light on the key success factors supporting innovation, and if possible innovation driven growth. The review scope has covered innovation and new product development key success factors. Both terms are not identical, however both are related, since new product development is a subset of the broader innovation term. The literature on this subject often relates to the success of innovation projects per se, looking at project management aspects and techniques, rather than considering a holistic view of innovation. The review has looked at contributions focusing on company-wide key factors and behaviors making the innovation option successful. The review in this area relates to the core of the investigated subject, and therefore will set the base line for the contribution of this doctoral thesis.

The “Innovation Leadership Study” made by IESE and Capgemini (Miller, Klokgieters, Brankovic, & Duppen, 2012), points out the influence of the Innovation Function, Strategy, Governance and Culture as key factors in innovation success. This study, based on quantitative research, with data

collected from a sample of 260 companies, and qualitative data collected from interviews with industry managers, reveals that the absence of a well-articulated innovation strategy is by far the most important constraint for companies to reach their innovation targets, followed by a lack of understanding of the external environment. The findings also suggest the effect of having implemented a formalized innovation governance on innovation results, and a correlation between having a formalized innovation governance and the reported innovation success rate. Agility in behavior is considered a key cultural element of innovation. The proximity of the CEO, high and low hierarchical organization levels help too.

The authors of the report also suggest that innovation governance with the ability to balance the long term and short term activity is relevant to success. And that to create growth, there is a need to move strategy development to the outer peripheries of the company. A development of the strategy with strong bottom up contributions, as opposed to top down imposition is a positive factor as well.

In summary, the IESE and Capgemini "Innovation Leadership study" shows that the factors supporting innovation success are:

1. Innovation strategy
2. Build and nurture a value added innovation ecosystem, driven by the strategy
3. Understanding of the external environment, to anticipate future trends and influence the strategy
4. Proximity of the CEO to innovation
5. Balance short and long term activities
6. Move strategy development to the outer peripheries of the company

The IESE and Capgemini study is well supported by research data and definitely contributes to the state of the art. It is, however, not specifically focused on LMT's in mature markets, and it does not deal with the need to breaking through the exploitation glass ceiling to create growth.

The Innovation Excellence 2005 report (Arthur D. Little), based on data collected from 800 companies around the globe, analyzed how companies use innovation to improve profitability and growth. The selection of companies covers all types of companies and segments. It contains LMTs, but not only, and this segment is not specifically identified in their classification. They found that the average EBIT potential improvement, through excelling in innovation is 4 percentage points. The conclusions are drawn from the best 25% innovative companies in every sector, however the criteria to select the top best quartile was not explicitly published. They conclude that the key of success was a well–balanced innovation approach on the following aspects:

- Good business intelligence
- Clear innovation objectives linked to the strategy
- Milestone-based idea generation and implementation process

- Use of resource platform and modularization
- Measurement of / feedback on innovation performance
- Wise use of partnerships
- Technology and resource management

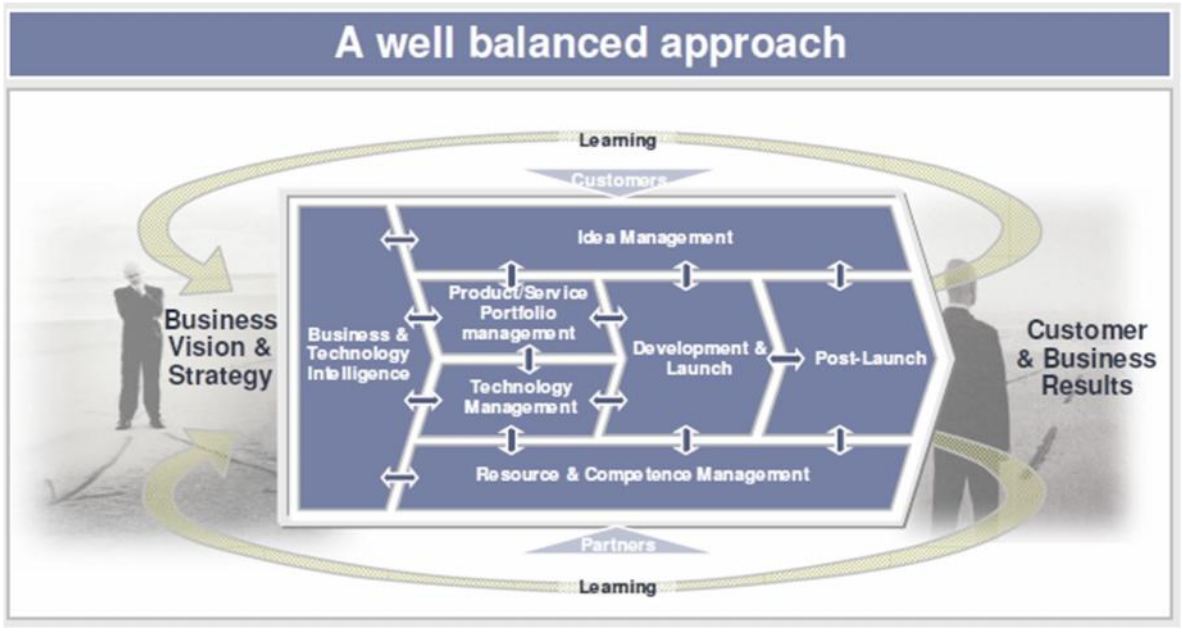


Figure 7: Arthur D. Little Innovation approach Source: *(Arthur D. Little, 2005)*

The Arthur D. Little report, in addition to the key success factors, proposes the model outlined in Figure 7, in which the elements of the analysis are presented as a system. The study provides a good overview and background of innovation practices and includes interesting statistics on how the sample of companies is positioned. The conclusion is that the best companies address all elements of innovation in a balanced way, with the ones listed above being the most relevant. The study is very general, obviously carried out for legitimate commercial purposes. The elements made public are useful and contribute to the definition of the state of the art.

The Product Development and Management Association CPAS comparative assessment study (Markham & Lee, 2013) identifies the practices on product innovation that differentiate the best companies from the rest. The study involved 453 companies from all global regions and business sectors, and a questionnaire of 562 questions structured in ten categories: Innovation culture, Strategy, Portfolio management, New Product process, Front-end innovation, Development tools, Measures and

metrics, Outcomes, Background and Summary & Comments. This survey provides quantitative statistical data on the success achieved in launching innovation projects into the market, and the different importance or time spent, in every factor of the questionnaire, between the best companies and the rest. Although the study is project centric, rather than company-wide oriented, some of the statistical findings are relevant for the current research and are similar to the outcome of other studies. The best companies differentiate from the rest in the factors shown in Table 2.

Table 2: CPAS/ NPD characteristics of best companies. Source: PDMA (Markham & Lee, 2013)

Factor	Difference
The company has a clear NPD strategy	The best: 76% / The rest: 54%
The top management is involved in NPD	The best: 68% / The rest: 53%
The company is engaged in regular follow up on technology advancements for a complete breakthrough	The best: 67% / The rest: 35% However, less than 5% of all companies feel technology not to be a major issue
Innovation projects use cross functional teams	The best: 66% / The rest: 41%
Clear NPD goals and objectives are deployed	The best: 80% / The rest 57%
The NPD goals relate to the company strategy	The best: 80% / The rest 55%

NPD = New Product Development

Surprisingly, the difference in percentages between the best and the rest, despite being significant, is not radically opposite. The reason could be the large number of companies studied and the cross contributions of different factors into the success, a fact that the CPAS study does not enlighten. The study also reveals that the rate of generated ideas to successful projects in the best companies is five (5) against a rate of twelve (12) in the rest. This is probably related to the existence of a clear NPD strategy and the proximity of top management to innovation activities in the best companies, which increases the quality and focus of the idea generation.

The rest of the study provides statistics on a great number of project related topics. However, other than the above listed key factors, the study does not aggregate the large number of questions into management clusters leading to a conclusion. Nor with a model on how to make Innovation successful. It provides a ground base for researchers to develop or contrast theories. For the subject studied here, since a construct explaining the creation of growth was not available, this set of quantitative data, other than the extracted items shown in Table 2, was not found to be applicable.

An analysis of critical success factors in new product development, based on questionnaires sent to senior managers from a sample of one hundred and thirty-five companies (135) from different industrial sectors in North America and Europe (Cooper & Kleinschmidt, 1995) and (Cooper, 2011),

studied the influence of the company factors on the success of the new product development project profitability and impact on the overall performance of the company. The critical factors identified were:

1. Thorough innovation process from idea to launch. With solid up-front homework; customer involvement; tough go/kill decision points; flexible
2. Clear and well-communicated new product strategy for the company. With goals and objectives well defined; role of new products in achieving the company goals communicated; specified areas of strategic focus; trust and focus
3. Having adequate resources. Senior management devotes enough resources to product innovation
4. Senior management commitment to new products
5. Entrepreneurial climate. This translated in two main features: provide free time for creative thinking and skunk works, meaning the formation of teams to work on "unofficial projects"
6. Senior management accountability
7. Cross functional teams

In this work of Cooper et al, the prime focus is to identify the company attributes influencing the success of innovation projects. However, external factors are not fully considered. The question on the genesis of breaking the exploitation glass ceiling to create growth is not treated and a systemic view of the factors is not presented. Nevertheless, this work provides good insight into innovation key success factors that will be contrasted against the conclusions of this doctoral thesis.

A survey of SMEs in Australia (Terziovsky, 2010) concludes that the key drivers of innovation in manufacturing SMEs are innovation strategy and formal structure. Surprisingly, he also concludes that Innovation culture has no correlation with innovation success. The work has the limitation of having only a respondent by company and it does not enter into the qualitative aspects of strategy and culture.

The work done by Schimoeller (2010), on the basis of a literature review, concludes that cross functional teams, upper management support and supportive organization structure are necessary for a successful process.

On radical innovation, Govindarajan and Desai (2013) surveyed 300 global executives between 2008 and 2009 to understand the key processes to continuously generate radical ideas. One of the prime concerns expressed by the managers interviewed was the need of a process to source radical ideas that would catapult the business to new heights, open up new markets, or bring in completely unfamiliar profit streams. Matter that echoes the subject researched in this thesis. The survey concluded that five practices are keys for success:

- Develop Creative discontent
- Use convergence thinking
- Find pivots
- Overturn orthodoxies

- Think frugally

In their context, a pivot meant: opportunities for innovation, based on the amount of change that disproportionate in size, provide an opportunity for movement in a completely new direction, a pivot. The authors are not specifically differentiating between business segments, therefore the conclusions are general and not specific for LMTs, however the subject contributes towards building the base knowledge state of the art, since the generation of growth, as generally accepted and expressed by the managers interviewed, is associated with radical innovation.

There are numerous papers, books and documents of consultancy firms proposing methods to be more effective and efficient in managing innovation, a significant number of these proposals have been studied, most of them are based on valuable experience and opinions, however not the result of a rigorous analysis of empirical data. While all these documents have been useful to gain awareness on certain topics and stimulate the thinking, they have not been retained to build the scientific basis for this work and are not exposed in this document.

2.4.Innovation management models

The purpose of the literature review in this area is to identify the most relevant innovation management models, utilized in previous research work and industry analysis. The study of the models will lead to creating a knowledge basis, upon which the structure to analyze the innovation practice of companies in this research will be developed.

In its origins, innovation was very much associated to novel technology discoveries and its applications in new products. This concept has progressively evolved towards a much wider view of the innovation phenomena. In the book “Innovación 6.0”, Ferrás (2012) analyzes the recent history of innovation. He identifies and describes six differentiated chronologic periods:

1: The technology	2: The market	3: The enterprise
4: The supply chain	5: Open innovation	6: The cultural innovation

The chronology starts with the first era of technology push. Invent something and it will be sold. It moves to a market pull. To invent what the market needs or create new needs and markets. It then evolves to a more integrative view of innovation that goes beyond products. The enterprise as a system that can generate innovation as a whole. It follows integrating into the system the supply chain. Later the global economy, open the horizons of innovation to take advantage of interactions across global regions. Innovation doesn't need to happen inside the company, open innovation (Chesbrough, 2003) proves to be a successful approach adopted by leading innovative companies. Finally, Ferrás argues that we have entered into a period, in which the innovation tentacles wrap the entire society, economy, businesses and individuals, forming a holistic system.

This historical overview introduction is pertinent, because some of the innovation models proposed in the literature still have a predominant technology and product orientation. The intent of this thesis is to analyze innovation from the widest possible perspective. Therefore the pursued innovation analysis structure has to be as broad and integrative as possible.

The list of innovation models hereafter is not intended to be exhaustive. Every institution and innovation consultant has developed his own approach into innovation. Listing all of them would have been nearly impossible and would have not added much value to the purpose of selecting a basis to develop the research structure.

The Chiesa, Coughlan and Voss model and its derivatives:

The innovation model in Figure 8, used by the Catalonian industry development center, CIDEM (2002) , looks at innovation as an internal systemic process in the company. It views innovation supported by a knowledge and technology supporting block, nurturing an internal innovation process primarily focused on product innovation. The innovation process description is completed with aspects on the Innovation culture of the company, mainly related to the attitude on management in regard to innovation and risk. The model is used to support an innovation diagnosis and evaluation methodology proposed by the center. Every one of the six elements of the model is broken down further into five factors, leading to a total of thirty evaluation items.

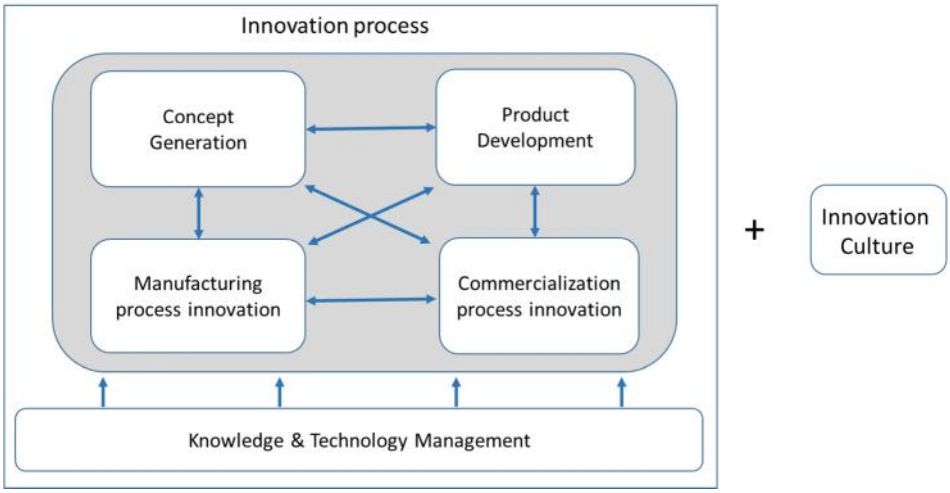


Figure 8: Systemic Innovation model. Source: (CIDEM, 2002)

The process innovation model in Figure 9, proposed by Barba (2008) argues also that the innovation process is systemic, being made up of interrelated processes and disciplines. Similar to the CIDEM model, it contains a block of four core internal processes, which include basic technology acquisition, generation of new concepts, development of the concepts into products, and the innovation of the manufacturing processes. Those specific processes are supported by enabling

management blocks including the company Culture, Leadership, Resources, Systems and Methods and a focus to the market.

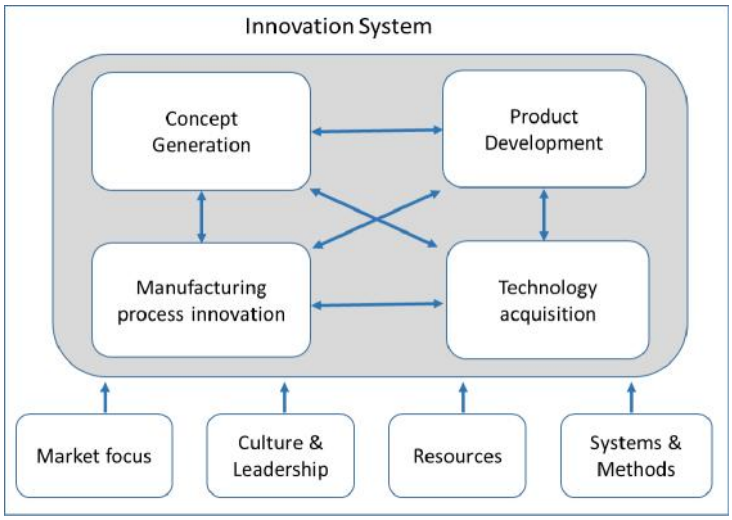


Figure 9: Systemic Innovation model. *Source: Translation from Spanish (Barba, 2008)*

The model from Barba is an adaptation of the Chiesa, Coughlan and Voss (1996) proposal, to which Barba added the market focus. The CIDEM proposal derives also from the same model, but adapted to be predominantly product and technology centered. These models place prime focus on internal product related processes, and do not elaborate in depth the aspects of general business management having impact on innovation performance. The influence of the business environment and stakeholders is not enough developed.

The Malinen model:

Malinen (2006) proposes a model aiming to understand the factors affecting the creation and management of innovations (see Figure 10). The model is fundamentally described by three dimensions, Value creation, Capabilities and Environment, bound to a Strategic Management and Leadership nucleus. In comparison to the Chiesa and other models, which predominantly pivot around internal capabilities and leadership, Malinen underlines the prime objective of Value creation for all the stakeholders – not only market and customers - and the relevance of the Environment.

The model acknowledges that management leadership and strategy play a central role in innovation management. Strategic management provides vision where to go and how to handle uncertainties and risk. Capabilities provide the know-how and resources to get there. The dimension environment underlines the role of external factors, such as politics, sustainability, social trends and economy. Intangible aspects related to the physical environment are also considered.

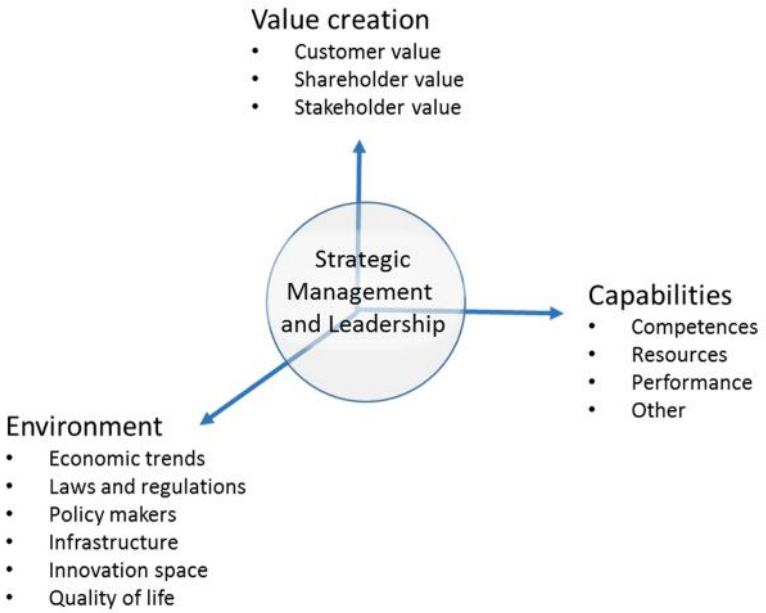


Figure 10: Three dimensions of innovation management Source: *(Malinen, 2006)*

Malinen provides a more integrative view of the innovation practice. He acknowledges that innovation is a complex process by nature and to manage it presumes understanding of the key drivers in the business and social environment. He argues that business innovation management deals with business development, which is a much wider topic than just product development. The innovations are created more and more in networks and this sets further requirements for collaboration and openness. The model was developed to provide a basis upon which more detailed and analytical models for each dimension could be developed.

The Cotec model:

The Cotec foundation for technological innovation in Spain (2010) (2013) uses a structure to analyze the Innovation ability of enterprises as shown in Figure 11 and Figure 12.

The model describes innovation supported by three main internal factors, and an additional fourth factor related to the environment. The first factor is to elect innovation to become part of the company culture, include it in the strategy and define an execution plan. The second factor integrates innovation as a company operation, assigning people and resources and defining processes and tools. This brings innovation from the planning stage into action. The third factor delivers the value of innovation to the stakeholders. The fourth factor, which looks less developed, evaluates the ability of the company to deal with external requirements and elements influencing innovation. The purpose of the model is primarily to offer to companies a method to evaluate their ability to innovate. The evaluation methodology is based on fifty questions covering the four proposed factors.

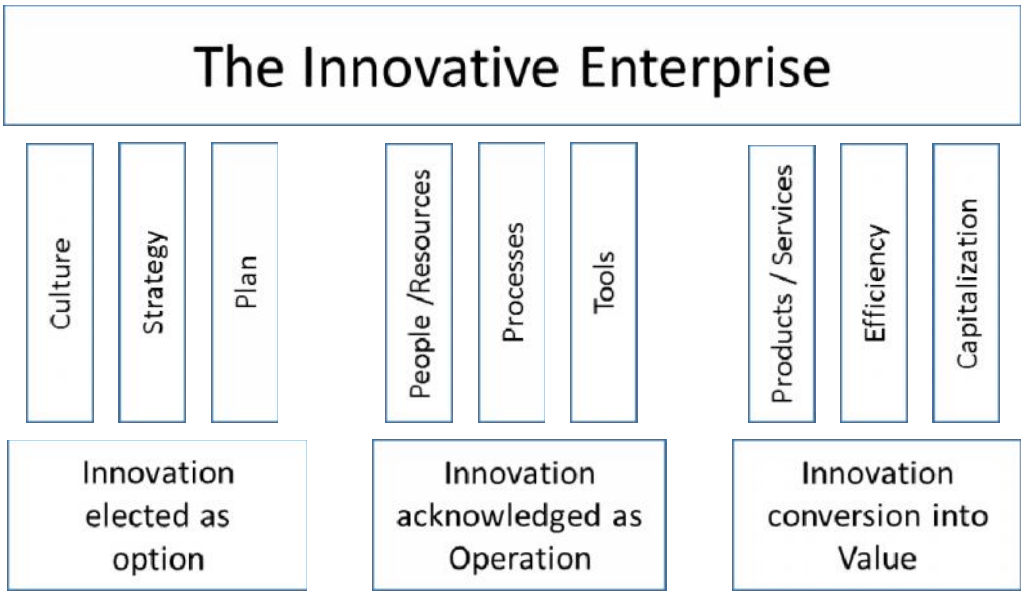


Figure 11: The Cotec Innovative Enterprise model. *Source: Translation from Spanish (Cotec, 2010)*

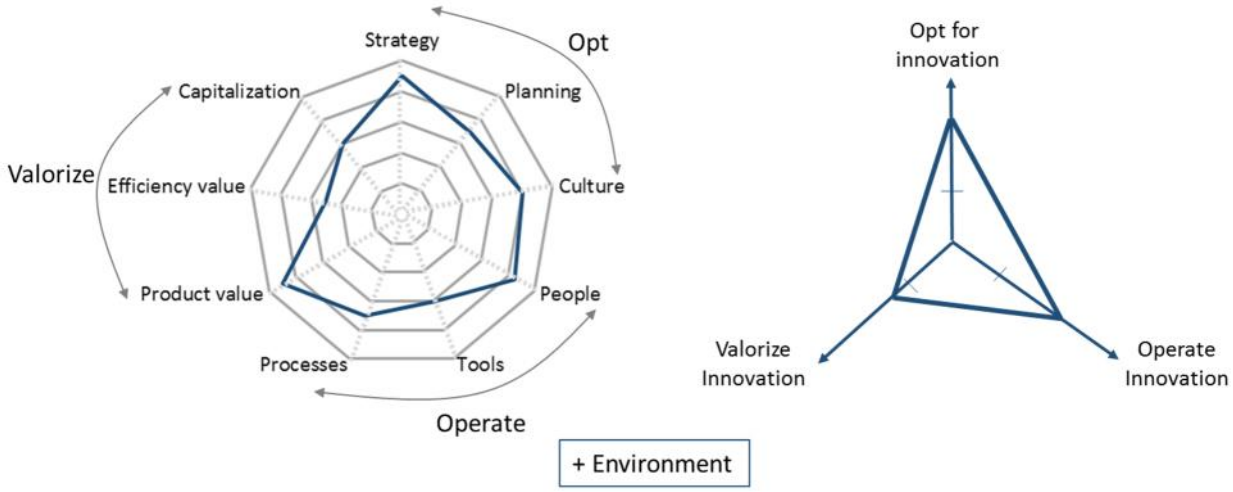


Figure 12: The Cotec Innovative Enterprise evaluation model. *Source: Translation from Spanish (COTEC, 2013)*

The IESE model:

The IESE innovation capability self-evaluation guide (Vilà & Muñoz-Nájar, 2003) proposes an integrative view of innovation management, it outlines that innovation is an integrative part of the general management action. The guide covers general management disciplines, specific innovation elements and the environment influencing factors:

- External environment: Customers, competitors, pricing, technology, economic, political and environmental
- Internal:
    - Leadership
    - Strategy
    - People management
    - Organization
    - Technology management
    - Value chain management
    - Knowledge management
    - Processes: front-end, middle-end and back-end innovation
    - Results measuring
    - Improvement

Every factor and sub-factor is broken down into specific questions, a total of sixty-one questions that managers can self-evaluate. The model has been primarily conceived as guidance for executives to improve their innovation management capabilities.

The PDMA/TIM Innovation maturity model:

The Product Development and Management Association (PDMA) in cooperation with the TIM Foundation have created an Innovation maturity model (2013), which has been drawn up following the historical research supported by the PDMA, and the assistance of an innovation expert panel group of thirty people, a mix of scholars and practitioners, working over a period of four years. The maturity model created contains a comprehensive set of documents including an innovation management standard, an assessment checklist and an interpretation guideline, among other support documentation. The aim of the model is to provide a universal guideline describing all the elements and factors, along with standard practice recommendations, having influence on innovation management. The standard has been developed to be applicable to all type of innovations, product and non-product related, business models, and for profit or non-profit organizations. On that basis, every company can develop an integral innovation management system built to serve its individual business intent. The maturity model and associated standard intends to become an international standard reference as the QS 9000 is for quality, or the ISO 14000 for environmental management.

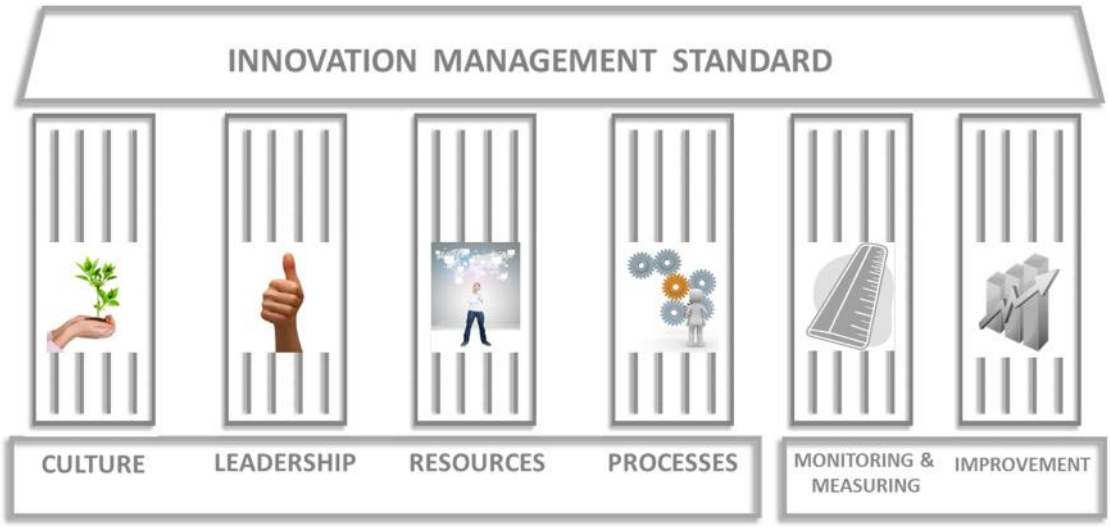


Figure 13: PDMA/TIM Innovation Management Standard. Source: PDMA (2013)

The standard is built upon four main constituent elements, Culture, Leadership, Resources and Processes, and two additional elements, one to monitor and measure the innovation outcome and one to improve the innovation management (see Figure 13). Each element is broken down further into factors and evaluation items to a total of fifty-eight clauses. A breakdown of each element into its main constituent factors is shown in Table 3.

Table 3: PDMA/TIM Innovation Management Standard elements and main factors

CULTURE	LEADERSHIP	RESOURCES	PROCESSES	MONITORING & MEASURING	IMPROVEMENT
Management commitment	Objectives	Finances	Discovery	Systems & Processes	Analysis
Stakeholders	Strategy	Human Resources	Development	Projects	Corrective actions
Core Values & Mission	Communications	Infrrastructure	Deployment		
Vision Statement	Review	Information			
Work environment					

The factors under the element Culture cover the fundamental influence of management commitment in innovation, the role as active driver of it. The influence of the stakeholders' needs, and how management interprets them in becoming reflected in the company identity, Values, Mission, Vision, and later in the objectives and strategy, are aspects thoroughly covered in the standard. While

the Culture element describes the more subtle internal and external aspects of innovation, the element Leadership enters into the management operational building blocks and actions. It will make innovation move from an abstract intent to a more concrete set up. The element Resources describes the fundamental factors that will enable innovation to take place. Without those elements any innovation intent would not move beyond being a dream. The element Processes inquires about the front-end, middle-end and back-end innovation practices and methods. Finally, the elements of Monitoring & Measuring and Improvement will allow a closing of the loop, and ensure a continuous improving of an innovation management system.

The PDMA/TIM standard offers a view of the four main innovation elements, Culture, Leadership, Resources and Processes, which in different measures were also found in the previous models. Using the PDMA/TIM model elements as a reference structure, the Chiesa and other models appear predominantly centered on the operational product innovation elements, within the PDMA Processes and Resources. Malinen and Cotec have expanded earlier models by adding some environment and culture factors, included in the PDMA Culture and Leadership elements. The IESE model adds a wide perspective of internal and external factors, oriented in this case to help management development.

The state of the art review on Innovation models shows an evolution from the initial models developed around the middle-end innovation processes (in this review the previous linear technology models have been omitted) to more integrative models, viewing innovation in the context of the firm general business management and the environment. The PDMA/TIM standard offers an integrative and comprehensive view of innovation management, covering external environment factors, cultural aspects, management practices and operational disciplines. It provides an open and flexible structure upon which specific management systems can be developed. It constitutes a holistic view of the company innovation practices upon which, based on other elements of the state of the art and the purpose of the research questions, the analysis structure of this doctoral thesis will be developed.

2.5. Innovation Culture and Leadership

Innovative Culture and Leadership are two factors that have gained consensus among scholars as being highly influential of innovation success. Are inherent to companies that have proved lasting success. Drawing upon a six-year research project at the Stanford University, Collins and Porras (1996) argue that successful companies are visionary. While constantly envisioning long-term (10 to 30 years) big, audacious goals, they manage to maintain a core stable ideology, values and core purpose. They have a culture and leadership focused on building a great future upon the basis of a company solid foundation, like yin complemented by yang or exploitation and exploration. The yin part of the vision has to remain strong to nurture the yang, which involves long-term explorative actions. Both have to be in good balance.

The most innovative companies of the future will be dominated by those that do not simply focus on specific new products and technical innovation, but by those who manage to build enduring innovation culture and climate (Ahmed, 1998). The author, lecturer in innovation management at the University of Bradford, and based on the observation of innovative companies and a review of the

literature, argues that culture is a primary determinant of innovation. A positive culture provides the organization with the necessary ingredients to innovate. Ahmed defines a comprehensive catalog of all aspects forming the culture of a company, and also the structures hindering innovation. However, a model, or recommendations to succeed when facing a specific innovation challenge, is not proposed. The main aspects proposed by Ahmed are included in the PDMA standard.

Some psychologist researchers have suggested that a strong culture can induce uniformity and therefore hinder creativity and innovation (Nemeth & Staw, 1989). They advocate the need of finding new mechanisms that can increase cohesion and at the same time diversity. However, distinction has to be made between culture strength and culture content. Flynn and Chatman (2001) argue that strong culture and innovation is not a paradox, organizations can foster a culture oriented to balance creativity and social control. A culture encouraging contributions of divergent ideas and challenges to established routines, within a context of protecting the basics of coherence across the organization. It is therefore the content of culture that makes it a supporting or hindering factor of innovation. This suggests that companies with a strong identity and culture do not necessarily have a handicap to innovate, providing that their culture includes elements to encourage diversity and innovation.

Most companies support incremental innovation for long periods of time, however executive leadership has to watch out for pending industry discontinuities, product life cycle shifts and leverage on internal dynamics to drive change. Periods of convergence are to be followed by an upheaval, a frame breaking change. The absence of these strong change periods, to proactively adapt to the environment, can induce serious performance decline. (Tushman, Newman, & Romanelli, 1986). Tushman et al suggest that the best companies have long periods of convergence giving support to a basic strategy followed by upheavals. Discontinuous changes which reshape the entire organization, involving a new strategy, a reformed Mission and Core Values, Organization and new structure of executives, power and interaction patterns between people. Periods of stability and success should not induce to blindness and complacency, falling into the “tyranny of success”, an impediment to driving changes ahead of time (Tushman & O'Reilly, 2002).

On the basis of a literature review and the seminal work of Schein (1985) defining organizational culture and leadership, Martins and Terblanche (2003) have developed a conceptual model describing a holistic view of organizational culture and the determinant aspects influencing innovation and creativity (see Figure 14). The authors argue that the determinants are strategy, structure, support mechanisms, behavior that encourages innovation and open communications. The proposal makes evident that the separation line between culture and leadership is quite fuzzy and depends on the author and point of view. Some items in Martins model, such as the strategy, support mechanisms and open communications, are fully covered in the chapter Leadership of the PDMA standard. Although some characteristics are repeated and included, within a different context, in both PDMA chapters, Culture and Leadership. The culture of a company is intimately linked to management leadership, and often the result of long periods of conducting business under highly influencing managers. For the purpose of this research, these subtle classification differences are not fundamental. Relevant for this work is that the compilation done by Martins and Terblanche is well reflected in the detail

interpretation guidelines of the PDMA innovation maturity model, it adds a useful view, without raising any conflicting issue.

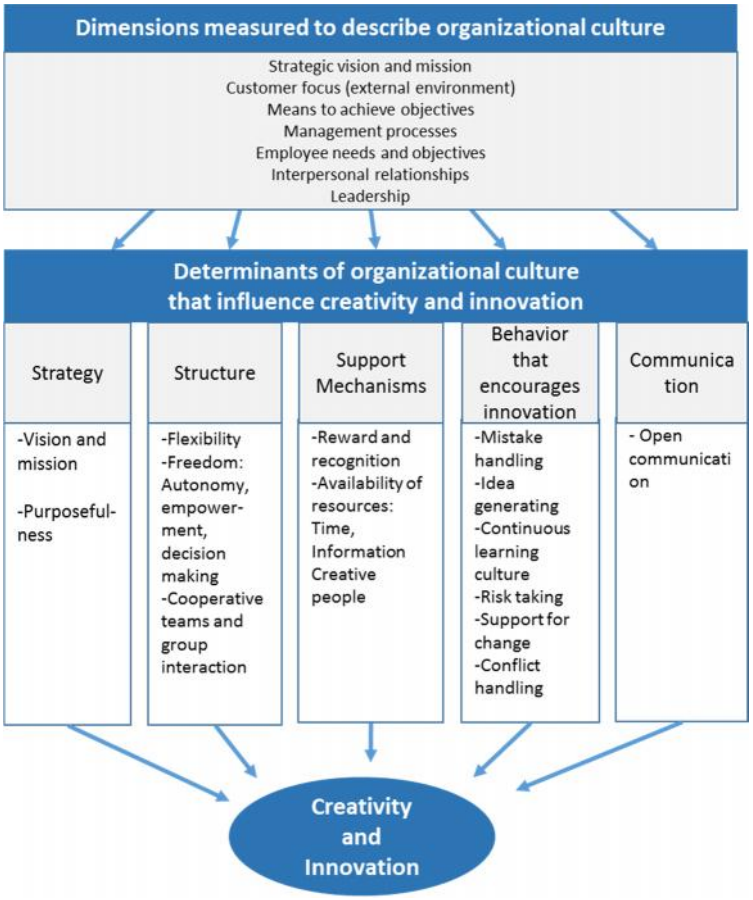


Figure 14: Influence of organizational culture on creativity and innovation.
Source: (Martins & Terblanche, 2003)

Some authors argue that innovation cannot be a sideline activity, where employees are sent to off-site events to return to daily exploitation activities. The culture of innovation has to be reflected in a systemic management and leaders have to become the innovation architects. Several approaches to implement systemic methodologies have been proposed. Miller and Wedell-Wedellsborg (Miller & Wedell-Wedellsborg, 2013), propose a leadership oriented to implementing a company culture based on 5+1 employee and organizational behaviors: focus, connect, tweak, select, stealthstorm, plus persist. The stealthstorm introduced concept has to do with overcoming any political internal resistance. The proposal touches on some cultural aspects of the company, but it doesn't provide a holistic view of the subject. Vilà (2012) also advocates that innovation has to be an integral part of company management and not an ad hoc activity. He presents a systematic approach to innovation management, which links strategy, problem solving and cultural change. A process to develop, in a progressive fashion, a company culture that will nurture the innovation process on an ongoing basis, so that innovation will be repetitive and not an isolated event. Barba (2011) (Barba & Magarzo, 2013) makes a full review of all the management aspects relevant to innovation management, the result is

that practically all the general management disciplines are included. This reveals the high complexity of innovating and the fact that innovation management cannot be dissociated from the management main stream. His work covers all the management disciplines, culture, strategy, selecting projects, managing projects and managing people.

Innovation and entrepreneurship are concepts intimately related, since an entrepreneurial action involves by definition to undertake something new, an innovation, and the other way around, the innovative action involves being entrepreneur, so that the value of innovation can reach the market (Solé P., del Palacio A., & Areyuna S., 2007). Solé et al advocates that the competences needed to innovate are creativity, management of information, network development, teamwork, and innovative capacity (Areyuna S., Solé P., & del Palacio A., 2009). Some of these competences apply also to entrepreneurs, to the extent that both entrepreneurs and innovators create new things, and are prepared to manage risks within an environment of uncertainty, to achieve the same ultimate goal, economic value. This association can also be applied to the culture of a firm, which to be innovative must have an entrepreneurial spirit. This view is aligned with the innovation leadership characteristics claimed by other authors (Collins & Porras, 1996) (Tushman, Newman, & Romanelli, 1986).

Looking at the literature on innovation culture and leadership, two things become obvious. The first is the wide consensus of the authors that both elements are crucial to support innovation sustained success. The second is that there is not a common approach to tackle the subject and even less a model describing priorities and what to do, when. We have viewed behavior, processes and lengthy catalogs of items to consider. Each approach on its own appears as common sense management. All seem to be highly relevant. Should everything be given the same emphasis? Or are some aspects more relevant than others? The answer probably depends on the purpose and the innovation scenario. A start up? An established company? Incremental? Radical and growth oriented? High tech in rapid changing environments or LMTs in mature segments? Or a specific combination of those circumstances?

