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Abstract

Radical innovation is seen as one of the key factors in keeping large companies competitive over time and renewing their competencies. However, these projects are characterized by uncertainty, long-term and high investment, and complexity. Thus, researchers, professionals, and policymakers are constantly interested in methods to achieve accelerated innovation.

This thesis aims to explore how do competencies help accelerate the radical innovation process in large companies. This study draws on the understanding that large companies desire to develop the innovation process and identify essential competencies to accelerate it. The study was conducted as a qualitative study, and a semi-structured interview was chosen as the data collection method. Nine interviews were carried out with five different companies, and all the informants represent managers involved in a large company's innovation activities. The data were analyzed using thematic analysis.

This study provides insight into the competence categories that positively affect the speed of the innovation process. According to the results, the key competencies are cross-functional competencies, social competencies, entrepreneurial and leadership competencies, and commercialization competencies. The results show that culture can foster innovation and competencies development, as well as the role of dynamic capabilities is more significant than large companies necessarily understand themselves. Dynamic capabilities are reflected, for example, in the increased interest in agile methods, the importance of networking, finding new customers, industries, and technologies, and responding to a new kind of customer needs. Besides, the results showed that management sees the most crucial task as reviewing and understanding the big picture, encouraging and supporting people through an appropriate culture, utilizing, developing, and acquiring competencies, and enabling experimentation.

The main findings of the empirical research are in line with the theoretical framework of the thesis. For a large company to present something completely radical, it takes courage, passion, and the ability to take the innovation project forward. The most important matters in implementing radical innovation projects are to achieve a suitable climate and culture to implement the project. This study raises the importance of generalists and suggests their role as a vital link between substance experts and at the interfaces of different organizations and cultures.

Key words	radical innovation, acceleration, commercialization, competencies, dynamic capabilities, innovation management
Further information	





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Tiivistelmä

Pitkällä aikavälillä radikaali innovaatio nähdään yhtenä niistä avaintekijöistä, joka pitää suuret yritykset kilpailukykyisinä osaamista uudistamalla. Radikaaleille innovaatioprojekteilte on ominaista epävarmuus, pitkäaikaiset ja suuret investoinnit sekä monimutkaisuus. Näistä syistä tutkijat, yritykset ja päättäjät ovat entistä kiinnostuneempia menetelmistä, joilla näitä innovaatioprosesseja voi nopeuttaa.

Tämän tutkielman tarkoituksena on selvittää, miten osaaminen voi auttaa radikaalien innovaatioprosessien nopeuttamista suurissa yrityksissä. Tutkimus perustuu käsitykseen, että suuret yritykset haluavat kehittää innovaatioprosessejaan ja tunnistaa olennaiset osaamiset niiden kiihdyttämiseksi. Tutkielma tehtiin kvalitatiivisena tutkimuksena, ja tiedonkeruun menetelmäksi valittiin puolistrukturoidut haastattelut. Yhteensä yhdeksää henkilöä haastateltiin viidestä eri yrityksestä. Haastateltavaksi valitut henkilöt edustavat suuryritysten innovaatiotoimintaan osallistuvia johtajia. Haastatteluilla kerätyt tiedot analysoitiin temaattisella analyysillä.

Tämä tutkimus antaa käsityksen osaamisista, jotka vaikuttavat positiivisesti innovaatioprosessin nopeuteen. Tutkimuksen tuloksena nämä avainkompetenssit ovat poikkitieteellinen-, sosiaalinen-, yrittäjyys- ja johtamis- sekä kaupallistamisosaaminen. Tutkimuksen tulokset osoittivat myös, että kulttuuri voi edistää innovaatioiden ja osaamisen kehittymistä, vaikka suuret yritykset eivät aina tunnista kulttuurin arvoa tässä kontekstissa. Dynaamisten kyvykkyyksien rooli on merkittävä, ja ne heijastuvat esimerkiksi lisääntyneenä kiinnostuksena ketteriä menetelmiä kohtaan, verkostoitumisen merkitykseen, uusien asiakkaiden, toimialojen ja teknologioiden jatkuvaan etsimiseen ja löytämiseen, sekä uudenlaisiin asiakastarpeisiin vastaamiseen. Sen lisäksi tulokset osoittavat, että radikaalien innovaatioiden kiihdyttämisen kannalta johdon tärkeimpinä tehtävinä on kokonaiskuvan ymmärtäminen, ihmisten rohkaiseva ja tukeva kulttuuri, osaamisen hyödyntäminen, kehittäminen ja hankkiminen, sekä kokeilujen mahdollistaminen.

Empiirisen tutkimuksen havainnot ovat linjassa tutkielman teoreettisen kehyksen kanssa. Pystyäkseen esittelemään radikaaleja innovaatioita, suurissa yrityksissä tarvitaan rohkeutta ja intohimoa viedä innovaatioprojekteja eteenpäin, kulttuurin ja ilmapiirin merkitystä unohtamatta. Tämä tutkimus nostaa esiin generalistien merkityksen innovaatioprosesseissa. Generalistit tuleekin nähdä olennaisena linkkinä asiantuntijoiden, erilaisten organisaatioiden sekä niissä vallitsevien kulttuurien välillä.

Avainsanat	radical innovation, acceleration, commercialization, competencies, dynamic capabilities, innovation management
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**UNIVERSITY
OF TURKU**

Turku School of
Economics

**KEY COMPETENCIES FOR ACCELERATING
THE RADICAL INNOVATION PROCESS IN
LARGE COMPANIES**

Master's Thesis
in International Business

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The originality of this thesis has been checked in accordance with the University of Turku quality assurance system using the Turnitin OriginalityCheck service.

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1 INTRODUCTION

This thesis examines key competencies in radical innovation that may have an accelerating impact on large companies' commercialization process. The research introduces the literature on innovation, innovation management, dynamic capabilities, and competencies and seeks to find ways to combine them efficiently. This section presents the research background, the research gap, the purpose of the research, and the structure of this thesis.

1.1 Background

The importance of innovation is hard to overestimate in the modern world, where the pace of change is persistent. Organizations are challenged by changing market needs, and customer demand drives industries and companies to innovate with greater agility, speed, and creativity. (Tidd & Bessant 2013, 9.) The shift towards increasing pressure for companies' continuous renewal has made innovation capabilities, competencies, and resilience critical for successful companies (Teece 2007). It requires companies to review the competencies that drive efficiency and success today and tomorrow (Bonesso et al. 2020, 22). Therefore, it is crucial to understand key competencies at the edge of innovation and how they should be continuously developed.

Firms focusing on innovation outperform their competitors and more effortlessly adapt to changing circumstances in the market (Tidd & Bessant 2013). Large companies cannot alone rely on incremental innovations, improving existing products, services, and ways of doing business. To sustain long-term competitiveness, firms need to develop radical innovations also. In contrast to incremental innovations, radical innovations are new to organizations and require a company to develop new competencies or combine some of the established knowledge with newly developed ones (O'Connor & DeMartino 2006). While the importance of radical innovations has been recognized, companies find it hard to achieve (O'Connor, 2008; Tidd & Bessant 2013). Difficulties on large companies' ability to commercialize radical innovation are well documented (e.g., Chandy & Tellis 2000; Assink 2006; O'Connor & DeMartino 2006). Their current structures and processes are formed around existing activities, and they face identified challenges related to rigid organizational routines, culture (Stringer 2000; McLaughlin et al. 2008), and reward system which is frequently designed to maintain and improve the established procedure

(Birkinshaw et al. 2007, 68). Despite the challenges, many firms perceive commercializing radical innovation as an increasingly critical path to growth, fueling organizational renewal and long-term success. (McDermott & O'Connor 2002, 424; O'Connor & DeMartino 2006, 476.)

Radical innovation projects are uncertain, require long-term investments and commitment as the lead time often takes up to ten years (Kristiansen & Ritala 2018, 34). Also, companies' financial pressure leads to high expectations in innovation activities, which drives them to meet the management and investors' expectations at high speed (Meissner & Kotsemir 2016, 15). Thus, the ambition of reducing the development cycle time is admirable because a company benefits from accelerating these processes (e.g., Hawk et al. 2013, 1544; Cooper 2019, 43). Achieving accelerated innovation processes has been of continued interest among academics, businesses, and policymakers (Ellwood et al. 2017). An accelerated innovation process can give a strategic advantage if a company has the capability to change existing resources to shorten product life cycles (Eisenhardt & Martin 2000, 1117). A range of strategic perspectives, such as fast-follower strategy, first-mover advantage, fast product development cycle time, and time-based competition, underlines the importance of accelerating innovation (Kessler & Chakrabarti 1996; Chen et al. 2009, 17; Tidd & Bessant 2018a, 13; Cooper 2019, 43). Even though this research focuses on accelerating the innovation process, innovation speed or time-to-market is not always the most desirable or beneficial outcome of innovation; the goal is profitability, but quality and quantity should also be considered (Cooper 2019, 43).

The capability to accelerate innovation may require transformations in the organizational structure, management, resources, and individual competencies – especially in radical innovation (Colombo et al. 2017, 395). Hence, an organization's capability to innovate and embrace innovation depends on its competencies that affect the connection between timing and firm performance (Hawk et al. 2013, 1546). The real drivers of innovation are people (O'Connor & McDermott 2004, 27; Kelley et al. 2011, 250), their teamwork, inspiration, competence, persistence, and talent (Matthew & Brueggemann 2015, 80). As a company's goals and the conditions for success create a dependency on its competencies, companies are increasingly seeking to understand the key competencies and the best ways to build them (Ringel et al. 2020, 11). In the literature, terms such as assets, capabilities, competencies, resources, and skills are often used interchangeably (Day 1994). This study focuses on competence, which is defined as

knowledge, skill, attitudes, experiences, and contacts that make good performance possible in each situation (Sydänmaalakka 2003, 142).

Considering that competencies form unique bundles and other resources construct the basis for competitive advantage, this study follows the dynamic capabilities perspective. To shorten innovation speed, a company must have the ability to create, extend, and modify valuable resources and competencies over time. (Helfat et al. 2007.) In literature, researchers (Teece et al. 1997; Eisenhardt & Martin 2000; Zollo & Winter 2003) recognize dynamic capabilities as a critical factor in developing a firm's innovativeness and competitiveness. Dynamic capabilities are "internal and external organizational skills, resources, and functional competencies" that support address the changing environments (Teece et al. 1997, 515) and enable companies to reach beyond existing practices to work and perform differently (Zahra et al. 2006). This study considers that radical innovation management must constitute a dynamic capability that represents the ability to change (Eisenhardt & Martin 2000; Zollo & Winter 2003; Zahra et al. 2006).

Although there is considerable literature on innovation acceleration, little attention has been paid to the specific competencies required for innovation (Toner 2011) and what competencies accelerate radical innovation in large companies. Studies concerning radical innovation have noticed that companies often face a lack of acceleration and commercialization competencies (Sandberg & Aarikka-Stenroos 2014, 1301) even though both are identified as key radical innovation competencies (O'Connor & Ayers 2005; Story et al. 2011). Thus, it is proposed a further examination of commercialization competencies (Aarikka-Stenroos & Lehtimäki 2014). Tidd and Bessant (2018b) suggest that innovation research and practice might benefit from a more extensive concentration on value-creating competencies and actions in a broader range of commercial contexts. Improving and acquiring new competencies during an innovation project provides a competitive advantage. In the level of competencies, West and Bogers (2017, 45) recommend paying more attention to individuals' role as the "innovation activity of an organization is interpreted, decided, and implemented by its employees". Also, Kodama (2017, 243) suggests future research on competence characteristics on the individual level that make up strategic innovation capabilities within large companies. The next section presents the research gap, research questions, and the limitations of the study.

1.2 Research gap and purpose of the study

More research is needed to understand how competencies enable innovation acceleration and what competencies and organizational structures are required to improve radical innovation activities' success rates. The motivation to further focus on the commercialization competencies is justified by a well-recognized association between commercialization competencies and radical innovation (Story et al. 2009) and understanding the nature of radical innovation; a successful introduction of it may be more critical than an incremental one (Cake et al. 2020, 1). Indeed, success on commercialization is among the most important processes if a firm regardless of an industry because it ultimately determines the success or failure it offers for the shareholders. Nonetheless, scholars argue that products fail due to the firms' poor understanding of commercialization activities (Chiesa & Frattini 2011) and poorly executed activities (Cooper 2019, 37–38). To ensure success, companies must understand their current competencies and the ones needed to introduce radical innovation successfully. Thus, they also must understand the competence gap they might have and adapt to it. (Day 2011, 193.)

This thesis aims to investigate key competencies to speed up radical innovation, especially in commercialization. The focus is to describe current practices and competencies in large manufacturing firms that develop and commercialize radical innovations. This purpose is specified by the research question: How do competencies help accelerate the radical innovation process in large companies?

Sub-research problems can be defined as follows:

- 1) What individual competencies are needed to speed up the radical innovation process, especially in commercialization activities?
- 2) How can large companies ensure to have the competencies for radical innovation?
- 3) How do dynamic capabilities foster the development of radical innovation competencies?

The main research problem is approached by using three sub-questions. The first sub-research question examines what key competencies are, especially in the commercialization activities, to understand what competencies need to be acquired in radical innovation teams. The second sub-question aims to find out how firms can ensure

to have the necessary competencies. Finally, the third sub-research questions examine the role of dynamic capabilities in future-oriented innovation from the competence perspective.

According to Tiberius (2020, 6), the competencies required for radical innovation should “be further specified on the individual, group (team), organizational, and inter-organizational level”. However, competencies are often considered only from two perspectives: organizational and individual (Murray 2003, 305; Håland & Tjora 2006, 1009) that this study follows. Organizational competencies are a higher level that affects performance in terms of innovation. When resources are combined in bundles, individuals and teams can perform specific activities, which form organizational competencies (Teece et al. 1997, 516). Thus, dynamic capabilities are part of the development of innovation that fosters the need to renew a company’s resources, including competencies (Teece et al. 1997; Helfat et al. 2007, 1). Companies can seize competencies through innovations that require a re-organization of resources.

The limitations of the study are the following. The focus of this research is on radical innovation and its commercialization activities rather than on other phases. The innovation process is briefly described, but other activities are not described well in detail. Another limitation of the study is that dynamic capabilities are addressed at the innovation management level. Therefore, this study considers managers have a role in organizing competencies to support the development and recognize opportunities in its operating environment. The final limitation refers to technical competencies that play an essential role in radical innovation, but this study no further looks at them.

This study’s commissioner company is UPM-Kymmene Oyj, a large multinational forestry company from Finland, employing around 18,700 employees in 12 countries. According to the company’s annual report (2019), their “portfolio consists of businesses with strong long-term fundamentals for demand growth and high barriers to entry”. UPM manufactures fiber products, wood products, molecular bioproducts, and low-emission energy. These business areas are related to a mutual idea that aims to innovate “to develop products and innovations that replace fossil-based solutions and create added value and growth”. (UPM annual report 2019, 23.) For instance, UPM has made a significant investment in biodiesel production and explores various new bio-based materials to generate new business. Citing to the Finnish Forest Industries (2017), the forest sector innovation and expertise environment is competitive because companies can operate flexibly, and the operating environment is conducive to continuous renewal. Together

with other forest companies, UPM has had to transform itself due to the shrinking demand for paper and increasing demand for wood-based products in different segments.

This thesis is structured in the following way. The first part of the thesis explores the topic's background, introduction to the research gap and research purpose, and the work's scope through limitations. The second chapter is the theoretical part, building the theoretical framework for the research. It introduces literature around topics of radical innovation, innovation management, dynamic capabilities, and competencies. As this study looks at competencies from two perspectives, both organizational and individual level competencies are explored. Radical innovation competencies are also discussed to get an understanding of the current knowledge related to the topic. At the end of this section, the theoretical framework is illustrated and summarized. The third chapter describes the research design, including the research method, data collection, and analysis methods. This thesis explores large companies operating in the manufacturing industry. Although the manufacturing industry is known as "the backbone of Finnish exports", the sector needs to continuously reinvent itself to succeed in international competition (Business Finland 2020). The data is collected through semi-structured interviews, and the choice of the method is justified in the section. After that, in the fourth chapter, the empirical results of the study will be presented. The fifth section contains a discussion of theoretical contribution, managerial implications, the study's limitations, and the recommendation for further research. The final section is a summary of this study.

2 COMPETENCIES AND MANAGEMENT OF RADICAL INNOVATION

The existing literature, definitions, and theories related to the topic of study are described in this section. This section has been divided into four subchapters. The first subchapter is divided into five parts: a definition of innovation, a classification of innovation into radical innovation and incremental innovation, and the key differences between them, innovation process, commercialization activities, and radical innovation in a context in large companies. The subsequent subchapter explores innovation management and dynamic capabilities that this study considers fostering radical innovation and competencies. The third subsection review competencies both at an organizational and individual level and explore radical innovation competencies. Finally, the last section summarizes the theoretical background and presents the initial framework of the study.

2.1 Radical innovation

Innovations are multidimensional, and different types of innovations in different stages require varying competencies (OECD 2011). It is essential to describe innovation and its various types to understand the theoretical background. This section deals with the classification of innovations according to their novelty and nature: radical and incremental innovations. Both innovation types are described to understand the differences and challenges they may bring to radical innovation and in terms of competencies. Further, the innovation process is explored to the extent that there is an understanding of the different stages and commercialization as its own section. Finally, radical innovation in the context of large companies, and significant obstacles in pursuing it, are explored.

2.1.1 Definition of innovation

The term innovation can be regarded from a range of perspectives, and in literature, different researchers define innovation in several various ways (Garcia & Calantone 2002, 110). The common perception is that innovation holds a promise of something new (Story et al. 2009, 463). The idea turns into value when it performs the development and

exploitation features of new knowledge (Tidd & Bessant 2018a, 15–16). The concept of innovation is considered initially to be introduced to business economics in 1934 by Schumpeter (Śledzik 2013, 89), who is called the “Godfather” of innovation studies (Tidd & Bessant 2013, 8). In his book *Capitalism, Socialism and Democracy* (1942, 83), innovation is defined as a “process of industrial mutation that incessantly revolutionizes the economic structure from within, incessantly destroying the old one, incessantly creating a new one”. Schumpeter’s idea is that the achievement of development requires new combinations. However, this thesis follows one of the most comprehensive and widely accepted definitions of innovation that is: “the implementation of a new or significantly improved product (good or service), or a process, a new marketing method, or a new organizational method in business practices, workplace, organization, or external relations” (OECD 2005, 46).

Companies may generate a competitive advantage by presenting innovations. Thus, a company’s agility and ability to quickly identify and react to innovation and competitive opportunities are critical (Roberts & Grover 2012, 579). Innovation results from individuals, teams, and organizational efforts to produce something new that is possibly attractive to a market. Developments or improvements bring economic added value to a company, which can be a process, an achievement, or the synergies they make (Tidd & Bessant 2018a, 82). Innovation is regarded as a high complexity that requires different thinking, and it must be “socially accepted to succeed” (Meissner and Kotsemir 2016, 3).

A well-known way to view innovations is the 4P model, which divides innovation into four broad categories: product innovation, process innovation, position innovation, and paradigm innovation (Bessant & Tidd 2018, 21). Similarly, OECD (2005, 47) classify the main types of innovations: product, process, marketing, and organizational innovations. The innovation types are described in the following way:

- 1) *Product innovation* affects market offerings, such as introducing a new idea, technology, or service unknown to consumers. On the other hand, product innovation can also be a significantly developed product or service if it has significant technological or operational development compared to its previous services or products.
- 2) *Process innovation* introduces a new or significantly improved way of producing and delivering products and services to achieve efficiencies such as faster processing, greater production volume, or decreased costs. It does not have to be

scientifically new, and it may also be a new way of commercializing a product. (Bessant & Tidd 2018, 21–22).

- 3) *Marketing innovation* means a new way of marketing a product or service or a new kind of marketing tool. Marketing innovations aim to drive demand by creating awareness, meeting customer needs better, opening new markets, or re-launching a company's product to increase its sales, which means it is not usually sold to consumers. The increase in social media use has provided companies with the opportunity to introduce new marketing channels through marketing innovations. Also, e-commerce, which increased significantly in the 21st century, can be considered a marketing innovation, as marketing innovations cover new sales channels for the company.
- 4) *Organizational innovation* means implementing a new organizational method that does not usually show outside the company. Organizational innovations can be new ways of working and corporate culture changes that have not been used in the company before. Such reforms aim to improve employee efficiency, workplace satisfaction, and information mobility within the company. (OECD 2005, 48–52; Toner 2011, 16; Kahn 2018, 454–456.)

A popular theme in literature in the field of innovation is openness in innovation activities (Chesbrough 2003; Tidd & Bessant 2018b, 3). Companies have gradually moved from a firm-centric approach to a collaboration-centric approach that endorses collaboration within an extensive network of partners (Bonesso et al. 2020, 4). Thus, a common perception is that innovation is an outcome of “multiple relationships of different entities and organizations in the open innovation paradigm” (Meissner & Kotsemir 2016, 11). Open innovation can be defined as “the use of purposive inflows and outflows of knowledge to accelerate internal innovation, and expand the markets for external use of innovation, respectively” (Chesbrough 2006, 1). Later it has been defined as “a distributed innovation process based on purposively managed knowledge flows across organizational boundaries, using pecuniary and non-pecuniary mechanisms in line with the organization's business model” (Chesbrough & Bogers, 2014, 12). It emphasizes external and internal ideas and paths to the market, based on co-operation with different entities, including suppliers, customers, and communities, which is the most central theme in open innovation (Chesbrough 2003). Innovation has evolved from technology-oriented to market-oriented, and within the change, innovation processes have led to open innovation and collaborative development. Consequently, this study regards the

innovation process to follow open innovation principles that affect the necessary competencies compared to closed innovation.

In summary, there are various classifications of innovations, and the importance of different types of innovations varies according to the context of the organization's operating environment. This further complicates the understanding of innovation as there are many different definitions in literature through various studies. Overall, innovation is a complex set of components in mutual interaction where each factor's success depends on the other. (O'Connor 2008, 315, 326.) This study aims to create an overall picture of radical innovation activity and the required competencies to accelerate it. Therefore, the next section discusses radical and incremental innovation to understand their main differences.

2.1.2 Radical versus incremental innovation

Innovations classify into two main types: radical and incremental innovations. It refers to the magnitude of the change that innovation brings to a previous product, service, or process. The degree of novelty and impact determines whether innovation is incremental or radical. The innovations can be minor, incremental improvements or radical changes that change how we think about and use the products or services. (Tidd & Bessant 2018a, 26–27.) Innovation can be a novelty to (1) an organization, (2) an industry, or (3) the world. (OECD 2005, 37, 57–58.) The difficulty with this division is that it is hard to measure the degree of novelty because there are no international indicators for evaluation. However, it is good to note that, like Garcia and Calantone (2002, 120) state, where one firm sees a particular innovation as radical, it appears incremental to another firm. Since radical innovation is the focus of this study, the paper first briefly describes incremental innovations followed by a more in-depth focus on radical innovation.

Incremental innovation is a gradual improvement of a product or service within normal development processes, and it is sometimes unclear when these improvements count as innovations and when they should instead be called development. Through development and improvement, the product becomes more valuable, for example, through functionality. (Toner 2011, 26–27.) Incremental innovations are more straightforward and more risk-free for the company than radical ones, as development continues from an already known area (Tidd et al. 2005, 13). This type of innovation is appropriate for a company's current strategy, technologies, and business model and needs fewer resources.

It moves the current strategy forward, and thus, incremental innovations within an organization's internal dimension build mainly on and reinforce existing competencies (Davila & Epstein 2014, 6, 65; Kodama 2017, 222). As the competencies accumulate, it can “trigger the achievement of radical innovation through the searching and creation of new capabilities”. (Kodama 2017, 222.)

For this thesis, radical innovation definition follows the definition by O'Connor and Rice (2013, 3): “radical innovation is a product, process, or service with either unprecedented performance features or with such dramatic changes in familiar features or cost that new application domains become possible. Radical innovations transform existing markets or industries or create new ones”. The general view of radical innovation is that it is no longer part of the organization's old continuum but defines a whole new direction. It can change the current industry by replacing existing products and services (Tidd & Bessant 2018a) and affect multiple industries (Toner 2011, 27). Thus, radical innovations often offer the potential for high growth and significant change, creating paradigm changes at the market, industry, or world level (Garcia & Calantone 2002, 120). The possibility of influencing the market and acquiring high profit for a company comes with high risk and uncertainty. (O'Connor & McDermott 2004, 13.) According to the OECD (2005), innovation must be new, specifically from the company's point of view in question. Thus, in this study, the innovations are considered radical even if bringing significant newness in only one perspective, for example, changes in a firm or a market (Bessant et al. 2010; Sandberg & Aarikka-Stenroos 2014, 1295). Radicalness is from the innovating organization's point of view, “in the eye of the beholder” (Bessant et al. 2014, 1285). Therefore, this study follows a definition that includes the categories of radical innovation and really new innovation, as proposed by Garcia and Calantone (2002).

Scholars have found that “distinctions between radical and incremental innovation relate to one or more of the following: processes, structure, people, and competencies” (Story et al. 2009, 463). A comparison of how incremental and radical innovation differ in strategies, structures, competencies, and culture in a company is shown in table 1.

Table 1 Organizational characteristics to facilitate incremental and radical innovations (adapted from O'Reilly & Tushman 2004, 8 and McLaughlin et al. 2008, 5–6)

Characteristics	Incremental innovation	Radical innovation
Strategic intent	cost, profit, efficiency improvement	innovation, growth
Critical tasks	operations, efficiency	adaptability, new products
Competencies	operational	entrepreneurial
People	homogeneous, older and experienced	heterogeneous, younger, and entrepreneurial, technical, questioning
Structure	formal, mechanistic, functional, efficiency oriented	adaptive, loose, facilitating knowledge gathering, supporting risk taking and experimentation
Controls, rewards	margins, productivity	milestones, growth
Culture	efficiency, low risk, quality, customers	risk taking, speed, flexibility, experimentation
Leadership role	authoritative, top down, exploitation	visionary, involved, exploration

As seen in the above table, radical and incremental innovations differ in many ways, but an organization should have both in its strategic portfolio of innovation projects (Tidd 2006, 127). The strategic intent is somewhat different between the innovation types. Radical innovation aims to innovate something new, generating new growth for a company. Thus, critical tasks are a requirement for adaptability and new products. (O'Reilly & Tushman 2004, 8.) Radical innovation demands small, entrepreneurial units with “loose decentralized structures, experimental cultures, strong entrepreneurial and technical competencies, and relatively young and heterogeneous employees” (McLaughlin et al. 2008, 5–6).