The outcome of the innovation culture and leadership literature review is a catalog of good practices and recommendations, topics to be aware of when designing the research of this doctoral thesis and to be used to challenge the findings. However, answers to the present research questions have not been found.

2.6.State of the art summary

The research questions are centered on the dichotomy exploitation-exploration, how firms move beyond exploitation in mature technology and mature markets. The literature review has shown that technology disruptions can influence the innovation patterns, especially after technology discontinuities, where the firms enter into periods of intense changes until a dominant design is accepted. Periods, that could distort the view that in mature technology firms in mature markets there are few external incentives for undertaking radical changes. This could condition the research of this doctoral thesis, and therefore is a matter that has been considered in the empirical setting.

Several authors concur on the convenience of ambidextrous leadership and organizational concepts. It seems proven that it has a beneficial effect to balance the exploitation-exploration conflict,

and therefore it facilitates exploration. Questions on that pattern will be included in the analysis of the subject to find out, whether this is also pertinent to the present research questions.

The problematic of innovating in mature markets has been studied from an inside perspective, studies based on research in mature firms, and from outside, this was looking at highly innovative firms in rapid changing environments and extrapolating the findings to the mature markets. Cooper et al research is focused in mature markets. They advocate the need of a structured discipline oriented to identify bold innovative ideas to generate growth in mature markets. Game changing ideas combined with the identification of attractive markets and a deployment and delivery process. Eisenhardt and Brown, and other, have centered their studies on rapid changing environments, however they argue that the findings are also beneficial in mature markets. They advocate the need of learning to move fast and to find the right balance between structure, assimilated to a core competence set up strategy, and dynamism, assimilated to their proposed Competing on the Edge strategy set up. Strategy in simple rules, not tight and restricted by the company legacy.

The two points of view, from inside mature markets, and outside, provide a good conceptual framework. Cooper's work is close to the research questions, however there are not many echoes from other researchers in the literature confirming or complementing Cooper's proposal. On the other hand, industrial LMT's add a new dimension of difficulty, not specifically considered by Cooper, which is the slow changing pace of the core technology. The view based on dynamic capabilities as a recipe to successfully innovate in LMTs in mature markets has also not received much empirical confirmation by researchers.

The literature review of research done on innovation and New Product Development key success factors presents a lengthy catalog of factors and attributes that support innovation. Most studies advocate for a balance of all the factors. The high complexity of the innovation subject is seen in the large number of questions that some of the research studies have addressed. It is difficult to draw a simple clear conclusion, one size doesn't fit all, and there is no magic recipe to success. Most of the available studies have analyzed companies from different sectors and therefore different competitive scenarios in their respective markets. However, despite environment differences, there are strong recurrent themes where there is consensus among the innovation and new product development researchers, independent of the specific background of the author and focus of the research. The strong recurrent key success factors found in the literature search have been:

- Clear innovation objectives linked to the company strategy
- Senior management commitment
- Proximity of the upper management to innovation and NPD activities
- Good business intelligence nurturing the strategy
- Supporting organization and process structure
- Use of cross functional teams

Most research studies do not distinguish between LMT firms in mature markets and firms in more dynamic environments. By default, given the predominant demography of LMTs, the results must have

a bias towards this segment, but do not provide a clean and complete answer to the research questions of this doctoral thesis.

The research questions entail the need of undertaking radical innovations as a means to generate growth. Studies on that subject (Govindarajan & Desai, 2013), advocate that developing creative discontent, use convergent thinking, find pivots, overrun orthodoxies and think frugally, are key success practices. Those aspects will also be considered in the present research.

On the selection of an Innovation structure to be used as the basis, upon which to develop the structure of this research, the conclusion is that the PDMA / TIM standard offers the more comprehensive and integrative view of innovation. This structure will be reviewed and complemented with aspects of the state of the art not already covered by the standard, and specific considerations deriving from the present research questions. This will create the structure to analyze innovation in this doctoral thesis.

The innovation science, as other aspects of management, is a complex matter having multiple edges. The innovation literature lacks an agreed construct that explains the best conditions to be successfully innovate. It does not have a single answer. The development of theories and models are still in an intense evolution phase. Most attempts deal with the operational aspects of managing innovation projects, or the best ways to stimulate creativity. The process of how to ignite an innovation journey (putting all pieces together) in firms in mature industrial technology segments, and how to mobilize people to start the innovation journey to successfully cross the exploitation line, and create growth, have not been sufficiently studied. The result of the state of the art review on the specific research questions reveals that the subject requires further investigation. This has led to the decision to carry out a multi-case qualitative research program, to collect more knowledge, and on this basis build a construct explaining the creation of innovation driven growth.

SECTION III

The Qualitative research methodology framework

SECTION III

3. Qualitative research.

The state of the art review has not found a construct proposal, nor, enough published empirical evidences allowing the building of a theory to specifically address the present research questions. A fact that would have led to undertaking a corroboration research work based on quantitative methods, a theory-testing research. Since a theory proposal has not been found, a qualitative research scheme, theory-building approach, has been chosen, to collect more knowledge on the subject, and on that basis try to build a construct providing answer to the research questions.

The research questions are centered on the innovation management of LMT firms. Are not, as other research works do, focused on the management of innovation projects, nor, only centered on managerial decisions, or the effect of external clusters. It is not that all those aspects will be ignored from the analysis of the problem of breaking the glass ceiling. However the unit of analysis has to be the company. The research questions are centered on a holistic concept of the company, their way to manage innovation. This thinking has led to choose a multi-case study methodology, with a case being an LMT company operating in a mature market.

The multi-case qualitative process design and execution of this doctoral thesis will follow an inductive process well-tight and adhered to the empirical data. Well done theory building from cases is objective because its adherence to data, which avoid falling into biases and subjective judgments. Multi-cases enable comparisons that clarify whether an emergent finding is simply idiosyncratic to a single case or consistent across cases. The use of polar types, good cases and less successful cases helps to unveil contrasting patterns (Eisenhardt & Graebner, 2007).

3.1. Multi-case study methodology

A review of the literature and the study of other qualitative research studies have led to adopting, as conceptual framework, the Qualitative Research based on Case studies shown in Table 4 (Eisenhardt K. M., 1989). The table shows the steps, the activity to be undertaken in each step and the main reasons for it. The steps are shown chronologically, however each step provides a new light to the subject that has to be used to challenge the previous steps and to some extent, modify them. This is inherent to Qualitative Research (Yin, 2011) (Eisenhardt K. M., 1989). This feedback loop process can induce modifications of the research question, the data collection or the data analysis process.

The cases to analyze should not be selected randomly; they are to be selected with the purpose of maximizing the learning process. The selection of polar types can be beneficial to the research process, this means analyzing companies with high innovation success in breaking the exploitation glass ceiling and companies that struggle inside the exploitation area. To obtain a balance between coverage of the subject and data complexity, Eisenhardt recommends a sample size between five and ten cases. As will be described in SECTION IV, these recommendations have been applied.

To facilitate obtaining data from the companies, without fears of confidential information leakages, NDA agreements are to be agreed upon. This means that the names of the companies studied

Table 4: Process of Building Theory from Case Study Research

Step	Activity	Reason
Getting started	Definition of research question Possibly a priori constructs	Focuses efforts Provides better grounding of construct measures
Selecting cases	Neither theory nor hypothesis Specified population Theoretical, not random sampling	Retains theoretical flexibility Constrains extraneous variation and sharpens external validity Focuses efforts on theoretically useful cases – i.e., those that replicate or extend theory by filling conceptual categories
Crafting Instruments and Protocols	Multiple collection methods Qualitative and quantitative data combined Multiple investigators	Strengthens grounding of theory by triangulation of evidence Synergistic view of evidence Fosters divergent perspectives and strengthens grounding
Entering the Field	Overlap data collection and analysis including field notes Flexible and opportunistic data collection methods	Speeds analysis and reveals helpful adjustments to data collection Allows investigators to take advantage of emergent themes and unique case features
Analyzing data	Within case analysis Cross case pattern search using divergent techniques	Gains familiarity with data and preliminary theory generation Forces investigators to look beyond initial impressions and see evidence thru multiple lenses
Shaping Hypothesis	Iterative tabulation of evidence for each construct Replication, not sampling, logic across cases Search evidence for "why" behind relationships	Sharpens construct definition, validity, and measurability Confirms, extends, and sharpens theory Builds internal validity
Enfolding literature	Comparison with conflicting literature Comparison with similar literature	Builds internal validity, raises theoretical level, and sharpens construct definitions Sharpens generalizing ability, improves construct definition, and raises theoretical level
Reaching closure	Theoretical saturation when possible	Ends process when marginal improvement becomes small

Source: (Eisenhardt K. M., 1989)

, later in this document, appear under pseudonyms, and that explicit company information is not shown. In counterpart, the NDAs have provided the benefit of additional openness and depth in the discussions and information obtained.

Multiple collecting methods are to be utilized. The options taken in this doctoral thesis include: semi-structured interviews, specific data provided by the company, public data and observations collected during site visits. The semi-structured interviews referred to here have been based on a pre-defined questionnaire of grand tour questions (Yin, 2011), structured according to a model that derives from the PDMA/TIM standard. The grand tour questions will be defined as openly as possible. The interviewed will be encouraged to provide his opinion in a fully free format and the interviewer's job will be to raise additional questions to encourage a candid exposé, just to try to obtain maximum information without directing towards any bias that the interviewer might have.

The semi-structured interviews will primarily provide qualitative data, which will build the basis to support the main analysis stream and the inductive process towards the final conclusions and construct. In addition, the PDMA/TIM structure will allow to quantitatively evaluate the data obtained, the innovation maturity level. This will be analyzed with statistical methods and be used as a complement to challenge the findings from the qualitative analysis.

The conclusions and construct, emerging from the inductive process, are to be contrasted against the state of the art, and specially try to identify conflicting literature. This process shall provide a critical view, and help to avoid falling into trap fallacies and biases. Seeking opinions from experts about their own conclusions is also a good practice that will be used in this work.

As indicated, the methodology shown in Table 4 has been used as conceptual framework and guideline to develop the specific research process of this doctoral thesis, which is presented in SECTION IV.

3.2.The inductive process

The steps "Analyzing the data" and "Shaping Hypothesis" within the framework in Table 4 will be analyzed using the conceptual inductive process proposed in Figure 15 (Yin, 2011). The process flows in an interactive and iterative fashion through five phases:

1. Compile the database
2. Disassemble the data
3. Reassemble the data
4. Interpret the data
5. Conclude

The first step, compile the data base, is the result of the field work, here all the information from the cases will be collected and organized in a database. Once this is done, an iterative process of disassembling, and reassembling the data base, using definitions and codes, will be undertaken, until

the initial raw data reveals patterns. The codes are to be designed to allow the future build of a construct. The reassembly of the data under the codes will facilitate interpretations to emerge, a process that often demands a review of the codes, to sharpen the interpretations and/or to prove the emerging constructs against rival interpretations. The process is iterative and interactive and should continue until a solid pattern or conclusion emerges.

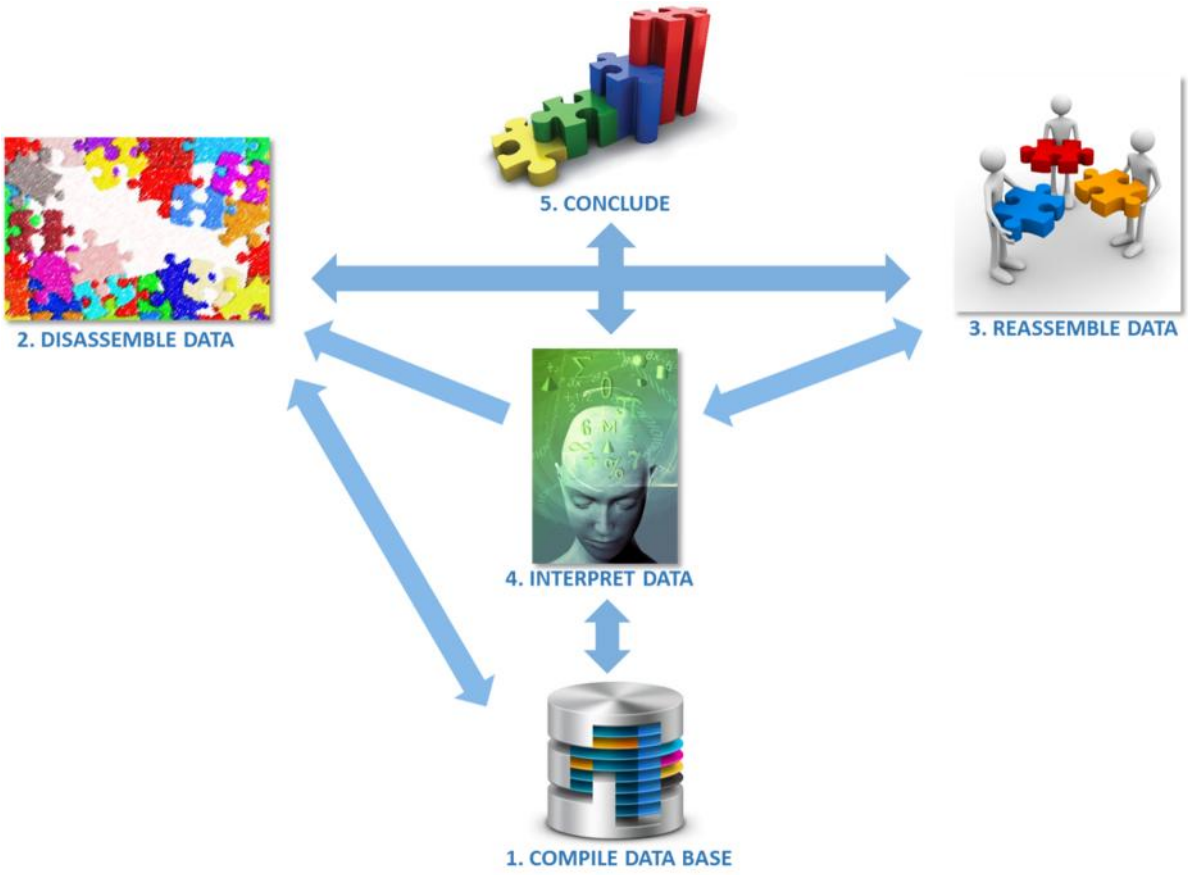


Figure 15: Five Phases of Analysis and their interactions. Source: *(Yin, 2011)*

The inductive process will be applied to every single case (company), obviously using the same codes and reassembly of data, which will provide a company innovation profile that can be compared against other companies to try to identify differences in patterns between the best innovative companies and the laggards.

SECTION IV

The empirical setting

SECTION IV

4. The research concept

To collect empirical evidence on how industrial mature technology companies break the exploitation glass ceiling to generate growth through innovation, a qualitative multiple-case study, on the basis of six companies, has been performed.

The research design is based on an in-depth analysis of the factors that drive innovation in each of the selected companies, assessed from the perspective of its contribution to the creation of innovation growth streams. The list and structure of the innovation factors analyzed, have been developed from the main structure proposed by the PDMA Innovation Management Standard (PDMA/TIM, 2013), and the innovation growth streams have been assessed using the "Innovation / Market" matrix introduced in SECTION I. The research program has been conceived with the objective to identify consistent empirical evidences across the cases, of links between innovation management factors and the creation of growth streams (see Figure 16).

To start the research three elements were to be identified:

- Six companies having created innovation growth streams
- The Innovation factors analysis structure and methodology
- A method to assess the innovation growth streams

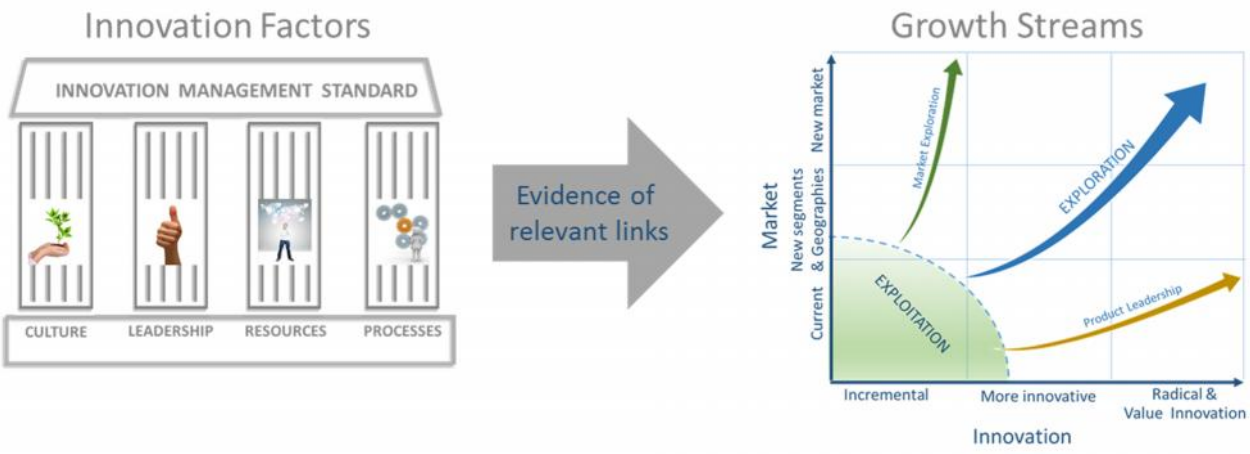


Figure 16: Research concept: Innovation factors leading to the creation of growth streams

4.1.The six selected cases

The sample of companies was selected with the basic criteria of being companies operating in mature technology industrial sectors, mature markets, targeting growth through innovation and showing an interest in the research subject. This last criteria to ensure that the companies would commit enough time and resources to the subject. An additional important target of the selection was to make sure that the aggregate of all the innovation projects carried out by the six companies was providing enough coverage of the "Innovation–Market matrix" sectors (Figure 2). The final six selected firms are headquartered in three different European countries, operating in mature industrial sectors, with five of the six addressing global markets and one a regional market.

None of the selected companies declared to be involved in a period of fermentation and competition to adapt their products to a radical basic technology change. This means that the sample of selected companies were operating in the periods of incremental basic technology improvements, not in rapid changing eras of fermentation (Tushman, Anderson, & O'Reilly, 1997). All had a view of possible future market changes, somewhere far in the horizon, with time spans evaluated to be a decade or more.

A Confidentiality Agreement was signed off with each company, so that the information could be handled in an open and in-depth fashion, without any fear of leakages of sensitive information to competitors. In consequence, the names and information provided hereafter have been indicated in a generic and abstract form. In this section, some highlights of the participating companies are briefly described. A short profile of each firm is included in Table 5 , and the innovation growth streams created by each company are shown in the "Innovation-Market" matrices in Figure 18, where circles represent a significant innovation activity.

4.1.1. Case "FMatE": Pioneering the industry transformation

In 2006, sensitive to the global socio-economical and industrial trends of resources' scarcity and climate change, board members saw some initial drift effects on their traditional business lines. They understood that the matter was not cyclical and, if the impact remained and worsened, in the long run it would pose serious risks to the company. After in-depth discussions and analyses, the identity of the company was redefined, and a vision and a strategy to pioneer a profound transformation of the industry, based on responsible sustainability, was developed. A number of new growth streams into forest bio-materials and energy have followed up, which include the development of advance technologies, very innovative product lines with their business models, to support the entry into new markets. The process has not subtracted attention to exploitation. An adequate focus on operational excellence and incremental innovation on the mature businesses has been the key to maintain sound financial performance, provide revenue stability and finance the transformation process. The exploration journey has started to pay off. Growth of the newly created businesses not only compensates the decline in mature businesses, but is also the main reason behind total net growth.

Table 5: Profile of the analyzed firms. Case studies

	FMatE	**ICons**	**EComp**	**EMNet**	**EquB**	**PMach**
Industry sector	Forest bio-materials & Energy	Industrial Construction	Elastomeric Components	Entertainment Machines & Network Systems	Building Equipment	Process Machinery & Solutions
Yearly sales & Market	~ € 10 Billion Global	~ € 30 Million Regional	~ € 800 Million Global	~ € 100 Million Global	~ € 500 Million Global	~ € 800 Million Global
Case synthesis description	Pioneering the industry transformation	Business model transformation leading to strong market share gain	Sales & Market orientation, steady organic growth	Business turnaround through innovation	From components to systems, steady organic growth	Technology leader facing a market downturn and new paradigm
Statements: Mission, Vision, Values	The statements reflect the strong transformation and drives the organization	The statements effectively give direction to the organization and encourage creativity	The statements at company and corporate level drive the organization and promotes innovation	The statements directly express the turnaround direction	The statements drive and lead the organization and provide a generic innovation direction	Statements are well shared but not linked to an innovation strategy
Firm Innovation strategy / actions	Industry transformation pioneer. Managing excellence, sustainability, while creating new growth streams	Top management anticipated the market downturn. Implemented a structured Innovation System to transform the business model	Market orientation, targeting growth in strategic selected segments. Innovation focused to serve the growth and maintain the core	Re-focus innovation to core business, to improve operational performance, and set a new basis from which to re-start exploration	Progressive transformation, from components into systems, to capture potential value of a new legislation	A change of industry paradigm irrupted faster than anticipated. After a right sizing process, the innovation direction is being re-defined
Results achieved	The newly created businesses growth streams, ~40% of total, offset mature business decline and create moderate growth	Strong market share gain, up to rank #2 from rank #6. Profitable in a severe downturn. >80% new business	Sales increased by 30% and operating profit doubled above 2010 base line. 5% organic growth	Performance turn-around from losses to a 20% + EBITDA in two years	Steady organic growth of 4% per year. New products represent a small percentage of total sales.	Dramatic reduction of sales consequence of the market drop. Right sizing ongoing

4.1.2. Case “Icons”: A Business model transformation in anticipation of a downturn

Top management felt that the firm needed to drastically change its traditional business model in spite of the prevailing excellent results in 2007, prior to, and in anticipation of, an eventual downturn of the industrial construction market. A radically new strategy was put in place, targeting to provide the best responses to a totally different environment expected in the next eight to ten years. Yet, upfront the analysis purposely deemphasized internal weaknesses. The top management team was fully committed to building a front-end innovation process, which clearly linked strategy with creativity and innovation. A large number of collaborators were invited to participate along the distinct steps of the process. Innovation was broadly defined, including new operating processes, market approaches, organizational practices and a new business model, in addition to new products. New working methods and competences were developed; some personnel could not take the change and decided to leave the firm. While revenues of the construction supply industry have dropped 80% since the crisis started and Icons dropped too in the first two years, in 2015 the firm has recovered the same business volume it enjoyed seven years ago and has remained profitable every single year during all this period.

4.1.3. Case “EComp”: Sales & Market orientation, steady organic growth

Historically, the firm has been focused on market exploration. It has enjoyed growth on the basis of adapting its elastomeric component technology to the specific needs of related industrial markets. Strategy is updated yearly, defining new growth targets in selected industries. A sophisticated customer segmentation is in place. The CEO encourages people to look for innovation and differentiation opportunities, with strong values in pursuing the wishes of key customers, not only with the best product, but also with the best solution and business set up. People are sensitive to add new initiatives every year. Organizational changes and process improvements are implemented to satisfy relevant customers and to accomplish growth targets. Leading change management has been a business as usual practice. Recently, product technology development activities have been strengthened. The aim is to add more product innovation growth streams on top of the already strong market exploration activities. The results have been the entry into new markets, initial successes on product technology and a steady growth, achieved over the last decade.

4.1.4. Case “EMNet”: Business turnaround through innovation

A period of low innovation activity led the company to lose market share in their entertainment machines main business, and enter into operational losses in 2006. A new CEO re-stated the Mission and set a new Vision, significantly more focused than in the past. Non-core businesses were eliminated or divested. An innovation strategy with well-defined goals was introduced. People, organization and competences were adjusted accordingly. This increased intensity and focus on the organization created

a continuous flow of incremental innovation that was key to overcome past exploitation issues. The firm underwent a significant turnaround, and subsequently recovered a leadership position in the main markets served and achieved strong profitability within one year. The newly achieved basis of solid exploitation has provided business stability and allowed the organization to initiate steps into exploration growth. With the development of more innovative and radical innovation, the firm has been able to enter into new markets. More recently, the firm is tracking possible market shifts, getting ready to compete in this new setting and expanding its vision to explore broader and more ambitious horizons.

4.1.5. Case "EquB": From components to systems

A new European legislation has set new challenges in the construction and equipment of buildings. Top management responded to it by reviewing the mission and driving a progressive transformation of the company, moving its focus from components into more complex systems to better respond to the requirements of the new regulation. The transformation of the firm is expected to take place at low pace due to the relatively high level of revenues related to renovation of old buildings, unaffected by the new legislation, which only applies to brand new constructions. The company has a long tradition of technology leadership and benefits from strong core competences in the components field. These have been recently expanded with new bolt in capabilities to develop integrated systems. A first wave of low complexity systems have been successfully introduced and consolidated in the market; and additional progress in launching more complex and innovative systems is underway. The firm has also expanded the operations in new geographies. In recent years, industry revenues showed moderate growth, and the company has been able to generate organic growth slightly above market average.

4.1.6. Case "PMach": Technology leader facing a market downturn and new paradigm

In the past, the company had enjoyed a dominant position in the market, with continuously excellent results thanks to first-class products and process solutions drawn from a strong competence focus on technology innovation. Given its strong reputation as a company, a risk of market shift to other products and an emerging trend towards a new industry paradigm were not considered to be relevant threats. With just minor adjustments, the company planned to refocus on the markets of emerging economies to compensate for the decline in its mature traditional markets. Yet, the reality was quite different. The new paradigm irrupted much stronger than expected, and the market turned down dramatically. The historical technology leadership lost value in the market and the competitive landscape changed. As a consequence, dramatic sales losses and a painful right sizing process followed up. Top management is strongly reacting to this, resetting the innovation direction in line with the new industry paradigm, to start growing again from the new reality. There is a tough feeling in the company

that they face a challenge in the attempt to regain competitiveness to foster growth from a high cost position and the loss of precious time.

4.2.The innovation factors analysis structure

The analysis of the factors driving innovation has been made following a framework of four chapters, Culture, Leadership, Resources & Competence and Processes. Each chapter was broken down into five constituent factors, as shown in Table 6, and every factor into several evaluation items, leading to a total of forty-five assessment items. This structure expands the PDMA Innovation Management Standard with adaptations based on the Innovation guidelines of IESE (Vilà, 2011) (Vilà & Muñoz-Nájar, 2004) (Vilà & Muñoz-Nájar, 2002) and own considerations made in the frame of this research. The Competence element has been added to the Resources chapter, Risk practice has been added to Culture, Recognition to Leadership and External & Supply chain has been made explicit in the Resources chapter. The chapter Processes has been further broken down to provide more granularity. The detail of the utilized structure, content and meaning of the chapters, factors and evaluation items is shown in Annex 2. The resulting structure covers all the innovation management factors seen in the review of the literature. It has shaped the tool used to assess the innovation practices of the selected companies.

Table 6: Structure utilized to analyze the innovation systems

Culture	**Leadership**	**Resources, Competence**	**Processes**
Management commitment	Strategy	People & Competences	Front-end innovation drive
Stakeholders influence	Objective deployment	Information & Know-how	Product development
Values, Mission & Vision	Management review	External & Supply chain	Research & technology
Risk practice	Communication	Infrastructure	Market research
Work environment	Recognition	Financial	Deployment, commercialization

Structure developed upon the basis of the PDMA – TIM Innovation Standard (2013)

The definitions and general considerations of the four innovation chapters -Culture, Leadership, Resources & Competence and Processes- utilized to solve conflicts when developing the detail content of the factors and evaluation items under each chapter have been taken from the PDMA maturity model definitions (PDMA/TIM, 2013) and considerations from the online www.businessdictionary.com.

The following paragraphs outline the definitions taken from the above mentioned sources. The meanings are subscribed by the author of this thesis and been used to guide this work.

4.2.1. Culture definition and considerations on innovation

The values and behaviors that contribute to the unique social and psychological environment of an organization.

Company culture includes an organization's expectations, experiences, philosophy, and values that hold it together, and is expressed in its self-image, inner workings, interactions with the outside world, and future expectations. It is based on shared attitudes, beliefs, customs, and written and unwritten rules that have been developed over time and are considered valid. Also called corporate culture, it's shown in

- *the ways the organization conducts its business, treats its employees, customers, and the wider community,*
- *the extent to which freedom is allowed in decision making, developing new ideas, and personal expression,*
- *how power and information flow through its hierarchy, and*
- *how committed employees are towards collective objectives.* (BusinessDiccionary.com)

A culture reflects an organization's values and pattern of behavior. It is usually an extension of executive management and often referred to as the organization's personality.

In order to achieve sustained innovation the organization's culture should foster creativity and support innovation as a planned and managed activity. Innovation would become a core function of the organization allowing innovation at all levels. (Innovation Management Standard TIM-PD-001-STD, 2013)

4.2.2. Leadership definition and considerations on innovation

The activity of leading a group of people or an organization or the ability to do this. Leadership involves:

- *establishing a clear vision,*
- *sharing that vision with others so that they will follow willingly,*
- *providing the information, knowledge and methods to realize that vision, and*
- *coordinating and balancing the conflicting interests of all members and stakeholders."* (BusinessDiccionary.com)

Strong leadership by executive management is essential for sustained innovation. Management should lead by example fully supporting the organization's mission, vision, and supporting policies, this cannot be delegated.

Executive management should include innovation activities in business planning and participate, support and promote innovation activities within the organization. Management at all levels should communicate the organization's mission, vision, policies, innovation objectives and the importance of innovation. (Innovation Management Standard TIM-PD-001-STD, 2013)

4.2.3. Resources & Competence definition and considerations on innovation

Resources are the Human, financial, physical, and knowledge factors that provide a firm the means to perform its business processes. (BussinessDiccionary.com)

Competence is the cluster of related abilities, commitments, knowledge, and skills that enable a person (or an organization) to act effectively in a job or situation. Competence indicates sufficiency of knowledge and skills that enable someone to act in a wide variety of situations (BussinessDiccionary.com).

Management is responsible for providing the resources required to implement the innovation activities and to support the organization's culture. (Innovation Management Standard TIM-PD-001-STD, 2013)

4.2.4. Processes definition and considerations on innovation

Sequence of interdependent and linked procedures which, at every stage, consume one or more resources (employee time, energy, machines, money) to convert inputs (data, material, parts, etc.) into outputs. These outputs then serve as inputs for the next stage until a known goal or end result is reached. (BusinessDiccionary.com)

The core processes needed to develop and manage an Innovation Management System and projects. Additional processes may be added to suit the organizations innovation activities. (Innovation Management Standard TIM-PD-001-STD, 2013)

4.3.The evaluation of the cases' success in creating growth streams

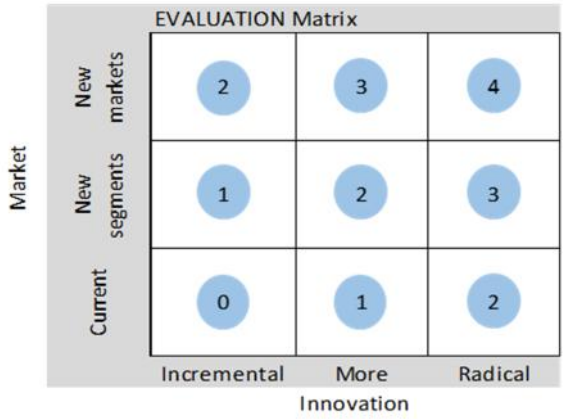
The main focus of this research is to identify common themes within the innovation factors that lead to success in creating innovation growth streams. The success of each company in creating innovation growth streams has been evaluated on the basis of the innovation projects reported by each

firm. Figure 18 provides an overview of the significant innovation activities of each company, drawn in the "Innovation / Market" matrix. Every circle represents a significant innovation activity. Each matrix was confronted and discussed with the corresponding company executives, to obtain confirmation that it was representing fairly the most significant innovation efforts and achievements of the firm. The insights and information generated in these review sessions were used to evaluate the relative success in creating growth streams. When available, public data was also utilized to complete the picture.

The six selected companies had experience in creating innovation growth streams, however some had been more successful than other, or had moved much further up to the right in the "Innovation / Market" matrix. To serve the research purpose, it was fundamental to establish a method to evaluate the relative success of the studied cases as far as their ability to create growth streams: a method to classify the six companies studied from the most successful to the least successful company. Such classification would allow an analysis of the innovation practices in perspective to the relative success in creating growth streams. The subjects that differentiate the best companies from the less successful ones, or the intensity and characteristics of some of the practices, or even aspects that had damaged the success of the companies in the cue of the classification.

To establish an innovation driven growth classification of the firms, two criteria items were considered: the created growth streams (as reported by management) and their effect on the overall performance of the company.

Weighing factors applied to innovation projects



Innovation driven growth classification

	INDEX	RANK	CLASS
FMatE	11	1	A
ICons	9	2	A
EComp	8	3	B
EMNet	7	4	B
EquB	5	5	C
PMach	4	6	C

Figure 17: Classification and ranking of cases based on the created growth streams

The first criteria item led to introduce an index number calculated on the basis of the significant innovation projects of every company, weighed with a factor related to the position of the project in the "Innovation-Market" matrix. Those projects and its relative position in the matrix had been accepted by the firm's executives as being a fair representation of their innovation activities; therefore its utilization for that purpose was consistent with the opinion of the management of the companies.

The weighing factors have been set to give more relevance to the innovation projects far away from the exploitation area than the ones close to it. Incremental innovation projects in current markets were well supported by all the firms, the weighing factor in this box of the matrix was set to zero (0). The weighing factors along the Innovation axis or Market axis were set to one (1) for "More innovative" or "New segments and geographies", and to two (2) for "Radical and Value innovation" or "New Markets". The projects combining innovation and market beyond "Incremental" and "Current" were weighed with a factor resulting from the addition of the two factors, the Innovation and the Market axis factors. These factors are consistent with the consideration that the difficulty increases with the distance to the exploitation area and the simultaneous combination of both growth streams: innovation and a new market. They are also consistent with the research question that attempts to understand the key innovation factors to move away from the exploitation area, thus the practices of companies having the ability to create innovation growth streams in the upper right hand corner of the matrix should be more relevant as far the research question is concerned. The result of this calculation led to a ranking of companies, with the best in position #1, FMatE evaluated with 11 points, and PMach closing the list in #6 with 4 points. The weighing factors, resulting Index and Rank is shown in Figure 17. A description of the growth streams of each company and the calculation detail of the innovation rank is shown in Annex 1.

The second criterion was found to be not as straight forward to calculate. The evaluation of the success of every project is difficult because of the project maturity phase; some of the projects were in the launching phase, some in the mature phase and a few maybe in the valley of a hype cycle (Fenn & Raskino, 2008). Therefore, to evaluate the growth effect and financial merits of every innovation project in isolation, in a comparable fashion, and as a snap shot in a certain time in the history, is an almost impossible mission. An evaluation of the aggregate effect of all the innovation activities was also not possible because, except for one case, the companies were not able to evaluate in a direct deterministic fashion the influence of the innovation projects in the overall performance of the company. In view of these difficulties, it was decided to apply the second criterion as qualitative coherence and plausibility evaluation. The approach taken was to assess whether the reported projects in the "Innovation-Market" matrices of every company in Figure 18 were consistent with the recent company performance, and to what extent the innovation projects had transformed the company. The reported successes in creating growth streams should somehow have translated in an overall company performance improvement.

Table 7 summarizes the considerations made to check that the reported projects had provided a beneficial effect on the overall performance of the company. The column "Results achieved" shows the company performance achievements, which are used in the column "Rank plausibility / Innovation class" as judgment to confirm the rank, and to assign a classification, A, B and C. With A including the two companies with higher performance, in terms of achieving the most successful bold growth initiatives and stronger results, according to the executives' self-reported assessments. B presents an intermediate level of performance, and C the lowest level, with moderate to low satisfaction by the focal managers. This exercise confirmed consistency between the ranking #1 to #6 determined through

the Innovation / Market matrix numerical criteria, and ratified the assignment of classes. Class A to the cases #1 and #2, class B to #3 and #4, and class C to #5 and #6. Classification that has been convenient to conduct the analysis of the innovation practices, as some attributes were found to be different or have different intensity in companies class A, B and C.