In contrast to incremental innovation, radical innovation requires the creation and recombination of new knowledge and competencies (Riel 2011; Colombo et al. 2017, 396). The organization competencies alone are not enough to develop radical innovation

(Chesbrough 2003; Story et al. 2009, 475; Riel 2011). Nevertheless, a company needs to leverage some of its existing competencies. As Danneels (2002, 1097) explains, “rather than trapping the firm, current competencies may be used as leverage points to add new competencies”. By understanding the need for renewed competencies, radical innovation offers an ability to influence a firm’s existing marketing resources, technological resources, knowledge, skills, capabilities, and strategy (Garcia & Calantone 2002, 113).

Besides the difference in the control and rewards system (O’Reilly & Tushman 2004, 8), another distinction between incremental and radical innovation is the clarity of goal. Naturally, in the early stages of a radical innovation project, it is not precisely known what is being pursued. Therefore, the goals cannot be too precise, but they must not be too vague to build the right kind of mentality. (O’Connor et al. 2008, 18.) There are also differences in culture. The culture that facilitates radical innovation is an “open, and inquiring environment that values experimentation, with leaders promoting innovation by creating a shared belief that team members are safe to take interpersonal risks” (McLaughlin et al. 2008, 12).

Moreover, the leadership role is being a visionary, involved within the process, and exploration is strongly present (O’Reilly & Tushman 2004, 8; McLaughlin et al. 2008, 6). Scholars argue that the team and project manager’s competencies differ from the typical product development team’s (O’Connor & Rice 2013, 13). Radical innovation entails uncertainty about results and more extended periods. Thus, an organization must find the appropriate balance between exploration and exploitation. Exploration is about seeking new opportunities and about search, flexibility, variation, risk-taking, experimentation, and innovation. Exploitation, the use of old confident actions and competencies, includes processing, selection, production, efficiency, and implementation. However, if an organization places too much emphasis on finding something new, the result is too many undeveloped ideas and too weak individual competencies. (March 1999, 114–117.)

In summary, radical innovations are rarer and more promising, giving a competitive advantage and allowing a company to enter new markets. The downside is that the level of uncertainty is considerable, reflected in both the investment and the innovation period from idea to launch. This study limits innovation analysis to large companies that acknowledge the importance of innovation but struggle with commercializing radically innovative products (Chandy & Tellis 2000; Chiesa & Frattini 2011). The radical innovation in large companies and their obstacles will be explored later in this section,

but first, it is necessary to examine the innovation process to understand different activities. There are many ways and models to describe the innovation process, but all these have a common perception that innovation can be explained and illustrated by the process model. The following section explains some commonly used innovation process models.

2.1.3 *Innovation as a process*

The fundamental perception on innovation is to consider it as a process that covers the period and activities from ideation to implementation. The main idea is making ideas into reality that brings value (Tidd & Bessant 2013, 18–21). The Oslo Manual’s innovation activities include “all scientific, technological, organizational, financial and commercial steps which actually, or are intended to, lead to the implementation of innovations” (OECD 2005, 47). Although innovation is generally understood as the result of these activities, those do not occur linearly. A common understanding is that the innovation process is an interactive model with integrated phases where individual phases overlap. (Meissner & Kotsemir 2016, 2–10.) The perception of innovation as a process is more related to how a company manages it and experience it (Tidd et al. 2009). In this subsection, a few classic innovation process models are explored.

A simplified model of the innovation process consists of four steps: search (discovery), selection, implementation, and capture (monitoring) (Tidd & Bessant 2018a, 76). Often, companies stress the importance of the front end of the innovation process, which is argued to be the most challenging for the company (Zhang & Doll 2001; Apilo et al. 2007). The company forms an idea of the future development of technologies, markets, and customer needs, among other things, and selects ideas from which the innovations to be developed will guarantee future competitiveness (Apilo et al. 2007, 132). The first phase of the process seeks to identify new opportunities both from the external operating environment and within the organization. Knowing well customers and their needs expose may arise a great source of opportunities. (Bessant and Tidd 2018, 76.) Menzel et al. (2007, 735) also suggest “a clear understanding of the industry’s value chain and an organization’s place in it” to raise new ideas. The search for an idea should include the utilization of existing knowledge of the organization’s familiar technological environment and market and a completely new exploration outside of the familiar operating environment, which more often may lead to radical innovations. (Bessant &

Tidd 2018a, 76–79.) Thus, external capabilities and technology are usually required in the early innovation activities, such as in the development and production phases (Pynnönen et al. 2019, 344). According to Cooper (2019 38), successful companies spend up to twice as much time and money as failed ones on market research and feasibility studies. He emphasizes the balance between marketing and business-oriented tasks and the technical side at the beginning of the process.

In the second stage of the innovation process, the implementation phase, the concept is transformed into a developed innovation ready for introduction, including marketing, design, product development, and quality assurance tasks (Bessant & Tidd 2018a, 79–81). Thus, commercialization is not considered a separate phase that has been earlier regarded to happen only at the end of the process. Today it is seen as a series of events that go through innovation and where the idea becomes offered and brought to market. (Chiesa & Frattini 2011, 437.) Finally, the third step is to monitor the success of innovation and achieve its value. It either succeeds or fails, but monitoring provides important lessons or opportunities for the future. (Bessant & Tidd 2018a, 82–83.) Companies may require external support throughout the process, but when and how a firm sources external knowledge and shares internal knowledge remains somewhat unclear (Tidd & Bessant 2018b, 3). Besides, external partner integration is considered an essential factor that affects innovation speed (Ellwood et al. 2017, 522).

One of the well-known innovation process models is the Stage-Gate model developed by Cooper in the late 1980s. The Stage-Gate model is “a conceptual and operational map for moving new product projects from idea to launch and beyond – a blueprint for managing the new product development process to improve effectiveness and efficiency” (Cooper 2008, 214). The model has been developed to shorten the turnaround time of the innovation process and to improve the hit accuracy of innovations, i.e., to increase the share of successful innovations in all innovations going through the process. Cooper’s model traditionally divides the innovation process into five stages: scoping, build a business case, development, testing and validation, and launch – all preceded by a gate, which controls access to a new level. (Cooper 2008, 215.) The advantages of the Stage-gate model are (Zhang & Doll 2001, 104):

- A step-by-step approach provides a disciplined approach that ensures that no steps are left out of the process, that quality remains high, and that top management can control technical and financial risks.

- The model emphasizes close contact with the market at an early stage of the process, and effective prioritization and evaluation of projects throughout the process.
- The development team gathered from the company’s various functions works according to a structured unified process.

However, the traditional Stage-Gate model was criticized for being too linear, rigid, inflexible, and controlling, especially for the most innovative and dynamic projects (Cooper 2014). In response to this and rising interest in agile methods to cope with volatile needs and ever-changing customer requirements gave rise to the next-generation State-Gate system and more Agile hybrid models (Cooper 2016, 22). Over the years, updates to the Stage-Gate model’s basic idea have emerged to “a more agile, vibrant, dynamic, flexible gating process that is leaner, faster, and more adaptive and risk-based”. Cooper calls the new system the Triple A because it is adaptive and flexible, agile, and accelerated. The next-generation idea-to-launch system (figure 1) has developed the flexibility to take the customer perspective and feedback into account. (Cooper 2014, 21–27.)

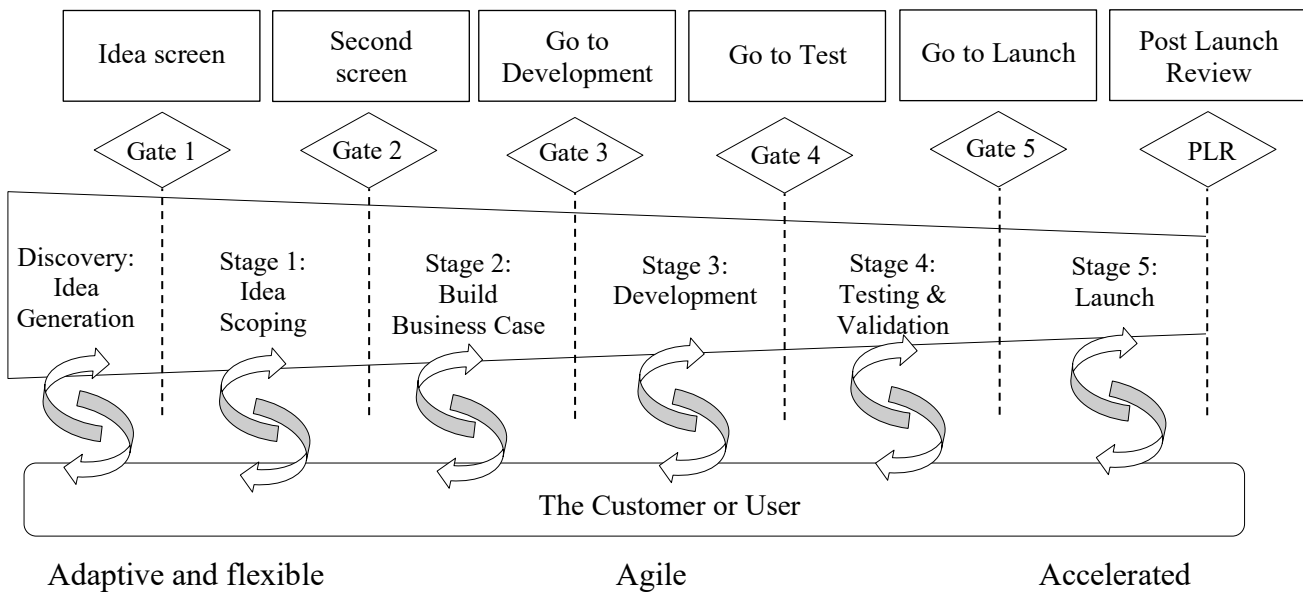


Figure 1 The next-generation idea-to-launch system (adapted from Cooper 2014, 21)

The spiral approach is designed to encourage experimentation and encourage project teams to fail often, fail quickly, and fail cheaply (Cooper 2019, 39). Stage activities are not happening in linear order but perform in parallel or on top of each other with looping, repetition, and back and forth activity within the gears. Each stage is associated with an

unpredictable number of iterations, and after each iteration, feedback is received from the customer on the result. (Cooper 2014, 21–22.) The steps are not precisely planned as in the traditional model but involve iterations according to agile methods. The process should operate according to agile policies, where all non-value-creating work is minimized. Agile methods improve communication within the development team and streamline design according to customer needs. The process is iterative with the customers or users, where each spiral incorporates the following steps: build, test, feedback, and revise. (Cooper 2014, 22–27; Cooper 2016, 21–23.)

To conclude, there has been a shift from the traditional linear innovation process to a more agile approach that emphasizes experimentation and customer involvement. The more radical an innovation is being developed, the less pre-set evaluation criteria and process steps will achieve a successful outcome. The different phases of the innovation process have different needs and requirements, and people with diverse qualifications and competencies are needed to create successful innovation. In this thesis, the innovation journey is described as a process that includes a series of events where innovation activities are perceived as those complex, interactive, and continuous processes that result in innovation.

2.1.4 Commercialization of a radical innovation

Innovation commercialization is “a process that aims to create and implement a feasible business model for an innovation-based product-service system in the surrounding business ecosystem” (Pynnönen et al. 2019, 341). It determines the success or failure of innovation and can be considered one of the most critical activities (Aarikka-Stenroos & Lehtimäki 2014, 1372). Commercialization is challenging as it handles new products for even unexplored demographic. Often it is considered the worst managed activity of the whole process. (Chiesa & Frattini 2011, 437.) A common challenge is a lead time, which must be short enough to respond to the identified market gap rapidly. Another matter is how to get various competencies together for co-operation in the different stages of the commercialization process and develop commercialization simultaneously with the innovation. (Pynnönen et al. 2019, 342.)

Scholars argue that companies that develop radical innovations focus too much on technical solutions and are unaware of the various commercialization activities that must be performed early in the process to be successful (Reid & de Brentani 2010, 514). It

describes the old perception of an innovation process where commercialization occurs only at the end of a linear innovation process when the finished product is offered to the customer. Commercialization is a series of events that go through innovation and where the idea becomes offered and brought to market. As the innovation process's interpretation has changed, researchers have found that many decisions and functions, such as marketing and value chain, technological development, and commercialization, interact and develop parallel throughout the radical innovation process (Aarikka-Stenroos & Lehtimäki 2014, 1373). The commercialization process's task is to combine several value-adding products and services to solve customer problems (Pynnönen et al. 2019, 343). Aarikka-Stenroos and Lehtimäki (2014) proposed a framework (figure 2) to commercialize radical innovation successfully.

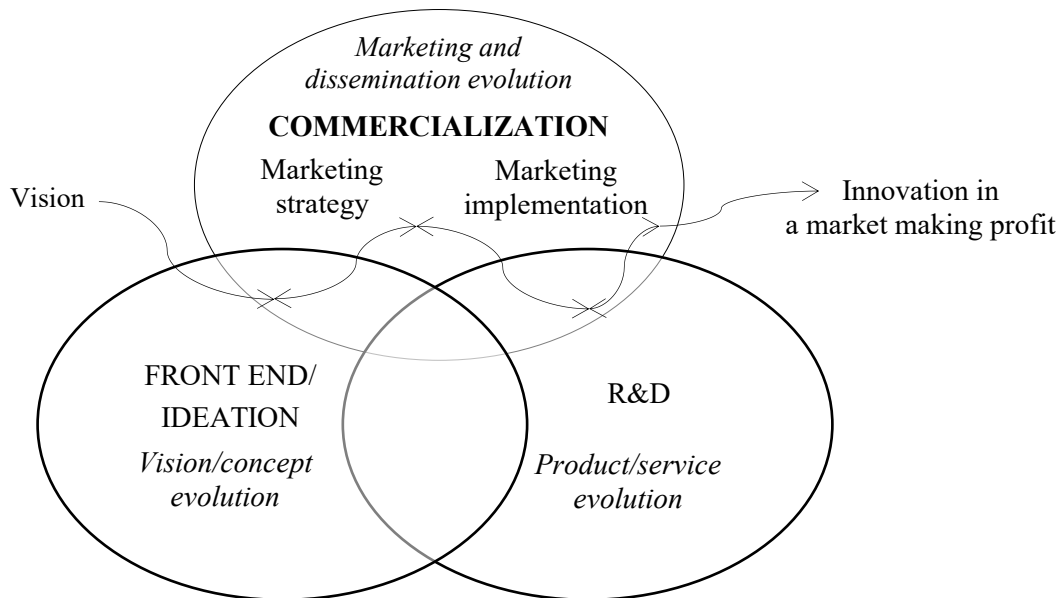


Figure 2 Framework for the process of commercialization (Aarikka-Stenroos and Lehtimäki 2014, 1374)

The process starts from a vision, moving to the marketing strategy and marketing implementation. The figure illustrates how the process is iterative, involving actions in the early phases in the front end and the research and development (R&D), and develops throughout the way. As stated earlier, different stakeholders' involvement is crucial in commercialization. A commercialization network refers to "a group of actors involved formally or informally in the commercialization of an innovation" (Aarikka-Stenroos &

Sandberg 2012, 199). For example, the actors in a commercialization network can be people, companies, or other organizations with the necessary resources, such as technical expertise, customer knowledge, market knowledge, or relationships. The network can also help manage legislation and standards, understand market dynamics, develop better solutions, support complementary offerings, or provide new distribution channels. Externals are also helpful in educating and demonstrating benefits and helping to form the critical mass behind innovation. (Aarikka-Stenroos & Lehtimäki 2014, 1379.) For successful commercialization, innovation requires a market introduction, diffusion, and acceptance among end-users (Garcia & Calantone 2002, 112).

To conclude, commercialization is considered as an iterative value creation process, and attitudes towards its importance have changed. The group of necessary activities start at the beginning of the process and co-created with customers and other partners to capture value, enhance productivity, and accelerate the time-to-market. Thus, firms can not underestimate the importance of commercialization capability, competencies, and the overall process. This means that companies must be agile, fast, exploratory, and decentralized. What the complexity of radical innovation brings regarding large companies will be next discussed.

2.1.5 Radical innovation in large companies

Companies' ability to renew themselves through innovation is one, and sometimes even the only way to succeed in the market. By introducing radical innovations, large companies can create a strategic advantage by conquering new markets and customers. However, they must stretch beyond current domains since there are no clear processes to follow. (O'Connor & McDermott 2004, 12–22.) The innovation theory suggests that large companies excel at incremental innovation. They know how to continuously improve known processes and products to existing markets and customers, but they rarely introduce radical innovations. (Assink 2006; Matthew & Brueggemann 2015, 71.) Scholars argue that they lack new business and new market creation competencies required to make radical innovation happen (O'Connor & Ayers 2005, 32).

Often large companies focus too much on their current position in the market and satisfy existing customers instead of looking for new routes that new products may lead to – that is, radical innovation (Matthew & Brueggemann 2015, 52). According to Stringer (2000, 71), “most large companies are genetically programmed to preserve the

status quo”. They tend to focus more on incremental innovations and design their internal organization to ensure day-to-day operations efficiency. The short-term focus is often a priority “over long-term orientation to the future, and where participants are rather uncertainty averse than risk aware” (Menzel et al. 2007, 740). However, it may hinder the pursuit of radical innovation (O’Connor & DeMartino 2006, 477). Incumbents may be reluctant to introduce radical innovations for three reasons: perceived incentives, organizational filters, and organizational routines (Chandy & Tellis 2000, 3).

However, scholars argue that large companies’ real challenge is not achieving great success through innovations but doing it again (Ringel et al. 2020, 11). To succeed, a company must understand the driving forces and barriers in a specific context (Chiesa & Frattini 2011, 439; Aarikka-Stenroos & Lehtimäki 2014, 1373). In a recent study of global innovation activities in large companies conducted by BCG (Ringel et al. 2020, 7), key findings resulted that large companies hinder to innovate for two reasons: “a lack of discipline in resource allocation and the difficulty of uniting the organization behind the innovation strategy”. Other scholars identify somewhat similar barriers. Sandberg and Aarikka-Stenroos (2014, 1299) describe the barriers such as restrictive mindset, lack of discovery competencies, and an unsupportive organizational structure. Assink (2006, 220–226) suggested somehow similar obstacles: adoption barriers, mindset barriers, risk barriers that are mainly financial, nascent barriers, for instance, lack of creativity, market sensing and foresight, and infrastructure barriers.

Nevertheless, a large organization often benefits from a vast talent pool they can leverage, its physical and financial resources, and its networks. Accordingly, many large companies have been able to utilize these opportunities to their advantage to introduce radical innovations to the market. (Chandy & Tellis 2000, 4.) Radical changes require learning new and unlearning from old and established ones – which is why incumbents may often fail. An organization may reject new ideas due to resource constraints or lack of competencies or because they are not perceived to fit its current strategy. (Tidd & Bessant 2013, 40.) The acquisition and integration of new competencies and operations may not easily adapt alongside other already established business units (Bessant et al. 2014, 1288).

Despite the sufficient resources that a large company usually has, the organizational structure may be a barrier to radical innovation (Sandberg & Aarikka-Stenroos 2014). Although there is a strong view in the literature about the damaging effects of bureaucratic and hierarchical structure on innovation, it is difficult to avoid the mechanism that firms

tend to increase layering with structures as they grow, making them more mechanical and bureaucratic (Lawson & Samson 2001, 393). For instance, according to Stringer (2000, 75), these types of environments often “discourage and de-motivate entrepreneurs who are the drivers of radical innovation: too many rules, too much compromise, too many meetings, and too little willingness to just do it”.

Previous experience and accompanying cognitive frames can blind the firm to see its opportunities and challenges (Bessant et al. 2014, 1286). Large companies often lose the capacity to be innovative “as some of the cultural enablers of previous incremental changes become the current cultural inhibitors of radical innovation” (McLaughlin et al. 2008, 300). Consequently, rather than focusing too many resources on internal R&D and existing networks, scholars suggest looking at external sources and emerging networks (Stringer 2000; Birkinshaw et al. 2007). Networks have an essential role in any innovation activity, and thus, fostering relations between people affects innovation capability, risk toleration and promotes individual growth and development (Menzel et al. 2007, 733).

One could think that a large company benefits from the reputation, but there are mixed results regarding whether a company can transfer its reputation from one market to another. For example, O’Connor and McDermott (2004, 26) argue that a company’s reputation can open new doors to new markets and partners to establish radical innovations. In contrast, Aarikka-Stenroos and Lehtimäki (2014, 1379) present that transferring a reputation to commercialize radical innovation appears challenging. At least, a firm should not be arrogant, and they should prepare for different levels of commercialization by combining a range of sources and competencies.

To conclude, this study concerns large companies that commercialize radical innovations, and the innovation process takes place in an open innovation environment. The innovation process emphasizes agility and iterations, as well as continuous collaboration. Radical innovation is a driver of organizational competitive advantage and strategic renewal. The barriers to successful commercialization have been well documented, and this section gives a solid understanding of them. Succeeding in innovation requires, among other things, continuous learning, building and acquiring competencies and capabilities, and active communication and collaboration with stakeholders (Bessant & Tidd 2018). The market or applications of new radical innovation are often unknown, technical feasibility is usually a significant problem, and sales forecasting is not easy. The next section answers what competencies mean at different levels and the identified radical innovation competencies.

2.2 Towards an integrated competence model

Competencies have been identified as an essential factor in a company's competitiveness in a rapidly changing and renewing world and strongly linked to companies' innovation capability. In this study, competence is understood as the driving force of radical innovation. An organization benefits from competencies when it creates value for customers, prevents the duplication of products and services, and helps the organization develop new business through innovations (Hagan et al. 2006, 359). In an organization, competencies occur at different levels, and competence links to the company's operations, industry, visions, and employees in several ways. This section explores competencies, both at organizational and individual and radical innovation competencies through previous studies.

2.2.1 *The notion of competence*

The interest in competencies in the management literature has grown since the 1960s (Jacob 2019, 168). Competence has various meanings and is thus one of the most fragmented terms in the organizational and professional literature (Murray 2003, 305). Competence is closely connected to capability as both manifest human abilities and skills. Thus, some authors use these terms interchangeably as synonyms. (Day 1994, 38; O'Connor & De Martino 2006; Boyatzis 2007, 6.) This study considers that competence supports capability, and as noted by Zhang et al. (2003, 176), "capabilities are visible to the consumer while the internal competencies that support those capabilities rarely are".

Spencer and Spencer (1993, 9) presented a commonly used definition of competence, which is defined as "underlying characteristic of an individual that causally related to criterion-referenced effective and/or superior performance in a job or situation". According to them:

- an *underlying characteristic* means that competence is "a fairly deep and enduring part of a person's personality and can predict behavior in a wide variety of situations and job tasks".
- *Causally related* means that competence "causes or predicts behavior and performance".
- *Criterion-referenced* means that the competence "predicts who does something well or poorly, as measured by a specific criterion or standard".

Competencies have long been recognized to refer to knowledge, skills, and related routines (Day 1994, 38). This study follows Sydänmaalakka's (2003, 142) definition of competence, which similarly proposes to include knowledge, skills, attitudes, experiences, and contacts that make good performance possible in each situation. It is the ability to act and apply knowledge, and ability means transforming competence into action. Competence builds on skills and knowledge, which "represents both the underlying knowledge base and the set of skills required to perform useful actions" (Fowler et al. 2000, 359).

The concept of competence originates from behavioral theory, where the maximum performance occurs when the competence is consistent with the task's requirements and the company's operating environment (figure 3). The behavioral approach defines competencies as "a set of related but different sets of behavior organized around an underlying construct, which we call the intent". (Boyatzis 2008, 6.)

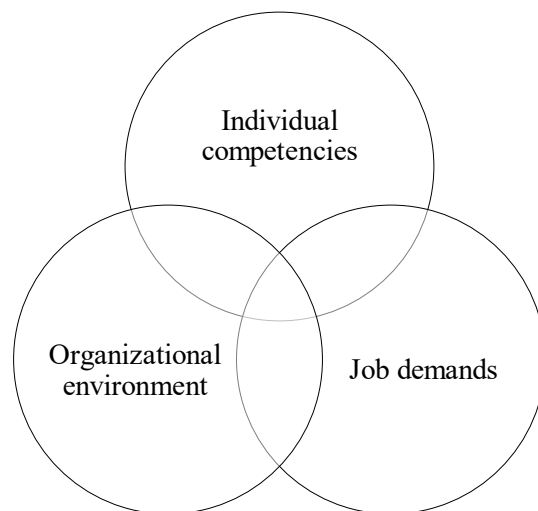


Figure 3 Model of action and job performance (adapted from Boyatzis 2008, 7)

Competencies encompass vision, values, knowledge, and interests. Job demand describes the responsibilities and tasks related to a person's position and the role that need to be performed, the decisions that need to be made, and the results that need to be achieved. Besides, aspects of the organizational environment are assumed to have a significant impact on the competencies. They comprise culture and climate, structure and systems, the industry's maturity and strategic location, and aspects of an organization's economic, political, social, and environmental elements. (Boyatzis 2007, 7.) The concept of competence encompasses both actions and intent that cause an individual's behavior. Competencies are interrelated but mutually different behavioral activities that organize

around an intention in each situation and time. (Spencer & Spencer 1994; Boyatzis 2008, 6; Bonesso et al. 2020, 18.)

Competencies arise from different building blocks, such as employees' competencies built through routines and the team (Van Kleef & Roemer 2007, 39). Those can be developed, learned, and described at different levels also to strengthen the ability to enable innovations (OECD 2005, 36; Van Kleef and Roome 2007, 43) and renew in the face of change that can be exploited to develop radical innovation. In addition, companies are more interested in the growing role of consumers in the innovation process. It has been suggested that consumers play an active role in developing a company's competencies as they affect new products that the company innovates. (Danneels 2002, 1115–1117.) The continuous development ensures that employees have the right kind of knowledge and ability to do appropriate work for themselves and the company. (Jacobs 2019, 168.) The development of competencies is not a linear, straightforward process, and it requires the readiness to change, learn, and unlearn from methods adopted and established (Augier & Teece 2009, 411). However, organizations need to be able to question current strategies and other familiar practices for learning to take place. They need to be able to think multidimensionally. Only by questioning the existing can the conditions be created for significant radical innovations. The learning journey is continuous, and competencies can and should be learned, developed, and changed. (Jacob 2019, 166–167.)

The competence model is often used in the literature interchangeably with the term competence. It is described as “a detailed and behavioral description of the qualities that employees need to be effective” (Mansfield 1996, 7). Thus, a set of competencies related to a job or role in an organization can be considered a competence model. Competencies are often viewed on two levels: organizational and individual competencies (Murray 2003, 305). Competencies can apply at both levels to prepare and support the individual and the organization to think differently and broadly (Dryer et al. 2009, 61–62). Håland & Tjora (2006, 1009) add asset and process concepts to the whole (table 3).