Table 7: Growth performance of the cases and its considerations in innovation

	Results achieved	**Rank plausibility / Innovation class**
#1 FMatE	The newly created businesses growth streams, ~40% of total, offset mature business significant decline to create overall net moderate growth. The trend has been increasing over the last five years	The projects reported, covering the full spectrum of the "Innovation-Market" matrix are consistent with the results obtained. Class "A" assigned.
#2 ICons	Strong market share gain. From position no. 6 relative to competitors in the served markets before the transformation, have achieved position no.2. Profit made all the years throughout a severe market downturn. The company has been fully transformed with the new business accounting >80% of the total	The projects reported transformed the company in its totality. Despite the project evaluation index (9) is only one point higher than the next company on the list, the total transformation and the excellent performance achievements make this company belong to class "A".
#3 EComp	Sales increased by 30% and operating profit doubled above 2010 base line. The average sales organic growth in the last five years accounts for 5%	The innovation projects effect are consistent with the organic growth achieved. Index confirmed and class "B" assigned
#4 EMNet	Strong market share gain to #1 in the main served market. Performance turn-around from losses to strong performance in two years, reaching 20% + EBITDA	Despite the impressive turnaround of the results of the company, the low performance level of the starting point taken into consideration for confirming the index and assigning of a class "B"
#5 EquB	Steady organic growth of 4% per year. New products represent a small percentage of total sales <2%	The organic growth achieved is satisfactory. However the level of new products is quite small, which confirms the index. The company has been classified "C"
#6 PMach	Strong sales reduction as a consequence of a dramatic market collapse. Company sales dropped in line with the market downturn, maintaining the market share.	Despite not having lost market share, the company has failed to anticipate the market downturn. There are no signs of having dampened the catastrophic market effects. Class "C" has been assigned

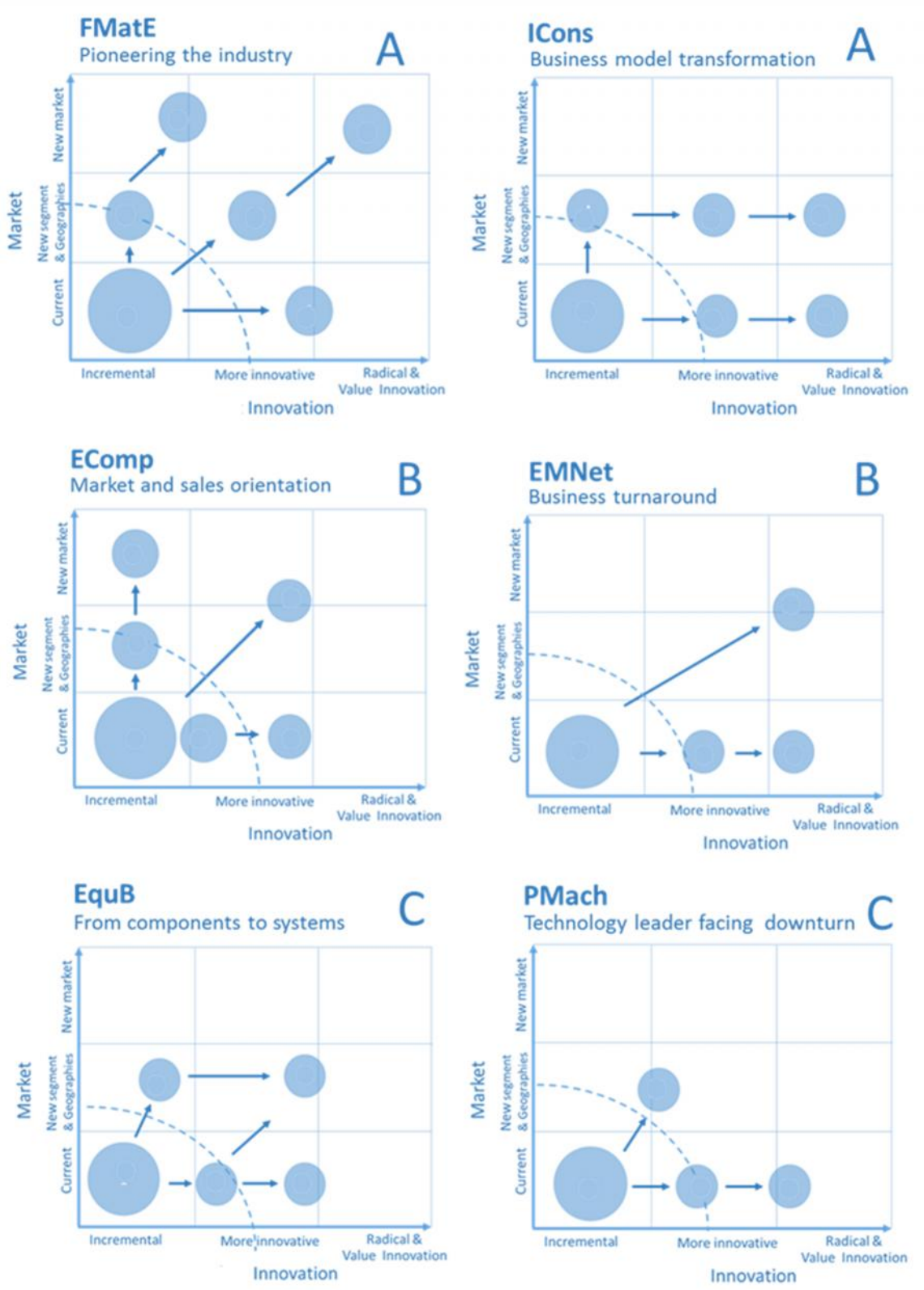


Figure 18: Innovation / Market matrices of the analyzed cases

The innovation success classification in A, B and C and the innovation rank obtained by each company will be a reference used later in the description of the findings, to relate exclusive attributes observed in the best innovation cases, with high class and rank and to underline the differentiation to the less successful companies in the low class and rank.

SECTION V

The description of the research process

SECTION V

5. The research process flow, analysis and methodology

The research process flow, from the data collection, through the data codification, analysis, and inductive process leading to the final construct conclusion is schematically shown in Figure 19. The process has two differentiated sections, “Phase I” and “Phase II”. In “Phase I” the data of the companies was collected, coded, analyzed, cross checked to the other cases and evaluated. With that done, a summary of the interpretation and evaluation was presented to every company. This was done to obtain feedback from management, observe their reactions, and ensure that the analysis done of every case was representing fairly the innovation practice and activities of the company. This process provided rigor to the analysis, and a consolidated truthful information database. The “Phase I” deliverable was a solid set of information and a first preliminary rough innovation construct, potentially answering the research questions. “Phase II” of the process started with a re-array of the data, made on the basis of the preliminary construct, which provided a more focused data structure to support an inductive process to the final construct.

Hereafter, the breakdown of activities in “Phase I” and “Phase II” are explained. The details of the methodologies used in every step are described in subsequent paragraphs.

“Phase I” started with the collection of data from the six studied cases. The collection utilized three main sources, interviews with managers of the firms studied, specifically requested company data and public data available. A description of the process utilized for every one of the three sources is explained in §5.1.

The information obtained formed the body of a database organized by company and first classified under codes matching the structure developed on the basis of the PDMA/TIM structure. For every company, the database included the relevant facts, manager opinions and company practice descriptions, classified under every one of the chapters, constituent factors and its evaluation items. This involved a total of forty-five (45) assessment items and additional complementary data structured under the four chapters, with five factors per chapter. The detail database structure is shown in Annex 2.

The data of every company, structured as indicated above, was then used to quantitatively evaluate every one of the forty-five factors. A score was given to every assessment item according to a criteria scale that was developed for every one of the items (details of the method is shown in §5.3). This gave a quantitative profile called “IMS PDMA Evaluation”. To ensure the six companies had been evaluated in a homogeneous and comparable fashion, a “Cross case consistency check” was made. This consisted in back to back comparisons of the descriptions and justifications of the score given to every single factor across all the cases. This self-imposed discipline obliged to execute several

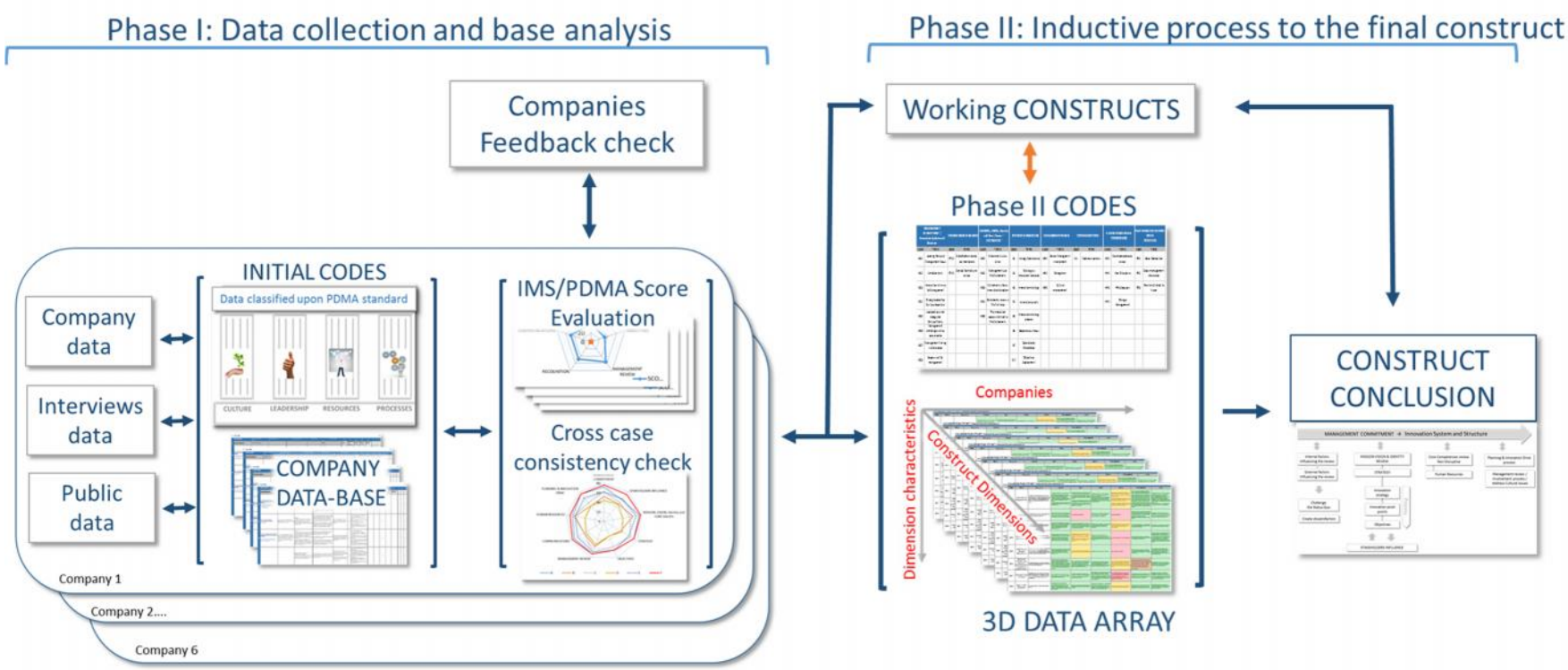


Figure 19: Research methodology and process flow utilized in this thesis

loops of critical readings of the database, leading to fine adjustments of the descriptions and assessments of every company. The result not only served the purpose of ensuring fairness and avoidance of biases in the scores given to every company, but it was also a very useful process to gain more in-depth qualitative understanding of all the cases. To complete this part of the analysis, a presentation of the results obtained, with comments on the strengths and weaknesses of every factor, was given to the managers of every company. Also, based on the preliminary conclusions of this Thesis, a set of recommendations to strengthen their ability to create growth streams was included in the presentations. In the same session, the "Innovation / Market" matrix of every company, as shown in Figure 18, was presented to the managers to obtain confirmation that the circles were representing fairly the significant innovation activities of the firm, with no significant activities omitted and that the ones represented in the graph were correctly placed. Thus the circles could be used to comparatively assess the relative success of every company in creating growth streams (details of this assessment were shown in paragraph §4.3). The presentations included the relative position of the innovation factors of every company compared to the peer companies in this research. Strict confidentiality on specific insights of other companies was maintained and company pseudonym names were used. In all cases the presentation and recommendations given were very well received, and the observations and changes requested by the managers of the companies were minor topics.

The completion of "Phase I" delivered an in-depth analysis of the innovation factors, and an "Innovation-Market" matrix describing the created innovation growth streams for every one of the six companies. With the two pieces of information having been presented and confirmed by the managers of the companies, as being a fair description of their reality, thus providing a solid basis for further analysis.

At this point in the process, and as a result of the analysis done, a first view of common factors and characteristics in relation to breaking the exploitation glass ceiling and creating innovation growth streams, emerged across the sample of analyzed companies. It also became clear that some factors were not relevant and could be discarded as future construct constituents. Some of the factors were found to be intimately related to others. The key relevant innovation factors identified and their inter-relations were then considered as the potential constituents of a possible construct, which was then used to re-organize the database under new codes. The analysis done also showed common specific characteristics of the factors across the more successful companies in creating growth streams, classes A and B. The key innovation factors identified and those characteristics were then used as codes to re-array the data in a format that would allow a second level of analysis. This was the starting point of "Phase II".

Based on the newly defined codes, a three dimensional data array was built to provide a good perspective of the practices done by every company in each of the factors and characteristics of the identified preliminary construct. One dimension of the array listed the companies classified following the innovation rank. The second dimension was the key innovation factors identified, and the third the characteristics of those factors. Every cell of the three dimensional array was filled in with a description of the practice and performance observed.

The critical review of the three dimensions array underlined the key differences between the best companies in creating growth streams and the less successful ones. The iterations led to better understanding of the common characteristics of every innovation factor, and surfaced the interrelations between them. The analysis revealed that the intensity and characteristics of executing certain factors by the best companies differed from the less successful ones. In the best companies, the identified interrelation between factors was found to follow a logic oriented to create a new space for innovation growth. This critical review process led finally to the proposal of an innovation construct, describing a top management innovation system to break the exploitation glass ceiling and create new growth streams. Based on the practices of the analyzed firms, the proposed construct seems to provide an answer to the research questions.

In the following paragraphs, the details of the execution of every step of the research process will be described further. In SECTION VI the findings and the conclusions will be exposed.

5.1.The data collection and the semi-structured interview set up

The collection of data from the companies studied utilized three sources: semi-structured interviews with managers, directly requested company information and public data.

The data directly requested from the companies included general information on the markets served, sales and financial historical performance, sales of new products, relevant innovation projects, investments, organization and business processes. A detail of the data requested is shown in Annex 3.

The biggest portion of the data was obtained through twenty-eight (28) semi-structured interviews carried out with managers belonging to the six companies. A breakdown of the number of interviews by company and level of hierarchy is shown in Table 8.

Table 8: Number of interviews by company and organization level

	FMatE	**ICons**	**EComp**	**EMNet**	**EquB**	**PMach**	**Total**
CEO or Directors	2	1	-	1	2	1	7
C-level management	-	2	2	2	5	3	14
Department level Management	-	1	2	-	-	4	7
Total number of interviews	2	4	4	3	7	8	28

Every company nominated a person to act as a liaison for this research. The managers to be interviewed together with the number of interviews were decided upon in discussions with the liaison manager to make sure that all aspects in the interview would be properly covered and that the company would be properly represented. The companies with a lower number of interviews, as for

instance FMatE provided a great amount of written information, part of it public and partly made available by the company. In all cases, information on the innovation factors and evaluation items was properly covered.

The interviews were conducted by this Doctor student, following a written protocol and questionnaire. The event started with the usual personal introduction of the interviewer and interviewee, followed by a brief introduction of the research question and a brief explanation of the structure of the chapters to cover. Also a written commitment confirming confidentiality of the answers and the electronic record of the interview was offered. This was important to create an open atmosphere, to obtain opinions and information, without fears of any possible political consequence, or seeing the recorded interview somewhere in the web. A copy of the introduction and confidentiality commitment given to every interviewee is shown in Annex 4.

The interview was conducted by raising to all the interviewees the same pre-defined grand tour questions. They were conceived to stimulate the interviewee to elaborate on every one of the innovation factors and evaluation items without pre-guiding in any specific direction. The interview protocol included secondary questions to remind the interviewer of the aspects that were expected to be obtained in the answer. Those secondary questions were only raised in case the initial answer was not covering the subject. A list of the grand tour questions by chapter and evaluation item is included in Annex 2,Table 22. The duration of each interview was circa two hours, with duration by chapter depending on the manager interviewed. Typically, CEOs and Directors spent more time on explaining details of the Culture and Leadership chapters and less on elaborating specific processes and resources. On the other hand, department managers spent more time on specifics of processes and resources of their area of responsibility than on the big picture within the culture and leadership factors.

The result of the interviews was very satisfactory. The information expected was disclosed in an open and candid fashion, providing a comprehensive description of company operations and behavior. In most cases, the answers followed the protocol with a good level of adherence and with little deviation from the grand tour question. In some cases though, the passion for the subject meant that some of the explanations extended into related subjects, classified in this thesis under other innovation factors and even chapters. In those cases, to the extent that the time management allowed, the explanations of the interviewee were not interrupted. These spontaneous expansions were found to be very useful in gaining more insight into the innovation practices and inter-relations between factors; the extra work involved in sorting out the information by code did indeed pay off.

5.2.The initial codes and the company database set up

The database raw data consisted of a set of documents obtained from the three sources described in the previous paragraph. The data from the interviews with different managers (electronically recorded and transcribed in a manuscript), data provided by the company and data obtained from public sources were then processed to configure descriptions of facts and practices, describing every one of the innovation factors and evaluation items of the initial codification. The

different sources of information were very useful to check consistency and to identify strong recurrent topics. The result of the data processing and codification was the creation of a database per company, organized in four innovation chapters: Culture, Leadership, Resources & Competence and Processes, with the constituent factors and evaluation items of every chapter fully described, including the significant facts and practices provided by the managers in the interview and complemented by the data from the other sources. This process transformed the large amount of raw data collected into a manageable information file per company.

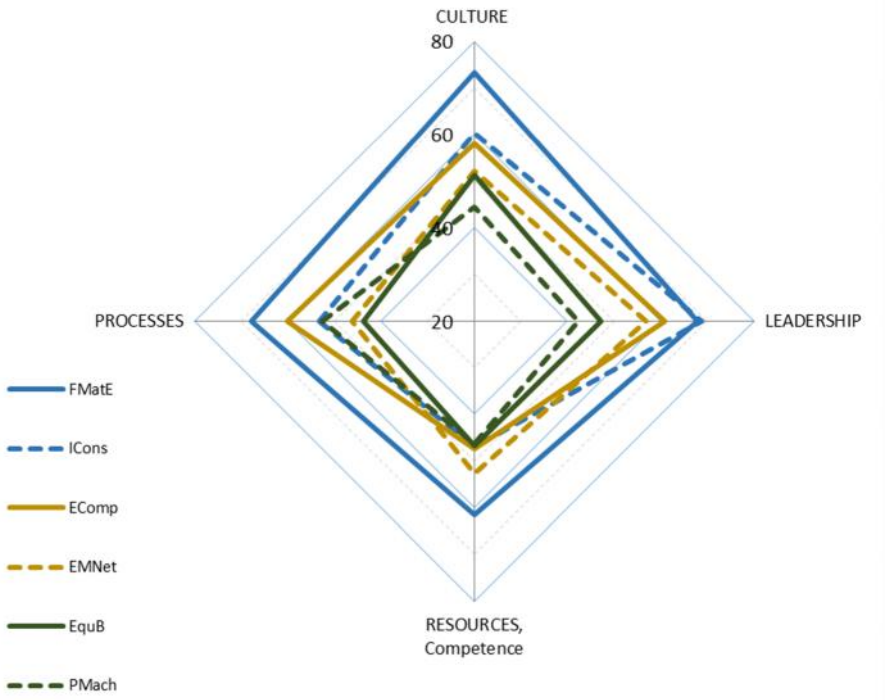


Figure 20: IMS/PDMA score evaluation

5.3.The IMS/PDMA score evaluation method

A scoring system with quantitative scales was created for every evaluation item and factor. This was developed on the basis of the PDMA/TIM Innovation standard guidelines (2013) and the evaluation guide proposed by IESE (Vilà & Muñoz-Nájar, 2003) and own judgments made to suit the purpose of this research. The score level of every evaluated item ranged from highest (equivalent to 80 points), meaning excellence in the development of the specific item and its connection with innovation-driven growth, to adequate for exploitation (rated with 40 points), meaning that practices for that particular item were in place to maintain the product portfolio competitiveness, and lower than 40 if the

management practice associated with the item was assessed to be insufficient to support a maintenance of the core business. The score of every factor and chapter was then calculated as the arithmetic average of the constituent evaluation items. This evaluation scheme proved to be very useful as a complementary analytical tool to the insights generated by the main qualitative inductive procedure.

In Annex 2, Table 22, the scales utilized to evaluate every item are listed. There, the scales are divided into five levels, one (1) to five (5), where level one (1) would translate to zero points and level five (5) to eighty (80) points. The reason for the scale translation from 5 to 80 was to provide a scoring system in line with the range of the PDMA practice.

This system provided an overview of the comparative levels achieved by each company against the established scale criteria. To illustrate this analysis, a comparison of the IMS PDMA scores obtained by each company on each one of the innovation chapters is shown in Figure 20. The detail results of this score evaluation by innovation factor, along with the qualitative findings and explanation of the differences between the cases are presented and discussed in SECTION VI.

5.4. Cross case evaluation consistency check methodology

At this point, the innovation factors of every company had been evaluated and studied on the basis of the structured information company files. To minimize the risks of uneven score evaluation and ensure that all the relevant aspects of the raw database had been properly considered and properly transcribed in every company information file, a reverse process was undertaken. This means, starting from the score given to a factor of a case, the reasons and justification for being higher or lower than the same factor in other companies were searched in the database. The method consisted of raising and answering the following questions for every innovation factor and company:

- Why is the score higher or lower than the other companies?
- What are the positive characteristics driving the score of the factor up? "**+**"
- What are the neutral characteristics? "**=**"
- What are the negative characteristics driving the score down? "**-**"

This created a matrix of companies and innovation factors, showing for every factor an executive summary of the "+", "=" and "-", explaining the reasons for the relative positioning among the peer companies analyzed. Figure 21 illustrates the format utilized to carry out the cross case evaluation for a single innovation factor, a total of twenty (20) were made, five (5) per innovation chapter. This discipline and tool provided a transparent and critical review across the cases. It allowed the introduction of fine tunings to the initial round analysis and to make progress towards the discovery of a first emerging construct. A summary of the positive, neutral and negative aspects of every factor and case were included in the presentations to the companies, so that the loop was closed and the information resulting from the analysis confirmed by the executives of the companies.

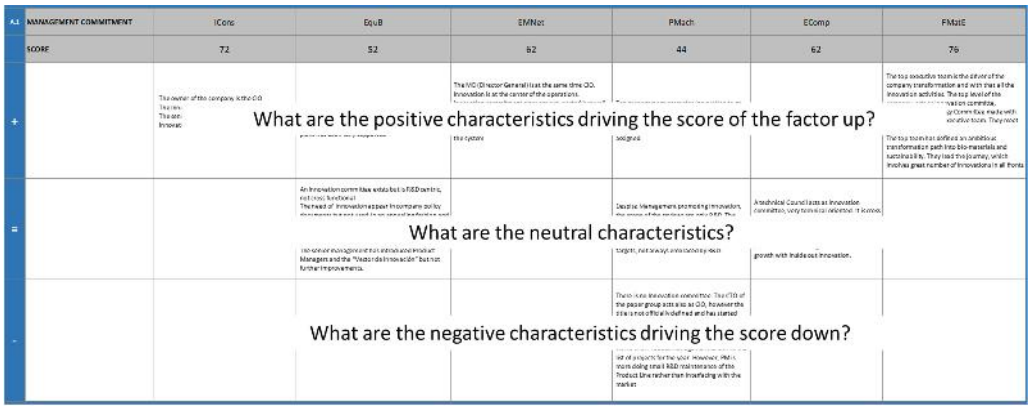


Figure 21: Cross consistency evaluation tool of an innovation factor.

5.5.Second phase codes and the inductive process to the conclusions

The study and analysis of the data provided evidence of common themes, across the companies. Some of the innovation factors were found not to be relevant to the creation of growth. Some did not show big differences across the companies “A”, “B” and “C”, some were remarkably different or had a different intensity. The answers from the interviews revealed direct links between some characteristics of the factors and the creation of growth streams, while others were found to be irrelevant. This doesn’t mean that the factors considered irrelevant for growth were minor issues, they could be very relevant for other subjects, but not to start the journey of breaking the glass ceiling. Some inter-relations and dependencies between the factors led to grouping a few of them as a single entity and later also into clusters of related activities. In SECTION VI, this subject will be revisited and the reasons for keeping or excluding innovation factors from Phase II of the analysis described in the context of the empirical findings.

The analysis led to the definition of a new structure of codes, whereby those factors found not to be linked to growth were taken out, and the ones found relevant retained and further described with associated characteristics that emerged as potentially being the key for success. The new structure of codes is shown in Table 9.

This structure became the basis to re-array the data, which allowed a more focused an in-depth analysis of the chosen factors and characteristics across the companies. The retained innovation factors became the potential construct dimensions of an innovation driven growth system. Yet, Phase II of the process had to develop it further.

Table 9: Codes utilized to analyze the data in Phase II of the research process

Potential constituent dimensions of a construct

Characteristics of the dimensions

MANAGEMENT COMMITMENT / Innovation System and Structure		STAKEHOLDERS INFLUENCE		MISSION, VISION, Identity and Core Values = ' STATEMENTS '		STRATEGY & OBJECTIVES		MANAGEMENT REVIEW		COMMUNICATIONS		PEOPLE & COMPETENCES		FRONT-END INNOVATION DRIVE	
CODE	TOPIC	CODE	TOPIC	CODE	TOPIC	CODE	TOPIC	CODE	TOPIC	CODE	TOPIC	CODE	TOPIC	CODE	TOPIC
MC.1	Forward Looking Management focus	STK.1	Stakeholders trends in the statements and strategy	MVI.1	Statements are a drive	S.1	Strategy Consistency	MR.1	Senior Managemnt involvement	C.1	Strategy Communication	HR.1	Core Competences review	FE.1	Ideas Generation
MC.2	Ambidexterity	STK.2	Served Markets are critical	MVI.2	Management use the Statements	S.2	Innovation strategy	MR.2	Delegation	C.2	Innovation strategy communication	HR.2	Non Disruptive	FE.2	Ideas management interaction
MC.3	Innovation intrinsic to Management			MVI.3	Statements shows Innovation direction	S.3	Innovation pivots	MR.3	Culture improvement	C.3	Internal communications	HR.3	HR adequacy	FE.3	Front end linked to Vision
MC.4	Strong leadership but participative			MVI.4	Statements review is the first step to break the glass ceiling	S.4	Innovation strategy process					HR.4	Change Management		
MC.5	Leadership is not delegated Only authority			MVI.5	The innovation scope is limited to the Statements	S.5	Scope versus focus								
MC.6	Management challenges status quo, creates dissatisfaction, with the purpose of promoting change					S.6	Operational Excellence								
MC.7	Management timing is of essence					O.1	Objectives deployment								
MC.8	Scope is set by management														

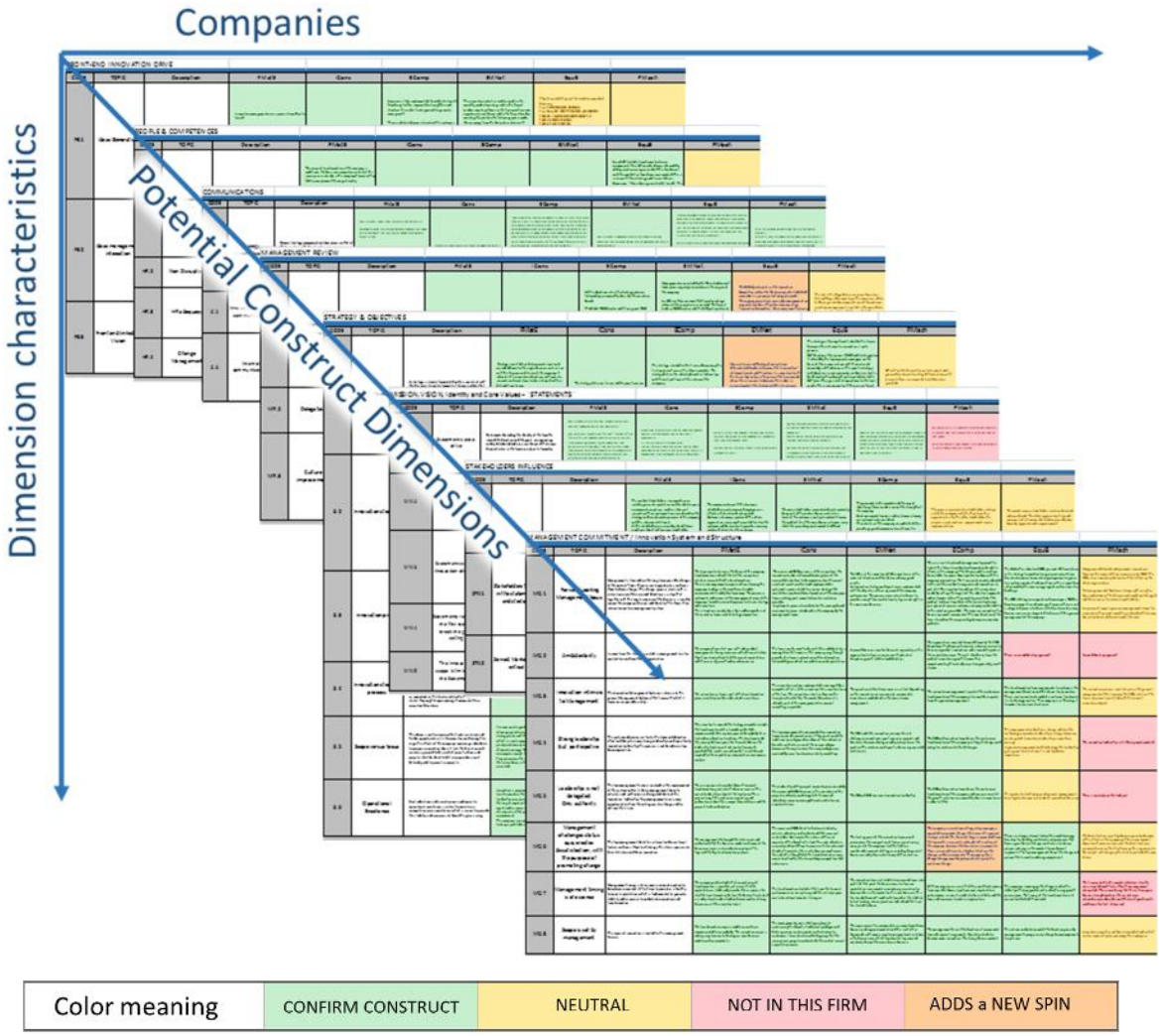


Figure 22: Data array model used to develop and confirm the construct

The more focused analysis codes of Phase II were utilized to create a three dimensional data array, schematically shown in Figure 22, with the three dimensions being: Companies, Potential Construct Dimensions and Characteristics. The new data arrangement allowed an in-depth analysis of all the dimensions and characteristics across the cases. For every factor and characteristic, a description of the practices of every company was included in the data array. This permitted identifying the common themes and also differences between the companies "A", with the highest success in creating growth streams, from the classes "B" and "C". Every box in the 3D data array was color-coded according to the following categories:

- CONFIRM CONSTRUCT: Meaning that the company in the particular factor and characteristic was supporting the description made.
- NEUTRAL: Meaning that the evidence found was not enough to support the description made
- NOT IN THIS FIRM: Meaning that the particular characteristic was not existent
- ADDS A NEW SPIN: Meaning that additional considerations to the description of the characteristic were to be made to be able to classify the particular firm as confirming the construct

Few iterations of critical reviewing of the new data arrangement led to conform and fine-tune a description of every characteristic with consensus ("Confirm construct", green color) across companies in the "A" and "B" category, and reducing the "Adds a new spin" category to the minimum. The process also revealed the way that the companies were linking the different factors in their process to generate growth streams. The final set of characteristic descriptions and links observed between factors were then used to shape the conclusions and construct proposed in this Thesis.

SECTION VI

The findings. The key success factors and its characteristics

SECTION VI

6. Insights into the factors that explain the success in creating innovation growth streams

This section describes the factual results of applying the research concept, methodology and process set out in SECTION V, to the selected six cases. It outlines the relevant findings for every one of the innovation chapters and factors. The findings narrative flows through the four chapters and five factors per chapter, applied in Phase I of the research process. For every innovation chapter and factor, the considerations made to select the constituent factors of the construct used to start Phase II of the analysis are exposed. For the factors selected to enter into Phase II, the observed characteristics, as result of the cross case analysis done in Phase II, are described. The outcome of this section is the selection of the innovation factors and description of its relevant characteristics, which are used to constitute the innovation driven growth construct presented in SECTION VII.

The analysis of the multiple cases shows a predominant relevance of factors within the Culture chapter: Management Commitment, Stakeholders Influence and the use of Statements (which includes Vision, Mission & Values), all three stand out as highly influential. This is followed by factors in the Leadership category, with the outstanding role of Strategy & Objectives and Management Review & Communications. On People and Competence, within Resources, and the implementation of a Front-End Innovation Drive (linked to an idea generation and selection process), within Processes, both came out as highly influencing factors in the firm's ability to break the exploitation glass ceiling and generate growth streams.

6.1. Culture. Findings overview

The Culture chapter is composed of five constituent factors:

- Management commitment
- Stakeholders influence
- Statements: Values, Mission and Vision
- Risk practice
- Work environment

The top executives of the six analyzed cases declared innovation to be one of their main strategical directions in maintaining and improving company performance. There was no difference related to the willingness of being innovative, yet the success of every company in creating growth streams was different. Within the chapter Culture, the factor Management commitment was found as having the highest influence in the creation of growth streams. This is followed by the factors

Stakeholders influence and Statements, which in fact were found to be intimately linked to the Management commitment. Statements are the tool used to share and communicate intentions, and Stakeholders is the source and sound board used to elect and define the direction in which to go. The factors, Risk practice and Work environment were not found to be key drivers in creating innovation growth.

In the best companies, the CEO or top executives, in addition to declaring the willingness and intention to innovate, they presented an appealing Vision to change the company and a process to do it. They were personally engaged in aligning the whole organization to achieve the vision in a structured and systematic fashion. They were the leaders of a thorough innovation process that had been implemented with the purpose of accomplishing their goal.

This was remarkable in cases like FMatE (rank #1) where the executive board developed an ambitious vision to pioneer a new way of creating value in their industry segment, based on sustainability principles. While most people take a low profile reaction to long-term sustainability market threats, the FMatE board regarded the subject as real and decided to turn it into opportunities for the company. They were not complaisant with the status quo and good results achieved every year. In the early 2000's, they started a progressive transformation of the company with the ambitious goal to fully transform it within a time span that would exceed one decade. The board introduced a management system to involve the whole organization and stakeholders in driving the transformation of the company. At FMatE, the transformation is visible, made public to all the stakeholders and the direction discussed on a frequently regular basis at executive board level of the company. At FMatE, innovation and company transformation are the two sides of the same coin, and both have created deep roots in the company culture.

At Icons (rank #2), the CEO understood that the current outstanding results were sustained by a construction market euphoria that could not last long time. Against strong opinions of investing in more of the same assets to serve the strong market demand, he gathered the management team and challenged the current industry paradigm. The result was a new Vision conceived to serve the market in the expected post euphoria conditions. It was the beginning of a company transformation and new value proposition that should strengthen the position in the currently served markets and support the entry into new geographies and countries. An innovation process, organization and tools were implemented by top management in a structured and systematic fashion. The CEO, also taking on the CIO position, drove the whole organization to embrace the new direction. A strong innovation culture became ingrained in the company.

The top management at EComp (rank #3) has implemented a culture based on being different from competitors, adapting products, processes and organization to suit the requirements of selected new growth markets. The Vision has not significantly changed in the last ten years, only specific growth goals are added in the yearly strategy review. A well-structured and effective Stakeholders communication is supported, especially with the markets served and targeted. The culture is such that

everybody knows that the only rule that cannot be changed is the readiness to accept change. Growth targets impulse the necessary changes to drive value differentiation and achieve the goals.

At EMNet (rank #4) the CEO acts also as CIO. A significant transformation to turnaround the company performance has been led and executed by the CEO. It started by questioning the identity of the company and creating a revised Vision. The transformation was strongly focused on innovation, in the first instance on incremental innovation, oriented to achieve a fast improvement of the company position in the market and short-term performance results. In a second phase, on the basis of an already achieved solid exploitation performance, growth targets beyond exploitation were pursued and achieved. The CEO personally drives and improves innovation management practices.

EquB (rank #5), the CEO, in response to legislation changes, started a transformation of the company to move from components into systems, change that was well reflected in the company identity statements. It was proactive and took a bold rather than conservative direction, anticipating possible market changes. Moderate growth was achieved. However a tendency to associate innovation with R&D led to some launch hassle, and confined the potential and success of creating growth streams.

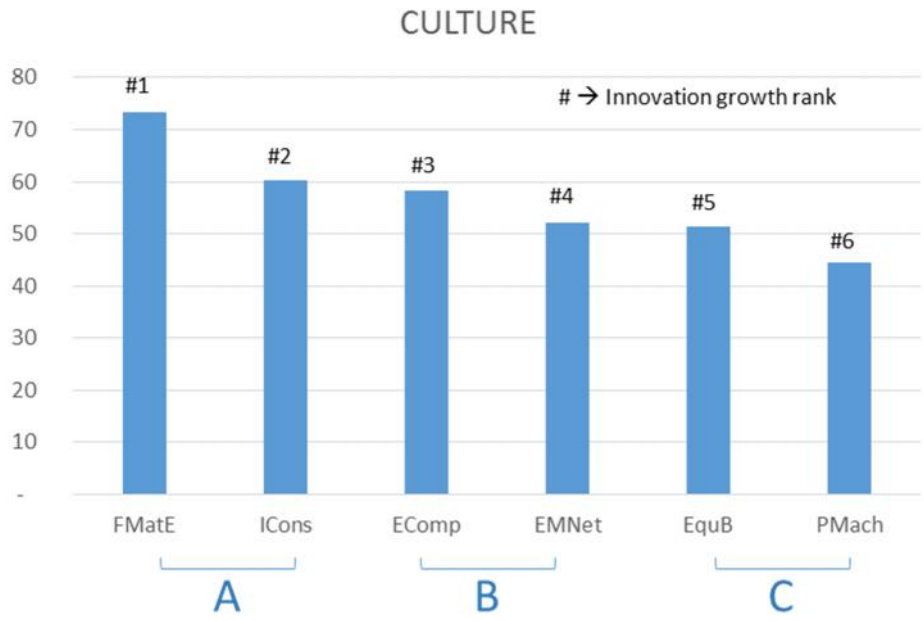


Figure 23: Culture. IMS/PDMA scores

Closing the innovation growth rank list, PMach (rank #6) did not show the same resolution and market anticipation in translating the CEO's innovation intentions into a company-wide undertaking. Complaisance on outstanding performance results together with the high reputation of the company in their market impeded management from considering long-term threats as real. Something that could not be solved with the geographical diversification actions already in place. The change came in faster and stronger than anticipated and the company suffered. Timing was an issue. A bias to associate

innovation with R&D, and not as a full company cross functional task, meant that the needs of key stakeholders were not properly shared across the organization, and therefore not used in full and in depth to drive innovation ahead of time. Despite the willingness from the top management to innovate, the message did not generate enough traction. A sense of frustration hindered the development of a strong innovation culture.

The bar chart in Figure 23 shows the overall IMS/PDMA score evaluation of the chapter Culture for the six studied cases, with FMatE having achieved the highest score with 73 points, and PMach the lowest score with 44 points according to the score evaluation method introduced in §5.3. The graph also shows the innovation growth rank and class obtained by every company. The comparison of the IMS/PDMA score and the innovation rank and class reveals that the sequence of both matches in reverse order. The cases showing higher IMS/PDMA score in the chapter culture have been more successful in breaking the glass ceiling and creating growth streams. Rank #1 matches the highest score, and it progressively follows down to rank #6 with the lowest. This correlation confirms the qualitative analysis observation that the chapter culture is relevant to the research question. Higher Culture score, higher innovation success.