Table 2 Different perspectives on competencies (Håland & Tjora 2006, 1009)

	<i>Asset</i>	<i>Process</i>
Individual	Competence as individual asset	Competence as work performance
Organizational	Competence as the collection of the employees' individual assets	Competence as process and relations in everyday work in the organization

From the individual level, competence is understood as the characteristic and skills of the individual. From the point of view of the organization, competence is the accumulation of individual competencies of employees. On the other hand, the process describes competence from the individual's perspective as performance at work and from the organization's perspective as processes and relationships in the organization's day-to-day work. (Håland & Tjora 2006, 1009.) The following sections explore these in more detail.

2.2.2 *Organizational competencies*

It is essential to distinguish the individual competencies and organizational competencies. When an organization can build and develop the competencies of individuals simultaneously, the competence of the organization also increases. Although organization competencies are not the sum of individuals' competence, shared competence within an organization substantially increases that amount. Organizational competencies consist of processes, systems, and practices that enable individuals to transform competence into organizational competencies. (Murray 2003, 305–306.) In other words, organizational competencies are the skills an organization needs to succeed and remain competitive in the marketplace that depends on individuals' competencies. It refers to the ability to construct short-term changes and long-term organizational changes to enable the firm's sustainable development. When firm-specific assets are gathered in integrated clusters spanning individuals and teams to enable specific activities to be performed, these activities form organizational competencies (Teece et al. 1997, 516).

In an organizational context of innovation, the concept of *innovation capability* is often raised in the literature, referring to the organization's ability to innovate and be

innovative. Innovation capability is “the ability to continuously transform knowledge and ideas into new products, processes and systems for the benefit of the firm and its stakeholders” (Lawson & Samson 2001, 348). In other words, it is the result of learning processes that are continually being developed. Learning and transforming knowledge and ideas into new or improved products, processes, and systems for the firm’s benefit is the foremost goal of innovation capability. It is a company's critical core competence as an organization’s ability to innovate is considered a key driver of innovation management. A company’s ability to innovate depends on two things: the company's knowledge and the company’s ability to utilize this information. (Saunila 2016, 162–163.)

Core competencies, initially introduced by Prahalad and Hamel (1990), identify the organizations’ resources that enable companies to continually develop and innovate its products and services. They argue sustainable competitive advantage underlie in a company’s core competencies. Thus, “the real sources of advantage are to be found in management’s ability to consolidate corporate-wide technologies and production skills into competencies that empower individual businesses to adapt quickly to changing opportunities” (Prahalad & Hamel 1990, 81). Core competencies are an integrated set of competencies and technology that create unique customer value (Matthew & Brueggemann 2015, 11) and enable companies to set them apart from their competitors. (Hamel & Prahalad 1994, 202–211.) However, core competencies focus more on the organization than on the individual, shifting the focus from analyzing individual competencies and strategic planning to organization-wide thinking and providing a new perspective on competence management. An organization must identify which core competencies to build. The competence cycle (figure 4) illustrates how to identify and measure competencies (Tidd et al. 2005).

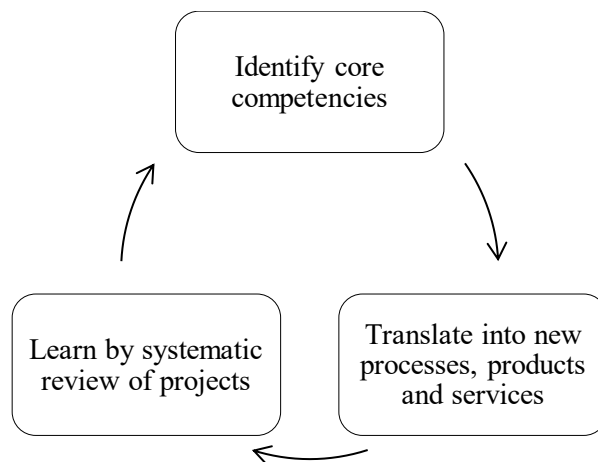


Figure 4 The competence cycle (adapted from Tidd 2006, 7)

The cycle consists of three questions: (1) “how are competencies identified and measured, (2) how are competencies translated into new products, services, and processes, and (3) how does an organization acquire new competencies” (Tidd et al. 2006, 7). For a company to benefit from its core competencies, those need to create synergies; core competencies must have a robust fit between the requirements of the innovation projects and the resources, competencies, and experience of the firm in terms of the following (Cooper 2019, 41):

- R&D or technology resources (ideally, the new product should leverage the business's existing technology competencies)
- marketing, sales force, and distribution (channel) resources
- branding, image and marketing communications, and promotional assets
- manufacturing, operations or source-of-supply capabilities and resources
- technical support and customer service resources
- management capabilities

These six synergy elements are beneficial for a company’s innovation development projects even though radical innovation projects may take the company to many unfamiliar areas: for instance, new customers with unfamiliar needs, unfamiliar technology, or an unfamiliar manufacturing process. Lack of these ingredients leads to uncertainty and high risk, which is the nature of radical innovation. (Cooper 2019, 41.) Nevertheless, few companies have the competencies to develop radical innovations sufficiently within a company (Story et al. 2011, 952, 966). Often when the project is directing to new or even undeveloped markets, it requires team members from outside the firm who have experience in related markets to understand foreign markets (McDermott & O’Connor 2002, 433). It can happen in various methods, including hiring new employees, purchasing equipment, licensed technologies, or other companies' acquisitions (Vanhaverbeke & Peeters 2005, 248). Thus, collaboration and open innovation can fill missing resources and competencies (Chesbrough 2003; Cooper 2019, 41).

2.2.3 Individual competencies

The importance of individual competencies has risen due to the emerge of knowledge work (Jacob 2019, 168). Individual competencies are a critical source for an

organization's ability to take advantage of opportunities and remain competitive. By them, a company can create innovations faster than competitors do while adapting to the evolving circumstances. It enables a company to provide customers with valuable products and services and innovate to produce new products and services as it adapts to changing conditions faster than its competitors. (Van Kleef & Roome 2007, 38–39.) Matthew and Brueggemann (2015, 10) define individual competencies as “the combination of learnable behaviors that encompass attitudes (wanting to do), skills (how to do), knowledge (what to do), practical experiences (proven learning), and natural talents of a person in order to effectively accomplish an explicit goal within a specific context”.

Although there are many different definitions of competencies and different ways of categorizes them, all definitions state that it consists of at least an individual's knowledge, skills, and characteristics that predict an individual's future behavior and success. At the individual level, competencies are the knowledge and skills related to being useful in a role (Jacob 2019, 166), including “a person's values, vision, personal philosophy, knowledge, competence, life and career stage, interests, and behavioral style” (Boyatzis 2008, 6). The competencies can be described using an illustrative Iceberg model developed by Spencer and Spencer (1993) (figure 5) in which skills and knowledge are the visible elements of competencies.

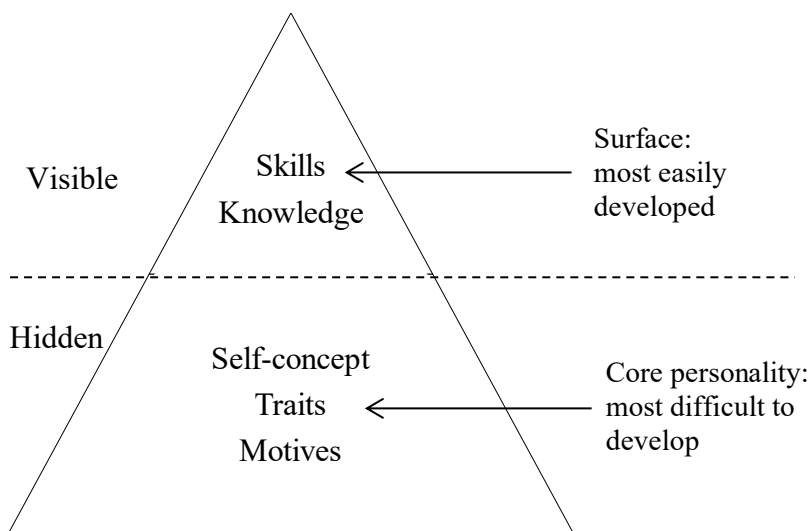


Figure 5 The Iceberg model of competencies (Spencer & Spencer 1993, 11)

In the visible part, skills refer to one's ability to perform a task, while motives create, guide, and direct action. Knowledge refers to specific knowledge related to a particular subject that predicts an individual's actual competence, which can only create value when

applied as required by the situation. (Spencer & Spencer 1993, 9.) Knowledge is often acquired through education and experience, and it is both explicit knowledge and tacit knowledge. Explicit knowledge mainly refers to knowledge expressed by visible elements such as text and databases. Tacit knowledge is intuitive knowledge born of experiences, which is difficult to explain by words or images. (Chen & Xu 2009, 216.) However, competence is applying expertise, which involves tacit knowledge, often experience-based understanding, and interpretation (Dealtry & Smith 2005, 9).

Moreover, the hidden part of the iceberg is formed by the individual's perceptions of oneself, individual traits (e.g., characteristics), and motives – the deeper reasons that allow the first to float. Traits are permanent human characteristics that determine situation-independent responses and styles. An individual's perception of themselves consists of the values and attitudes that guide an individual's behavior. (Spencer & Spencer 1993, 9–10.) Individual traits “influence how people think, act, respond and feel in various situations” (Jacobs 2019, 170). However, competence is seen as an outcome of a learning process; thus, not all scholars count competence as part of a personality or personal trait (Sydänmaalakka 2003, 107). Motives, in turn, guide an individual's behavior toward selected goals. Individual motivation reflects employees' attitudes and behaviors and their willingness to extend themselves to help their organizations succeed (Matthews & Brueggemann 2015, 94). Motives unknowingly or consciously guide and direct behavior for certain goals and aspirations. Self-concept, individual characteristics, and motives predict an individual's skills and behaviors, which, in turn, predict success at work. Although an individual's self-concept, traits, and motives fall below an iceberg's surface, they strongly influence an individual's actions. They form the basis for an individual's competence, a visible activity, and are therefore essential. They appear in the actions of the individual and the interaction of people. Such things that affect the surface are complicated to measure and develop, even though they are precisely the factors that significantly impact an individual's skills. (Spencer & Spencer 1993, 9–12.)

In summary, individual competencies are multidimensional. It covers the knowledge needed to reach a particular outcome, the ability to implement that knowledge, and the personality traits required to motivate for achieving the desired result. Companies need to develop and exploit individuals' competencies to accelerate the innovation process to respond to the existing and future challenges more effectively. The following section seeks what radical innovation competencies have been explored in previous studies.

2.2.4 Radical innovation competencies

The radical innovation competence is defined as “the ability to commercialize radical innovations repeatedly” (O’Connor & DeMartino 2006, 476) and across the organizational settings (O’Connor & Ayer 2005, 25). It is also described as “the internal driving energy to generate and explore radical new ideas and concepts, to experiment with solutions for potential opportunity patterns detected in the market’s white space and to develop them into marketable and effective innovations, leveraging internal and external resources and competencies” (Assink 2006, 219). O’Connor and DeMartino (2006, 489–492) studied radical innovation in major U.S. corporations and identified three phases and competencies that enable radical innovation: discovery, incubation, and acceleration (figure 6). These competencies are relevant, especially within large multinational organizations (Story et al. 2009, 475).

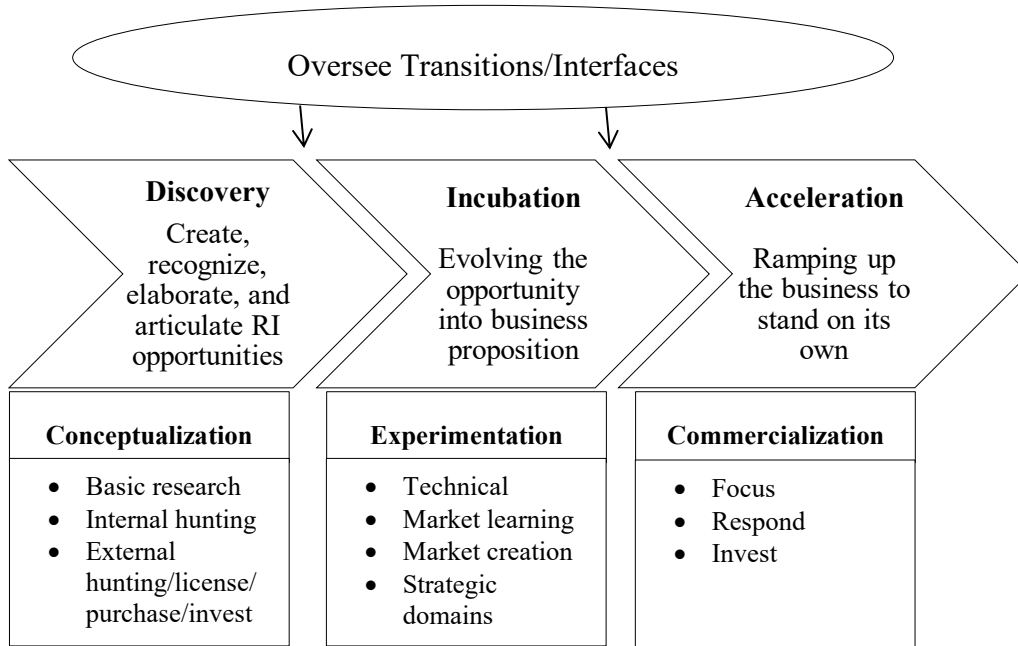


Figure 6 Three sets of competencies needed for radical innovation (O’Connor & Ayers 2005, 28)

Discovery is the ability to create, identify, develop, and express opportunities. Conceptualization can be done either internally or sourced from outside the company. Incubation capability makes the idea into exploratory business propositions where the primary competence is experimentation. Finally, acceleration competence enables exploitation and commercialization. (O’Connor & DeMartino 2006, 489–492). However, Story et al. (2009, 472) later added commercialization competence to the framework as

its own, as it is as critical as the other competencies regarding the success of radical innovation. The commercialization competence is essential to support “successfully capitalizing upon the network and ensuring that the final product is accepted by the market and delivers returns consistent with other products in the business’s portfolio” (Story et al. 2009, 472–473).

Innovation is a complex phenomenon and requires competence in multiple areas, ranging from technical skills to soft skills and learning ability (Stanwick & Beddie 2010, 30–31; OECD 2011, 31) and diverse competencies in each phase (Schilling 2019, 46). Hero et al. (2017, 104) defines individual innovation competence as “a synonym for a set of personal characteristics, knowledge, skills (or abilities) and attitudes that are connected to creating concretized and implemented novelties via collaboration in complex innovation processes”. In their study, they found 71 competence factors that they organized into six upper categories (Hero et al. 2017, 108):

- 1) Personal characteristics: flexibility, motivation and engagement, achievement orientation, self-esteem, and self-management
- 2) Future orientation: future thinking, alertness to new opportunities
- 3) Creative thinking skills: creativity skills, cognitive skills
- 4) Social skills: collaboration skills, networking skills, communication skills
- 5) Project management skills: process management skills, management skills
- 6) Content knowledge and making skills: content knowledge, making skills, technical skills.

Moreover, especially behavioral competencies have been in great interest in recent years. A behavioral competence has been defined as “an underlying characteristic of the person that leads to or causes effective or outstanding performance” (Boyatzis 1982, 20–21). Bonesso et al. (2020, 40) argue that fostering behavioral competencies for product innovation consist: “achievement orientation, pattern recognition, experimenting, opportunity recognition, strategic thinking, observation, and diagnostic thinking”. Drawing on the data from successful leaders’ performance of 5,000 executives and innovators from a large set of innovative companies, Dyer et al. (2009, 61–62) found five *discovery skills* that push new ways of thinking, encourage, and support innovation – most of them being behavioral competencies. The key innovators’ skills are questioning, observing, experimenting, networking, and associating. The first four competencies are behavioral competencies related to the way things are done, and the last is a cognitive skill related to the innovator’s thinking. Associating helps combining unrelated ideas can

generate new insights and ideas; it is about connecting the dots. The findings are rather in line with Pisano's (2019) competence profile for leading to better innovation performance. It consists of five competencies: (1) tolerance for failure, (2) willingness to experiment, (3) psychological safety, (4) collaboration, and (5) organizational flatness (Pisano 2019, 5).

This study utilizes the competencies framework with five dimensions proposed to assess the radical innovation process's key competencies in large organizations. However, the competencies are categorized as a combination of the above competencies that goes hand in hand: experimentation and risk tolerance, network competence, leadership and entrepreneurial competence, and commercialization competence (Story et al. 2009) as its own. A description of each dimension follows.

Risk tolerance and experimentation. Two common themes that motivate successful innovators are (1) the desire to change the status quo and (2) take risks to make that change happen (Dyer et al. 2009, 66). Radical projects often involve much uncertainty and high risk, which requires participants to be risk tolerant. The management and organizations' support and acceptance for failure. (Kelley et al. 2011, 264.) deal with uncertainty and unexpected results (Toner 2011, 29). When disappointments and mistakes occur, innovative companies learn their lessons and are open about them. They have generally internalized a systematic process for evaluating failed projects as valuable opportunities to learn and develop. (Lawson & Samson 2001, 394.) Thus, tolerating failure is essential concerning the nature of radical innovations, but it also requires an intolerance for incompetence (Pisano 2019). To fail, a company needs to experiment, which is an essential part of radical innovation's competencies (O'Connor and DeMartino 2006, 489). With experimentation, successful innovators observe small details that can lead to new ways of doing things and seeing what is not there (Dyear et al. (2009, 62). Relating to experimentation and taking risks, psychological safety is important regarding accepting individuals to speak openly and honestly and, critically, without retribution fears (McLaughlin et al. 2008, 12; Pisano 2019, 5–8).

Social competencies. Social competencies are divided into three sub-categories: collaboration, networking, and communication skills (Hero et al. 2017). Collaboration as one of the innovation competencies is vital to harness the alliances, networks, relationships, and potential synergies (Pisano 2019, 9). The interaction with people from diverse backgrounds enables companies, for instance, to uncover new insights and

perspectives (Dyer et al. 2009, 62). Moreover, external partner integration is considered an essential factor that affects innovation speed (Ellwood et al. 2017, 522).

This study considers innovation processes to follow open innovation activities that consist of three broad tasks suggested by Chatenier et al. (2010, 273): (1) managing the inter-organizational collaboration process, (2) managing the overall innovation process, and (3) creating new knowledge collaboratively. All the activities require the three mentioned social competencies. Companies can be achieve more through collaboration, and therefore, a company needs to develop, build creativity, and innovate together. (Sawyer 2006; Tidd & Bessant 2013, 133.) Thus, the real added value arises from the multidimensional capability to leverage various sources and competencies. However, collaboration must be balanced with individual accountability to ensure performance excellence and know whom to turn to when problems or failures occur to avoid “a dysfunctional climate in which everyone jealously protects his or her own interests” (Pisano 2019, 11). The importance of boosting soft skills, such as communication and teamwork, is crucial in promoting innovation (OECD 2011, 43–47).

Sydänmaalakka (2003, 118) defines networking competence as “the ability to continuously build and maintain friendly contacts and networks with people which can someday be useful in your work”. According to Aarikka-Stenroos and Sandberg (2012), there are two types of network relations in a radical innovation process: an R&D network and a commercialization network. Network competence in R&D refers to identifying and involving resources for R&D and managing the network for technological development. Whereas they argue that network competence in commercialization is the ability to (Aarikka-Stenroos & Sandberg 2012, 200):

- access resources for the commercialization through social relations and trust building
- mobilize resources for the commercialization through motivating and providing resource trade-offs
- organize resources for the commercialization and accommodate interconnectedness, reciprocity, and goal coherence

Active presence and participation increase innovation efforts, while the absence of networks can even risk radical innovation. Innovation projects emphasize opportunities seeking, visionary thinking, and bringing together different professional cultures, and social skills such as teamwork and network building are essential. (Menzel et al. 2007, 733.)

Leadership and entrepreneurial competencies are an area of expertise discussed in the literature to turn ideas into innovation and enable companies to adapt and respond in competitive environments. Leadership is emphasized to be one of the key factors (Hanel 2008, 8). Sydänmaalakka (2003, 121), in his dissertation, has described leadership competencies through the leadership competence tree, which comprises six areas: professional competence, interpersonal competence, leadership competence, efficiency competence, well-being competence, and self-confidence. The leadership competence consists of six competencies: visioning, achievement, empowerment, team leadership, teaching, and change management (Sydänmaalakka 2003, 118–119). The roots of the tree describe the values and principles of the leader, the energy and talent, and the personality and self-awareness. However, he notes, “many competencies need a wide experience-background before they can really develop. This is especially true when it concerns leadership competencies” (Sydänmaalakka 2003, 107).

Radical innovation has many characteristics with entrepreneurial activities (Riel 2011, 10) and competencies (O’Reilly & Tushman 2004, 8), as discussed in section 2.1.2. Often, corporate entrepreneurship, intrapreneur, is the basis of innovations and firm renewal (Menzel et al. 2007, 732). Entrepreneurial characteristics consist of “passion, planning with vision, tools with the wisdom to use them, strategy with the energy to execute it and judgment with the propensity to take risks” (Tidd & Bessant 2013a, 8). The mindset of intrapreneurship arises from reflection, collaboration, and analysis of activities involving various stakeholders. (Menzel et al. 2007, 739.) The general perception is that the use of cross-functional competencies may lead to accelerated innovation outcomes (Ellwood 2016, 517, 522; Cooper 2019, 43). However, instead of cross-functional teams, radical innovation teams are formed of highly multifunctional individuals who have entrepreneurial characteristics (O’Connor & McDermott 2004; O’Connor 2008, 323). Moreover, entrepreneurial competencies are increasingly needed in large companies and mature industries.

Commercialization competence. Commercialization is identified as one of the four radical innovation competencies (Story et al. 2009). Remarkably, competencies required for commercialization are different from those required for scientific research and R&D. For instance, scholars have emphasized risk-taking aspects in presenting new ideas. (Hanel 2008, 8.) In a study of behavioral competencies for innovation, at different stages of the innovation process, the members of the marketing unit emphasized social competencies and strategic thinking competence. According to it, the most important

social competencies are persuasion, teamwork, and customer orientation. (Bonesso et al. 2020, 59.) Aarikka-Stenroos and Lehtimäki (2013) examine how the commercialization competence develops and propose a model shown in figure 7.

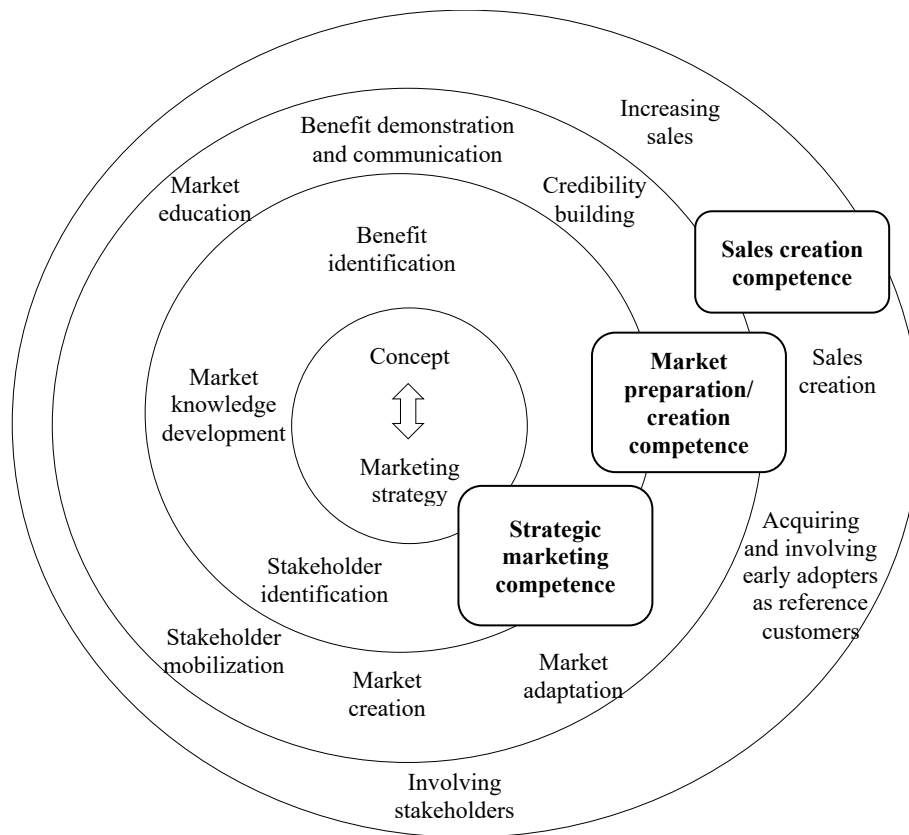


Figure 7 Dynamic commercialization process model for radical innovation (Aarikka-Stenroos & Lehtimäki 2013, 192)

The model is divided into three zones which build-up a specific competence. The authors describe the zones as follow (Aarikka-Stenroos & Lehtimäki 2013, 190; 2014, 1379):

- 1) *Strategic zone of commercialization*. It includes competencies for developing a profitable and realizable business model around the innovation, “including developing knowledge on the market, customers, and ecosystems, identification of stakeholders, and potential attractive benefits of the innovation for the market”.
- 2) *Market creating and preparation zone*, requires competencies for understanding the antecedents of adoption and facilitating it, and building credibility for the innovation. It includes “building awareness, educating the market, demonstrating, and communicating benefits, building credibility for the firm and product or service, involving and activating stakeholders”.

- 3) *Sales creating and development zone*. Competencies for “creating and developing sales, including acquiring initial sales and customer references, mobilizing stakeholders, and increasing sales”.

The zones build during development, and the idea is to return to them whenever necessary. Many decisions and functions, technological development, and commercialization interact and develop parallel during the radical innovation process (Aarikka-Stenroos & Lehtimäki 2014, 1373). The radicalness of innovation influences the market’s perception; the more innovative a product is from a market perspective, the longer and more difficult it is in the market preparation area (Aarikka-Stenroos & Lehtimäki 2014, 1379). Thus, to capture value for customers, competencies linked with managing risk and concluding appropriate commercialization strategies are foregrounded. In practice, markets for highly innovative products usually do not yet exist or are very limited. Therefore, companies need to try and test different ways to commercialize innovation. Especially radical innovation requires “learning as you go” capability. (O’Connor et al. 2008, 20.) Eventually, the experimenting process will lead to the emergence of a new market, increased competition, and various ways to take advantage of new technology. (Garcia & Calantone 2002, 121–122.)

When a company succeeds in developing and commercializing innovations, it can build and expand its knowledge and competencies. Therefore, new business development acts as an enabler for developing new competencies in the company and plays a vital role in renewing of the company’s technical capabilities, core competencies and long-term profitability. (Vanhaverbeke & Peeters 2005, 248.) Superior commercialization competence is then among the most critical competitive challenges managers face in new business development. However, competencies are not operating in an empty box. Thus, the next section discusses how innovation management and dynamic capabilities foster both radical innovation and the development of competencies. How can large companies organize to harness the potential of radical innovation?