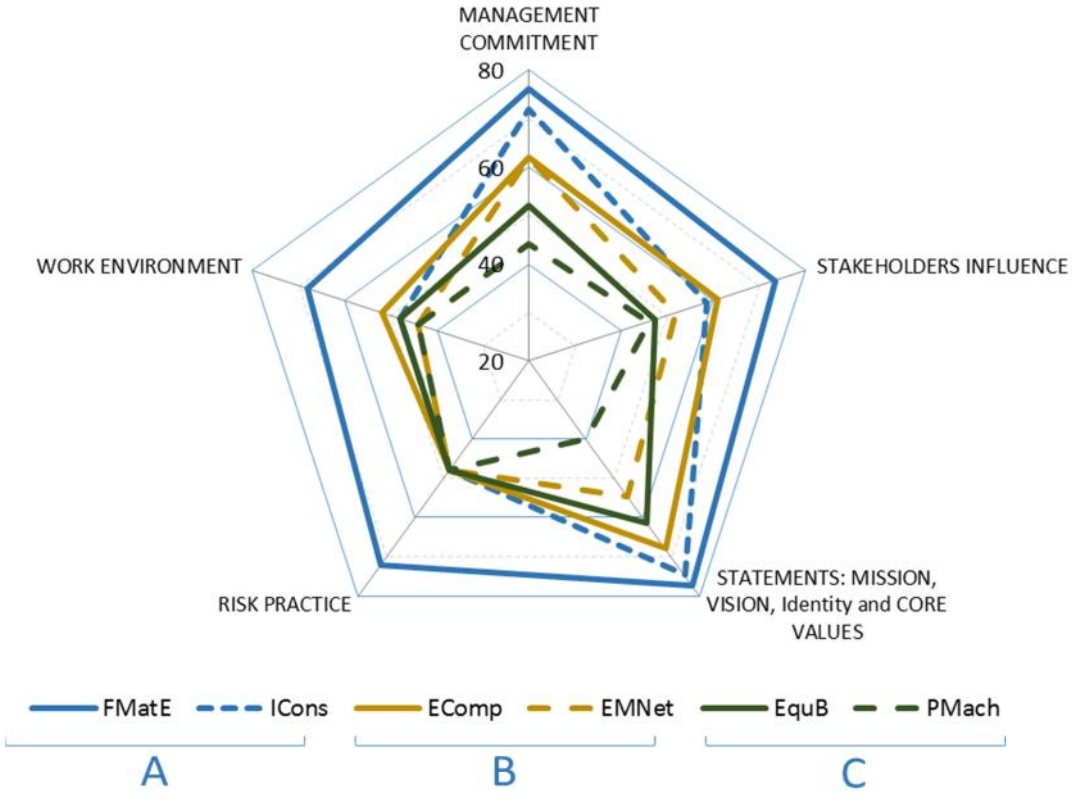


Figure 24: Culture innovation factors. IMS/PDMA scores

The radar chart in Figure 24 shows the IMS/PDMA scores of the Culture innovation factors for each one of the six studied cases. FMatE, the case with the most ambitious transformation project, was active in all fronts of Culture. The factors Risk practice and Work environment, with the exception of FMatE, do not show significant IMS/PDMA score differences across the companies. While the Management commitment, Stakeholders influence and Statements show clear differences. Indeed, the average score of the A companies is higher than the average of the B and C. This observation on the scores of the factors, and the correlation seen in Figure 23, confirm the election of key factors within the chapter Culture coming from the qualitative analysis. A numerical statistic treatment of this observation is exposed in §6.6. Hereafter, the findings of each one of the factors within the chapter Culture are presented.

6.1.1. Management commitment

The factor Management commitment is one the factors identified, at the end of Phase I of the research, as the potential constituent dimension of an innovation construct providing an answer to the research questions. The key success characteristics of this dimension were first identified in Phase I and then confirmed in Phase II through an in-depth, cross case analysis. This analysis identified relevant common themes across cases that were then used to create a generic description of each identified characteristic. A summary result of the characteristic descriptions and cross case analysis is shown in Table 10, where the companies, whose practices respond to the description and the ones that do not, are identified by means of a color code.

In general terms, the findings show that Management commitment with innovation goes beyond support. In all the studied cases, the top management was supportive of innovation and considered it to be the key for company success. However, for better firms (in groups A and B), with innovations delivering growth streams, the top executive (CEO) or the executive board acted as entrepreneurs and leaders of the innovation journey, were passionate about the Vision, were personally involved in building and implementing the innovation system, and were leading the organizational changes necessary to make innovation possible. Their aim was to align and energize the teams in a new direction. Top management in firms in the C group did not sustain comparable intensity in fostering innovation.

Timing of management innovation moves is critical. Management teams that are forward looking, ahead of the game, avoid being caught out by market changes, resulting in exploitation performance issues, perform better. In most of the cases timing was managed proactively, yet the conviction of the need to change differed. In one case, market changes irrupted much faster than expected, causing severe exploitation pain (PMach). On the other hand, the best cases have proved to be very proactive, and top management had the skills to anticipate future threats as real, and acted consequently building

Table 10: Management commitment. Description of key characteristics

MANAGEMENT COMMITMENT

			A		B		C	
CODE	TOPIC	Description	FMatE	ICons	EComp	EMNet	EquB	PMach
Summary	Highlights	Top executive acts as entrepreneur of a growth program based on innovation and change. A comprehensive Innovation Management system has been implemented and is led by top management.						
MC.1	Forward Looking Management focus	Management is focused on the long term possible changes of the market. Takes them as real opportunities and uses them to drive change. The change process starts with a critical review of Mission and Identity, as a step that together with the long term view of the business is used to review the company Mission and Identity. This flows then into an Innovation management system						
MC.2	Ambidexterity	In some form the firm has created a management line for exploitation and another for exploration. In small companies this is done sequentially in the time, periods of intense exploration followed of periods of predominant exploitation.						
MC.3	Innovation intrinsic to Management	The Innovation Management System is intrinsic to the general Management System of the firm, with which it forms an inseparable entity. It is not a parallel management stream.						
MC.4	Strong leadership but participative	The system and processes foster the team collaborative effort and despite a very strong leadership, and specifically innovation leadership, the process is not based on a top down imposition. People are encouraged to make decisions within the frame of the strategy.						
MC.5	Leadership is not delegated Only authority	The top management team is involved in the improvement of the system and in its daily management. Specific activities and authority are delegated, but not the Innovation leadership. Top management uses every opportunity to show the willingness to change and to achieve the Vision						
MC.6	Management challenges status quo, creates dissatisfaction	The top management identifies internal and/or external factors, and uses them to challenge the status quo, create dissatisfaction to drive innovation and change. In EComp management introduces continuous changes to serve the growth targets						
MC.7	Management timing is of essence	Management timing is of essence, early anticipation to downturns or market shifts, helps to maintain a healthy financial exploitation, which is fundamental to generate stability and resources to undertake innovation and transformation						
MC.8	Scope is set by management	The scope of innovation is limited to the horizon seen by management						

Color code: CONFIRM CONSTRUCT | NEUTRAL | NOT IN THIS FIRM | ADDS a NEW SPIN

the foundations to create growth streams ahead of time. The avoidance of complaisance on good results, escaping from the “tyranny of success” (Tushman & O'Reilly, 2002), and a deep belief of the need to challenge the status quo, proved to be key elements of a robust innovation management culture.

All companies in the A and B groups showed some kind of ambidexterity. This last finding confirms the proposals of Tushman and other (Tushman & O'Reilly, 1996) . In small companies like Icons, where resources are limited, periods of intense exploration were followed by periods of consolidation, where the exploration activities were slowed down to use the resources to consolidate the achievements and collect results (Tushman, Newman, & Romanelli, 1986). Once all the changes settled down, top management started a new wave of exploration and change. This might not respond to the parallel scheme proposed by Tushman & O’Reilly, but in small companies, the concept seems to work.

Innovation has to be core, neither a complement not a privilege. The findings also show that in the best companies, top executives considered the innovation system to be an integral part of the business, as regular processes of the company, not forming a parallel avenue, sporadically reviewed by the board or an investment area that is nice to have when profits are present. In the best companies, it is impossible to differentiate innovation relevance from the rest. The cases where the innovation system was not an important protagonist for management, results were close to the exploitation core maintenance, i.e. a long industry average, and significantly more modest in the creation of new growth streams.

A strong leadership of top management in innovation matters was seen as determinant for success in all the cases, however in the best companies the leadership intensity of top management, using every opportunity to promote innovation was higher. The innovation leadership was not delegated; however authority to execute and make decisions was in place. The leadership was participative.

In summary, top management commitment was found to be an outmost determinant factor of the success of innovation. There is an agreement on this critical role in the literature (Cooper & Kleinschmidt, 1995) (Felekoglu & Moultrie, 2013) (Stanley Kam Sing Wong, 2013) and this has been corroborated by this research and other previous studies on the success factors of innovation and new product development (Miller, Klokgieters, Brankovic, & Duppen, 2012). This factor seems to be the cornerstone and builds the foundation of any robust innovation system.

6.1.2. Stakeholders influence

Firms with high success in creating growth streams were proactive in monitoring the needs and expectations of the key firm's stakeholders, used to define and review the company statements and strategy. The bigger companies conducted this activity in a more thorough and formal way, while smaller ones did it less structurally and tended to be restricted to only a few critical stakeholders. The

Table 11: Stakeholders influence. Description of key characteristics

STAKEHOLDERS INFLUENCE

CODE	TOPIC	Description	A		B		C	
			FMatE	ICons	EComp	EMNet	EquB	PMach
Summary	Highlights	Stakeholders are a driver of innovation. Systematic and open communications with them foster innovation, helps to confirm or change initial ideas and motivates the teams to deliver. Excessive hiding or "shy" behavior of innovation programs does not help success						
STK.1	Stakeholders trends in the statements and strategy	The needs and trends of the firm's Stakeholders, having the highest influence in the company are continuously monitored and considered in the statements and strategy.						
STK.2	Served Markets are critical	The served markets are a critical stakeholder to maintain and improve exploitation performance, which is consistent with the importance to keep a stable performance in the exploitation activities as seen in MC.7 and S.6						

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Table 12: Statements. Description of key characteristics

STATEMENTS = MISSION, VISION, Identity and Core Values

			A		B		C	
CODE	TOPIC	Description	FMatE	ICons	ECom	EMNet	EquB	PMach
Summary	Highlights	The statements are appealing and have been revised to include the direction in which the company wants to create growth and innovation. People in the company feels identified with the statements and management uses them to drive direction and solve conflicts						
MVI.1	Statements are a drive of innovation	Statements describing the identity of the firm, the intend, the direction and the goals are appealing, widely distributed and are a real driver of the teams daily activities in the firm, are not just a formality						
MVI.2	Management use the Statements	Management often refer to the statements to give direction to conflicts and to promote innovation						
~~MVI.3~~	Statements shows Innovation direction	The statements include general description on the way the company wants to differentiate in the market and a direction of Innovation						
MVI.4	Statements review is the first step to break the glass ceiling	A critical review of the statements is the first step in defining the way of "breaking the exploitation glass ceiling". They review sets the intended company transformation						
~~MVI.5~~	The innovation scope is limited to the Statements	The Vision sets the horizon where the company wants to go. People unlikely will go beyond the boundaries set by the statements						

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best practices show that an active and open communication with stakeholders is important in order to gain the support for innovation. Thus, it was associated with positive effects in the employees' commitment to engage in innovation activities on time and trust. Obviously, this was done with the logical reservation on sensitive matters. In a few episodes when a firm was hermetic, concealing intentions or relevant actions, relevant feedback from stakeholders became insufficient and new growth streams resented.

In all cases, current customers and markets served were treated as a key stakeholder. All companies balanced their exploration efforts with the need to maintain a high performance in exploitation. This is coherent with the lasting importance of exploitation in mature technology industries. Thus, innovation initiatives in the companies did not just focus on exploration, they pursued as well incremental innovation, to maintain the competitiveness in their core businesses, necessary to obtain the resources to support exploratory activities.

Table 11 shows that the characteristics of this dimension are well supported by all the A and B companies. In the companies C, the intention to support the listed characteristics and establish good interchange with the stakeholders was present, however some aspects were needing improvement.

The FMatE management of the Stakeholders influence was found to be excellent, the best and well above the other analyzed companies. All the stakeholders were systematically managed, their needs analyzed, and actions to respond to those needs included in their operational plans. The FMatE management declared that the effort was paying off, and contributing towards focusing innovation in a successful direction. The open communications with stakeholders were also a stimulus for the employees to deliver the innovation promises in full and on time. The other companies were limiting their management actions to the most relevant stakeholders for the company.

6.1.3. Statements: Mission, Vision and Values

Solid established firms in mature technology tend to have a set of statements that guide their people and businesses for long periods of time. While this is a factor that provides stability, it can also be a corset impeding exploration into new ways of running a business and creating new growth streams. The best companies in the studied sample started their journey into exploration with a critical review of its Mission, Vision and Identity, challenging the established order and, in some cases, even the conventional wisdom in the industry, the dominant paradigms.

Changes in statements are used as pillars of change in mindsets and attitudes. Only rarely, prevailing Values were directly questioned. More often, they were recalled and used to energize the company in the newly defined direction. This suggests that rather than preaching, top management placed emphasis on making people work in different ways, aligned with the pursued type of innovation as the most effective way to build a new set of values. Also, it confirms that company statements are not modified very often, only when a significant change in the business is pursued. In this event, a new

journey has to start by questioning the statements that define identity in the firm. Some managers felt that such a review was a must, if they aspire to mobilize people outside the comfort zone, in which the firm had operated for a long time. The findings concur with Trusko (2009), in that revised Statements set a new frame of reference and a new scope for innovation, and create a space of consistency between the intentions of the company and the innovation projects. Management teams used them to facilitate and focus change in the company.

Table 12 shows the result of the cross case characteristics analysis. Two of the characteristics identified in Phase I, MVI.3 and MVI.5 were not consistently supported by the companies A and B, and therefore not retained as part of the final construct. The first, MVI.3, assumes that the statements must include Innovation direction. The analysis in Phase II shows that the innovation direction must be properly defined in the innovation strategy and the election of innovation growth pivots, therefore the inclusion of innovation direction in the statements is a nice to have but not a fundamental attribute. The second, MVI.5, assumes that the statements set the boundaries of innovation. This is partially true, however the innovation strategy might be more restrictive than the statements. The conclusion is that the strategy is the activity setting the innovation scope and not the statements. What is true, as presented later in the innovation strategy findings, is that the statements and the innovation strategy have to be consistent with both complementing each other. In consequence, this specific attribute of the statements was considered to be not essential.

The characteristic MVI.4, was confirmed with a caveat. The review doesn't mean that the statements are to be changed. EComp has not significantly changed them for a long time, but they have the process to re-visit them on a regular time basis, to make sure that they continue to be consistent with the management intend. The case of EMNet was coded as neutral due to the fact that, despite a consistent identity and vision answered in all the interviews, the statements were not formalized in a document, which led to considering this firm as neutral in regard to this characteristic. The statements were implicitly embedded in the context of company strategic documents, and management preached them at every occasion.

6.1.4. Risk practice

Risk practice was not retained as a key innovation factor driving the creation of new growth streams. Basically, all the companies had a somewhat common conservative way to manage risk. Managers of most of the companies regarded themselves as very cautious and quite risk averse. They only accepted entering into projects where an eventual failure would not put the company financial targets at risk, which is nothing extraordinary, just good management practice. In case of doubts, small investments were made to evaluate feasibility, and only when the projects were showing high plausibility to succeed, were significant money and resources invested. This appears to be an attribute, consistent with the intensive efforts made to achieve good performance in mature technology firms. Generally, it is not acceptable to allow stability and performance achieved in exploitation to be jeopardized by uncertain explorative risky projects. Therefore the findings did show that the risk

practice was not the driver to break the glass ceiling and generate growth, all the companies had the same flat profile regarding this matter, but still, despite the conservative behavior, all had managed to create innovation growth beyond exploitation.

FMatE was the only company somehow deviating from this general behavior. According to management interview answers, FMatE was very conservative in their origins, and management has been consciously widening the scope of risk acceptance. FMatE has indeed risky projects in their portfolio, involving nanotechnology (still in research at universities) to enter into complete new markets for the company: projects in the upper right-hand corner of the Innovation / Market matrix. The acceptance of those risky projects is made in the context of a large portfolio of projects, with risks and time horizons ranging from short-term low risk projects to long-term higher risk. The portfolio is managed to an aggregate acceptable risk, compatible with the performance financial projections.

The analysis of the observations and the fact that no significant differences across the cases were seen, led to the decision to eliminate this factor from the potential constituents of the final construct.

6.1.5. Work environment

The Work environment factor tries to evaluate whether the physical environment set up and/or purposeful communication environment were driving innovation. No significant differences were found across most of the cases. Once more, FMatE was setting the difference. They have invested in purposeful office spaces, with no walls around offices, even the CEO's office, and created numerous events to promote spontaneous interchange of information and ideas. Most of the other companies had also introduced innovation events and meetings, involving people from inside and outside the company, to foster innovation, but the intensity of FMatE was clearly higher.

This factor was found a nice to have, but not a deciding factor in driving a team to break the exploitation glass ceiling.

6.2. Leadership. Findings overview

The Leadership chapter is composed of five constituent factors:

- Strategy
- Objectives deployment
- Management review
- Communications
- Recognition

Within Leadership, the factors having more relevance in the creation of growth streams were found to be Strategy, Objectives, Management review and Communications. Recognition came out as a healthy practice but not as a determining factor to starting an innovation growth journey, it was therefore excluded from the Phase II analysis. Strategy and Objectives were found to be intimately related, since the main purpose of deploying innovation objectives was to support the execution of the innovation strategy. In fact, all the companies, showing good practices in defining an innovation strategy, had deployed related objectives. Management review and Communications were also found to have a significant link. In the chapter Leadership, Management review evaluates the involvement and support provided by management to innovation operational matters, which involves a great deal of communications and proximity between management, the teams and the stakeholders. This explains the link between both. The findings of these associated factors, Strategy & Objectives and Management review & Communications, are hereafter described under the same paragraphs.

The companies with higher innovation growth rank in the sample, classes A and B, showed a well elaborated Innovation strategy, set as a seamless expansion of the company strategy, the company Statements, and specifically serving the achievement of the Vision. The Innovation strategy was widely communicated and deployed in form of objectives. The top management was involved in project reviews, providing support to the teams, to maximize the chances of making people and company successful in achieving the objectives.

At FMatE (rank #1), the Vision of pioneering the industry transformation based on sustainability principles drives the development and definition of the company strategy, which in turn is deployed in an innovation strategy, innovation axis and projects in the business units of the corporation. Objectives are very clearly defined, and include delivery time and expected results. A committee of the executive board follows the execution of the innovation projects, they coach the teams and check the adherence to well defined road maps, in a close fashion. Support is provided when needed. In case of perceiving risks of drifts in achieving the objectives, they act with determination. Here the goals have been openly communicated to the stakeholders and therefore delays or deviations do not have location in the company culture. The Vision and innovation strategy definition was the result of long and intense discussions and analysis made by the executive board, not a fast decision made in reaction to obvious threats or opportunities in the market. It took several years, and learning experiences, to adjust all the edges of the ambitious and pioneering Vision. One of the adjustments was to stop an initiative that, despite being potentially very attractive, did not have enough synergy with the technology identity of the company, and was having issues because of that. The learning brought management to revisit the technology scope portion of the innovation strategy. In the innovation reviews, occasionally, the top management gives direction, but not in specifics of a project, they care about giving free space for serendipity. Communication is excellent, they are open internally and externally, and especially with stakeholders. Innovations are published, in exhibitions, leaflets and presentations. The organization is in this respect not shy at all. The strategy is widely communicated, internally and externally to stakeholders.

At ICons (rank #2), the Strategy, Mission, Vision, and Purpose, forms an interlinked body connected to operational Innovation axis and projects. A transformation strategy was developed

following a systematic process, which started with the willingness to break the paradigm and conventional wisdom of the industry. A new Vision was created. The company teams were involved in a process to develop the content of the transformation and a new value proposition in line with the Vision. This resulted in the definition of a company strategy that was strongly focused on innovation and in developing specific innovation axis, which later were materialized in innovation projects. The innovation strategy provided guidance to the teams on expected financial returns, payback time, technologies and targeted markets. Managers of the company quoted that the involvement of the teams in the development of the innovation strategy and innovation axis was the key to gaining a strong momentum and commitment of the people, in achieving a vision that involved a profound transformation of the traditional way of conducting the business.

At EComp (rank #3), the strategy is linked to the Vision, which is growth oriented in selected markets. A strategy exercise is done every year. It is developed on the basis of the analysis of industry trends and needs of customers that are collected by the different departments of the company. The source of a great deal of information derives from practicing customer intimacy. The strategy provides good guidance to the organization to prioritize innovation to serve the needs of key industrial branches and specific growth targets. It includes specific innovation projects and an innovation strategy. Strategy objectives are deployed and all the growth initiatives are tracked by the board on a regular time basis. To improve the innovation success in creating growth streams, top management promotes organizational changes and encourages people to identify ways of solving issues in the market that can potentially create growth. In summary, management is following very closely the achievement of growth, and with that the agility to implement the necessary changes in the company to deliver the yearly goals. Management diligently applies the principles of change management to prevent resistance and cultural obstacles hindering the achievement of innovation growth.

At EMNet (rank #4), the Vision developed to drive the company turnaround was linked to a specific innovation strategy, which is reviewed on a yearly basis. The strategy plan drives actions, there are objectives, discussed and cascaded down in the Product and R&D meetings. Innovation is the engine of the company to achieve the yearly results. The CEO, who acts as chief innovation, is very much involved in the operational aspects of innovation, he leads project reviews, and helps to accelerate the decision making on innovation matters. The innovation strategy gives guidance on the intended product portfolio architecture and specific features to be achieved.

EquB (rank #5) has a well elaborated and appealing company strategy, linked to the company Statements, and communicated to first line management, who in turn deploy actions to lower levels. People are very committed and identified with the general direction set by the top management of the company. Management reviews of innovation projects and technology development take place regularly. Moderate growth has been achieved, driven by the launch of moderate “more innovative” products and favorable market conditions. The innovation strategy is formulated in very general terms, it does not elaborate on the different product groups and specific growth pivots. The lack of detail in the innovation strategy means that the formulation of innovation goals is not possible and that innovation continues to be too weighted towards R&D. This was associated to some weaknesses

identified in the creation of bold growth streams, projects that had difficulties because of insufficient interaction with stakeholders and strategy definition.

At PMach (rank #6), the Mission-Vision statement and the strategy are formulated in a generic fashion, they give business direction, but do not enter into Innovation details. There is an R&D strategy, however it is also quite generic, not sufficiently linked to product management and market segment considerations. Management reviews are systematically carried out, with events and meetings scheduled throughout the year. However the main focus is to approve the budget, yearly activities and follow up progress of specific R&D projects, not with the purpose of defining innovation direction, priorities and scope. This means that the existing objectives are related to the approved R&D projects and operational cost reduction targets, but not to innovation achievements. Following a market downturn and industry paradigm change, management is not satisfied with the innovation contribution to growth and feels that the above described practices, primarily, innovation strategy, R&D orientation and objectives should be reviewed.

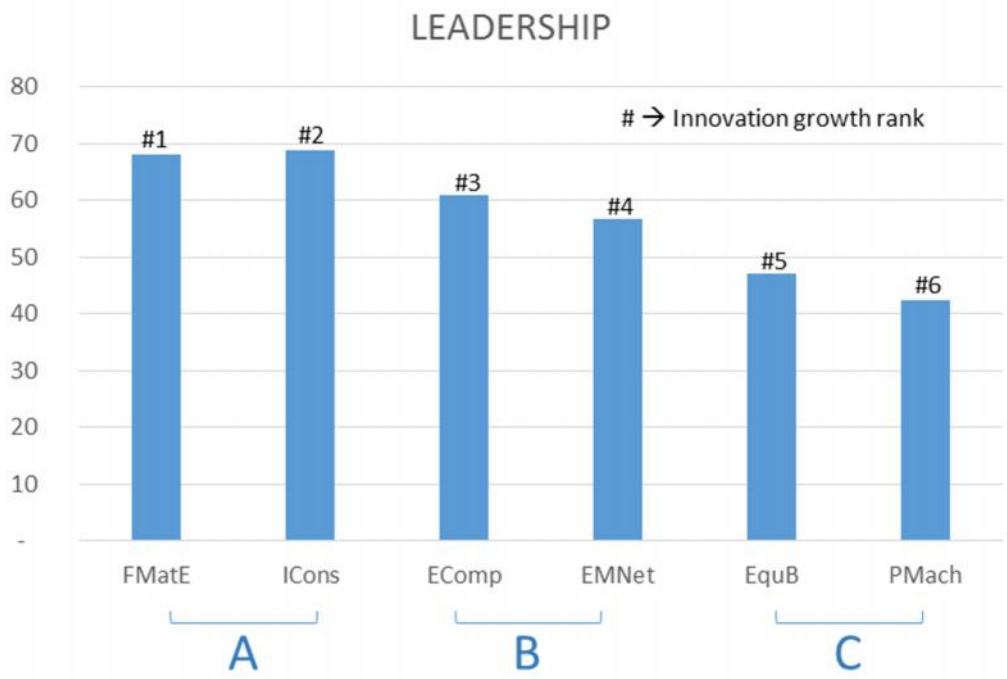

Figure 25: Leadership. IMS/PDMA scores

The bar chart in Figure 25 shows the IMS/PDMA score evaluation of the chapter Leadership for the six studied cases, with ICons and FMatE having achieved the highest score (69 and 68 points respectively) and PMach the lowest (42 points). Here the same observation applies as made in the chapter Culture, the scores of the class A, B and C are in a descending order, except the two A's that are practically at the same level. This correlation indicates that the Leadership IMS/PDMA score

evaluation is relevant to innovation driven growth, a fact matching the qualitative analysis done, in the sense that four out of the five constituent factors of this chapter have a significant link to the creation of innovation growth streams.

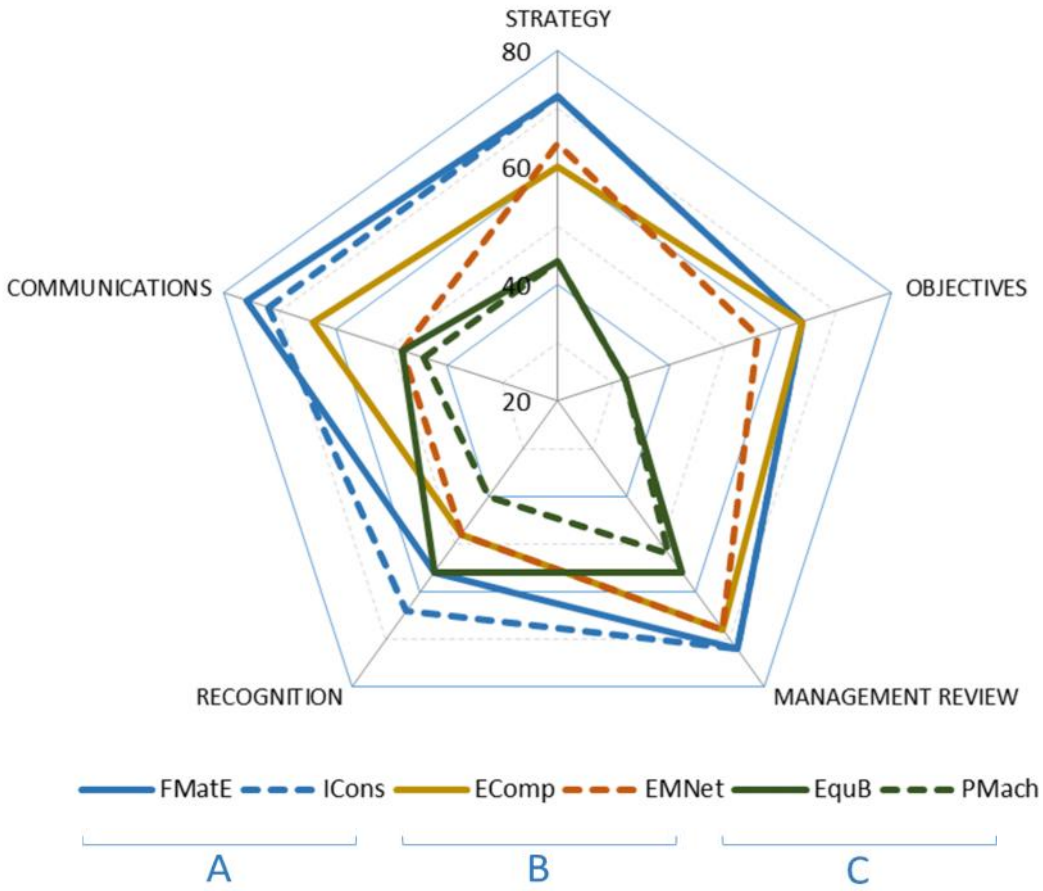

Figure 26: Leadership factors. IMS/PDMA scores

The radar chart in Figure 26 shows the IMS/PDMA scores of the Leadership innovation factors for every one of the studied cases. Here the companies A show the highest scores in the four factors retained as relevant to the research question. The B companies follow the scale and the C companies have received the lowest scores in the four factors. EComp showed remarkable performance in Objectives, the same as the A cases, but only in this factor. EMNet was scored low on communications due to the lack of formal written communication of the strategy and objectives. However, this was not seen as hindering the creation of growth streams. Despite the lack of formal written communications, in this company the CEO is the chief innovation officer, so that everyone knew what to do. A statistical analysis of the scores and its correlation to the innovation growth rank and size of the company is

exposed in §6.6 . Hereafter, the findings of each one of the factors within the chapter Leadership are presented.

6.2.1. Strategy & Objectives

The analysis reveals that the existence of a company strategy supporting innovation is a major determinant of innovation success. In mature technology firms, changes perceived far away on the horizon do not impose the making of urgent decisions. In the better performing companies, the sense of urgency to transition towards exploration was built from inside the company. Top managers saw the need to start a transformation and managed to gain the complicity and enthusiasm of the rest. Strategy was a key tool in the hands of senior management for this purpose.

Table 13 shows a summary description of the characteristics found and an indication of the cases responding to the descriptions. All the cases had a company strategy consistent and being a logical continuation of the statements (S.1), except one that has been quoted neutral due to not having seen enough evidence of this characteristic. EMNet is adding a further edge to S.1, related to a small business section not supported by a Vision statement and a specific strategy. The technology nature of this business section, networks, is at the edge of mature technologies, here market tactics of following opportunities, rather than long term strategizing, seems to apply (Eisenhardt K. M., 1989). The companies with stronger exploration results, A and B, furthermore had a clearly defined innovation strategy (S.2), providing the teams with a business framework, within which innovation was expected to take place. The purpose of it was to set priorities, translate the business targets into innovation goals, and define the boundaries in terms of markets, technology, business model, alliances and financial constraints. The firms in the category C had a generic innovation strategy, less elaborated, and not providing the same level of guidance than the best companies. For the best companies, the innovation strategy was found to be a key element to guide the path of moving from the abstract innovation intend to concrete plans to grow.

Firms A and B, in addition, had developed innovation growth pivot points (S.3), while companies C did not. These pivot points served the purpose of making sense of innovation for people in the ranks. These consisted of innovation axis and guidelines targeting specific features, markets, segments and product lines. The definition of the pivots was open enough to allow for free creative contributions, yet focused enough to avoid dilution of innovation efforts.

Companies A and B had developed the innovation strategy and pivots with participation of the teams, which facilitated developing a shared view of what was pursued (S.4). Thus they contributed with a double objective, a well-defined innovation strategic direction and people engagement. The engaging participative approach was understood as important to the outcome of the process, given that the innovation strategy would be evolving over time, but the engagement builds on the company culture. The process was led by top management, with a cross-functional participation, and with open

Table 13: Strategy & Objectives. Description of key characteristics

STRATEGY & OBJECTIVES

CODE	TOPIC	Description	A			B		C
			FMatE	ICons	EComp	EMNet	EquB	PMach
Summary	Highlights	Innovation guidance seems to be key to gain traction. The innovation strategy and the pivots conforms the management tool to get people confident in undertaking journeys beyond operational excellence. Operational excellence is a part of the strategy, it is a must to provide a stable base to undertake exploration						
S.1	Strategy Consistency	A strategy is clearly formulated and is consistent with the Mission, Vision statements. It forms a whole that gives clear direction to the company team. The strategy is aligned with the Vision and makes reference to the innovation direction. EMNet, entertainment product cycle is very short, about 30% of their growth initiatives are related to market short term opportunities, not directly tight to the vision-strategy						
S.2	Innovation strategy	There is also an Innovation strategy –or the general Strategy gives enough guidance on that concern- providing a general frame and boundary conditions showing the direction in which innovation is expected to be developed. This includes aspects as: - Financial boundaries - Markets -M&A - Technologies - Risk balance -Alliances The innovation strategy is well linked to the company identity and general company strategy						
S.3	Innovation pivots	In addition Innovation pivot points have been developed to identify the specific areas, attributes, canvas and paradigm where the firm wants to develop its Innovation and growth opportunities						
S.4	Innovation strategy process	The above has been developed under the leadership of the top management in collaboration of cross company teams, using data and covering all departments and disciplines of the firm. The process energizes the team to achieve the Vision, so that the discussion process is as important as the final results, which might not be static, they keep evolving within a direction consistent with the company statements						
S.5	Scope versus focus	The above is not too narrowly defined that limits creativity and pre-judge opportunities, it is however focused enough to align the efforts of the company, and to encourage individuals to propose innovative ideas. The innovation strategy and pivots sets the direction and creates a ground field, in which specific ideas and projects are to be identified. It also provides a well-defined guide to prioritize projects. In EMNet, the scope is very tight for incremental innovation activities, which have strong influence on the short term performance and very open on potential growing businesses.						
S.6	Operational Excellence	Cost reductions and a continuous endeavor to operational excellence is critical to maintain a competitive core exploitation, which is crucial to provide the stability and resources to break the glass ceiling. Icons was also focused on operational excellence, but cost reductions were not reported as fundamental.						
O.1	Objectives deployment	The strategy and Innovation strategy are deployed in form of objectives across the whole company. Innovation is expected to provide results within a time frame. It is tracked and evaluated.						

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communications with selected stakeholders. The end result was to widen up the scope of innovation and aligning the organization in favor of innovation goals. The analysis therefore confirms the findings of previous studies in the sense that the existence of an Innovation Strategy and its alignment with the company general strategy has a positive effect on success (Markham & Lee, 2013) (Miller, Klokgieters, Brankovic, & Duppen, 2012) (Kahn, Barczak, Nicholas, Ledwith, & Perks, 2012) (Acur , Kandemir, & Boer, 2012) and other.

In less performing companies, the absence of an innovation strategy frame and pivots plus a less structured participative process turned into resignation and a certain level of frustration in top management, although they were convinced of the value of innovation. In best companies, management felt that Innovation would not have gained traction without a sound innovation strategy process, guided to build shared understanding, trust and commitment of the teams on the newly defined objectives.

In all of the cases, the strategy was covering a great deal of operational excellence and cost reductions activities (S.6). This was found consistent with the observations made in §1.2 and the need to maintain good exploitation performance as a pre-requisite for stability and a good base for exploration. This was also related to the characteristic MC.7.

The best companies A and B showed deployment objectives (O.1) derived from the innovation strategy and pivots, a practice that was not possible for the companies C because of the absence of innovation strategy specific details.

6.2.2. Management Review & Communications

In the Culture chapter, the Management Commitment factor regarded the top management function in serving as entrepreneur and architect of the innovation framework. Here, in the Leadership chapter, Management Review looks at top management involvement in more operational innovation activities. These include its interactions and engagement with the teams, facilitating resources, helping to unlock decisions and addressing any cultural conflict that might interfere in the execution of innovation projects.

Table 14 shows the characteristics found on the factor Management review and Table 15 the characteristics on Communications. Top managers in the best companies, A and B, were deeply involved in driving innovation as part of their business as usual activities (MR.1). Their role was exercised at every opportunity, making the vision and strategy tangible when needed, protecting innovation teams against opponents, giving guidance without being prescriptive, helping people to engage in a process that was not familiar to them. They were not deciding on specifics, they encouraged people to identify the right answers to problems and to make decisions on their own. In summary, delegating operative authority, but keeping a leadership responsibility (MR.1, MR.2). The companies in class C showed less intensity or deviations on these characteristics.

Table 14: Management review. Description of key characteristics

MANAGEMENT REVIEW

			A		B		C	
CODE	TOPIC	Description	FMatE	ICons	EComp	EMNet	EquB	PMach
Summary	Highlights	The top management is not only acting as architect and entrepreneur of the innovation journey as described in MC.1 to MC.8, it is also actively involved in the ongoing operational aspects of innovation. Their job is to facilitate resources and give guidance to solve conflicts. To make sure that the teams are successful in delivering the innovation goals						
MR.1	Senior Management involvement	The top management is not only involved in defining the Vision and strategy, but also systematically involved in the innovation ongoing activities and projects. Senior management continuously promotes and drives innovation						
MR.2	Delegation	The top management is the innovation leader, however it is not the main actor, he is not prescriptive and let the teams do and decide on their own						
MR.3	Culture improvement	The main task of top management role being to provide help in removing road blocks, facilitate resources, assume the risk in critical decisions and addressing any cultural that might hinder the execution of programs or the generation of new ideas						

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Table 15: Communications. Description of key characteristics

COMMUNICATIONS

CODE	TOPIC	Description	A		B		C	
			FMatE	ICons	EComp	EMNet	EquB	PMach
Summary	Highlights	The strategy of the company, the innovation strategy and pivots are well communicated. Internal cross functional communications are fluent. There are not silo syndrome issues.						
C.1	Strategy Communication	General strategy communication takes place. All the teams knows the direction to go as a company						
C.2	Innovation strategy communication	The Innovation strategy is communicated so that all the teams understand the direction to go, the goals and the reasons for that. Since EquB and PMach do not comply S.3 and S.4, this characteristic doesn't apply						
C.3	Internal communications	Internal fluent communications It is a hygienic factor but not an innovation engine on its own. The contrary would be very relevant. A lack of communications across departments, silo effects, is an impediment to successfully innovate, as would also be to undertake any other endeavor in the company. One company showed some issues on this respect.						

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Communication is associated to this potential construct dimension. This is the ability of top managers to communicate strategic goals and objectives, and to facilitate cross as well as up and down bi-directional communication. Also including communications with stakeholders (C.1, C.2, C.3). Again the companies in the A and B categories were doing a remarkably good job within those characteristics. Companies in class C showed some deviations, most of them associated to an upstream issue, an insufficiently elaborated innovation strategy not giving enough direction to communicate specific objectives

6.2.3. Recognition

None of the companies studied presented a structured and formal recognition practice. In some cases, the high enthusiasm and pride of belonging to the company very clearly perceived in the interviews, and expressed in conversations with people, contrasted with management declarations in the sense that recognition was poorly practiced, or only occasionally done depending on the personal style of each manager. In some companies, some of the practices perceived from outside as being good recognition practices, such as publishing names and pictures of employees associated to relevant projects in company magazines, were in reality badly quoted by those people concerned. This reveals that recognition is a very subtle matter, probably a tacit practice, related to behaviors and not always the result of a structured program. This makes this factor difficult to evaluate. However, beside these considerations, recognition and the consequence of it, which is to have highly motivated people, was neither regarded as a determinant nor even a relevant factor to break the glass ceiling. There is no question that the subject helps, and that is a very important matter in many aspects, however it was not seen determinant of growth. Stronger empirical evidences were crystallizing the fundamental blocks of the construct in a different direction.