2.3 Fostering radical innovation

Conscious development of innovation requires a process of change that involves leadership and managerial work. As noted earlier, innovation acceleration is in the interest of large companies. Scholars argue that efficient time and innovation management are solutions to reduce time-to-market (Ellwood 2016, 512). This section provides an

overview of innovation management and dynamic capabilities and considers how they support radical innovation.

2.3.1 Innovation management practices

Innovation management acts as a link between the company and innovation. Without leadership, they may not realize the competencies either; therefore, it is essential for research to look at innovation management. It is regarded as a management field that guides innovation activities in companies and the results achieved through them (Apilo et al. 2007, 228) that can also be considered organizational competence (Lawson & Samson 2001, 377). Innovation theories are a key concept affecting organizations where employees are understood as individuals who want to learn, develop, and innovate (Matthew & Brueggemann 2015). Innovation management is often based on two basic assumptions: innovation is a process, and it is possible to influence this process (Tidd & Bessant 2013, 86). Leading an innovative organization and team is paradoxical, and leaders should carefully manage tensions arising from its processes. In recent studies, proper discipline and management are emphasized, even though creativity and freedom are part of an innovative culture and operations (Pisano 2019, 5–7).

Innovation management is not an automated process but requires various skills, knowledge, experience, and practice. Most of the management training and guidance aim to maintain stability, which is why companies cannot apply the same procedures to managing radical innovation. (Tidd & Bessant 2018b, 2.) Innovation management practices link to performance and success in innovation. For instance, Tidd and Thuriaux-Alemán (2016, 1025) define innovation management practices as any structured administrative or technical help to influence the innovation process's efficient implementation. In their study of the effectiveness of innovation management practices across and within sectors, scholars identified four specific methods most significantly associated with higher innovation performance (Tidd & Thuriaux-Alemán 2016, 1036):

- 1) Use of external sources in a structured way.
- 2) Technology is understood in terms of its quantified contribution to corporate goals.
- 3) A systematic review of portfolios.
- 4) Mobilizing the whole organization to develop new ideas.

Other recognized practices are such as idea value chain, co-innovation, and continuous learning (e.g., Riel 2011, 12). There are contrary views of innovation management

practices if they share similarities across industries. While it is argued that there may be a small core of innovation management practices globally, the general perception is that the use and efficiency of most them vary by the industry, making them highly context specific. (Tidd & Thuriaux-Alemán 2016, 1028–1036.) However, many scholars suggest that the process of innovation can be managed, organized, and replicated in companies, as successful innovation involves core elements and processes that are independent of industry (Lawson & Samson 2001, 378).

According to Apilo and Taskinen (2006), the innovation process is managed by means indicated by the innovation strategy in organizations and networks, supported by the innovation structure and culture in innovation management. They find specific factors of innovation management, shown in figure 8.

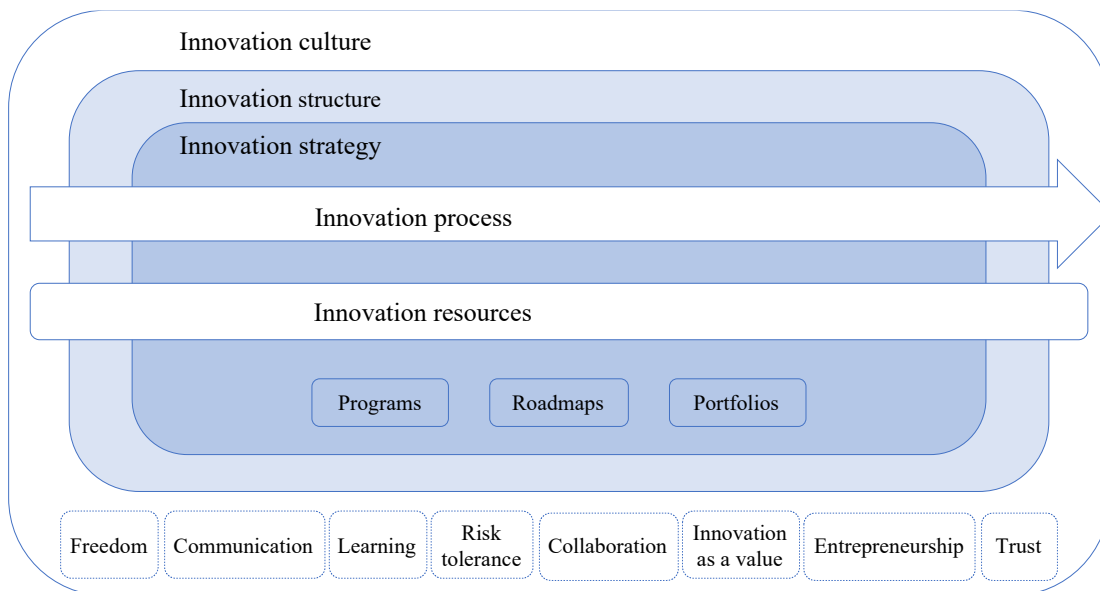


Figure 8 Main factors of innovation management (adapted from Apilo & Taskinen 2006, 8)

Organizational culture is one of the most discussed factors influencing an organization's ability to lead innovation and has even been identified as a primary driver of innovation (Smith et al. 2008, 663; Cooper 2019; Pisano 2019). Innovation requires a leadership style that supports culture, tolerates risk, and an organization that has enough resources to support all competence areas. These all link to *innovation culture*, and without these, it suffers, leading to poor results. (Matthew & Brueggemann 2015, 24.) Innovation culture refers to the organization's approach to experiment and address emerging aspects, but also to organizational values and beliefs and how these affect an

organization's ability to lead innovation (Smith et al. 2008, 661). A proper culture and climate help build trust, build relationships, and encourage independent decision-making in organizations (Matthews & Brueggemann 2015, 97). Things that foster the culture include learning, communication, co-operation, trust, freedom, innovation as an organizational value, risk tolerance, and entrepreneurship (Apilo & Taskinen 2006, 8). Besides, building an encouraging and positive atmosphere maintains an innovative culture (Lawson & Shawson 2001, 294). The development of it hinders by the emphasis on failures and searching for culprits for them. Also, companies should avoid rewarding individual performance based on short-term results. (Apilo & Taskinen 2006, 41.)

Developing, modifying, and supporting an idea requires people from different levels of the organization and different competence areas. Those construct an *innovation structure* that describes how the organizational structure supports innovation, including the innovation process and knowledge management, information systems, processes, and organization structure. (Apilo & Taskinen 2006, 8, 32.) *Innovation strategy* provides direction and guidance for the development of new innovations in the organization. It is an integral part of successful innovation and links to a company's overall business strategy. Whereas *innovation resources* tell whether a company has enough resources for innovation activities and how those are utilized, including technical competencies, market knowledge and learning ability in the company and its networks. (Apilo & Taskinen 2006, 27, 32.)

The general view is that the same management practices do not apply to incremental and radical innovation. The differences have been observed, particularly in strategy, structures, and leadership. Radical innovations are unpredictable, risky, and complex, making the innovation process and its management more complicated (McDermott & O'Connor 2002, 434). It requires management practices that often conflict with the operations in mainstream organizations (O'Connor et al. 2008, 6). The traditional aspects of process management, evaluation, and monitoring are not as central as in incremental innovation, but the process requires different management skills. It can include negotiation skills, tolerance for uncertainty, or strong decision-making ability in complex circumstances. (McDermott & O'Connor 2002, 434.) The key challenges in managing radical innovation are

However, there are plenty of innovation models that are often complex and "require emotionally intelligent employees, who are able to understand and manage themselves and others," which must consider organizing the innovation process (Bonesso et al. 2020,

9). Scholars suggest that radical innovation needs an entrepreneurial approach from managers. Someone with passion (Kelley et al. 2011, 261) can make the team's work more comfortable, giving them autonomy and instructions (Ringel et al. 2020). According to Cake et al. (2020, 7), "the hiring of new managers who may already know the new radical innovation product or service segment and do not have a firm bias or dogmatism may be necessary".

Moreover, scholars agree that companies can support radical innovation activity by evolving project management competencies and organizational structures and processes (O'Connor et al. 2008, 6). The leaders of a radical innovation project are responsible for monitoring uncertainties, determining what to take care of at any given time, and deciding which direction to choose from among the many possibilities (O'Connor & McDermott 2004, 20–21). Managing incremental innovation is more about managing knowledge, whereas managing radical innovation requires the management of ignorance and uncertainties (Davila & Epstein 2014, 5–6). Many scholars have explored innovation management capabilities that enable radical innovation (e.g., O'Connor 2008; Kelley et al. 2011; Chang et al. 2012). Some discuss that innovation management capability is a learned competence that "combines business-building experience, diverse thinking, and the ability to work under high ambiguity" (Kelley et al. 2011, 261). According to O'Connor (2008), a management system for radical innovation should cover these seven elements:

- 1) A clearly identified organizational structure
- 2) Internal and external linkages mechanisms
- 3) Exploratory processes
- 4) Requisite skills
- 5) Appropriate governance and decision-making mechanisms and criteria
- 6) Appropriate metrics
- 7) Suitable cultural and leadership context

These elements are interdependent, and therefore their development requires changes to all components of the system. Chang et al. (2012, 441) suggest somewhat similar capabilities develop radical innovation performance: openness capability, autonomy capability, integration capability, and experimentation capability. Openness implies the ability to collect ideas and competencies from various sources. Autonomy means a company's ability to encourage and tolerate risky, vague, failed radical ideas. Integration capability refers to the integration and adaptation of radical innovation to mainstream

business. While experimentation is the ability to explore, experiment, and commercialize radical ideas in the R&D, manufacturing, and marketing industries. According to Tidd and Bessant (2013), the components of successful innovation management are supporting and encouraging innovation culture across the organization, providing feedback, creating the conditions for critical and innovative thinking, adequate resources for individual innovation, management commitment to innovation, project-based organizational learning and promoting and highlighting the importance of innovation in visions and strategy (Tidd & Bessant 2013, 86). The above categorizations have similarities, such as a culture of experimentation, supporting organizational culture, and external linkages. Hence, those can be viewed as the building blocks of efficient innovation management.

To conclude, a project leader of radical innovation has two roles in orchestrating the project. To begin with, providing support to teams and individuals in making ideas into innovation. They must ensure adequate resources as capabilities and competencies can lead to better performance and success (Augier & Teece 2009, 411–412). Second, they manage to keep innovations in line with the organization's goals and operations. They must seek “new value-enhancing combinations inside the enterprise, and between and amongst enterprises, and with supporting institutions external to the enterprise” (Teece 2007, 1341). Moreover, a key management task is to enable and manage innovation-related knowledge creation and implementation processes. This development, also known as dynamic capability (Tidd 2006, 127), is discussed next.

2.3.2 *Dynamic capabilities*

The need to explore dynamic capabilities began to appear in the 1990s to seek this problem when resource-based thinking could not explain individual companies' competitive advantage in rapidly and unpredictably changing operating environments (Teece et al. 1997). The resource-based view has been characterized as the ancestor or ‘sister theory’ of dynamic capabilities. Its purpose is to describe from which internal sources a competitive advantage arises or, correspondingly, which lacks or gaps in internal sources hinder competitive advantage. (Eisenhardt & Martin 2000, 1106.) The perspective sees capabilities as static and does not consider how capabilities are combined or modified according to the environment.

Wang and Ahmed (2007) define the firm's hierarchical order resources: resources, capabilities, core capabilities, and dynamic capabilities. Resources, the “zero-order”, is

the basic element of the resource-based view that can provide a short-term and sometimes even lasting competitive advantage if they are unique and based on valuable, rare, imperfectly imitable, and not substitutable (VRIN criteria). (Wang & Ahmed 2007, 34–35.) The resource-based view has been criticized for not considering how to keep a company's resources beneficial over time (Teece et al. 1997). Thus, dynamic capabilities have attracted attention because it helps understand how firms create a sustained competitive advantage in a changing business environment as part of strategic management (Helfat & Peteraf 2009, 91). For understanding the dynamic capabilities, it is essential to note that companies have two types of capabilities they need operational (ordinary) and dynamic capabilities (Teece et al. 1997; Winter 2003; Helfat & Peteraf 2015). Operational capabilities are essential for the firm's daily operations, such as customer segments or production lines (Schilke et al. 2018, 393) or market and technological capabilities (Danneels 2002). In other words, dynamic capabilities define an organization's capability to continuously develop its resource base.

Two studies have already long time dominated the academic debate on dynamic capabilities: Teece et al. (1997) and Eisenhardt and Martin (2000). They provide different and somewhat contrary views on the nature of dynamic capabilities, which is why the theoretical field of dynamic capabilities is complex and not uniform (Di Stefano et al. 2014, 308). Teece et al. (1997, 516) define dynamic capabilities as a firm's capability to integrate, build, and reorganize internal and external competencies to respond quickly to changing operating environment conditions. Dynamic capabilities are more in intangible organizational skills, resources, and functional competencies, reflecting an organization's capability to generate a new kind of competitive advantage in the current market environment. It is done by “adapting, integrating, and reconfiguring internal and external organizational skills, resources, and functional competencies” (Teece 1997, 515). Whereas Eisenhardt and Martine (2000, 1107) describe them as the organizational and strategic routines and business processes to use resources in the best possible way that requires integration, reconfigure, gain, and release resources to match and even create market change. Thus, they state dynamic capabilities are the firm's resource base that includes physical, human, and organizational strengths.