6.3. Resources & Competence. Findings overview

The Resources & Competence chapter is composed of five constituent factors:

- People & competences
- Information and know-how
- External & Supply chain
- Infrastructure
- Financial

Within the chapter Resources, only People & Competence was retained, the rest was not found to be a differentiating matter in the creation of growth streams. Information & Know-how is considered in the literature as a relevant topic for the success of innovation, however in the sample of companies analyzed no significant differences were found between the companies in innovation growth classes A,

B and C. None of the companies had an outstanding system to manage information and know-how, but no-one reported having any issues with this subject, if information or know-how was required to execute the strategy, the company was able to find a way to gain access to it. This was not the driver to break the glass ceiling, nor an impediment. This finding redounds on the findings of the Innovation Excellence 2005 report (Arthur D. Little), where less than five percent of the respondents declared this to be an issue. External & Supply chain relates to the extent to which the company is sharing innovation plans with the supplier base or other external sources, it was found to be related to the company set up and the use of an open innovation approach (Chesbrough, 2003), which can be very beneficial to other considerations, but in the sample of companies analyzed, this was not a determinant driver to create innovation driven growth. Infrastructure and Financial were also excluded, they appear to have some relation to the size of the company (see statistical analysis in §6.6), and not a strong link to the subject studied.

In the case of FMatE (rank #1), the strong transformation and the focus on more radical innovation required stronger use of external resources, including agreements with universities, research institutes and organizations providing the required new technologies and information to enter into new markets and segments. People competence has been adapted to the new needs, engaging new talents, retaining the historical resources but sizing them to an affordable level. Despite the bold ambition to pioneer the industry, the historical core competences continue to receive high management attention. Innovation focus and investments to maintain the performance and competitiveness of the historical businesses remains a priority. The goal is to achieve a financial balance, keeping the mature businesses in good shape, while developing the future. This leads to a detailed financial analysis of the innovation activities: balancing investments and resources between declining mature businesses and growing innovative streams.

At ICons (rank #2), the CEO is the chief innovator, decisions are made fast, authority delegation is well managed, making good use of people to execute the strategy. However the transformation process revealed a few skeptics that had to be relieved. New pushers and talents emerged and gained protagonism in the new phase of the company. A selective addition of people was made, to acquire new skills that were needed to develop and implement some of the strategic innovation axis. Despite all changes, the transition was not traumatic and the core competences were preserved.

At EComp (rank #3), change management receives high attention. The selection of people, participating in cross functional teams and devoted to specific growth targets, receives high consideration and support. The company is well aware that change and innovation start with individuals. Principles of change management are applied and follow up team building workshops are done to help managers in aligning their people and teams with the new direction. New people incorporations are also made to support the entry into new markets, primarily people bringing into the company the know-how and business model culture of the targeted new industrial segments. This is, however, non-disruptive of the historical core competencies.

At EMNet (rank #4), the team has been adapted to serve the new Vision and strategy. During the period of strong change, some people in relevant positions did not embrace the new direction and were relieved. Young talents showing the willingness to innovate emerged and were assigned to management positions. The company is making good use of the supply chain, sharing a Vision around a sub-system with a specific supplier, thus receiving external help in achieving its own business goal. A big part of the innovation activities, due to the short-term cycle of the products, are part of the company operations and have an impact on the yearly results, for those the financials are planned and followed up at project level.

At EquB (rank #5), new people were incorporated to bring in new technology skills required to execute the transformation from components to systems. These incorporations have been additions and not substitutions. The resources have increased encompassing the market growth within a good sense of prudency to safeguard the bottom line financial performance. The organization was also strengthened by adding new roles and positions, deemed necessary to succeed in the execution of the new direction. The most relevant achievements accomplished were found to have a very direct link to the people and organization introduced changes.

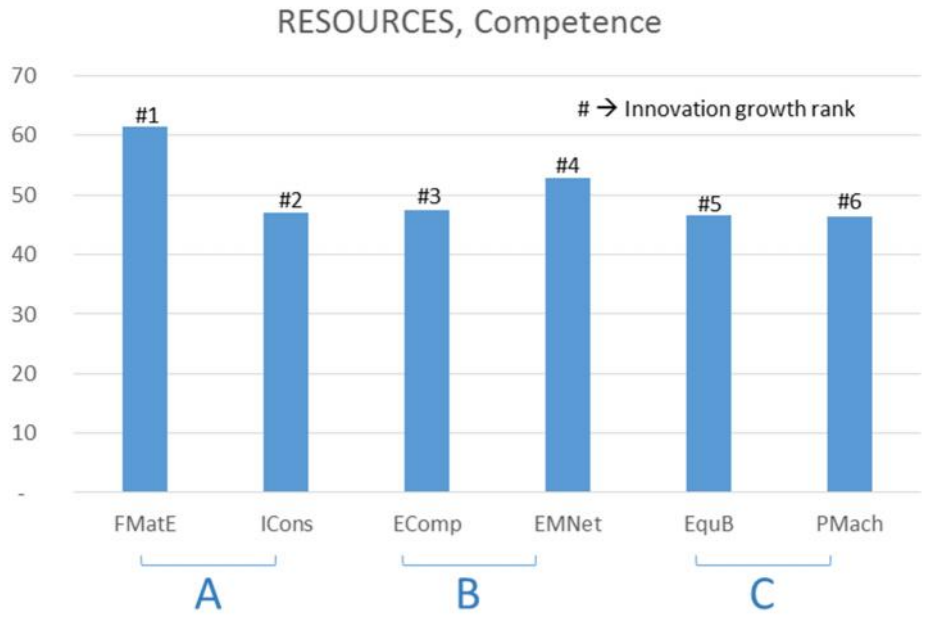

Figure 27: Resources, Competence. IMS/PDMA scores

In the PMach case (rank #6), given the fact that the market downturn has surprised the company, the adequacy of the people and competences has only been executed partially. Right sizing is still fresh and the new strategic direction still in development. The infrastructure at PMach was found to be the more comprehensive and the best of all the companies studied, having excellent capabilities to design, build and test their systems, in conditions close to market reality. However, the excellent infrastructure did not prevent the company from being surprised by market changes. Rather the contrary, some managers felt that the maintenance of the big infrastructure had been a too heavier burden impeding agile and proactive reactions to market changes. The company has learned the lesson and already decided to eliminate the heaviest part of the infrastructure and focus instead on lighter and more flexible support elements.

The bar chart in Figure 27 shows the overall IMS/PDMA score evaluation of the Resources chapter, with the highest score achieved by FMatE with 62 points and the rest of the companies at a similar level around 50 points. A correlation with the innovation growth rank and class cannot be seen, which is also consistent with the view that only one of the five factors of this chapter has a link to the creation of growth streams.

Figure 28: Resources & Competence innovation factors. IMS/PDMA scores

The radar graph in Figure 28 shows the IMS/PDMA scores of the Resources innovation factors for each one of the six studied companies. The graph shows that almost all the companies have good practices in managing people. PMach came out low because of the effects of the still fresh right sizing process. The rest of the factors receive different attention in every company. The qualitative findings described above for each company also provide a synthesis explanation of the scores shown in the radar score chart. A statistical treatment of the scores is shown in §6.6. Hereafter, the findings of each one of the factors within the chapter Resources & Competence are presented.

6.3.1. People & Competence

As companies defined a path and targets into the exploration arena, they had to assess the adequacy of their resources, people and competences to execute the strategy. Table 16 shows the characteristics found on the factor People and competences along with the companies supporting them. All companies made a review of people adequacy with regard to the strategy, except one (in the C category), that had planned for, but not yet fully executed. People skills and organizational competences are at the center of this review (HR.1). Radical innovation implies major changes that are not always accepted. Selective relieves of managers were sometimes necessary, and people with new skills had to be recruited (HR.3).

The principles of change management (Kotter, 2006) (Gupta, 2011) apply in this context (HR.4), with its level of intensity depending on the degree of transformation and speed of change pursued. However, in the analyzed sample, this journey was not disruptive (HR.2). Firms preserved their historical core competences. To move into exploration, firms acquired and subsequently integrated new capabilities. Competence substitution only took place in the periphery of some technologies. This doesn't exclude rationalization processes to optimize the overall cost structure, yet the final shape looks more like new capabilities being nested around historical core competences. This is consistent with the view that in mature industries, the exploitation operational excellence cannot lose focus, since it still constitutes the main source of economic resources and financial stability. Exploration comes on top, as a new growth stream, which eventually may substitute some of the historical businesses. Indeed, the study suggests that mature companies with strategies targeting new technology segments, without clear synergy with the firm's core competences, have higher chances of failing. Along this line, one of the firms studied had to stop a substantial diversification initiative into a new technology field. Finally, to support growth streams to the upper right-hand corner of the innovation/market matrix, one of the firms used external alliances to narrow the competence gap and reduce risk, which turned out to deliver satisfactory results.

Table 16: People & Competence. Description of key characteristics

PEOPLE & COMPETENCE

			A		B		C	
CODE	TOPIC	Description	FMatE	ICons	EComp	EMNet	EquB	PMach
Summary	Highlights	A review of the people talent and company competence is key to achieve success in the execution of the innovation strategy. The process has a strong focus on people and change management, it often involves changing of key positions, however is not disrupting the historical company core competence.						
HR.1	Core Competences review	A review of the adequacy of the core competences is carried out to make sure that the Vision and Strategy can be achieved. This has special relevance and the main focus on the Human Resources side but is not limited to that, technology acquisitions may also be necessary						
HR.2	Non-Disruptive	Since the maintenance of a successful exploitation keeps being crucial, the core competences review will be enhancing but not disruptive of the historical competences						
HR.3	HR adequacy	Recruitments and relieves in some key positions, organization and roles and responsibilities are also reviewed for adequacy to the innovation purpose. New positions and responsibilities might be needed to strengthen the direction into exploration.						
HR.4	Change Management	Since the journey into exploration requires changes, the principles of change management applies, and any resistance to accept the change are promptly corrected. The top management leadership is in this specific area very relevant.						

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Another aspect that was asked during the interviews was directed towards understanding whether the innovation effort was the result of specific individuals, acting as "star" entrepreneurs, opening and developing a way that later was followed by the rest, or rather was the result of teamwork. An aspect that relates to one of the dimensions described by Brown and Eisenhardt in their work "Competing on the edge" (1998). The result was clearly teamwork. Very few answers recognized that some individuals were taking a relevant role, however those answers also quoted that it was not the deciding characteristic of achieving growth success and progress was not made without moving the whole team ahead. This aspect was not retained as a key contributor to the investigated subject, however was a common attribute of the sample of studied companies, and seems consistent with the strong interdependencies seen in mature technology industries. The change is a team effort, not a star acting as single entrepreneur.

6.3.2. Information & Know-how

In this innovation factor, the analysis was looking at the influence of the information and know-how in the creation of growth. Aspects about the adequacy and scope of the information and know-how were analyzed to find out whether this could be the detonator of creating growth streams. Questions about patents, market information and manufacturing technology were asked. Also the systems used to archive the information in databases, to later share it and make it easily available to all people concerned, were asked in the interview. The purpose was to check whether the sharing of information had triggered the start of a journey to break the glass ceiling. None of the answers indicated that any of these had provided the key for success. None of the companies showed a sophisticated archive methodology and sharing practice, most companies said that they were thinking about improving the systems, but most felt that this was not a top priority. The information was there, and people wanting it, knew how to obtain it, which often, to obtain a full picture, involved a telephone call to the person owning the information source. Even the big companies of the sample quoted: we are not that big; we know who to call when information is needed. One of the issues reported is the difficulty to document in a comprehensive fashion all the information details to answer every possible question. Much of the company knowledge was reported to be tacit and not explicit (Nonaka, 1991), which results in an archive always being incomplete.

The access to information and know-how to define a strategy was present in all cases. In some bold initiatives external know-how and information was needed and it was successfully obtained, recruiting people or establishing adequate external collaboration agreements. In none of the cases was this reported as having been an impediment to start an innovation driven growth journey. The conclusion here was that the availability and adequacy of information and know-how was not a key factor. The underlying key relevant matter was more related to the ability of top management to use and interpret the already existing information.

6.3.3. External resources & Supply chain

The analysis of this innovation factor was trying to identify whether the use of external resources was the key to impel a way to break the exploitation glass ceiling. This could be the consequence of a well built supplier network or the influence of collaborations with external partners. Or whether the principles of applying open innovation (Chesbrough, 2003), had been decisive in the creation of growth. All the companies studied used the supplier base as one of the most valuable source of knowledge and information -fact confirming the observation of (Heidenreich, 2008) -, however only two firms were sharing innovation programs and a Vision regarding specific components or technologies of the business. One of the two companies was FMatE, who given the challenging and advanced nature of some of the innovations, management decided to establish narrow collaboration and alliances with external partners to develop new technologies or entering into new markets. This was primarily done to accelerate the process. Management felt that the benefits of shortening the time to market were compensating the risk of having sensitive information leakages. The second company was EMNet, the reason here was to take advantage of external specialized resources, in a field that, despite being relevant for the products, was not considered a core exclusive technology of the business. The disadvantage of sharing the knowledge with others was compensated by the benefits of obtaining the desired results with low use of resources.

The use of external resources was not seen in any of the cases as being the relevant factor that had triggered the way into exploration. It is, however, related to the process of checking whether the company competences are adequate in executing the innovation strategy and reaching the Vision. In most of the studied cases, the gap identified in the process of reviewing the core competences, was closed by means of hiring people with new talent and skills. For the two mentioned companies and given reasons, the review of competences led, in addition, to the development of external alliances. The conclusion is therefore that the use of external resources is a valid option to complement the People & competences review (§6.3.1), to close the gap between existing competences and the ones needed to execute the strategy. In the final construct this aspect will be integrated into the People & competences factor.

6.3.4. Infrastructure

The question to analyze was to check whether the infrastructure could be a key element to generate growth. None of the cases acknowledged having any issues because of a lack of infrastructure, if something was missing, management found a way to cover the need, either through investments or by using external resources, or a combination of both. Some managers felt that having a better infrastructure would be nice, however nobody regarded it as being a handicap, nor as a key factor in becoming more innovative. Managers were pointing the success of innovation more in the direction of the talent and attitude of people rather than on material means. It has already been described in one case, where management reported that their heavy infrastructure had caused inertia and static

thinking, and considered an impediment when viewing problems in a fresh new way. In consequence, a plan to dismantle the heaviest and more inflexible part of their infrastructure had been decided.

The conclusion of the factor Infrastructure is that it is not relevant as a key factor for the final construct. Every company will have to put in place whatever is needed to execute the plans or use external resources, but this is not a deciding factor.

6.3.5. Financial

The availability of financial resources and the financial management concerning innovation was also studied. The innovation budget in absolute numbers and even as a percentage of sales was not considered to be relevant for this study. The task here was to try to identify qualitative links between the financial availability of innovation budgets, its management, and the success of creating growth streams. Furthermore, absolute or relative innovation budgets would have not been comparable across different industries and the definition of the perimeter to consider would have been an endless task, without location in this work.

The feedback from all the companies showed that innovation budget was not considered as an issue to promote innovation. None of the companies had an innovation budget consolidated under a single entity, most had budgets assigned to innovation projects, and the different departments had a general budget availability to undertake small exploration activities. Each company had its own method and authority level guidelines to obtain financing of the innovation activities. A specific innovation budget fund, invested with the purpose of promoting innovation growth projects, was not existent in the analyzed companies. This doesn't mean that explorative activities were not supported, they were supported within the levels of authority and funds availability in every department. Typically, once an exploratory idea gained some entity, a project approval was submitted. Financial resources were neither seen as a handicap nor as a key to succeed in generating great innovation projects.

Some managers quoted that projects fitting in the Vision and strategy obtained fast approval and financial resources. In some companies, managers reported that people refrained from requesting funds for projects that they knew were not within the strategy and Vision direction. In case of doubt, they were socializing the idea with management to check reactions. These cultural behaviors seem to indicate that the availability of financial resources is not the key factor moving the needle, the underlying key success factors are within Culture and Leadership.

Another aspect considered was the financial management of innovation. The subject to study was to try to identify the existence, of a cause-effect relation, between the financial analysis of the innovation activities and the success in creating growth streams. Would the fact of having a very good understanding of the financial results of innovation be a driver to create more innovation? Based on the sample of studied companies, the answer was: no evidence found. The best company had a very good financial analysis, they were financially monitoring all new growth streams, and they had a precise

understanding of the contribution of the new and the old business. The picture was confirming the expected benefits, and therefore in this case, the analysis was encouraging to continue the journey. The second best company had no financial tracking of innovation. Here management declared it almost impossible to evaluate the financial impact of innovation in isolation. They had changed the business model, not only created a new list of products that were sold separately from the old. Old and new products were interlinked shaping a new value proposition. What was the contribution of the new value proposition and business model? Impossible to put a Euro number behind it, however, qualitatively, management felt that innovation had an enormous impact on the results. Without it, the company would no longer exist. Another company in class B was using the yearly performance of the different business lines and market share as a main measure to evaluate innovation success. Here it was taken for granted that innovation was one of the higher impact elements of performance.

The conclusion is that, in most cases, the innovation activities form an inseparable part of the whole, and therefore an isolated measure of financial performance is not always possible and meaningful. The benefits of innovation are assessed by management looking at the performance of the company on several fronts. If profitable growth streams are created, its effects are to be seen in the financial performance, however a measurement in isolation is not always possible. It will be top management who, based on their reading of the results, will decide upon investing more in innovation or undertaking something else.

6.4. Processes. Findings overview

The Processes chapter is composed of five constituent factors:

- Front-end innovation drive
- Product development
- Research & technology
- Market research
- Deployment, commercialization

In the chapter Processes, only “Front-end innovation drive” was found relevant to the research question. The other factors in this chapter are without doubt important for other innovation purposes, however no significant differences between companies A, B and C were found. In consequence the factors, Product development, Research & technology, Market research and Deployment & commercialization were excluded from being potential constituents of the final construct. The Product development process and also Research & technology are proposed by Cooper (2011) as key success factors of innovation. Cooper’s findings are probably correct when considered from a wide innovation management perspective, however, in relation to the actual research questions, this matter did not come out as a decisive factor. Indeed, in the sample of companies analyzed, the best organized companies around R&D stage gate processes were the ones with less success in creating innovation

growth streams, which seems to indicate that this is not the key driver that makes a company operating in mature technology markets break through the exploitation glass ceiling.

At FMatE (rank #1), an IT supported front-end innovation system is well established. It is used not only to collect innovation ideas but also as a communication tool across the company. The transformation strategy of the firm is posted on the system and management uses it to set innovation challenges to all the people in the company. A kind of "innovation challenge of the month". An example would be things like: How could we benefit from the internet of things in our company? (In Catalonia and Germany, this would be the How do we go about "Industry 4.0"?) This kind of challenge will stay for a period of time. Management collect ideas, people receive feedback on their ideas and to close the loop, actions are undertaken. In addition to those time-related challenges, ideas to develop the innovation strategy and pivots can be posted by anyone in the company. The proposals are then socialized in the system, and finally some are selected to become projects. A team administers the system. Important is that people who propose ideas can follow the status, it is a live communication system, not a static tool. From the ideas proposed, projects are retained. The projects are selected based on their potential and alignment within the innovation strategy and pivots. In addition to the IT based system, workshops on specific topics, conferences including customers and external people are also organized periodically. As reported in previous chapters, communication at FMatE receives high attention. The whole front-end innovation system adds more on communication and provides the tool to materialize the strategic intentions into tangible concrete proposals. A Stage Gate process to support product development activities is in place. At FMatE, innovation process places special emphasis on engaging the commercialization process at the very early stages of the creation of innovation streams, and with higher intensity in projects going into new markets.

At ICons (rank #2), the front-end innovation process is very much like the one at FMatE. It is IT-supported, used to communicate the innovation axis, and to allow people to post ideas in a very simple fashion. The posted ideas are then socialized and enriched with contributions from other people interested in the subject. In addition to this IT-supported platform, workshops were organized to develop specific ideas to solve the challenges set by the innovation axis. The workshops were led by individuals that had been trained in creativity tools and project management, and participants were representing different departments of the company. The ideas coming out of the workshops and IT system were then prioritized according to the innovation strategy and pivots, and the best assigned to project teams for execution and implementation. Both in FMatE and ICons the front-end innovation is the logical continuation of the innovation strategy, the process to materialize it with concrete projects. At ICons, the R&D processes, Market and Commercialization, are not as sophisticated as the front-end process, however, given the small size of the company, they work properly.

At EComp (rank #3), an innovation process, from idea to launch, is fully implemented. At present the idea generation is predominantly outside-in, originating from the voice of the customer and customer intimacy. A great deal of projects now starts from marketing, which is consistent with the strong historical market growth orientation of EComp. Recently the front-end process has been expanded with activities focused to strengthen the technology and product leadership growth stream.

Innovation processes, events and workshops to create more inside-out value proposals have been organized. The organization has also been adapted to facilitate the execution of the technology dimension. The expectation is to accelerate the generation of growth, by adding more technology and product orientation to the already strong new markets growth stream. Crowd idea sourcing is also practiced based on a web-supported system. The Market research processes at EComp are strongly developed. Also here the front-end innovation process is the key element used to materialize the growth strategy into concrete innovation activities.

At EMNet (rank #4), front-end innovation supporting incremental exploitation projects is well established and the CIO (who is also the CEO) fosters internal creativity, promotes and searches external sources of ideas, and exposes his team to those external inputs. There is no IT-supported tool to run front-end innovation at EMNet. The CEO drives innovation as a need to achieve the strategic goals and the yearly results of the company. Here the product cycle is short. The need to innovate and the strategy are re-visited during the monthly product and project meetings chaired by the CEO. Ideas emerge from the daily interactions with stakeholders and attendance at exhibitions. Also new technology features and even cost reductions are a source of achieving differentiation and growth. To turnaround the company, the idea generation was strongly focused on achieving the Vision and was well guided by the innovation strategy and pivots. The more exploratory front-end ideas generation is less structured and more based on jumping into opportunities available in the market. The exploratory fields of this company, primarily based on network systems, are on the edge of what could be described as a mature technology segment. Hence the exploratory part of this business somehow deviates from the patterns seen in the other cases, which are more representative of mature technology segments.

At EquB (rank #5) , the front-end innovation ideas generation includes proposals outside-in, coming from the marketing people and communicated to the R&D team, however the process is not supported by a systematic approach towards identifying the market current and future needs. The majority of the ideas are inside-out and are based on technology and product performance opportunities conceived, primarily in the R&D department. The company has an historical technology bias. At present they are thinking about reviewing the generation of ideas to include a more cross functional business approach.

PMach (rank #6) is also scored towards technology and product development. The generation of ideas is primarily centered upon identifying technology improvements. Here the ideas originate from the interaction of the R&D engineers and product managers, however systematic idea generation processes involving the whole company are still being developed. A handicap is the lack of a well-elaborated innovation strategy, which was found to be a major reason for the weak cross collaboration between departments in identifying market needs and innovative solutions. The Product development processes and Research processes are well established.

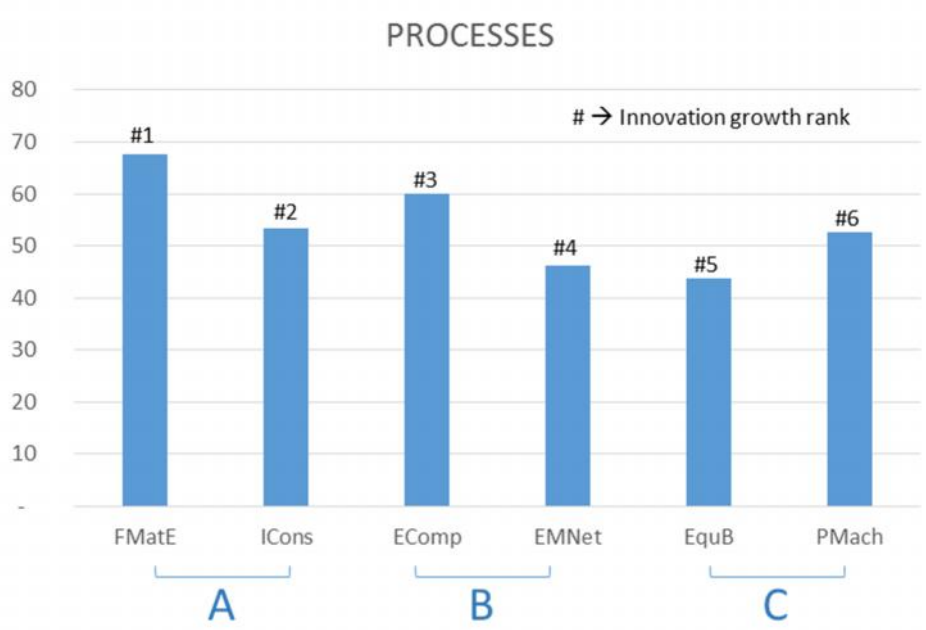


Figure 29: Processes. IMS/PDMA scores

The bar chart in Figure 29 shows the IMS/PDMA scores of the chapter Processes for the six companies studied, with the highest score achieved by FMatE with 68 points and the lowest EquB with 44 points. Beside the fact that FMatE (rank #1), once more came out with the highest score, the scores achieved by the rest of the companies do not show a clear correlation with the innovation growth rank. Hence, ICons (rank #2) came out at the same level as PMach (rank #6). This provided evidence that the IMS/PDMA overall scores of the chapter Resources do not seem to be relevant to the achievement of innovation growth. An observation aligned with the qualitative finding that only one out of the five constituent factors of this chapter was found to have a link to the creation of innovation growth streams.

The radar chart in Figure 30 outlines the IMS/PDMA scores of the innovation factors within the chapter Processes. The scores outline that the Front-end innovation drive of companies A have received the highest evaluation, B came out in the middle, and C received the lowest scores. This matches the qualitative findings, in the sense that the growth streams generated by the best companies were seen to be strongly supported by a purposely conceived Front-end process. The process was serving the direction defined under the Culture and Leadership factors. Other than the Front-end innovation drive, the rest of the factors in the Processes score chart do not show a descending evaluation sequence matching the innovation growth rank, which corroborates the decision of not retaining them as potential constituents of the construct. A correlation analysis between the IMS/PDMA scores of the innovation factors, the innovation growth rank and the size of the company is shown in paragraph §6.6. Hereafter, the findings of each one of the factors within the chapter Processes are presented.

Figure 30: Processes innovation factors. IMS/PDMA scores

6.4.1. Front-end Innovation drive

The analyzed firms with high success in creating new growth streams have implemented a comprehensive front-end process with supporting tools. Table 17 shows the characteristics found on the factor Front-end innovation drive along with the companies supporting them. In best performing companies, A and B, the front-end innovation process supporting the generation of ideas and its selection and conversion into innovation projects was very well ingrained with strategy and pivot points in place (FE.1). They also used it to foster broad cross functional participation of company collaborators and some external players (FE.2). This is a clear differentiating factor when compared to "C" companies. Less performing companies paid significantly less attention to the front-end innovation process.

Table 17: Front-end innovation drive. Description of key characteristics

FRONT-END INNOVATION DRIVE

CODE	TOPIC	Description	A FMatE	A ICons	B EComp	B EMNet	C EquB	C PMach
Summary	Highlights	A front-end system to generate ideas has been put in place. It is designed to convert the Vision and Innovation Strategy into concrete projects. Vision, Strategy and front-end system form a coherent and linked system. The front-end system is used as communication tool to foster the participation of people in innovation						
FE.1	Ideas Generation	A system to foster and support the generation of ideas to contribute to the Vision, the innovation strategy and pivots has been created. The Culture and Leadership key innovation factors set the conditions to make the system successful. EMNet generation of some of the more innovative and radical came from market opportunities, not linked to a predefined strategy, in this field EMNet is more exposed to rapid changing environments						
FE.2	Ideas management interaction	In successful companies this is a participative process, cross functional, open to all employees and managed by a person or a team. The process also seeks external contributions.						
FE.3	Front end linked to Vision	It is also part of the mechanism to communicate the strategy, pivots and desired direction. This provides focus and encourages people to participate.						

Color code: CONFIRM CONSTRUCT | NEUTRAL | NOT IN THIS FIRM | ADDS a NEW SPIN

In top performers, the front-end process was also used to communicate the innovation strategy and pivot points (FE.3). People could better understand the overall change process and, therefore, their expectations were more aligned with innovation. It also shaped the perception that management choices responded to objective judgments. The existence of an innovation strategy and pivot points focused the search of creative solutions and provided criteria to select ideas and prioritize projects. Workshops on idea generation, design thinking, open innovation and other approaches to creatively solve problems were tried. Yet, the relevant aspects are that all those efforts were aligned with a front-end process headed by the innovation strategy and guided by pivot points.

Some managers felt that such a front-end system set out of context in isolation would not provide satisfactory results. It is this combination of defining a direction, providing guidance in the form of innovation strategy and pivots that gives confidence to collaborators in conceiving ideas outside the comfort zone of their daily efforts to support exploitation.

6.4.2. Product development

All the studied companies had appropriate Product development processes, adapted to their needs. Some had higher sophistication and maturity in their processes; this was somehow linked to the nature of their businesses. More complex products, involving different sub-systems, showed higher sophistication than more simple products. The size of the company also had an influence on this factor. Bigger companies showed more sophisticated tools to coordinate projects across the company, sometimes involving different locations and countries. The small companies showed more simple tools, management of projects relied more on close communications between people and management, and were supported by simple tools.

Table 18: Product development process performance

# Rank. Firm	Management quotes on Product development process performance
#1. FMatE	The effectiveness of the system is satisfactory
#2. Icons	The process is satisfactory. The failure rate is small
#3. EComp	The achievement of the goals is satisfactory. Time delays are to be improved
#4. EMNet	The performance is acceptable. No significant failure rate
#5. EquB	The product performance achievement is satisfactory. Delays are to be improved.
#6. PMach	Moderate satisfaction. Failures were reported in several projects.

#Rank = Innovation growth rank. See §4.3

The grade of satisfaction reported by managers, regarding the success in delivering the product development projects in full and on time (see Table 18), varied across the companies, going from

satisfactory to experiencing some time delays and even failures. Although companies A and B seem to be a bit more satisfied with the performance, none of the companies reported the matter to be critical for the general company success, nor to be relevant to generate growth streams. It seems to be more a matter of efficiency. The conclusion, based on the sample of studied companies, is that the Product development process performance is not a critical success factor to generate growth streams beyond exploitation. Beside the empirical findings, a logically obvious standpoint indicates that a bad performance in this factor would impede any growth. This would however, be a consideration that also applies to the other innovation factors. This research is looking for the key factors linked to successful innovation growth in normal conditions. With normal, meaning that all other factors are performed in a manner not endangering basic business performance.

6.4.3. Research & technology

Research & technology was not found to be a decisive factor in the creation of growth streams. Under this innovation factor, the analysis tried to identify whether the company had research & technology processes inducing the creation of growth streams. The existence of research and basic technology development programs, technology scouting practices, or the search for technology licensing was investigated. Two of the studied companies were significantly involved in research programs, FMatE, innovation growth rank #1 and PMach in rank #6. The best one and the one in the cue of the company sample. All the other companies reported minor activities in this field, with no significant involvement in research programs. Figure 30 reflects also that these two companies are the ones having achieved the highest IMS/PDMA score in this factor.

FMatE was involved in research programs, partially supported by internal resources and also in collaboration with universities. The programs were a consequence of the pioneering spirit of their strategy and were set to support the growth streams involving radical innovation. Research & technology was, in this case, contributing to the innovation driven growth success of FMatE.

In the case of PMach, research was inherent to the company's technology orientation. This had led the company to become the technology leader and to benefit from a long period of business success. Yet, following the market downturn and new business paradigm, more focused to business financial performance than to product excellence, the creation of new growth streams began to fade. The research programs were no longer strongly contributing, as it was in the past, to serving the business growth direction. Recently, the company had created a technology scouting group, however tangible results were not yet available.

These observations reveal that Research & technology programs can be beneficial in the creation of technological growth streams, they serve specific growth targets, however they are not at the genesis of growth. The underlying principles to create growth are within the Culture and Leadership factors, which are determinants of the direction to go. The rest are factors to serve the chosen Vision and Strategy, and Research & technology is not an exception.

6.4.4. Market research

The subject studied here was to examine the existence of company processes to provide market intelligence, information on trends, customer lead user's feedback and trend analysis. Two companies distinguished in this factor, because of having more sophisticated tools and putting more emphasis on this matter: FMatE, innovation growth rank #1 and EComp in rank #3. This did not come as a surprise, these two companies are the ones having created more growth streams in markets beyond adjacent geographical zones. Their innovation strategies had a remarkable market growth stream orientation. The IMS/PDMA score of these two companies, shown in Figure 30, reflects also the highest evaluation of the sample. The rest of the companies had also processes providing market information. According to the opinion of managers expressed in the interviews, market information availability was adequate to run the business. In none of the cases, a lack of information was reported as being a handicap to start a growth journey.

In some instances, like FMatE and ICons, the information, that did trigger the decision to change the company Vision and set a company transformation strategy, was in the public domain. In both cases, it was not an exclusive knowledge of the company obtained as the result of its own market research process. All the competitors had access to the same information. However, these two companies decided to undertake a profound company transformation to drive future growth. Both achieved success, while most competitors suffered.

PMach was surprised by a market downturn, and industry paradigm change, which had already shown clear signs in the market for some time. Management was aware of the risk, they had the information. However, circumstantially outstanding results obtained shortly before the downturn masked top management from the coming reality, which irrupted faster and much stronger than anticipated.

The above shows that having outstanding market information is not per se a driver to create innovation growth streams. The key matter is the interpretation and use made of the information. Once a growth strategy direction has been defined, it is possible that specific new market research activities are needed to execute the direction. This was the case for FMatE and EComp, where the strategy was directed towards discovering new markets. Here, once more, a clear sign that the critical key factors, at the origin of growth, are to be found within the chapters Culture and Leadership.

6.4.5. Deployment & commercialization

This factor tried to evaluate the company process and success in launching to the market the new businesses and product innovations. The ability of the firms to transmit to the customers the full value proposition of the innovation projects and how early and intensive was the influence of the

commercialization process in the overall innovation process. A question was raised on the innovativeness applied in the commercialization process per se. It could be that the launching process was making the difference, converting standard products into top sellers. Marketing enhanced products gaining high acceptance in the market. The result: pure marketing was not found in any of the companies.

None of the companies reported this factor as having an influence on their ability to generate growth streams. FMatE and EComp, the two companies having the strategy to enter into new markets showed more intensity in the interaction between the launching process and the early phases of the innovation projects. EComp was innovative in their logistic centers, but this was related to the type of packaging, number of pieces, frequency of the delivery, stocks available, delivery lead time, and not just a launching campaign. All those aspects were tangible value perceived by the customer and differentiating EComp from its competitors. Not product launch marketing.

None of the companies showed innovation projects in which the launching marketing had made the product successful. All the innovation projects had been conceived with the purpose of creating a genuine value, and then well conveyed to the markets in the launching process. In none of the cases, did the launching process play a capital role.

6.5.Summary of the key innovation factors in relation to the research question

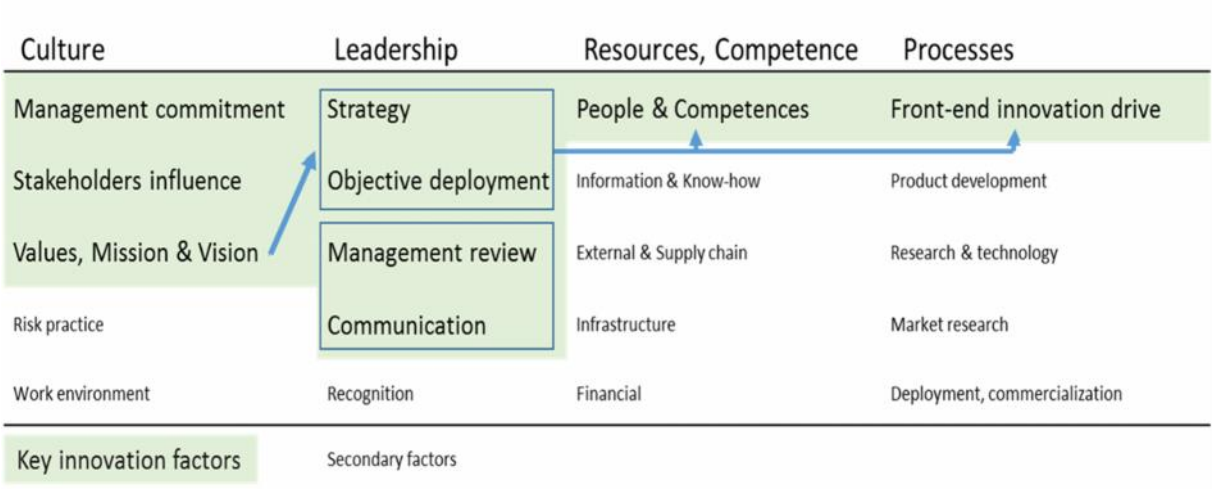
The analysis of the cases has revealed that not all the chapters and innovation factors have the same influence in relation to the success in breaking the exploitation glass ceiling, and creating innovation driven growth streams. Some of the factors have emerged as being the key pillars of a construct answering the research question, while others were found to be secondary, helping innovation but not being fundamental matters for this study. The best companies have shown a couple of pairs of key factors that were intimately associated, and some that were part of a process, where the deliverables of the actions associated to a factor, were the input to the next. All being part of a holistic system.

Table 19 provides an overview of the results; it shows the key innovation factors and the secondary factors under the chapters, Culture, Leadership, Resources & competence and Processes. The table also underlines that Strategy and Objective deployment were found to be intimately related and also Management review and Communication.

The innovation factors within Culture and Leadership were predominately found more relevant to the research question than the factors within Resources & competence and Processes. Indeed, Culture contributed with three factors: Management commitment, Stakeholders influence and Statements (Values, Mission & Vision); Leadership with four factors: Strategy, Objective deployment,

Management review and Communication. While Resources & competence and Processes contributed only with one factor each: People & competences and Front-end innovation drive (see Table 19).

Table 19: Key innovation factors and secondary factors



The non-retained innovation factors within the chapters Culture and Leadership were factors found to be good practices to support innovation, however not decisive and determinants of growth creation. They will be considered as secondary factors, with the potential to contribute towards innovation management success, but not constituent dimensions of the construct explaining innovation driven growth.

The non-retained innovation factors within the chapters Resources & competence and Processes came out as providing a relevant contribution to the execution of innovation growth projects; however they were not seen as the determinant factors having influenced the genesis of starting a journey to break the glass ceiling. These factors will be considered as secondary factors, which might be needed to support specific innovation projects. Yet, they will not become a dimension of the construct, explaining the way that companies break through the exploitation glass ceiling to create growth.

The best cases of the sample showed processes linking some of the key innovation factors. The identified links are represented in Table 19 with arrows. The arrows indicate that the outcome of the first factor is the input of the following factor in the chain. Hence, the Vision is the foundation upon which the company strategy, the innovation strategy and growth pivots are developed. People & competences is an activity that was carried out by the cases on the basis of the demands set by the innovation Strategy and Objectives. And the Front-end innovation process was built to materialize the strategy with ideas and projects.

In SECTION VII, the key innovation factors, identified characteristics for success, its associations, and process links, will be developed further, to form an innovation system construct, describing how the best firms managed to break the exploitation glass ceiling and created innovation growth streams.

6.6. A confirmation of the significant factors based on the IMS/PDMA scores

The radar chart in Figure 31 provides an overview of the IMS/PDMA scores of the retained key innovation factors. The two cases in class A have achieved the highest scores in the selected key factors; the profile of these two companies approaches the denominated "Innovation excellence" score, in the outer periphery of the radar. The two B's are in the middle and the two C's are closer to the "Exploitation mode" scores in the center of the chart. The chart underlines that the key factors marking

Figure 31: Key innovation factors. IMS/PDMA Score evaluation

the biggest differences, between the four companies in classes A and B and the two C companies, are the Strategy & Objectives and the Front-end innovation drive. Indeed, in the best companies these two factors were playing a fundamental role in the creation of growth streams. The Strategy & Objectives was giving direction and guidance to the teams and the Front-end innovation drive was materializing

the strategy with ideas and projects. The two C companies did not have a sufficiently developed innovation strategy and their Front-end processes suffered because of that.

The two class A companies achieved a consistent high score for all the factors, with only ICons showing a relatively low score in the Stakeholders influence factor, but still on an acceptable level. This was indeed an aspect where management felt that improvement could be made.

EquB, class C and rank #5, shows strong scores in Statements and People & Competences, but low on the Strategy & Objectives and Front-end innovation drive. These two strong factors were not enough to propel growth streams at the level of success of companies in classes A and B. In A and B companies, the Strategy & Objectives and Front-end innovation factors, were used as transmission belts to transform the power of the Vision into concrete innovation projects. At EquB, the Vision was powerful, the people ready to go, however the belts were not strong enough. In consequence, despite having excellent Vision and People & Competences, the success in creating innovation growth streams is on the low range of the sample.

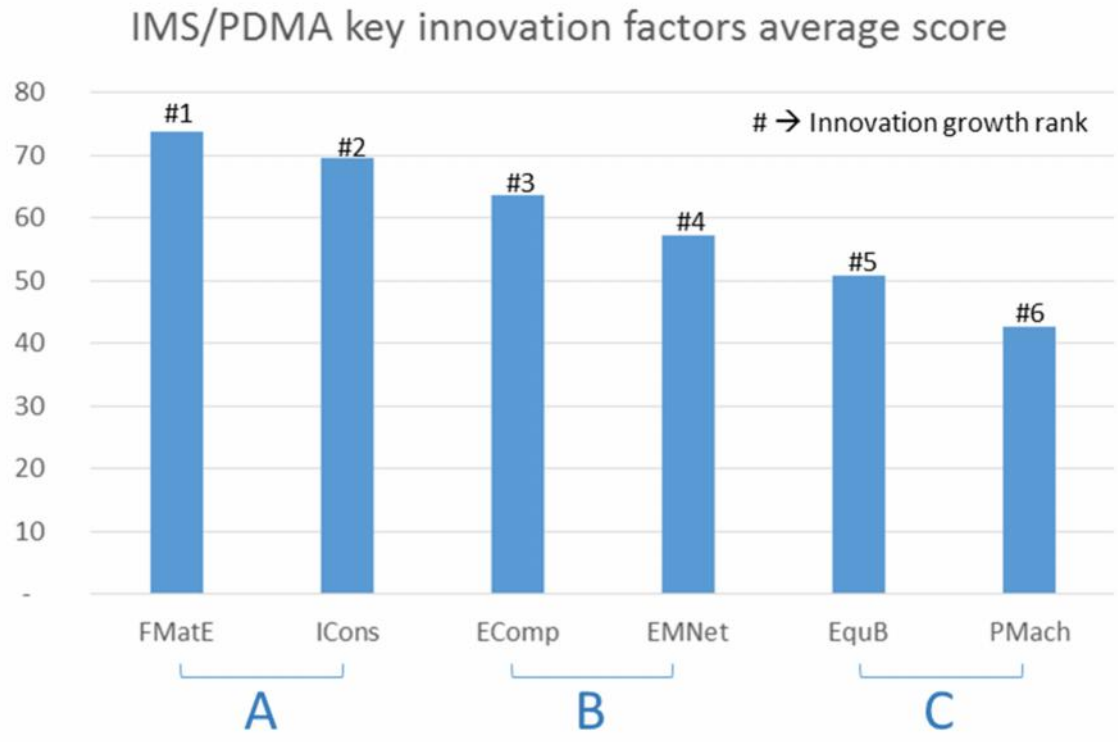


Figure 32: IMS/PDMA average scores of the key innovation factors

Table 20: Innovation factor scores correlation to innovation success and company size

	Company size rank	1	6	3	5	4	2					
	Innovation growth Index	11	9	8	7	5	4	Inn. rank	Inn. index	FIRM SIZE		
	Innovation growth success rank	1	2	3	4	5	6	CORRELATION >	CORRELATION >	CORRELATION >	VARIANZ >	RANGE >
	Innovation factor	**FMatE**	**ICons**	**EComp**	**EMNet**	**EquB**	**PMach**	**0,8**	**0,8**	**0,8**	**123**	**26**
✓	MANAGEMENT COMMITMENT	76	72	62	62	52	44	0,98	0,97	-0,11	143	32
✓	STAKEHOLDERS INFLUENCE	73	59	61	52	47	46	0,94	0,95	0,36	105	27
✓	MISSION, VISION, Identity and CORE VALUES	77	75	68	55	61	40	0,92	0,89	-0,09	193	37
	RISK PRACTICE	72	48	48	48	48	48	0,65	0,73	0,65	96	24
	WORK ENVIRONMENT	68	48	52	44	48	44	0,76	0,80	0,62	81	24
✓	STRATEGY	72	72	60	64	44	44	0,92	0,92	-0,18	163	28
✓	OBJECTIVES DEPLOYMENT	64	64	64	56	32	32	0,89	0,86	-0,14	250	32
✓	MANAGEMENT REVIEW	72	72	68	68	56	52	0,93	0,90	-0,23	73	20
	RECOGNITION	56	64	48	48	56	40	0,66	0,63	-0,46	70	24
✓	COMMUNICATIONS	76	72	64	48	48	44	0,96	0,95	0,09	190	32
✓	PEOPLE & COMPETENCES	72	67	61	64	61	40	0,84	0,82	-0,22	121	32
	INFORMATION & KNOW-HOW	52	40	48	44	40	40	0,68	0,70	0,59	26	12
	EXTERNAL RESOURCES & SUPPLY CHAIN	60	40	40	60	44	44	0,27	0,34	0,27	90	20
	INFRASTRUCTURE	56	48	48	40	48	64	-0,21	-0,14	0,72	68	24
	FINANCIAL	68	40	40	56	40	44	0,48	0,56	0,48	134	28
✓	FRONT-END INNOVATION DRIVE	75	75	64	51	43	43	0,96	0,95	-0,01	223	32
	PRODUCT DEVELOPMENT	64	52	52	44	48	56	0,47	0,53	0,78	47	20
	RESEARCH & TECHNOLOGY	72	48	48	48	48	64	0,20	0,30	0,84	113	24
	MARKET RESEARCH	68	44	72	44	36	52	0,49	0,50	0,67	207	36
	DEPLOYMENT, COMMERCIALIZATION	60	48	64	44	44	48	0,58	0,57	0,58	73	20
											123	26
											Average	**Average**

The bar chart in Figure 32 shows the average IMS/PDMA score of the key innovation factors for every one of the studied companies. The chart shows a remarkable progressive decreasing sequence of scores, it starts with FMatE in innovation growth rank #1, with an average score of 74 points, to progressively go down to the 43 points achieved by PMach in rank #6. The IMS/PDMA scores and the innovation growth rank apparent correlation seem to confirm the qualitative observation, in the sense that the selected key innovation factors are significant in the creation of growth streams. A higher score translates into a better innovation growth rank, meaning higher success in creating growth streams.

To complete the analysis of the IMS/PDMA scores of the innovation factors, the following statistical analysis checks have been made:

- Correlation IMS/PDMA score to the Innovation growth index
- Correlation IMS/PDMA score to the Innovation growth rank
- Correlation IMS/PDMA score to the Company size rank
- Variance and Range of the IMS/PDMA scores across the cases

The results of the statistical analysis are showed in Table 20. The key innovation factors retained to become constituents of the construct came out with a correlation factor between the IMS/PDMA scores and the Innovation growth index and the Innovation growth success rank close to 0,9. See correlation indexes in columns “Inn. Rank correlation” and “Inn. Index correlation”. This indicates that, in the sample analyzed, a high IMS/PDMA score performance in those factors positively influences the creation of growth streams.

The two columns on the right of Table 20 show the Variance and Range of the scores of every innovation factor across the companies. The factors with a variance and range higher than the average of the column have been marked. Remarkably, most of the selected key factors have a range above the average of the factors or at least in the upper range. This shows that the IMS/PDMA scores have sufficient differences between companies, and therefore the correlation factor has not been calculated within a small range, where the error tolerance of the score appreciations could make the calculation irrelevant.

Finally, a correlation to the company size rank has also been made. The biggest company in annual sales turnover has been assigned rank #1, and the smallest rank #6. None of the selected key factors has a significant correlation to this rank. The factor Research and technology process came out with a correlation above 0,8 and Product development at 0,78. This could indicate that bigger companies tend to better support Research and Development and have more structured processes. However, these two factors were not found relevant for the subject studied.

The statistical evaluation revealed in this paragraph confirms that, for the analyzed sample of companies, the IMS/PDMA scores of all the selected key innovation factors are relevant to the research question. A fact that provides additional confirmation to the findings of the qualitative analysis.

SECTION VII

Construct. The path to create innovation growth streams.

SECTION VII

7. Innovation system as a construct. The four blocks of a top management innovation system

The identified drivers of innovation success would lose most of their effect if treated in isolation. Any of the key factors per se would not have delivered results. In top performing firms, they were strongly interrelated. As a whole they formed a system. It was a gestalt, the overall framework with its contents and processes that energized and guided top management and operating teams to progress in the search of new growth streams. While the relative intensity of a factor would depend on the specific purpose of each case, there seems to be a common logic behind the task of building a solid path to break the exploitation glass ceiling.

The comparison and contrast of performance differences in the cases studied leads to rethink the management innovation system as a construct. Here the factors identified as relevant for success have been included and sorted according to the observed pattern. These factors are grouped in four blocks, I to IV (see Figure 33), each with a distinguished meaning, yet interdependent in their effect on results. Each block has a clear role and is logically connected to the next. As mentioned, top management leads and monitors progress in the building process of the innovation system. It goes with an uncontested strong personal commitment, involvement and support of critical ingredients. While the process can be described as putting together the pieces of the four building blocks, the analysis of the cases showed that, in better performing companies, the process was a true construction of a robust innovative culture. This confirms that innovative culture is not just a set of values and beliefs, it is the result of the way a firm operates its innovation system.

The construct schematic representation in Figure 33 is headed by the arrow referred to as “Top Management Innovation Process”. This responds to the observations of the best companies, underlines the fundamental role that top management plays in driving the journey to break the exploitation glass ceiling. The top management has to be involved in the execution of every one of the four blocks, execution authority can and has to be delegated, however the innovation leadership role has to be exercised by top management. It cannot be delegated.

The four blocks of the construct respond to four phases and disciplines of the process to create innovation growth streams. While there is a logical linear chronology, the real execution shown by the cases, involved some overlapping, and had a closed loop character, in the sense that, periodically, initial blocks were reviewed to improve the outcome of the innovation efforts. A typical example would be a periodical review of the strategy and innovation pivots, which will, in turn, trigger a new check of the resources and a review of the front-end process.

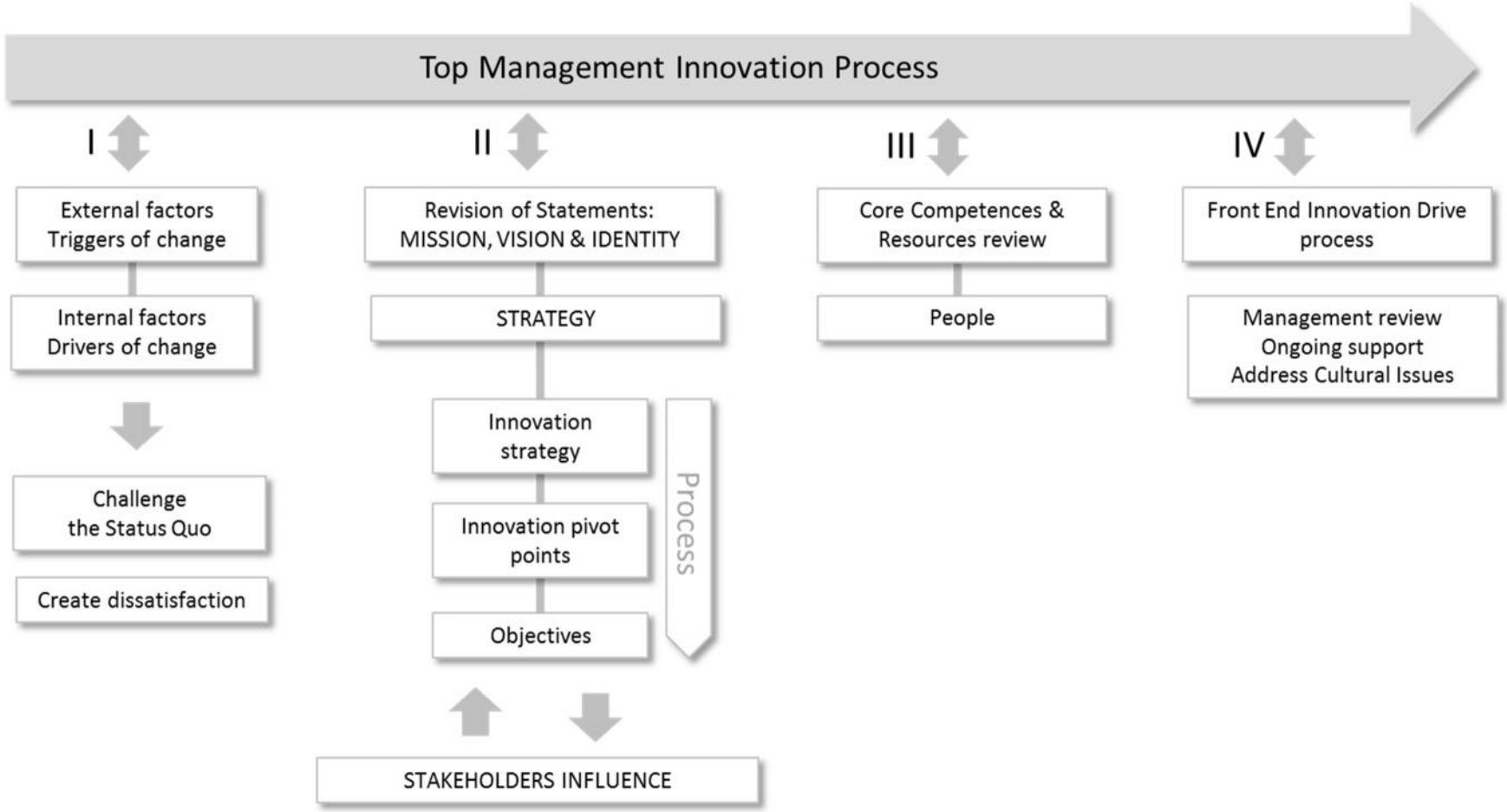


Figure 33: Innovation management system to break the exploitation glass ceiling

The purpose of the four blocks of the construct responds to the following headlines and questions to be answered:

I. The forward looking inception block. Why to innovate?
II. The business architecture conception block. Where to go and how?
III. The reshaping and adapting block. Who does what, and with what?
IV. The execution block. What specific projects? How to support success?

In the next paragraphs every one of the blocks of the construct will be described.

7.1. Construct Block I. The forward looking inception

The first block opens up the need to innovate, to step away from the comfort area. It raises the why to innovate question. Top management has to embrace the notion that significant changes are needed to sustain profitability in the mid- and long-term. Triggers are often external and normally seen as distant clouds on the horizon; for instance these can be expected changes of legislation, in the competitive landscape, emerging market trends or economic conditions. However, in mature markets, the effect of those external factors in short-term firm performance is, at most, moderate. Any initial impact from an external threat can be greatly compensated with some extra portion of operational excellence. This mutes change advocates and usually blinds management teams. External factors tend to be downgraded until they get close to the tipping point, a time at which its effect may already be catastrophic.

Top management must have the willingness and skills to assess the potential impact of external factors, even in the absence of short-term effect on results. It has to leverage on internal factors to create awareness of the need to drive change. It is fundamental that top management challenges the status quo and conveys the message that operational excellence and incremental innovation, focused on exploitation alone, will not suffice for sustained growth.

In this starting block, top management can highly influence the culture of the company regarding the way to react in front of long term trends, or to respond to a legitimate internal ambition to make more profit. In the sample of studied companies, we have seen a wide range of top management reactions to long-term trends and threats. From having a soft and late reaction, thinking as the Titanic, nothing can destroy our ship. To very pro-active attitudes, where long term threats drive the start of a profound transformation of the company, even pioneering new ways. Some cases were in the middle of the two attitudes, transmitting to the organization, in a categorical fashion, the need to change, however within a sense of prudency. Beside the scope of the top management reaction to the internal or external triggers, in the best cases, top management was transmitting to the teams a sense of unconformity with the status quo and was creating dissatisfaction. Those are key cultural elements,

highly influenced by top management, and are fundamental elements to achieve success in the following blocks. If top management transmits a sense of accepting the status quo, it is very unlikely that any other statement in the company will have the courage to embark on some bold innovation with the potential to create growth.

In this block, a number of the common characteristics, identified in the best companies under the innovation factor Management commitment, assume a high relevance:

- MC.1 : Forward looking management focus
- MC.6 : Management challenges status Quo, creates dissatisfaction
- MC.7: Management timing is of essence
- MC.8: Scope is set by management

(These characteristics were described in §6.1.1)

One of the secondary innovation factors within the chapter Culture, Risk practice could perhaps facilitate the execution of this block. However, in the best company, although their historical roots were of a risk-averse nature, top management resolution and conviction of the need for change managed to start a progressive pioneering transformation. Later, they progressively changed the risk practice, and this was done after the first successes in creating innovation growth stream had been achieved. This confirms that risk management is not a fundamental element of this first inception block of the construct. In all other cases, with growth streams not on the up right corner of Innovation / Market matrix, the risk practice continued to be prudent.

Other secondary innovation factors, such as Information & Know-how within Resources and Research & technology and Market research within Processes, could also provide good hints to top management to realize the need for change. However, in the studied cases, the quality of the information available was not identified to be a determinant in inducing top management to adopt a position of willingness and resolution to change. The quality of information was considered by all the companies to be satisfactory. The answer to the why to innovate question was not found to be dependent on the available information. It rather depends on the attitude and personality of top management.

In summary, Block I of the construct will create a sense that, to create growth, a profound change is to be undertaken. It opens minds and hearts of people to start a changing journey outside the comfort exploitation zone.

7.2. Construct Block II. The business architecture conception

The second block of the innovation system provides both content to the purpose and credibility to the intended journey. This is a fundamental piece with a pivotal role to show people that management is serious-minded in its intent to change. The first element of the block assesses the need to revise the

company statements (Mission and Vision) and to challenge the company identity. This will not always necessarily result in a change of the statements, but if what is pursued is a significant transformation, very likely the statements will have to be adapted accordingly. A new company-wide strategy to reach the vision is to be developed, guiding the type of innovation and growth direction pursued. In the next step, active participation to translate the broad strategy into an innovation strategy frame and innovation pivot points is central to building a shared understanding on the innovation path to growth streams. All the activities are to be supported by fluent bi-directional communications with the company stakeholders. The aim of this piece is to build a common view on the direction to follow to create growth streams, to guide people's efforts in the search of innovation opportunities and reduce fears to move away from the comfort exploitation arena. In summary, this block gives guidance on where to go, what the priorities are, how boundaries are set, and how issues are to be addressed.

The first two elements of Block II, Revision of Statements and Strategy, are not exclusive to innovation management, are activities requested to support all other company undertakings. However, as the Management commitment characteristic MC.3 (Innovation intrinsic to management, in §6.1.1, Table 10) indicates, innovation management, to be effective, has to be embedded and be part of the general management system of the company. Thus these two activities also become constituent parts of an Innovation Management System. Without a valid clear set of Statements, and a general company strategy, a meaningful Innovation strategy could not be conceived.

The next element in the block is a process that starts defining an Innovation strategy, follows with the definition of innovation pivot points and ends up with the deployment of innovation objectives. In the best companies, the whole block, from the revision of the statements to the deployment of objectives, was highly influenced by the company stakeholders. Indeed, the Stakeholders influence factor emerged as being a key success factor to create growth. It helps to elect the right decisions in every activity of the block. As seen in the best companies, it widens the creativity space, helps to choose a direction with growth potential and motivates people in the company to deliver. Companies in class C showed a tendency to conceal innovation; this led to endogamic decisions and less success in the creation of growth streams.

The best companies undertook the innovation strategy definition process in a participative fashion. The open involvement of cross functional teams in this activity enriched the discussion process, and won the commitment of the company teams in executing the strategy. The absence of an in-depth innovation strategy discussion can result in the Vision set by top management not being embraced by the teams, generate skepticism and therefore growth streams are not generated. This was seen in one of the cases in the cue of the innovation growth rank of the sample.

The common characteristics of the Innovation factors, Stakeholders influence, Statements, Strategy & Objectives, seen in the best companies having high relevance in this block are:

- STK.1: Stakeholders' trends reflected in the statements and strategy
- MV.1: Statements are an innovation drive
- MV.4: Statements review is the first step to break the glass ceiling
- S.1: Strategy consistency with the statements
- S.2: Innovation strategy
- S.3: Innovation pivots
- S.4: Innovation strategy process
- S.5: Scope versus focus
- S.6: Operational excellence
- O.1: Objectives deployment
- STK.1: Stakeholders' trends influence in the statements and strategy
- STK.2: Served markets are a critical stakeholder

(These characteristics were described in §6.1.2; §6.1.3; and §6.2.1)

Inherent to this block, as it is throughout the whole construct, is the factor communication and all its characteristics, but specifically the ones referring to a wide communication of the strategy, activity that starts while organizing the participative process to develop the innovation strategy. The characteristics are:

- C.1: Strategy communication
- C.2: Innovation strategy communication
- C.3: Internal communications

(These characteristics were described in §6.2.2)

The two fundamental deliverables of Block II are the definition of the Innovation strategy and the innovation growth pivots. The objectives are also important but are just a tool to communicate and assign the strategic tasks to individuals and teams. In mature technology industries, the guidance provided by the innovation strategy and pivots will give confidence to the people that breaking the glass ceiling is possible. It draws a growth image on the other side of the exploitation glass ceiling, an image that prior to the strategy discussion was not envisaged by the teams. Yet it becomes a target for the whole company. Achievement of the goals requires the alignment of people from different departments, and sharing resources with the exploitation activities. The strategy and pivots have to provide sufficient guidance to be effective in aligning the teams, yet broad enough to allow for creativity.

The content of the innovation strategy describes the business boundaries within innovation, which is expected to be developed. It typically includes:

- A reference to the company statements: identity, values and vision
- A reference to the general company strategy, recalling the goals to be supported by innovation
- Financial frame. Guidelines on financial expectations

- Target markets
- Technology identity and limitations
- Risk management
- M&A policy
- Alliances policy

The innovation strategy provides a frame in which to inform the teams on the general rules and boundaries of carrying out innovation. It helps people to understand the expected financial returns, time horizons, the targeted markets, technology limitations and whether certain alliances or acquisitions can be considered. Projects defined outside the strategy framework might fail. For instance, the best case of the sample had to interrupt a project, because the technology used had no synergies with the company technology competence and identity. It was not gaining traction because of that. The combination of the innovation strategy, company strategy and company statements already provide good guidance on the direction the innovation efforts are to take. Yet, it might not be enough to create growth streams in mature technology firms; the best companies had provided further direction.

The innovation strategy frame might not provide sufficient guidance and business direction to generate growth. It is fundamental that innovation endeavors are focused on matters with growth potential, achievable within the desired time-frame. To illustrate the observations in the studied sample, let's consider a hypothetical automobile firm. Should the company focus efforts on alternative engines? On fuel efficiency? On style? Or, on alternative mobility business models? Where is the growth and why? It can be a very complex question to answer. This cannot be allowed to be answered through decisions and choices of people in isolation. It requires top management involvement. If the company has different product lines and markets, guidance for every product and market might be needed. In our imaginary automobile company. Should a specific model be the best in environmental matters? Or introduce innovative sales and service channels? Or both? and Why? This is the role of defining innovation pivots. They provide concrete targets and business visions, around which the teams can develop their creativity, to translate the pivots into specific executable projects. The best companies in the sample have carried out a participative process to define, those in the construct named, pivots.

In summary, Block II will transform the willingness and ambition to create innovation driven growth into a concrete strategy and objectives to achieve. Upon completion of the block, the innovation journey will have earned credibility, but not only this. Because of the participative process approach, the top management initiative will have gained a lot of adepts and momentum to move ahead. An innovation growth concept has been ingrained in the company culture.

7.3. Construct Block III. Reshaping and adapting

The third block of the construct reviews how people and competences match the requirements and puts in place a capability building plan in selected areas of the innovation process. It clarifies who is expected to do what, and ensures that the competences needed to deliver the objectives within the targeted time-frame will be available. Specific plans will allow the building of strength for resources and organizational processes to match objectives and priorities. Change management principles are to be applied to drive organization changes and accommodate new capabilities. The process identifies and builds on champions, and supporters, but also deals with skeptics and stoppers, to approach innovation as a change program to move the organization in the new growth direction. Especially here is where it becomes crystal clear that innovation is foremost about people.

The first element of the block is a process to check whether the company has the competences and resources to be successful in executing the innovation strategy and pivots, and to reach the defined objectives in full and in time. All the companies in the sample had done this activity, except one C company that had not yet finalized it. The review is narrowly linked to the deliverables made in Block II. The best companies had specific innovation pivots and objectives, thus their review of competences and resources could be more specific than in companies with less elaborated innovation strategy and objectives.

The second element in the block underlines the relevance of people. Most companies centered the reshaping and adapting purpose of this block on people and organization. Recruiting new talents and introducing organizational changes to suit the innovation purpose. External resources and competences were also used by some companies, however this was in all cases seen as a complement to enhance the first priority, which was to identify or acquire the right talents and people to improve the strength of the company teams.

All the common characteristics of the innovation factor People & Competence seen in the best companies of the sample apply to this block:

- HR.1: Core competence review
- HR.2: Non disruptive
- HR.3: HR adequacy
- HR.4: Change management

(These characteristics were described in §6.3.1)

Indeed, in none of the companies was the process disruptive. The new competences were not acquired in substitution of the old ones, but to improve or expand the existing core competences. As previously already discussed, in mature industries, since the business transition from current exploitation activities into the new businesses tends to take a long time, it is fundamental to preserve

and support the competences and resources to maintain high performance in the traditional business. Both old and new will co-exist for a long while.

In this block, changes are to be implemented. Here principles of Change management can help the process. The best companies provided good examples of this activity. People have to accept changes and embrace a new direction. The process might reveal skeptics and enthusiasts, new leaders might emerge. It offers a great opportunity to strengthen the company teams to maximize the success chances in the pursued growth journey.

At the end of this Block III, the company has been reshaped and adapted to the requirements deriving from the revised Vision, company strategy and innovation strategy. Individuals and teams know what their roles are and what the goals to achieve are. Yet, the goals are still abstract and need to be translated into concrete executable projects.

7.4. Construct Block IV. The execution

The first three blocks together create the necessary conditions for innovation driven growth to flourish. In industrial mature technology firms these initial building blocks of the innovation system are essential, otherwise people will continue to focus on their daily hard working exploitation tasks, and will rarely enter into explorative growth initiatives. In the short-term, the market is not obliging to that. To generate growth, a direction has to be elected, guidance on the approach to take is to be provided to the teams and changes in the company are to be implemented. This is the role of the first three blocks, they create a new space and a fertile breeding ground where novel approaches to problems, creative ideas and innovation projects can flourish.

Once blocks I to III have set the right context to launch sound innovation, the fourth block in the innovation system walks the journey. The objective of this piece is to deploy a process that links strategic guidelines, innovation pivot points, objectives and milestones, with innovation outcomes. The front-end process of innovation moves from challenges, to ideas generation and to concept development. This is coupled with the more frequently used back-end process, entailing project development to the commercial introduction of innovation initiatives. These two operating processes (front and end) are enhanced by the three former blocks of the innovation system. For instance, the innovation strategy is used to guide progress and select the winning opportunities, ready-to-use competences on innovation are necessary for the front- and back-end processes to deliver, and organizational processes and resources need to be aligned to foster progress.

The first element of the block relates to the implementation of a front-end innovation process. The role of it is to create a funnel of innovation projects, select the best and deliver them to specific teams that will take care of the execution. The best companies had put emphasis on this area; they had created a system to gain the maximum participation of the company collaborators and also of external contributors. The front-end system was also supporting the communication of the innovation strategy and pivots. The channels to collect ideas were multiple. The best two companies had an IT

system open to all the collaborators, but not only that. Specific creativity events targeting the development of the innovation pivots were organized, and a range of creativity tools utilized. Ideas submitted by individuals were socialized and enriched with contributions from other people. The system was not static, was managed by innovation managers and utilized by top management. People submitting ideas could at all times follow the status, and receive feedback on the reasons for transforming the idea into a project, put on hold or reject it. Since the innovation strategy and pivots are transparent and the criteria, used to prioritize projects, were based on the strategy, the logical disappointment when a project was rejected was not translating into frustration. As a result of these characteristics and the activities of the three prior blocks of the construct, the front-end innovation system enjoyed high success.

The key function of the second element of Block IV is the involvement of top management in the on-going innovation activities. The execution of innovation projects is not an easy task; it deals with uncertainty, and encounters crucial cross roads where key decisions are to be taken. The top management function is to provide support to the teams. It plays a key role in providing a wide business perspective, to help to resolve conflicts. They recall the strategy and the statements to support teams to make decisions aligned with the overall company intend. The proximity of top management to the execution of projects is also a key to resolving potential cultural issues that might not have been totally resolved in the execution of the first three blocks of the construct. Especially important is the leadership exercised to support good communications across departments, with stakeholders and up and down in the organization. Continuous involvement of top management will ensure that the innovation culture creates deep roots in the company and that the commenced journey does not fade. Indeed, in the best firms of the sample, a close involvement of the top executives following the execution of innovation projects was noted. In the less successful firms, the involvement had less intensity or had a lack of focus, which was found to be consistent with the less intensity in the execution of the first three blocks.

The common characteristics of the innovation factor Front-end innovation drive, Management review & Communications seen in the best companies of the sample apply to this block:

- FE.1: Ideas generation
- FE.2: Ideas management interaction
- FE.3: Front-end linked to Vision
- MR.1: Senior management involvement
- MR.2: Delegation
- MR.3: Culture improvement
- C1.: Strategy communication
- C.2: Innovation strategy communication
- C.3: Internal communications

(These characteristics were described in §6.4.1 and §6.2.2)

The total execution of the innovation projects does not conclude with Block IV, it will of course continue to the middle and back-end innovation activities and finalize with a successful launch into the

markets. However, as seen in SECTION VI, the factors belonging to the back-end part of the innovation process were not found to be key dimensions, of a construct describing the differentiating attributes in the creation of innovation growth streams in mature technology firms. The proposed construct will create growth streams, provided that, the middle and back end innovation practices are carried out at an acceptable performance level.

7.5. Summary. The construct as a top management system.

On the basis of the empirical findings of this multi-case qualitative study, a construct as a top management innovation process, based on four blocks of activities, has been identified as path leading to the creation of Innovation growth streams. The construct starts with an inception block informing the question why to innovate. It follows with the business architecture conception block, where the direction to take is to be defined, continues with a block focused on reshaping and adapting the firm for the journey, and finalizes with the selection and execution of growth streams.

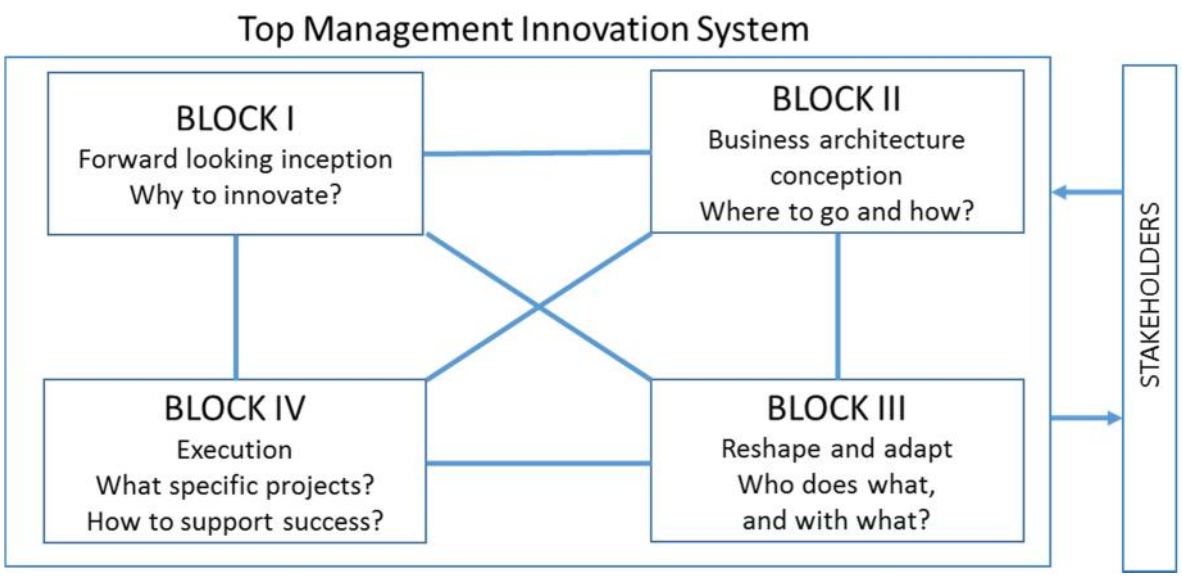


Figure 34: The four blocks of the construct as a system

The proposed construct shows a systematic process that management teams, in mature technology industries, can follow to create innovation growth streams, outside the virtual exploitation glass ceiling barrier. All the companies studied declared the purpose and willingness to generate innovation for growth. The ones with best results in creating growth streams had followed an overall process conceptually matching the four proposed blocks. The companies with more modest achievements showed less intensity and clearly deviated from this pattern. The most significant

differences were found in the first and second blocks of the innovation management system, which inevitably shape the prospects of a successful execution in the third and fourth blocks.

Although the four blocks have a logical linear sequence, with the output of each block being the input of the following one, the execution of the process was seen as a system with links between all the blocks, and all them being directly or indirectly influenced by the stakeholders. Figure 34, shows an alternative diagram to the linear representation of the four blocks, it underlining the systemic character of the construct. Here direct links between the four blocks are recognized as possible paths. The activities in Block I and Block II can identify quick win projects that can move directly to execution within Block IV. Also the identification of ideas and execution of projects in Block IV can invite management to fine tune definitions made in prior blocks. Finally the system forms a closed loop, the results of Block IV are used to revisit the prior blocks, so that the whole keeps improving. The four differentiated blocks form a system, which led by top management and with active communications with the stakeholders drive the company teams to create innovation growth streams.

Based on the studied sample and analysis of the data, a Top management innovation system, structured under the four proposed blocks seems to be highly relevant in the attempt to break the exploitation glass ceiling and achieve profitable growth.

SECTION VIII

Conclusions and contributions

SECTION VIII

8. Conclusions

In mature industrial technology firms (LMTs), operating in mature markets, trying to foster innovation driven growth under an exploitation regime, jumping directly to ideation and innovation project management, is inevitably doomed to failure. Unfortunately, this is what most companies in this segment do, and this is the reason why, in most cases, growth is not achieved.

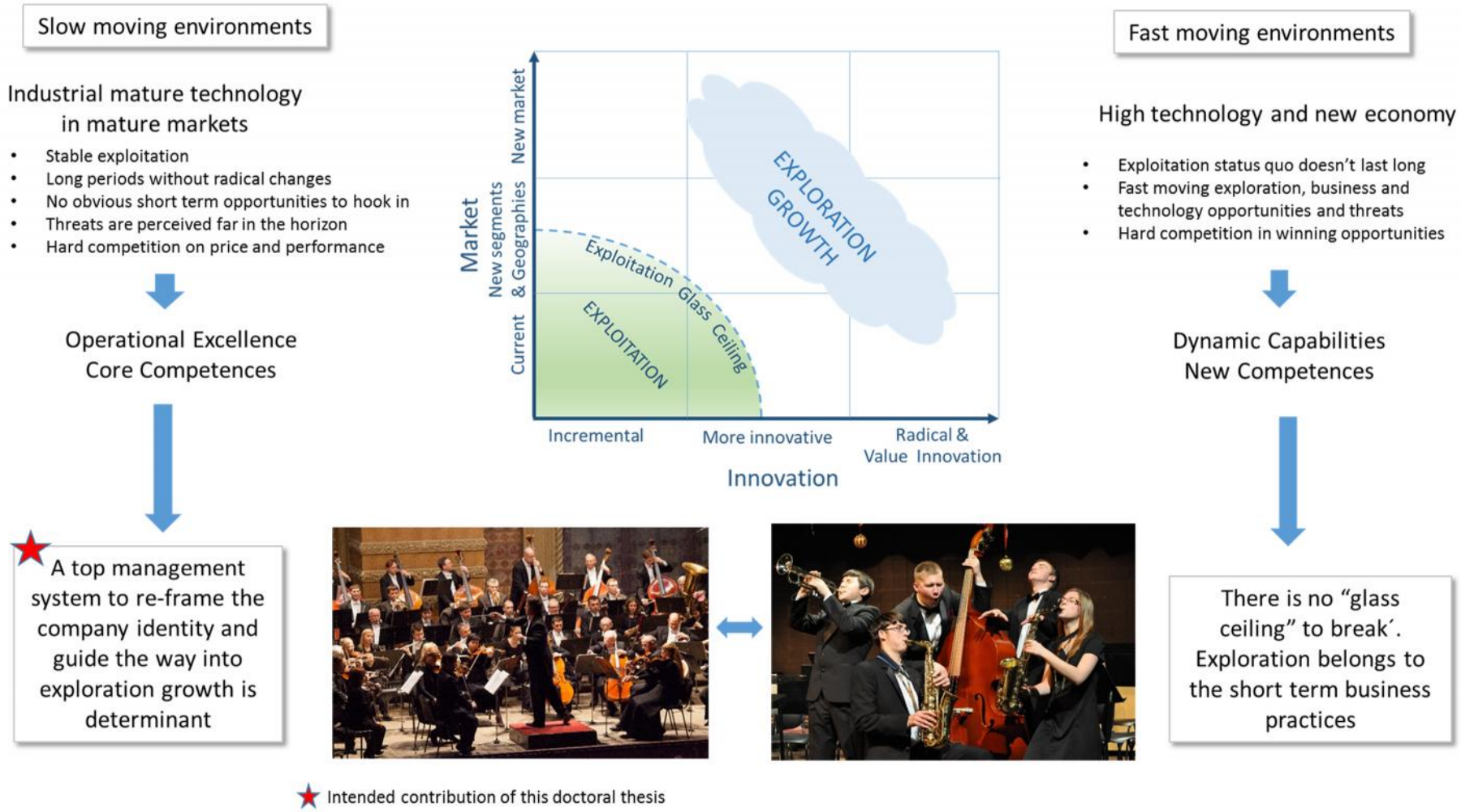
Slow moving business environments, where industrial mature technology firms in mature markets operate, set a real challenge to create innovation driven growth. The growth recipes applied in fast moving environments might not work for LMTs in mature markets. The chart in Figure 35 summarizes a conceptual framework showing the main differences between the two scenarios, and spotlights the intended area of contribution of this doctoral thesis: A construct explaining the mechanism to create innovation driven growth in LMTs in mature markets.

In fast moving markets, business environment turbulences and status quo falling out of alignment offer opportunities for growth. Incumbents and new comers compete to gain the biggest share of new businesses opportunities. Dynamic capabilities and the acquisition of new competences is the key to winning that competition. This is the matter to master in creating growth. It will affect business performance and profitability in the short-term. There is no glass ceiling to break, the game is a permanent change, chasing opportunities. The successful companies act like a Jazz band, agile and flexible, with the skills to quickly improvise a new melody.

Growth in mature technology firms in mature markets is not natural, it is not called from the market. The opportunities have to be created from inside the company. A new space for growth has to be discovered and conquered. Often the company has to be re-framed, which implies an in-depth revision of the original identity, mission and vision. The process touches the foundations of the company, which could never be successfully changed without having the company's top management and stakeholders committed and well aligned in this endeavor. If this re-foundation process is not carried out, strong exploitation inertia will keep people working hard to further strengthen the core competences, and to deliver an extra portion of operational excellence. They are trapped in their business, like the musicians of a philharmonic orchestra playing a sheet music under the inflexible instructions of the conductor.

The two images in Figure 35 show two environment extremes, some companies might be aware of having elements from both sides of the described scenarios. The sample of companies studied were strongly scored to the left-hand side of the chart in Figure 35, and therefore the conclusions of this work apply to this typology of companies.

Figure 35: Slow versus Fast moving environments. Effect on exploration growth



Some lines of thinking in the literature advocate that mature companies have to behave like entrepreneurial firms and learn from the dynamic capabilities that characterize success in dynamic markets (Eisenhardt K. M., 1989) (Brown & Eisenhardt, 1998). This was found to be only partially true. The innovation growth streams will not replace the big bulk of the mature business in short-term, as might be the case in fast moving environments. Growth requires changes, however the efforts to change cannot distract attention to the current exploitation activities. Exploration has to take place without losing sight of the company foundation and current business pillars.

In the studied companies, innovation driven growth is a top management process. Dissatisfaction with the prevailing state of affairs has to come from the top. Mobilizing people in favor of an uncertain business model, when indicators of traditional operations show strong results, is a true test of high caliber leadership. Undertaking changes to protect a company against external threats, with a lack of measured evidence, is an essential top management attribute to generate growth. The matter is to lead the team that has been acting as musicians of a philharmonic orchestra, to step out of the sheet music, to break the exploitation glass ceiling and discover new horizons where growth is possible.

The generation of growth in LMTs, is primarily a matter linked to Culture and Leadership, Resources and Processes are, of course, also necessary to execute the intended plan, but are not the main differentiating subject. The genesis of growth is directly linked to a top management process discipline. Inspiration and vision of the top manager, and even entrepreneurial passion, is needed, however is not enough to drive growth. The successful companies have shown evidence of a top management process discipline that converted the initial vision into a well-organized business development initiative, where the whole company became involved.

A top management system has been identified as construct to create innovation growth streams beyond the exploitation area. Basically it starts by reframing the company identity. To open it and adapt it to environment triggers. Future trends, instead of being seen as threads, are embraced as opportunities to drive change and create growth. This is a cultural attitude driven by top management. The process identified serves the purpose of winning adepts, to convert the culture in leadership elements that will manage and organize people, resources and processes to convert the abstract intent into concrete executable plans. This will lead the organization to escape from the exploitation trap, break the glass ceiling and create innovation growth streams.

The creation of growth streams in LMTs in mature markets cannot be achieved through a balanced high performance in the front, middle and back-end innovation processes, as most of the Innovation and NPD study reports advocate. It is not enough to be good at all the operational disciplines. Innovation driven growth goes beyond that. Good innovation processes will help the execution, but not the foundation and genesis of creating a new space to grow. This is a top management task that, in its essence, requires a re-framing of the company identity.

9. Contributions

This doctoral thesis is a contribution to the knowledge of the mechanisms that lead to the creation of innovation growth streams in mature technology firms (LMTs), operating in mature markets.

On the basis of existent literature in related topics, a conceptual framework describing the business environment affecting innovation management of LMTs in mature markets, has been proposed, and been contrasted to the conditions of companies operating in fast moving business environments. This distinction could not be critical when studying particular facets of the innovation processes, but is decisive to the understanding of innovation management from a systemic and holistic perspective. Here the business environment plays a fundamental role.

The intimate association of innovation, to the achievement of growth, led to the introduction of growth streams categories: oriented to market exploration, to product leadership exploration or a balance of both. These were represented in an Innovation/Market matrix that also introduced, in this context, the concept of the virtual Exploitation Glass Ceiling[4], which seems to keep the teams of the studied companies trapped in their exploitation arenas. The matrix is close to that utilized by other authors (O'Reilly & Tushman, 2004) (Tushman, Anderson, & O'Reilly, 1997), but the way of introducing the growth models are contributions of this work. This has provided good help in the design of the research, the analysis of the data and the process to draw conclusions.

The use of the relatively new PDMA/TIM Innovation Maturity Model (2013) as a structure to analyze innovation management from a holistic perspective, and to develop the specific research tool utilized in this doctoral thesis, is a novel approach in research studies. The four chapters utilized in the analysis, Culture, Leadership, Resources & Competence and Processes have proven to be a useful structure. Modifications to the PDMA/TIM maturity model original chapters have been introduced. Some were initiated to expand the scope of the model to enquire on specific topics of the state of the art, and therefore are specific to this research work. However, other modifications, such as including Competences to expand the Resources chapter, and including the Risk management as a constituent of the chapter Culture, might become proposals that, in view of the results obtained, could be considered in future editions of the standard.

This thesis proposes a construct for LMT firms to achieve growth in mature markets. Gives priorities to specific factors and identifies nice-to-have and secondary factors. It proposes a defined gestalt, a top management system. This differentiates from the general studies advocating to improve all innovation management disciplines. A fundamental identified key factor is a proactive role of top management (Construct Block I) in correctly interpreting market signals, and use them as levers of change and growth. This was also outlined in the CIDEM study of SMEs in Catalonia (Solé, et al., 2003). It is a cultural factor with much higher influence than enhancing the technology profile of the region. Access to technology is without doubt positive, however it has been viewed as not critical in the Arthur

[4]The metaphor of „Breaking the Glass Ceiling“ was introduced first time at the National Press Club in July 1979 to describe invisible barriers through which women can see elite positions but cannot reach them.

D. Little study (2005) and also in the present research. In this respect the proposals of the European and Catalan administrations to foster innovation by reinforcing the links between firms and technology institutions, could not be sufficient to create innovation growth, unless the entrepreneurship/innovation skills (Solé P., del Palacio A., & Areyuna S., 2007) of the recipient executives are competitive. The contribution of this thesis can help to solve this paradigm. It offers a systematic process to help executives to manage the teams in entrepreneurship/innovation growth endeavors.

The main contribution comes from the findings of the multi-case research program. An inductive process has revealed the significant innovation factors to create innovation driven growth, along with its distinctive characteristics. Factors within Culture and Leadership were found decisive and the factors within Resources & Competence and Processes, important but not at the genesis of innovation growth. This view differs from the image of some of innovation models that tend to present innovation management centered on the operational processes and activities to drive ideas to a product launch, with the Culture and Leadership factors being supportive activities. This doctoral thesis, focused on innovation growth, proposes a reverse point of view. Here the fundamental blocks are built by the Culture and Leadership factors. If those are right, the Resources & Competence and Processes, will be put in place, if needed will be acquired. Should the innovation factors within Culture and Leadership not be sufficiently developed, all the innovation efforts, at best, will contribute to maintain the status quo of the company, but will not create growth streams.

A construct describing a top management process that proves successful in guiding industrial LMTs operating in mature markets in the creation of innovation growth streams has been identified and proposed. The construct is described as a system of interrelated activities and is embedded in the general management system of the company. The identified construct sheds light on the genesis of innovation driven growth. Most of the innovation constructs in the literature starts at the point where the construct proposal of this doctoral thesis ends.

10. Future research

The present research has been made from a wide outlook perspective. The conclusions offer a general framework on the creation of innovation growth in mature technology firms. It proposes the key innovation factors and a top management process construct. This has been the result of sizing down to the fundamentals the wide range of innovation factors and possible attributes leading to success. It has contributed to delineate the outer boundaries of the research questions, and proposed a specific construct.

Basically, future research lines deriving from the present work could follow two distinct dimensions, a horizontal dimension, which would imply expanding the research to more firms, and a vertical dimension to further define the construct with more details on every one of the identified factors and interrelations.

Within the horizontal dimension, a further research theme would be to find out whether the proposed construct shows variances when applied to specific industrial sectors. For instance, are there elements with more relevance or differences for companies in the automotive industry? None of the companies studied were operating in the automotive branch. Does the construct apply to all the sectors? More qualitative research could be undertaken to gain more knowledge in those aspects. Also, along the horizontal direction, quantitative research studies could confirm the validity of the model. Here the empirical set up could be made to cover different industrial sectors.

The objective and role of the construct constituents, blocks, activities and processes, have been identified and described. Yet, the present research has not entered into an in-depth analysis of the best tools and methodologies that would maximize success. This opens several avenues for further vertical research work that would shed additional light on the subject. An in-depth breakdown of every one of the identified key management disciplines, keeping the same overall focus on the creation of growth streams in LMTs, would contribute to developing further the proposed construct.

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Annex 1. Studied cases and its innovation growth activities

This annex includes a description of the growth streams created by every company, represented in the Innovation / Market matrix. The evaluation of the innovation growth index of every company is also shown.

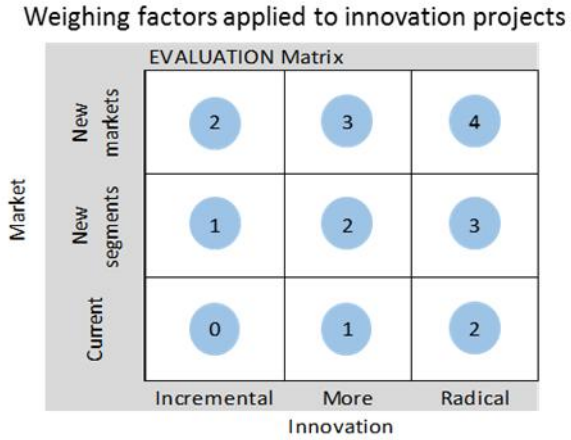


Figure 36: Weighing factors utilized to evaluate growth stream

Innovation driven growth classification

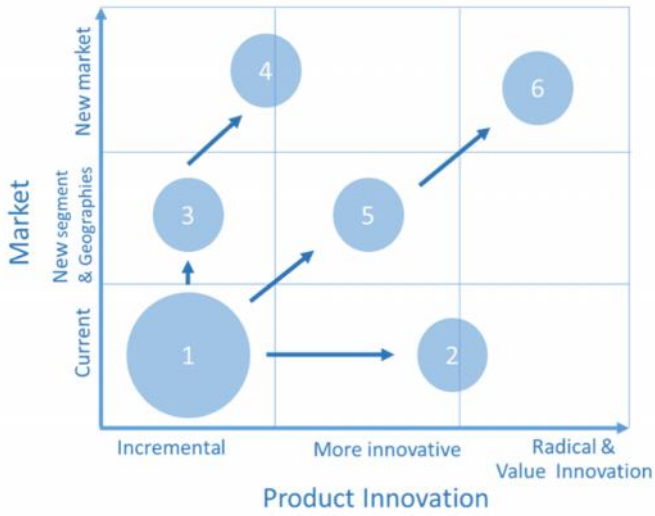
	INDEX	RANK	CLASS
FMatE	11	1	A
ICons	9	2	A
EComp	8	3	B
EMNet	7	4	B
EquB	5	5	C
PMach	4	6	C

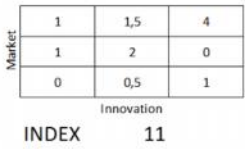
Figure 37: Innovation growth index, ranking and class of the studied cases

The growth streams in the matrices have been evaluated using the weighing factors shown in Figure 36, which led to the company innovation driven growth classification shown in Figure 37 (as introduced in §4.3). Growth initiatives between two cells of the matrix have been evaluated at an average value of the two cells. Hereafter, the Innovation / Market matrix of every case and the evaluation of the index are presented. For confidentiality reasons, references to specific product details and brands have been excluded.

FMatE

Industry	Business unit analyzed	Market	Company ownership & year turnover	Firm strategy / actions	Results achieved
Forest, bio-materials and Energy	Corporation	Global market. Mature businesses stagnant or declining.	Corporation, Euro 10 Billion public listed company ~ Euro 10 Billion	Industry transformation pioneer. Managing excellence, sustainability, while creating new growth streams	The newly created businesses growth streams, ~40% of total, sales offset mature business decline and create moderate growth





INDEX 11

GROWTH STREAMS:

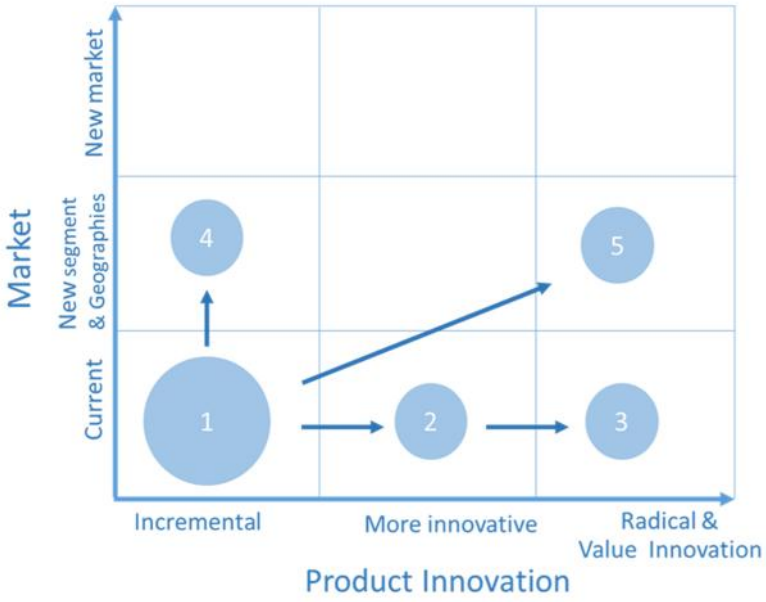
- Strong Incremental innovation focused to maintain profitability and strong cash flow in all the mature business areas (1). This area sets strong focus on cost effectiveness, sustainability and reduction of resources
- More innovative products are also developed, some new to the world, allowing strong savings to customers and creating new capabilities (3, 5).
- A geographical expansion into growing areas, mainly Asia with products and brands conceived for this area (3)
- Entering into new markets with more innovative products. Energy sector (4) Entering into new markets with bio-materials and new to the world engineered bio-materials, which includes the use of nanotechnology (6) This is a disruption for incumbents in these markets

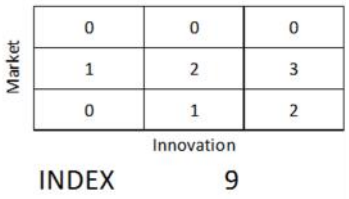
RESULTS:

- A balance of short term actions, growth and future transformation. With focus on the maintenance and operational excellence of the mature businesses, to providing a healthy cash flow to invest in exploration
- Strong innovation and transformation drive in the whole company, resulting in the launch of new products and business lines offsetting the declining sales in mature markets
- Despite declining market in the historical businesses areas, the company shows overall stable sales and profit

ICons

Industry	Business unit analyzed	Market	Company ownership & year turnover	Firm strategy / actions	Results achieved
Industrial Construction	Whole company	Regional	Family owned ~ Euro 30 Million	Top management anticipated the market downturn. Implemented a structured Innovation System to transform the business model	Strong market share gain, up to rank #2 from rank #6. Profitable in a severe downturn. >80% new business





GROWTH STREAMS:

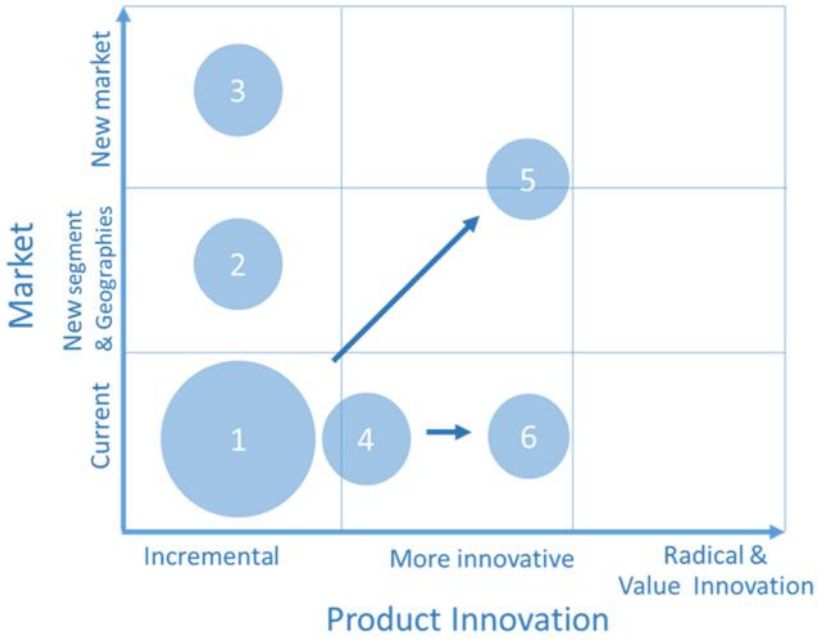
- Incremental innovation of the current range of products, reducing weight for more convenient transport, thus enlarging the area of sales influence and reduced tolerances for easier assembly, with the goal of gaining market in the value chain before and after the installation of the sold elements (1,4))
- Addition to the product portfolio of a range of innovative products, options and solutions not traditionally offered in the industrial construction business. Some developed on the basis of technologies borrowed from other industries (2)
- Value created through the implementation of a cultural change: from a catalog products provider to selling building solutions tailored to the customer wishes. Industry paradigm game change (3,5)

RESULTS:

- The above made the firm differentiate from competitors and was key to increasing the market share in the construction collapse in 2008
- Gained a significant share in a new geography
- Despite a market collapse in the main served region in 2008, market down by 95%, the firm never entered into losses

EComp

Industry	Business unit analyzed	Ownership	Market	Company ownership & year turnover	Firm strategy / actions	Results achieved
Elastomeric components	Business Unit	Public Company	Global Market	Group Euro 2,4 Billion BU ~ Euro 800 Million	Market orientation, targeting growth in strategic selected segments. Innovation focused to serve the growth and maintain the core	Sales increased by 30% and operating profit doubled above 2010 base line. 5% organic growth



Market \ Innovation		
2	1,5	0
1	1	0
0	2	0

INDEX 7,5

GROWTH STREAMS:

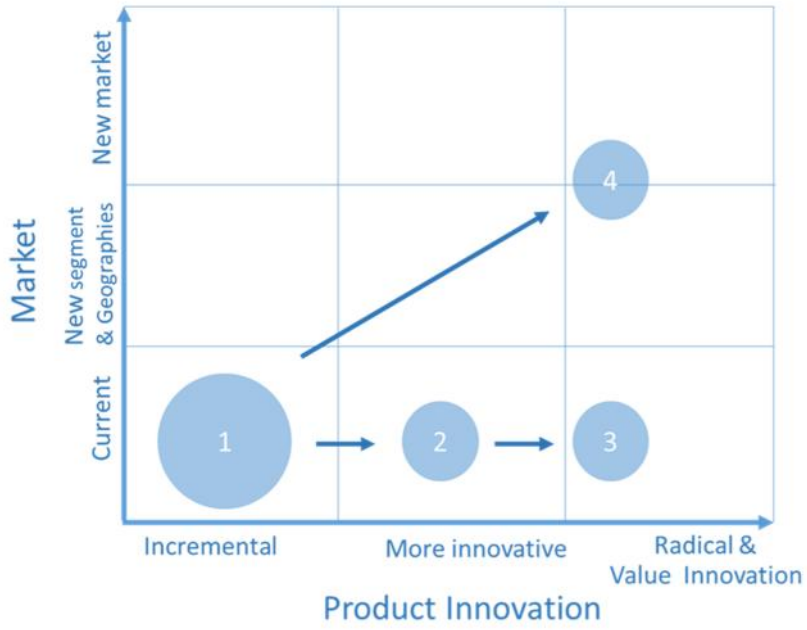
- Incremental innovation and some more innovative projects are carried out to serve the needs of "A" customers (1,4), to defend the position and to grow in the customers with potential
- The strategy Plan elaborates macro trends. On that basis growth initiatives in specific industrial markets are defined. Innovation is then a tool to help the growth plans in those areas. At present are based on Voice of the Customer resolved with incremental innovation. The new industries can be adjacent or totally new(2,3)
- The company has designed a systematic approach to develop more projects based on inside – out innovation (5,6). This adds to the historical market leadership strength

RESULTS:

- Strong organic growth drove the company well above the levels before the 2008 crisis.
- Organic growth achieved year by year, combined with targeted acquisitions in the growth industrial segments, led the company to increase the top line by 30% and double the operating profit in the period 2010 -14

EMNet

Industry	Business unit analyzed	Market	Company ownership & year turnover	Firm strategy / actions	Results achieved
Entertainment Machines & Network Systems	Division	Global, with a main strong regional	Division of a Euro 1,6 Billion family owned company ~ Euro 100 Million	Re-focus innovation to core business, to improve operational performance, and set a new basis from which to re-start exploration	Performance turn-around from loses to a 20% + EBITDA in two years



Market			
	0	0	2
	0	0	1,5
	0	1	2

Innovation

INDEX 6,5

GROWTH STREAMS:

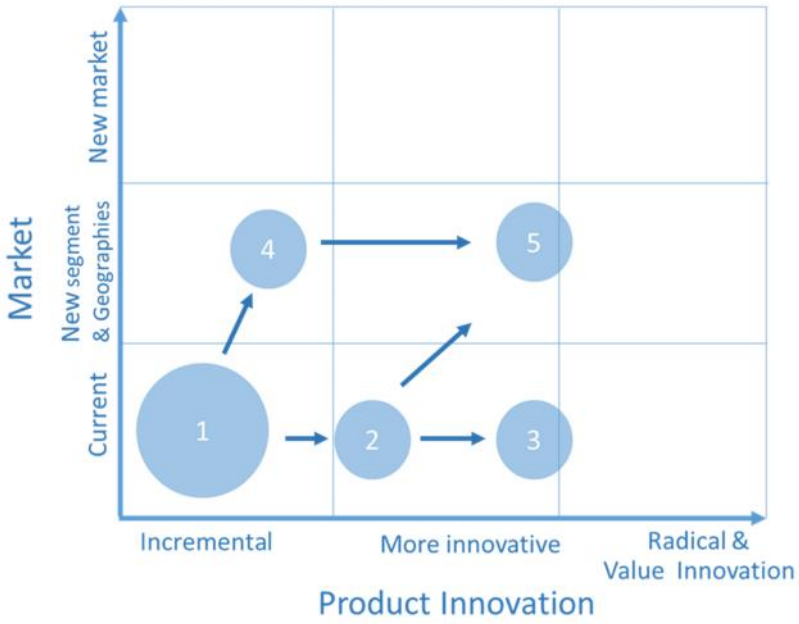
- A fast pace of incremental innovation, very focused to the company mission, gained intensity and pace in 2006 after having eliminated non-core activities that drained resources (1, 2)
- A new business model created, selling refurbishments changed the business landscape, reducing cost for the customer and increasing margins (2)
- Spot projects moving into new product areas oriented to helping customers run the main business more efficient. The insights on what to do were gained thanks to voice of the customer (3)
- A new business created to develop network interconnectivity, helping the historical customers to dramatically improve performance (4)

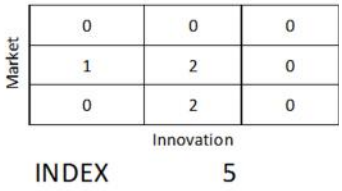
RESULTS:

- A strong performance turnaround. From losses into a 20%+ EBITDA
- Customer diversification, dramatically reducing the dependency on the main customer
- Regained trust and self-confidence to enter into new markets (4)

EquB

Industry	Business unit analyzed	Market	Company ownership & year turnover	Firm strategy / actions	Results achieved
Building equipment	Whole company	Global market	Family owned ~ Euro 500 Million	Progressive transformation, from components into systems, to capture potential value from a new legislation	Steady organic growth of 4% per year. New products represent a small percentage of total sales





GROWTH STREAMS:

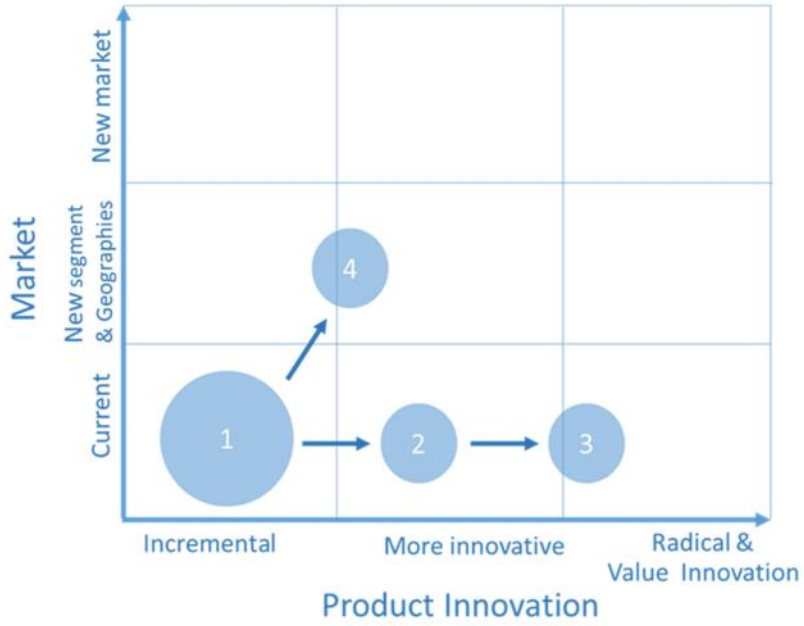
- A continuous flow of incremental innovation maintains the products at the high-end performance range of the market (1)
- A new generation of products, -architectural innovation- adding features to the former products was created. This was the result of having purposely expanded the internal capabilities and core competences of the firm. This is a first step in the change from components to systems (2)
- A second step of more innovative systems was accomplished, re-inventing products manufactured by an acquired company in a new geographical market (4)
- A third step into more complex and innovative systems has been accomplished as a result of organizational changes and newly acquired competences (3,5)

RESULTS:

- A continuous organic growth slightly above market average
- Favorable market conditions post crisis 2008
- Dramatic increase of sales in new geographies have more than compensated the decrease in the domestic market

PMach

Industry	Business unit analyzed	Market	Company ownership & year turnover	Firm strategy / actions	Results achieved
Process Machinery & Solutions	Division	Global market	Group Euro 5,7 Billion family owned company BU ~ Euro 800 Million	A change of industry paradigm irrupted faster than anticipated. After a right sizing process, the innovation direction is being re-defined.	Dramatic reduction of sales consequence of the market drop. Right sizing ongoing



0	0	0
0,5	1	0
0	1,5	1

Market

Innovation

INDEX 4

GROWTH STREAMS:

- Historically, the firm has been the market technology leader, launching very innovative or even pioneer products and solutions, being the preferred partner in big investments (2,3)
- More recently, innovation has been more incremental, using the core competence leadership, to provide the best answer to the paradigm based on product quality and volume output (1,2)
- A movement to innovate through new technology in growing segments started some years ago and is starting to gain traction (4)
- At present the focus is on cost reduction activities (1)

RESULTS:

- The market has gone down by half and the firm has lost sales in about the same proportion
- Following the 2008 crisis, a shift in geographical regions and a new industry paradigm have irrupted in the market causing a loss of commercial leverage of the competitive edge gained in the positions (2,3)

Annex 2. Analysis structure: Innovation Chapters, factors, interview questions and evaluation items

This annex describes the content of the four chapters: Culture, Leadership, Resources & Competence and Processes. Every chapter is divided into five constituent factors, each describing a different dimension of the chapter. The whole structure was developed on the basis of the PDMA (2013) and IESE (Vilà, 2011) (Vilà & Muñoz-Nájar, 2004) (Vilà & Muñoz-Nájar, 2002) guidelines and own elaboration adaption made to serve the purpose of gaining knowledge that potentially could provide answers to the research questions. This section also shows the evaluation items, along with the scale criteria developed for each one of them, utilized in the quantitative scoring system that was used as a complement to the main qualitative analysis. Finally, the grand tour questions utilized in the interviews for every chapter and factor are also listed.

A summary of the analysis structure is shown in Table 21. The five chapters are coded A, B, C and D and the factors of every chapter from 1 to 5. The table also shows the number of grand tour questions and evaluation items by chapter and factor. In total, the interviews were conducted on the basis of sixty (60) grand tour questions and the quantitative analysis evaluated forty- five (45) items.

Table 21: Number of interview questions and evaluated items by chapter and factor

A. CULTURE	I	E	B. LEADERSHIP	I	E	C. RESOURCES, COMPETENCE	I	E	D. PROCESSES	I	E
A.1 Management commitment	3	4	B.1 Strategy	5	2	C.1 People & competences	5	3	D.1 Planning & innovation drive	3	3
A.2 Stakeholders influence	3	3	B.2 Objective deployment	2	2	C.2 Information & know-how	5	2	D.2 Product development	2	2
A.3 Values, mission & vision	5	6	B.3 Management review	2	2	C.3 External & supply chain	3	2	D.3 Research & technology	3	1
A.4 Risk practice	3	1	B.4 Communication	2	2	C.4 Infrastructure	2	1	D.4 Market research	3	2
A.5 Work environment	2	2	B.5 Recognition	2	1	C.5 Financial	3	2	D.5 Deployment, commercialization	2	2
Total	16	16	Total	13	9	Total	18	10	Total	13	10

I = Number of grand tour questions in the interview E = Number of evaluation items

Total number of grand tour questions: 60

Total number of evaluation items: 45

This provides a list of all the chapters and constituent factors, the utilized grand tour questions, description of every factor and evaluation items along with its scale criteria. Every factor is divided into several items, which describes the different aspects and meaning of the factor.

The first column in Table 22 shows the classification code: *chapter.factor.item (i.e. A.1.1)*

The second column in Table 22, "Interview Questions", lists the grand tour questions utilized to conduct the interviews. The first question written in every box is the grand tour question, the one that was utilized to invite the interviewee to elaborate on the subject. Most of the boxes in this column contain additional secondary questions, those were listed to guide and remind the interviewer of key information expected to be obtained in the answer. The secondary questions were only utilized if the information was not forthcoming as a spontaneous answer to the main question.

The third column in Table 22, "PDMA item", lists the description of the factor and item as written in the PDMA/TIM Innovation Management Standard (2013) , the code shown (from 1.1.1 to 4.3.1) matches the numbers used in the PDMA/TIM standard. Some boxes in this column contain descriptions preceded by "JB", this meaning that the concept has been added by this doctor student to serve the purpose of this thesis.

The fourth column in Table 22, "Evaluation item and scale", lists the evaluated items, which refers to aspects described in the column "PDMA item", and describes the characteristics of each one of five (5) levels of achievement, with level one (1) meaning a very poor execution or inexistence of the evaluated item, to level five (5) meaning excellence in the execution of the evaluated item. The evaluation scale for every one of the evaluated items has been developed by this doctor student using the criteria of the PDMA/TIM, IESE and own considerations to suit the purpose of collecting knowledge on the research subject.

The design of the analysis structure and interview questions was made to try to obtain comprehensive information of every chapter and factor in an aggregate form, every line in the table has cross implications with other lines in the factor. A view of the table on a line by line basis does not provide complete, meaningful information. Therefore, the three descriptive columns in Table 22 are not to be seen as having a horizontal univocal link. Each interview question intends to invite the interviewee to describe aspects that will cover more aspects than the specific PDMA item and Evaluation item, listed in the adjacent boxes in the table. The same happens with the column PDMA item and Evaluation item, they are not univocally linked.

This structure was used as an initial classification (coding) of all the data obtained from each company. This provided an information database of all the cases from which, through an inductive re-classification and analysis process, the final innovation construct, as proposed in this doctoral thesis, emerged.

Table 22: Analysis structure: Interview questions and evaluation items by chapter

A 1: CULTURE. Management commitment

	Interview Questions	PDMA item	Evaluation item and scale
A.1.1	How important is Innovation for your company? What are the top three expected benefits? Is the company doing well on innovation?	1.1.1. Is there evidence of direct executive management commitment of initiating, facilitating, managing and supporting all activities relating to innovation? What is the accountability of senior management for innovation activities? Is there a deployed systematic review system for innovation where senior management involvement is present?	LEVELS: Senior Management involvement 1. Executive management is not committed 2. Executive Management is somehow committed but not always demonstrated with facts 3.Executive Management defends and support innovation, it gets involved as needed 4. Executive Management foster and drives innovation, often carries out reviews and/or proposes plans and actions 5. Executive management foster, drives and is highly involved in promoting new exploration activities
A.1.2	Is there an innovation committee? To whom is it reporting?	1.1.2. Is there an innovation team, board, council, committee, etc. and if so is it a cross functional group and are roles & responsibilities defined?	LEVELS: Innovation Forum, Roles &Responsibilities 1. There is no Innovation forum 2. Innovation is handled as an agenda item in other forums 3. There is an innovation forum but not cross functional, most cases within R&D. 4. There is a specific innovation forum. Roles & responsibilities are defined 5. There is an innovation forum, roles & responsibilities are fully defined and reports to the top level in the organization
A.1.3	What is your involvement in innovation activities? Who are the top contributors or pushers of Innovation?	1.1.3 Is there evidence of commitment to innovation needs in all policy documents, such as statements of values, strategy, descriptions of organizational objectives, the rewards Systems, its presence in governance structures, allocation of resources and utterances of leadership?	LEVELS: Innovation commitment signs 1. Innovation is not mentioned in any document 2. Innovation is mentioned, as a fuzz word, however it is not a live subject 3. Innovation needs are mentioned in several documents and effectively drives actions in different departments of the organization 4. Innovation needs are mentioned in relevant documents with in a clear appealing fashion and consistently drives actions across company 5. Innovation needs have an overwhelming presence in all relevant documents and in most actions of the company
A.1.4			LEVELS: Senior management involvement with the Innovation system 1.There is no Innovation system to improve 2. An innovation system exists but is not comprehensive. Senior management gets involved only in case of failures 3. Senior management has been sometimes involved in the definition of the system, however the system is not yet comprehensive 4. Senior management time to time propose improvements. The system is comprehensive covering from idea to launch. 5. Senior management gets involved on a regular time basis to improve the system

A 2: CULTURE. Stakeholders influence

	Interview Question	PDMA item	Evaluation item and scale
A2.1	Who are the stakeholders having more influence on the company? Why? What are the drivers?	1.2.1. Is systematic identification and analysis of stakeholders conducted? Do you use models that explicitly raise the stakeholder question to the appropriate level of attention in the organization?	LEVELS: Stakeholders identification 1. Stakeholders are not considered 2.The stakeholders are identified but models to evaluate needs not fully developed 3. Stakeholders and their requirements are identified and communications models established 4.Stakeholders communications takes place systematically, conducted by the appropriate level of the organization 5. Communications and feedback are fully established and implemented. Proactive engagement on important issues
A.2.2	What do they expect from the company? And as far as Innovation is concerned? Are they, at present, satisfied?	1.2.2. Is there evidence of systematic inventory of regulatory requirements and stakeholder needs and expectations? Is it linked to statements of organizational requirements and objectives, typically in a strategy plan? 1.2.3. Is there documented activity of regular monitoring of organizational requirements and stakeholder satisfaction levels?	LEVELS: Stakeholders needs deployment 1. Stakeholders are not considered 2. Requirements are somehow understood but not for all the stakeholders. Not comprehensive. 3. The requirements are documented and managed. The key requirements are included in the Strategy Plan 4.The key requirements in the strategy plan are deployed in form of objectives 5. The key requirements are deployed at all levels in the organization
A.2.3	How do you track their current expectations and level of satisfaction? Do you have a view on what they might want in the future?	1.2.4. Is there a conscious and systematic attempt at determining future needs of stakeholders?	LEVELS: Stakeholders future needs analysis 1. Future stakeholders needs are not discussed 2. Future stakeholders needs are discussed , however not supported by data analysis 3. Future stakeholders needs are internally discussed based on the ongoing contacts and feedback obtained from Stakeholders 4. Systematic attempt of configuring future possible needs is made on the basis of the data collected and expert opinions 5. Scenario management is carried out

A 3: CULTURE. Values, Mission & Vision

	Interview Questions	PDMA item	Evaluation item and scale
A3.1	What is the purpose of the company in short words? Let's say the company Mission. What are the capabilities of the company? What differentiate you from the competitors?	1.3.1. Is there a Mission Statement that summarizes purpose and core values of the organization? Are there other safety and health, social or cultural guidelines that form the core policies of the organization? If not, is there implicit or tacit evidence of a Mission Statement? Is the Mission Statement appealing?	LEVELS: Mission & Values 1. Core Values, Mission do not exist 2. Mission and core Values exists but somehow uncompleted 3. Mission, Core Values exists, it is however not straight forward and appealing 4. Mission, Vision and Core Values exists and is easy to understand 5. Mission, Vision and Core Values is comprehensive, well-structured and effectively lead the organization
A.3.2	What do you envisage the company to be in about five years' time? Let's say the Vision.	1.3.2. Are stakeholder needs and expectations as well as the organization's requirements represented in the Mission Statement or its cultural counterpart?	LEVELS: Consistency with stakeholders needs 1. The stakeholders requirements are not included in the statements 2. The stakeholders requirements are somehow considered but not clear enough 3.The stakeholders requirements are fully considered 4. The stakeholder requirements are considered in a clear concise fashion. The statements are appealing in that sense. 5. The statements are very effective to drive the stakeholder needs in the organization
A.3.3	How should I read it, in respect to Innovation direction?	1.3.3. Are stakeholders and especially employees as stakeholders aware of above policies? How well are these communicated?	LEVELS: Policies communication 1. Statements not communicated 2. Communicated but only a small number of managers know them 3. Attempt to widely communicate has been made, however it has not reached everybody. 4. Communication is effective, people share consistent identity, Mission and Values. 5. Highly effective communication, item 4 plus announcement boards (or other media) display them
A.3.4	How is the Mission and Vision experienced by your employees?	1.4.1. Is there a Vision Statement? If not, is there implicit or tacit evidence of vision statements?	LEVELS: VISION 1. A Vision statement does not exist 2. It exists but not clearly and consistently formulated 3. The Vision statement is clear and consistent 4. The Vision statement is clear, consistent and appealing. It drives Progress in the organization 5. The Vision statement is a very effective tool in the organization
A.3.5	How would you describe the Values of the company? Does the company have a Code of Conduct?	1.4.2. Can you reproduce the Vision Statement and its contents? Is there a reference to Mission Statement and early innovation objectives as part of the Vision Statement?	LEVELS: VISION versus Innovation 1. A Vision statement does not exist 2. A Vision statement exists but the role of innovation on it is not clear 3. The role of innovation is implicit in the Vision statement 4. The role and objectives of Innovation are explicit in the Vision statement 5. The Vision statement receives continuous management attention to make it highly effective to drive innovation
A.3.6		1.4.3. Is the Vision Statement known among key stakeholders such as employees? How is it documented, posted and communicated?	LEVELS: VISION communication 1. Vision is not known by employees 2. Vision is somehow known 3. Vision and Innovation direction is well known by key employees 4. Vision and Innovation direction is known consistently across the company (respectful with confidentiality) 5. Vision is known consistently by everybody at all levels.

A 4: CULTURE. Risk practice

	Interview Question	PDMA item	Evaluation item and scale
A.4.1	How does the company deal with projects involving a certain risk?	JB: Do shareholders and management care about mid and long term programs involving certain risk?	LEVELS: Risk Management 1. Risk is ignored 2. Risk boundaries acceptable by the company are not clear, which sometimes creates confusion. 3. The company has understanding of the acceptable risk boundaries and if interpretation is needed, discussions with management are open. 4. The company has a clear policy that defines acceptable levels of risk. It is known by all employees It is consistent with the VISION and VALUES, employees are invited to undertake initiatives within those boundaries 5. The company is proactively engaged on risk management and uses it as a tool to allow expanding the scope of its Vision
A.4.2	What is the level of risk acceptable at the different levels of the organization? Does the company encourage internal entrepreneurship?	JB: Is management encouraging employees to take on some risk if the return is attractive? What is the culture? Tight or lose ride?	No Score evaluation
A.4.3	What is the company approach to manage exploitation and exploration?		No Score evaluation

A 5: CULTURE. Work environment

	Interview Question	PDMA item	Evaluation item and scale
A.5.1	Is there any practice that you believe help innovation to take place? I.e.: Freetime, coffee corners, openoffices, teamactivities, playingground, socialfacilities, pleasant atmosphere	1.5.1. Are applicable regulatory requirements observed? Is encouragement of innovation, catering for creativity, serendipity and personal initiatives of an entrepreneurial nature in the workplace stimulated? 1.5.2. Are these physical and human components of the workplace being observed in the workplace? 1.5.3. Is the upkeep of physical and human components safeguarded byaregular process?	LEVELS: Physical environment 1. Inadequate, quite old fashion 2. Requires improvement 3. Adequate for innovation 4. Innovation on purpose improvements implemented 5. Encourages stakeholder interaction, innovation and systems are implemented for continual assessment
A.5.2	Does the environment and culture induce open and easy communications?	JB: Check any"silo" issue and the amount of interaction with the external world	LEVELS: Communications environment 1. The communication is difficult, separated and isolated individuals with difficult communication 2. Communication good within departments but silo effect across departments 3. There is an adequate communication facilitated by the environment 4.On purpose events have been implemented to foster communication across stakeholders without agenda. Coffee corners, common rooms.... 5. Events with stakeholders are made on a regular time basis and continues improvement attention is put to foster effective communications

B 1: LEADERSHIP. Strategy

	Interview Questions	PDMA item	Evaluation item and scale
B.1.1	Would you please describe the strategy of the company? How was it developed? Who did it? Stakeholders influence?	2.2.1. Is there an organization strategy that implements the organization's innovation objectives in line with mission and vision as stated in section 1? Are there analytical toolsets to ascertain the innovation objectives are adequate? Do they provide a full picture of the organization in its environment, monitoring trends, developments? Do they give differentiated pictures of an organization's possible future using scenarios?	LEVELS: Company Strategy 1. A company strategy is inexistent in explicit or implicit mode 2. A strategy exists but it has been built without using analytical data and does not cover all the aspects of the business environment, a link to the vision is not clear 3. A strategy exists, build on the basis of data analysis, covers the whole business environment defined by the mission and it is clearly linked to the vision. 4. Item 3 plus Innovation strategy 5. The formulated strategy has been made using advanced tools as scenario management
B.1.2	What are the implications on Innovation? New Products, Business Models, New markets . Do you have a roadmap to execute it?	2.2.2. Does the use of conceptual tools link the organization's vision to concrete innovation objectives and guidelines, by means of for example road mapping techniques and Product Innovation briefing documents?	LEVELS: Strategy effect on Innovation 1. An innovation strategy is inexistent in explicit or implicit mode 2. The strategy is somehow linked to an innovation strategy in an implicit generic fashion. 3. The strategy is linked to innovation in a generic fashion describing innovation axis or pivot points 4. The strategy contains innovation axis (or pivot points) that have been discussed and developed using analytical tools 5.The formulated strategy includes innovation axis (or pivot points) with proven positive effects on company teams to innovate
B.1.3	How often do you review the strategy? Is it based on a static vision of the future or to suit short term market tactics?	JB: To understand the strategy position "Competing on the Edge"	No Score evaluation
B.1.4	How relevant for your success is cost/value/price on new products?	JB: Hypothesis check that in mature segments cost and price of new products is fundamental for success, no matter the value.	No Score evaluation
B.1.5	Are there M&A opportunities considered in the strategy?	JB: To understand the focus organic versus acquisition growth target. Is the purpose to bolt in sales and markets, acquire capabilities or both?	No Score evaluation

B 2: LEADERSHIP. Objective deployment

	Interview Question	PDMA item	Evaluation item and scale
B.2.1	What are the specific objectives linked to the strategy? Is that reflected in the budget? Any Moon Shot? Or just SMART	2.1.1 Are there measurable, quantifiable innovation goals in the strategic plans of the organization that are directly linked to named budgets in the first plan year that is part of its derivative? Are objectives noted using SMARTER goals?	LEVELS: Company Objectives 1. The strategy is not linked to innovation objectives 2. The strategy is linked to innovation implicit general objectives. Objectives not clearly defined 3. The strategy define innovation objectives deployed by product or market as appropriate. 4. The strategy describes innovation axis and innovation objectives linked to each axis, by product and/or market. 5. The strategy is linked to innovation objectives by innovation axis that effectively foster and drives innovation
B.2.2	What is the link to the Vision? Do you have objectives at all levels? What are the objectives of your department? On innovation?	2.1.2 Are innovation objectives linked to all levels of the organization, and do they reflect the vision? Can you identify top-down and bottom-up communications around setting innovation objectives? Does management's actively encourage top-down and bottom-up communications? 2.1.3 Is there evidence of whether innovation objectives are regularly reviewed, monitored and communicated to all parties involved?	LEVELS: Objectives deployment at department level 1. The strategy is not linked to innovation objectives 2. The innovation objectives deployment to the different levels of the organization is implicit, there is no evidence of communication on this respect other than the one related to managing ongoing product development projects. 3. The innovation objectives have been deployed at all organizational levels and discussions on this have taken place 4. There are innovation objectives at all levels, they are clearly linked to the vision, and the objectives have been discussed with management. 5. The innovation objectives at all levels are linked to the Vision and top down / bottom-up discussions to define them are part of the management routines.

B 3: LEADERSHIP. Management review

	Interview Question	PDMA item	Evaluation item and scale
B.3.1	How does top management follow up the innovation activities? Does management foster and promote ideas and projects?	**2**.4.1 Is there regular management activity to review innovation activities and processes? What does it consist of? 2.4.3 Is there evidence of documented regular review activity? Is there evidence of appropriate managerial action when activities and processes do not meet planned arrangements?	LEVELS: Operative level 1. Management is not reviewing innovation and product development progress 2. Management review takes place only occasionally. Ad hoc reviews to follow escalated issues 3. Management reviews takes place on a regular time basis, it does not cover all aspects, and some are still in implementation or need improvement. 4. Management review system is fully implemented and takes place regularly 5. Management reviews are regular and are an effective innovation engine in the organization. Senior management is involved in improvement proposals or actions that derive from the reviews
B.3.2	What are the actions taken by management to correct innovation project delays or any type of issues?	2.4.2 Are the cultural requirements as specified in "CULTURE" heeded? (See PDMA" Culture General" 1.0.1 to 1.0.9)	LEVELS: Cultural level 1. Management does not review innovation 2. Management acts when required to remove road blocks that affect the progress of innovation projects 3.Management follows innovation and resolves conflicts or removes any road block affecting the progress 4. Management is engaged on facilitating the cultural aspects supporting innovation, so that road blocks are removed immediately and eventual failures are converted in learning successes 5. Management proactively works on improving the cultural aspects that makes innovation effective.

B 4: LEADERSHIP. Recognition

	Interview Question	PDMA item	Evaluation item and scale
B.4.1	How does management recognize good achievements done by employees? Whatare the practices? Monetary rewards? Can you explain the alignment with the vision?	Res. Overall items 5 & 6. RECOGNITION. JB: Management give employees recognition, not necessarily monetary, for their achievements contributions to innovation.	LEVELS: 1. Recognition is not practiced, there are obvious conflicts between recognition, incentives and Strategy / Vision 2. Recognition and incentives are neutral 3. Recognition is practiced and has moderate positive effects on the employee motivation to innovate 4.Item 4 covering all areas of the company with obvious good results 5. Recognition is very well practiced. Management uses every opportunity to do it. This practice foster the participation of a high number of employees in innovation matters fully aligned with the vision
B.4.2	Does the incentives and the recognition practices pose a conflict with the innovation targets? Are there conflicts between departments?	JB: A reward and incentive program is used to foster innovation and connected to objectives	No Score evaluation

B 5: LEADERSHIP. Communications

	Interview Question	PDMA item	Evaluation item and scale
B.5.1	Are Innovation Strategy and plans discussed at Board level? Executive level? Department level?	2.3.1 Are innovation activities and progress communicated with stakeholders in a two-way fashion and on a regular basis?	LEVELS: Innovation operational and exploration activities communications 1. Innovation communication does not exist 2. Basic communication systems have been implemented 3. Innovation is communicated across the company. 4. Innovation communication is well established, At Board of Directors (or equivalent level) innovation is an agenda discussion item. 5. Innovation communication is excellent and multi-directional between the company and the stakeholders. Note: All within an adequate treatment of confidential aspects.
B.5.2	How is progress on the strategy communicated with employees and other stakeholders? Is the communication of the strategy documented? Press releases? (Int. or ext.) Do you have examples? How do you deal with the confidential aspects of it?	2.3.2 Is the organization's communication and sharing of knowledge around its strategy properly supported? 2.3.3 Is the communication of strategy documented? Do they take heed of security and confidentiality policies?	LEVELS: Strategy communication 1. The strategy is not communicated at all 2. The strategy and goals are communicated, but not in detail, everyone knows only his piece. 3. The strategy and basic innovation axis are communicated 4. The innovation strategy, innovation axis are widely communicated, posted in electronic or in posters, placards... 5. The communication of the strategy and innovation axis is excellent and effective at all levels Note: All within an adequate treatment of confidential aspects.

C 1: RESOURCES. People & competences

	Interview Questions	PDMA item	Evaluation item and scale
C.1.1	Would you please describe the innovation role in your company? Who does what?	3.2.1 Can you enumerate point responsibility for innovation management? What is the role of individual employees with regards to innovation management process activities? Are they required to contribute? Is ownership of innovation initiatives projects and innovation processes separated adequately?	LEVELS: Innovation: System versus Project management 1. Innovation is not part of any job assignment 2. An Innovation function exists predominantly focused on managing innovation projects, the management of the system is not clearly assigned to a manager 3. The Innovation Systems Management function and the Innovation Projects management function are operational covering the main body of the innovation activities 4. = item 3 plus: covering the full range of innovation from front end to middle and back end of the innovation activities 5. Innovation management of projects and system is proactively assessing future needs
C.1.2	Who is/are the leaders? What is there level of authority? What are they doing? How are they connected to top management? Would you give me examples?	3.2.2 If there is a recognizable innovation manager or innovation leader: can you ascertain reporting, responsibilities, roles as precisely as possible? What is the authority, managerial remit and relative position of the innovation manager? Can you provide us with a function description?	LEVELS: Innovation function Reporting & authority 1. Innovation is not part of any job assignment 2. The innovation top management functions are reporting to a Department but not to top senior management 3. The innovation top management functions are reporting to the top management level of his organization. i.e. at least BU CEO 4. The innovation top management positions report to the top level and have sufficient authority to implement systems and develop projects without entering in unproductive discussion loops 5. The innovation top management positions report to the highest management level and has authority to run exploration projects that are material for the size of the company
C.1.3	How is the strategy and objectives linked to the HR policy? Recruitments, promotions, training, replacements	**3**.2.3 What is the extent of individual employee participation in innovation activities? Does the organization have talent management and development policies? Is there active management support of talent management and development? Is there active encouragement rewarding group results? 3.2.4 Are innovation management learning activities conducted and do they have a direct link to the organization's vision, innovation objectives and projects? Do learning activities include story-telling on innovation projects? How does the organization handle failure? Is making mistakes a source of career risk?	LEVELS: Talent management & Employee participation 1. Employee participation is not encouraged 2. Employees participate in innovation as required. Talent is revised by exception 3. The HR function takes care of promoting innovation participation of individuals and/or teams and to promote adequate talent level. Recruitments and training activities are designed in line with the Vision and the Strategy 4. The HR management is proactive adapting the teams' size and talent to the Vision and Strategy. Development policies and rewards and/or recognition encourage individuals and group results in line with the recognition practices in CULTURE 5. Participation and Talent management is excellent

C.1.4	Do you have the talent and competence to execute the vision? How are you sure that communication between business view and product is harmonic? (story-telling) Could you explain some actions taken? How do you go about success and failure, regarding carrier development?	JB: To understand the mechanism to match innovation strategy , goals and people	No Score evaluation
C.1.5.	Team work or "Star" entrepreneurial leadership? How do you find the right balance? Tiki-taka against star individual entrepreneurship, individual run to score	JB: To understand the approach from "Competing on the Edge" (Eisenhardt 1998)	No Score evaluation

C 2: RESOURCES. Information & know-how

	Interview Questions	PDMA item	Evaluation item and scale
C.2.1	Are there trends in the market driving needs of acquiring new information, know-how and competences?	3.4.1&2 Is there verifiable presence of a validated and supported information process? / Are there documented methods for information gathering, analysis, reporting and communications?	LEVELS: Information existence 1. There is no system to manage information and there is no information on Technology, Market and Patents stored 2. Information is available but not comprehensive, there is no evidence of covering all information needs to execute the strategy 3. Information is available for all the disciplines relevant to the strategy. Examples are on market, technology, quality, benchmarking, patents...but improvements are needed. 4. Information is continuously collected and updated in all fronts 5. Information comprehensiveness in relation to the strategy and Vision is continuously and proactively pursued.
C.2.2	How are you sure that the information, know-how and competences of the company are adequate to execute the strategy and reach the vision?	3.4.4. Is there an archive process for the adequate storage of all relevant information? In the archive process, does it facilitate appropriate access to authorized individuals, and protect archived information resources from loss, theft, and abuse? Does it have measures for appropriateness? Is information stored and disseminated in a user-friendly and user-centric way? Can information be shared among participants, and are they able to work collaboratively on projects?	LEVELS: Information archive and sharing method 1. An archive does not exist 2. An archive exist but is not available for all the disciplines, Information is difficult to be retrieved 3. A management system exists, available to authorized people, allows to retrieve archive data and to collaboratively work on projects. It requires improvements 4. A management system exists as item 3,it is fully operational in all fronts 5. The management information is very effective in all fronts relevant to the Vision , always up to date and being continuously improved
C.2.3	What are the practices to share the information and know how across the organization? Do you have an archive system?	JB: Market oriented information comprehensiveness including customer satisfaction, competitive analysis, geographical needs, and segments trends.	No Score evaluation
C.2.4	Are there Technologies and Patents crucial for the development of the company?	JB: Product Technology and Patents information comprehensiveness	No Score evaluation
C.2.5.	Is the company leader in Manufacturing Technology and KnowHow? Or just average in the market?	JB: Manufacturing Technology information comprehensiveness	No Score evaluation

C 3: RESOURCES. External & supply chain

	Interview Question	PDMA item	Evaluation item and scale
C.3.1	Do you rely on external resources to execute part of your innovation strategy? How does that work?	3.4.3 Does the organization identify which suppliers are essential to the innovation objectives of the organization? Are existing or new essential supplier relations measured against? Is there a policy towards suppliers and subcontractors in terms of collaboration and information-sharing?	LEVELS: Supplier chain collaboration 1. Suppliers are not involved in Innovation, only deliver components or services made to a blue print 2. Suppliers are required to provide technology information and ideas however the supplier management system is not structured to allow collaborative co-design 3. Suppliers are managed as partners and collaborative systems to share information and co-design adequate to the Strategy objectives are in place. Prospects of key suppliers to support the Vision are being made. 4. Alliances with key suppliers have been identified and the future vision shared in the field of collaboration 5. The collaboration with suppliers boosts the innovation success
C.3.2	Do you have contracts with external scientific or technology institutions?	JB: Does the organization identify universities and research institutes essential to the innovation objectives of the organization? Are there collaboration contracts in place?	LEVELS: Other external. Universities. Institutions 1. The strategic question on whether external resources such as Universities has not been considered. 2. External resources are sought only if something fails internally 3. The Vision and strategy is analyzed vis a vis the needs for external resources. If needed, resources are identified and contracted. 4. Resources are prospectively sought as a mean of providing additional thoughts and competitiveness. Exploration 5. External alliances and resources have been developed in line with the Vision and Strategy, such relationships boost the company innovation success
C.3.3	Do you have innovation partners?	JB: Is the company developing innovation partners? Is Open innovation practiced?	No Score evaluation

C 4: RESOURCES. Infrastructure

	Interview Question	PDMA item	Evaluation item and scale
C.4.1	Does the company have adequate infrastructure to conduct innovation and achieve the objectives? Labs, IT systems, Buildings, equipment, prototyping, Customer management.	3.3.1 Is there adequate infrastructure for conducting innovation activities and running active projects? Are there guidelines for infrastructure? Are there minimum levels of compliance? Is there adequate information on the Innovation Management System? Are its activities and employee responsibilities part of the organization's employee handbooks? Is presence of information about the infrastructure part of regular employee reference materials that are made available to all staff members?	LEVELS: 1. Essential elements to support innovation are absent. The infrastructure is a major blocker of the innovation activities 2. The infrastructure has been assessed on appropriateness, but may not necessarily already fulfil all requirements 3. Infrastructure contribute to innovation, improvements were done, is adequate 4. Infrastructure is adequate, and management has on purpose improved it to foster innovation 5. The infrastructure and that of essential sub- contractors required for innovation activities are fully established, monitored and reported on a regular basis. Proactive assessment of future needs takes place.
C.4.2	Do you review the infrastructure in the yearly budget?	3.3.2 Are reviews and maintenance of the infrastructure conducted regularly? 3.3.3 Are the system requirements known to sub-contractors or partners? Are there defined minimum levels of compliance for sub-contractors or partners?	No Score evaluation

C 5: RESOURCES. Financial

	Interview Question	PDMA item	Evaluation item and scale
C.5.1	How do you track your innovation activities financially? Do you have innovation financial schedules discussed at board level? Or is Innovation shown as a lump sum position?	3.1.1 Does the organization possess a balanced financial toolset with appropriate explanatory information (also see section 3.1.2, and the TIM-R-004-2 Standard Innovation Metrics)? Does the organization use and process consistent information resources across the entire portfolio for decision-making? Are financial resources balanced with innovation objectives? 3.1.2 Can you provide information about a balanced financial analysis toolset, including but not limited to the following basic metrics and values? .. See description of options in the TIM documentation	LEVELS: Innovation BUDGET Process 1. Innovation is not budgeted and does not have a specific treatment in the finance statements of the company 2. Budgets are not clearly defined, some funds have been allocated to the IMS, but no firm managerial commitment has been made in financial terms to support an IMS permanently. Innovation projects are still funded as one-off projects 3. Budgets are defined and allocated for the IMS itself, and initial innovation projects more systematically and also part of the yearly budget cycle 4. Funds have been allocated to meet all innovation activity budgets, either the system, or individual projects, tools or processes, regularly and purposefully, and will now be part of the yearly budget cycle and strategic planning activity 5. All innovation budget and financial transaction are fully established, monitored, measured and reported on a regular basis. Innovation management system is a regular element of repetitive yearly budget cycles and strategic planning activity.
C.5.2	Are the innovation activities considered in the budgeting process? Long Range Forecast? Yearly Budget?	3.1.3 Does regular monitoring and reviewing of innovation activities take place? 3.1.4 How are measurement of organization and stakeholder value conducted? Are there zero-point measurements? What are intervals of collection? What about rules around collection of data?	LEVELS: Innovation Financial Review 1. Innovation is not budgeted and does not have a specific treatment in the finance statements of the company 2. A basic financial schedule is used for every project to approve investments, reviews are done after launch 3. An innovation financial schedule, with breakdown by project, balanced with other aspects as risk is utilized to analyze and decide upon innovation projects at executive level 4. An innovation financial schedule is used at the executive level to follow on current and future prospects 5. The financial schedules review show good accuracy with budgeted numbers
C.5.3	What is the Value of Innovation for the company? How do you measure it?		No Score evaluation

D 1: PROCESSES. Front-end innovation drive

	Interview Question	PDMA item	Evaluation item and scale
D.1.1	What is the process to drive innovation? Could you please describe it?	4.1.1 How many and what type of processes are used for planning innovation activities and projects? What is their scope? Are any missing that would make sense? 4.1.2 Is there a planning and decision-making process on the identified minimum requirements? 4.1.2 Does the organization consciously uses and updates the process for key decision-making around initiating, developing and commercializing and deploying products, services, and processes?	LEVELS: Front End innovation process 1. Innovation is not planned 2. Planning processes are in-process of development for the front end of the innovation cycle 3. Planning processes are established for the front end of the innovation cycle 4. Processes are fully implemented for the front end of the innovation cycle 5. Front end processes (innovation cycle) are fully monitored and measured
D.1.2	How do you foresee the future and/or market unmet needs? How do you generate Innovation ideas? Do you use any specific tool? Inside -out or outside-in?	4.1.2 cont. Does the organization have a toolset of problem capturing, problem solving, generating concepts, generating, and evaluating opportunities out of these concepts? Does the organization subscribe to principles of outside-in versus inside-out? What is its orientation in this respect? 4.2.1 Is there a balance between creative (generation) and selective (elimination) techniques?	LEVELS: Front End process MATURITY 1. Innovation is not planned 2. The process does not include events or tools to on purpose facilitate the generation of ideas. 3. On purpose tools or activities are utilized to fertilize innovation ground, the balance between idea creation and elimination is considered satisfactory. The process is cross functional. 4. The full span of possible innovation sources for the company are utilized involving cross functional participants and stakeholders as appropriate. 5. The drive of innovation projects is excellent with proven success record in the previous years
D.1.3	How are the innovation ideas prioritized andselected? Is there a balance between creative generation and selective elimination? How wide is the consensus on the selection made? How do you manage the Product Portfolio?	4.2.1 (taken from PDMA R&D 4.2.1) How are ideas, concepts, opportunities and their outputs systematically stored and archived in a system capable of exchange of selected information notably with stakeholders? Is there a balance between creative (generation) and selective (elimination) techniques? How does the organization prevent undesirable projects from progressing well into the new development pipeline which could have been filtered out in an early stage? How does the organization handle serendipity? 4.1.3 Does the organization use documented portfolio review methods used? Are they appropriate? What kinds of methodology, review criteria, and consistency do they possess?	LEVELS: Front End CONSISTENCY with Vision & Strategy 1. Innovation is not planned 2. The ideas generation are prioritized according its merits, according the current business environment 3. The ideas are selected and prioritized consistent with the strategy 4. The ideas are selected and prioritized fully consistent with the strategy. Reviews are made to control that projects do not deviate from the approved strategy criteria 5. The selection of projects is excellent with proven record of success

D 2: PROCESSES. Product development

	Interview Question	PDMA item	Evaluation item and scale
D.2.1	Please describe the process to manage Product Development What are its strengths and weaknesses? How are the teams organized? Are they cross functional?	4.2.1 Does the organization use particular R&D and Technology Toolsets, such as, but not limited to… (See details in PDMA Guidelines 4.2.1)	LEVELS: Project Management & Development process 1. There is no defined process for Product development process 2. There is a Process defined but it is not followed in all cases 3. A Development Process is in place, led by Project Managers with cross functional teams and supported by proper collaborative tools and practices 4. The Process is part of the operations of the company and therefore the Project managers have adequate authority 5. The process is excellent having proved outstanding results in the past recent years
D.2.2	How often are the projects reviewed? With whom?	4.2.2 What is the review interval of Research and Development processes, and what is the extent and scope of reviews?	LEVELS: Development process maturity 1. There is no defined process for Product development process 2. The process is defined but the results show that it is not state of the art for the business. Failure rates and delays are too high 3. The process works at an acceptable level of failures and delays. It has adequate tools and practices for the business. There is room for improvement but is not critical 4. The process runs fine for the business 5. The process proves to have delivered excellent results with a minimal failure rate and delay.

PDMA Guidelines 4.2.1:

Does the organization use particular R&D and Technology Toolsets, such as, but not limited to:

- Technology Watch
- Technology Scouting
- Conscious licensing-in and licensing-out, spinning-in, spinning-out
- Technology scenario building?

Does the organization use methods for systematic problem solving where that is relevant and applicable?

Does the organization use intellectual property protection measures, and does it conduct a regular review?

Are there balanced idea inception and management toolsets being used? Such as but not limited to:

- Personal creativity techniques
- Group creativity techniques
- Idea selection techniques
- Idea clustering and combinatory techniques
- Concept evaluation techniques
- Opportunity analysis and validation
- Crowd creativity techniques?

Does the organization have a toolset of problem capturing, problem solving, generating concepts, generating, and evaluating opportunities out of these concepts?

How are ideas, concepts, opportunities and their outputs systematically stored and archived in a system capable of exchange of selected information notably with stakeholders?

Is there recognition and presence of essential supplier input processes?

How does the organization prevent undesirable projects from progressing well into the new development pipeline which could have been filtered out in an early stage?

Is there a balance between creative (generation) and selective (elimination) techniques?

How does the organization handle serendipity?

D 3: PROCESSES. Research & technology

	Interview Question	PDMA item	Evaluation item and scale
D.3.1	Would you please describe the technology core competences and strengths of the company?	See 4.2.1 and 4.2.2 above	No Score evaluation
D.3.2	Do you carry out research or base technology programs to expand or change the technology competences? Do you carry out Technology scouting? How do you select the programs? Who does it? Have you recently imported new technologies to the company?	JB: Are there processes to carry out research programs? Internal or external. How does that link to the Vision and the Strategy? 4.2.1 (Taken from PDMA R&D) Are there processes for importing or learning of new core technologies and implement them in the company? Does the organization use particular R&D and Technology Toolsets, such as, but not limited to: • Technology Watch • Technology Scouting • Conscious licensing-in and licensing-out, spinning-in, spinning- out • Technology scenario building? Does the organization use intellectual property protection measures, and does it Conduct a regular review?	LEVELS: Technology management 1. New Technologies are not sought 2. A new technology or capability is sought to improve aspects of the business that have proved the need of changes. It is done to stay competitive in the market. 3. New technologies acquisition and/or research programs are put in place in case that the execution of the strategy and Vision requires it. 4. New Technologies and/or research programs are used proactively to provide new dimensions to the Vision and strategy 5. The company is pioneer in leveraging on technology to achieve highly competitive and successful business. A success track record supports this level.
D.3.3	Do you use external sources to manage your technology?		No Score evaluation

D 4: PROCESSES. Market research

	Interview Question	PDMA item	Evaluation item and scale
D.4.1	What is the process to analyze the market present and future needs?	4.3.1 Are there processes to analyze the market current and future needs? Is there a comprehensive set of external analysis and market research methodologies? Does the organization provide systematic competitive intelligence, trends monitoring and customer feedback mechanisms, to systematically chart and monitor its environment? Is this information consistently stored, disseminated and used across the organization?	LEVELS: Market analysis processes 1. There are no processes to analyze the market 2. Basic market analysis exist. Predominantly, own sales trends and ad hoc information from competitors and lead customers 3. Market analysis are carried out time to time with adequate detail so that it serves the Strategy and Vision monitoring 4. Like item 3 but is carried out on a continues basis, and includes prospects of new opportunities or/and (if pursued) markets and future needs 5. The market analysis is comprehensive and excellent. There is a proven track of success based on the analysis done.
D.4.2	How do you obtain customer feedback?	4.3.1 Are there processes to collect customer feedback? Are so-called 'Voice of Customer' toolsets used? Customer is used in a generic sense of end-user and customer. They include but are not limited to: • Lead User Analysis • Focus Groups • Questionnaires	LEVELS: Voice of the Customer (VoC) 1. Customer feedback doesn't exist 2. A basic customer feedback process is in place. For instance based on trend sales and quality claims 3 Customer feedback processes are adequate, so the Voice of Customer is used to monitor the progress of the Strategy and Vision. 4. Like item 3, but the VoC is a tool to understand future needs. 5. The VoC is an excellent tool in the company and has proven success
D.4.3	Do you have processes to identify new market opportunities for the company? New segments, Geographies, adjacent markets ...	JB: Are there processes to identify new markets where the company could enter by leveraging on current capabilities or on capabilities currently under research or learning process?	No Score evaluation

D 5: PROCESSES. Deployment & commercialization

	Interview Question	PDMA item	Evaluation item and scale
D.5.1	Do you innovate in the way you sell and commercialize your products?	4.3.3 Are proper deployment, commercialization and launch processes created and maintained? Is there consistent use of sales, marketing and launch plans that are executed upon? How well are sales, marketing and launch plans adhered to? If they are not, can they be dynamically adjusted, or are they just ignored?	LEVELS: Commercialization Innovativeness 1. There is no process for deployment and commercialization 2. A basic commercialization process is used. Thoughts to adapt it to the new product and/or market are not made 3. The company considers the commercialization process as part of the innovative process, if needed the tools and launch process are adapted or changed 4. The commercialization and launch process takes advantage of innovative techniques that boost the success of the launch 5. The Commercialization process is very innovative and has a proven excellent success
D.5.2	What is the process to commercialize new products? When does it starts? What are its strengths and weaknesses?	4.3.1 Are post-launch reviews conducted as part of the regular planning process cycle? Do post-launch reviews form an integral part of the project, or are they at least part of the decision-making process itself (the review is conducted outside of the team if the team does not launch)?	LEVELS: Commercialization & Launch process 1. There is no process for deployment and commercialization 2. A basic commercialization process is used, however it is not thorough and systematic 3. The commercialization process runs parallel to the product development process. It is adequate for the purpose, it has a launch process, but there is room for improvement 4. The commercialization and launch process is thorough and systematic, enhances the Value of the innovation and follows the ramp up providing valuable customer feedback. 5. Like item 4, carried out with excellence. The sales force is proactively selling the new innovative product.

Annex 3. Collection of general background data from the companies

The text under "initial data collection" is an extract of the document provided to every company, where specific background data was requested before the interviews were carried out. The purpose was to put a frame to the research work and provide background to allow a better quality interview time.

This set of data was collected for all the analyzed companies. A relevant piece were the innovation projects, and the sales and financial performance of the company. The last providing a way to confirm that any reported success in the execution of innovation programs was somehow reflected in the overall company performance.

Here below, text provided to the companies as initial request on data:

Initial data collection

1. Market

This intends to collect data of the markets served to position the company in perspective of the business environment in which operates. Please provide information on:

- Markets served and its size
- Are the markets served growing or declining? Can you evaluate it?
- Position and market share
- Main competitors

2. Sales and financial performance history

Please provide the last 5 years net sales turnover for the company and for the domain subject of this research. As pertinent, please provide split by market and product line.

Provide as well relevant facts affecting the sales in specific years, as for example, financial crisis 2008-09, M&A's, competition effects, or any other relevant fact explaining the sales trend…

Please use the financial performance as normally used by the company (EBITDA, EBIT or other as used in the company…)

3. Sales of new products

The purpose of this section is to collect information of the sales of new products by product group and market in relation to the total sales of the company. In this document he meaning "Products" include as well "Services".

3.1. New products definition

Please provide your definition of new Product in terms of the time from product launch. For instance, products launched in the market within the last 3 years. For some businesses, one (1) year would be more appropriate and for other five (5) years. Typically, the number of years is taken as a fraction of the product life cycle in your market, counted from launch to product phase out.

3.2. Total sales of new products

Please provide the total yearly sales of new products for the last five years and the split by product group and by market. Please define the product groups and markets utilized. See here below a suggested format.

Table. Company New Products sales (sample format)

Company :	**MUSTER GmbH**
Currency :	**'000 €**

Total Company	2013	2012	2011	2010	2009
Total sales	100,0	98,0	97,0	96,0	94,0
Sales of New Products	29,5	27,0	27,0	26,0	24,0
%	29,5%	27,6%	27,8%	27,1%	25,5%

By Product Group in 2013	Market 1	Market 2	Market 3	Other	Total
Total sales "Product Group A"	20,0	15,0	12,5	2,5	50,0
Sales of New Products	5,0	4,0	3,0	0,5	12,5
%	25,0%	26,7%	24,0%	20,0%	25,0%
Total sales "Product Group B"	8,0	7,5	4,0	1,0	20,5
Sales of New Products	2,0	4,0	2,0	0,0	8,0
%	25,0%	53,3%	50,0%	0,0%	39,0%
Total sales "Product Group C"	6,5	6,0	4,0	5,0	21,5
Sales of New Products	1,0	2,0	2,0	1,0	6,0
%	15,4%	33,3%	50,0%	20,0%	27,9%
Total sales "Other"	2,0	3,0	1,0	2,0	8,0
Sales of New Products	1,0	2,0	0,0	0,0	3,0
%	50,0%	66,7%	0,0%	0,0%	37,5%
Total Company sales	36,5	31,5	21,5	10,5	100,0
Sales of New Products	9,0	12,0	7,0	1,5	29,5
%	24,7%	38,1%	32,6%	14,3%	29,5%

3.3. New products financial performance

Is the company tracking the profitability of the new products separately? If available, please provide the profitability of the new products in comparison to the rest.

4. Selected projects data profile

For every selected project please provide the following data:

Project Name	*Name currently used to refer to the project*
Description	*Description of the project and product, object, value proposition and objectives*
Project organization	*List of people, positions and roles used to manage the project.*
Type of Innovation	*Incremental, More innovative, Radical or Value Innovation. Justify the choice using the definitions in §3.1*
Months from idea to launch	*Number of months to develop the innovation, from first idea to product launch*
Market	*Current, new segment, new geography, new market according the definitions in §3.1*
Date of product launch	*Date*

Yearly sales ramp up	*Include a sales performance history.*
Project performance assessment	
Launched on time?	*Yes/ No*
Launched on budget?	*Yes / No*
Reached pay back?	*Yes/ No*
Reached profitability?	*Yes / No*
Reached expected sales?	*Yes / No*
Reached expected profitability?	*Yes / No*
Reached expected tech. performance?	*Yes / No*
Are the customers satisfied?	*Yes / No*
Please describe the incremental profit obtained by the company. Evaluate it in Euro.	*This shall evaluate the total benefit of the project for the company. The benefit can derive from market share, incremental sales, lower cost, sales price, higher margin, new markets, and other, or a combination of effects. Please describe and If possible, evaluate it in bottom line € effect.*

5. Organization and headcount

Please provide copy of the company organization chart and job descriptions of the positions where the innovation function is assigned.

6. Innovation spend and investment

Please provide yearly spend and Capital Expenditures related to R&D, innovation and new products for the last five years with Indication of the main investment projects and categories.

7. Processes

Please provide information of the processes used to manage the innovation function. For instance this might include processes related to:

- Innovation ideas generation and employee participation
- Customer and market surveys
- Project selection approval
- Stage Gate
- Management R&D and innovation review
- Resources allocation to projects
- Knowledge share management
- Patents
- Other related innovation management

Annex 4. Interview kick off protocol

INNOVATION KEY SUCCESS DRIVERS OF INDUSTRIAL COMPANIES IN MATURE TECHNOLOGY SEGMENTS

Interview structured upon the PDMA / TIM Innovation Management Standard

INTRODUCTION:

1 For practical reasons, the interview will be recorded.
The recorded data will only be used as a tool to capture the full conversation in a short time.
It will be used exclusively for the purpose of this research and not be shared with third parties
It will not be published or handled to other people, internally and externally
Once finalized the research, the record will be deleted

2 Your opinions will be treated with confidentiallyty and be anonymously used for the purpose of the doctoral research
In case that in the course of the research, opposed or rival opinions expressed in different interviews, needs an open discussion, the interviewed people will be contacted and be asked for permission before starting further enquiries.

3 The interview has been structured upon the base of the PDMA/TIM INNOVATION STANDARD and the IESE Innovation evaluation guidelines.
It will cover the following chapters:
CULTURE, LEADERSHIP, RESOURCES Competence & knowledge and PROCESSES

4 The duration of the interview is expected to be about 2 hours, however this depends on the extend of the open discussion

5 The data obtained, together with the data of the other interviews of your company will be used to elaborate the INNOVATION profile of your company. This will be compared to other companies and all together be analyzed to identify the innovation key success drivers

6 In the measure it is possible, please illustrate your responses with examples of representative projects

Interviewed:
Company:
Place and date:
Signature:

The undersigned commits to maintain the contain of the interview and the recorded data confidential in the terms expressed in items 1 and 2 above and the CONFIDENTIALITY AGREEMENT signed by the company and Joan Badrinas.

Joan Badrinas