However, there is no universal definition for dynamic capabilities. The definition has evolved, and the following explanations have been brought to make incremental improvements. Ambrosini and Bowman (2009) reviewed the explanations shown in table 2 that is adapted with the latest definitions.

Table 3 Selected definitions of dynamic capabilities (adapted from Ambrosini & Bowman 2009, 32–33)

Definition of dynamic capabilities	Author(s)
“The capacity to renew competencies so as to achieve congruence with the changing business environment.”	Teece et al. (1997, 516)
“The firm’s processes that use resources – specifically the processes to integrate, reconfigure, gain, and release resources – to match or even create market change.”	Eisenhardt and Martin (2000, 1107)
“A dynamic capability is a learned and stable pattern of collective activity through which the organization systematically generates and modifies its operating routines in pursuit of improved effectiveness.”	Zollo and Winter (2002, 340)
“Those that operate to extend, modify, or create ordinary capabilities.”	Winter (2003, 991)
They are “the abilities to reconfigure a firm’s resources and routines in the manner envisioned and deemed appropriate by its principal decision-maker.”	Zahra et al. (2006, 918)
They “refers to the capabilities of a company to integrate, build, and reconfigure internal and external resources/competencies to innovate in rapidly changing environments.”	Teece et al. (2007, 1319)
“A firm’s behavioral orientation constantly to integrate, reconfigure, renew and recreate its resources and capabilities and, most importantly, upgrade and reconstruct its core capabilities in response to the changing environment to attain and sustain a competitive advantage.”	Wang and Ahmed (2007, 35)
“The capacity of an organization to purposefully create, extend or modify its resource base.”	Helfat et al. (2007, 1)
“The firm’s potential to systematically solve problems, formed by its propensity to sense opportunities and threats, to make timely and market-oriented decisions, and to change its resource base.”	Barretto (2010, 271)
“Dynamic capabilities enable firms to identify profitable configurations of competencies and assets, assemble and orchestrate them, and then exploit them with an innovative and agile organization.”	Schoemaker et al. (2018, 17)

Common to all definitions presented in the above table is that the dynamic capabilities are the organizational level capabilities. As thought by Schilke et al. (2018, 393), “dynamic capabilities can be considered a distinct subset of organizational capabilities; specifically, they are those capabilities that can affect change in the firm’s existing resource base, its ecosystem, and external environment, as well as its strategy”. Dynamic capabilities enable an organization to identify profitable arrangements of competencies and assets and exploit them with an innovative and agile organization (Schoemaker et al. 2018, 17). However, some researchers connect individual-level capabilities to influence dynamic capabilities. For example, in Zahra et al. (2006) definition, dynamic capabilities are affected by individual-level capabilities when they define dynamic capabilities to reorganize firm resources and routines as desired and envisioned by managers. Hence, Helfat and Peterad (2015) suggest that especially individual competencies and knowledge have come to the forefront, the study of which is now an integral part of the dynamic capabilities (Schilke et al. 2018, 403).

In this work, dynamic capabilities are defined by Schoemaker, Heaton, and Teece (2018) as a firm capacity “to identify profitable configurations of competencies and assets, assemble and orchestrate them, and then exploit them with an innovative and agile organization” (Schoemaker et al. 2018, 17). A few reasons justify why this definition is chosen for this study. First, this definition is a synthesis from the long-dominated seminal works of dynamic capabilities by Teece et al. (1997) and Eisenhardt and Martin (2000). Second, it suits this study’s purpose; to understand the key competencies to accelerate a radical innovation process in large companies and explain how dynamic capabilities influence the development of those competencies. Third, this definition observes both the development of internal and external competencies, thus, “how ordinary capabilities should be combined and reorchestrated inside the firm, and which capabilities need to be added or retrenched”. (Schoemaker et al. 2018, 18).

Dynamic capabilities are particularly crucial in fast-paced industries (Teece 2007, 1319). Examples of this are multinational companies and, on the other hand, industries where technological change is rapid. Somewhat differing perception sees dynamic capabilities essential also in “moderately dynamic” markets, where “change occurs frequently, but along predictable and linear paths” (Eisenhardt & Martin 2000, 1110). However, dynamic capabilities are not an ad-hoc problem-solving or spontaneous response but always include some appropriate object (Winter 2003, 992; Ambrosini & Bowman 2009, 33). In the past, stable environments and sectors dominated by large

companies have evolved into complex ones. Thus, agility has become one of today's critical dynamic capabilities. (Roberts & Grover 2012, 579.) A rather common understanding is that dynamic capabilities create value for an organization because it helps build and maintain its long-term profitability (Teece 2018). Dynamic capabilities enable a firm to influence changes to achieve a sustained competitive advantage (Teece et al. 1997; Helfat et al. 2007; Wang & Ahmed 2007; Ambrosini & Bowman 2009, 32).

Nevertheless, they alone do not necessarily guarantee continued competitive advantage and higher company performance (Eisenhardt & Martin 2000). Some even argue that a firm may be able to operate without dynamic capabilities (Winter 2003). However, without dynamic capabilities and relying only on resources and competencies, a company can stay in the market and survive the competition for a short time but not for the long term except due to chance (Teece 2007, 1344). Through these perceptions, dynamic capabilities' importance comes when a company should renew its valuable resources as the external environment changes. In summary, dynamic capabilities can be used to create and adapt firms to meet the external business environment's challenges and circumstances, and they "serve as the bridge between the present and future" (Schoemaker et al. 2018, 18).

2.3.3 *Elements of dynamic capabilities*

There are various views on the elements of dynamic capabilities. Wang and Ahmed (2007, 36) identify three factors of dynamic capabilities: *adaptive capability*, *absorptive capability*, and *innovative capability*. The adaptive capacity helps organizations adapt to changes in the environment. The absorptive capacity enables organizations to prepare for the future by integrating new knowledge. Finally, innovative capability means applying theory and knowledge in practice and understand what the other two capabilities can produce. The innovative capability also includes the ability to adapt structures to guide innovative behavior through organizations. (Wang & Ahmed 2007, 36.) In comparison, Teece et al. (2007) identify three factors to include capabilities that constitute processes that express dynamic capabilities: *sensing*, *seizing*, and *reconfiguring*. These capabilities are further explored in this study.

Factors defined by Teece et al. (2007) reflects the value creation process of a firm (Ambrosini & Bowman 2009). These factors are described as follow (Teece et al. 1997; 2007; 2018; Schoemaker et al. 2018, 19–22):

- *Sensing*: the capacity to sense and shape opportunities and threats, as well as assessing them.
- *Seizing*: seizing capabilities forms when new opportunities are identified and captured by investing resources in them.
- *Reconfiguring*: continued renewal (“transforming” or “shifting”) to maintain competitiveness, combining, protecting, and strengthening capabilities, and when necessary, reconfiguring the organization’s intangible and tangible capital.

Sensing, seizing, and reconfiguring capabilities are considered higher-level capabilities. Second-level dynamic capabilities are considered micro foundations, including various skills, process practices, organizational structures, decision-making routines, and rules (Teece 2007, 1329–1330) that are recognized to facilitate strategic change (Helfat & Peteraf 2015). The activities for each dynamic capability defined by Teece (2018) are illustrated in figure 9.

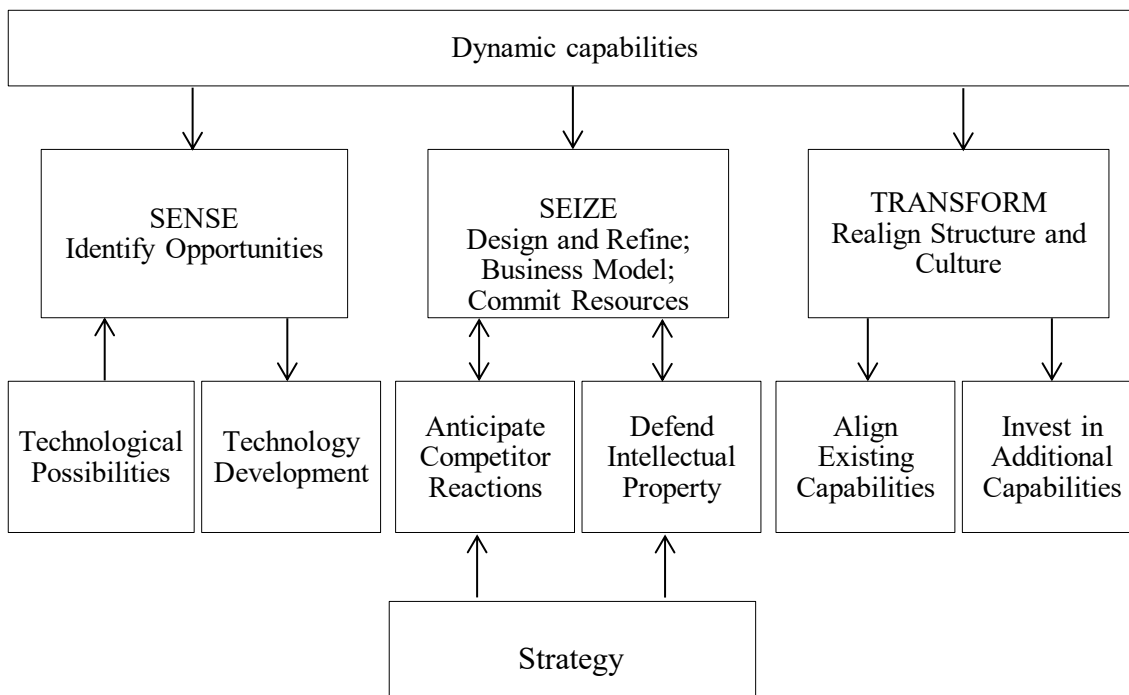


Figure 9 Dynamic capabilities (Teece 2018, 44)

More specifically, the process of sensing involves intensive market research aimed at gathering information and enabling organization-wide learning about the market, customers, competitors, and the company’s external environment (Augier & Teece 2009). It means feeling "weak signals in the broader marketplace at a fundamental level, including government regulations, technological developments, economic trends, and

sociopolitical currents" (Schoemaker et al. 2018, 20). Thus, sensing activities may involve investing in research activities and customer needs, latent understanding demand, and evaluating likely supplier and competitor responses. It also requires an understanding of latent needs, structural changes in industries and markets, and suppliers and competitors' activities (Teece 2007, 1322). Many scholars emphasize both the creative and analytical organizations' capabilities in sensing capability (Teece et al. 1997; Zollo & Winter 2002; Teece 2007).

Research on seizing market opportunities focuses on experimentation, development, and firm decision-making (Teece et al. 1997; Eisenhardt & Martin 2000; Zollo & Winter 2002), where learning and exploration are essential emphases. Moreover, these activities are also underlined in sensing and transforming. Seizing market opportunities promptly by "successfully innovating and implementing new systems that take advantage of external changes". (Schoemaker et al. 2018, 21, 29). Seizing opportunities nearly always requires investment in development and commercialization activity. Significant changes in the operating environment often create new opportunities, which requires the organization to have capabilities and competencies and operating models that differ from continuous improvement. However, the ability to make unbiased decisions in the context of innovation and change is challenging (Teece 2007, 1327).

The third element, the capability to reconfiguring, enables a company to continuously assess and organize operational capabilities according to the market opportunities seized. It requires massive investment in technologies to achieve the market's acceptance; thus, commitment is necessary. Periodic organizational renewal is needed to complete the full advantage of new opportunities. Companies grow, and markets and technologies change, and thus, the key to sustained growth is evaluating, combining, and reforming resources and organizational structures. (Teece 2007, 1326–1327, 1338.) "The degree to which a firm can sense and respond quickly to customer-based opportunities for innovation and competitive action" is additionally defined as the firm's customer agility (Roberts and Grover 2012, 580). Hence, the lack of alignment of the firm's sensing and responding capabilities can lead to ineffectiveness, and therefore managers should align these capabilities (Roberts & Grover 2012, 584).

Dynamic capabilities help create, expand, improve, protect, and maintain a firm's competitive advantages as firms can systematically create and change operating routines to enhance effectiveness (Zollo & Winter 2002, 340). According to Helfat and Peteraf (2009, 998), all kinds of capabilities, including non-dynamic, can adapt to change. Thus,

different dynamic capabilities are not necessarily required as an independent facilitator to enable an organization to learn, adapt, and change. Teece et al. (2016, 18) emphasize that the processes of sensing the market, seizing opportunities, and reconfiguring about evolution are not sequential but somewhat overlapping and continuously evolving in relation to each other. Thus, it is practically impossible to distinguish between them, but it is necessary to look at them separately at the theory level for analytical reasons.

Many scholars see the company's dynamic capabilities as unique and very company-specific elements developed through its history (e.g., Teece et al. 1997; Barretto 2010, 263). Other researchers also agree that those are typically the outcome of an organization's learning and experience (Eisenhardt & Martin 2000, 1114; Zollo & Winter 2002; Ambrosini & Bowman 2009; Schilke et al. 2018, 400–401). Learning encompasses different forms in an organization and the capability to use all available knowledge to continually adapt, change, and innovate. However, Eisenhardt and Martin (2000, 1114) argue that learning through small losses and mistakes may be a more effective form of learning than learning through successes or massive errors or failures. Learning takes place experientially, for example, through experimentation and testing and by doing and learning. Furthermore, internal factors are argued to influence the use of dynamic capabilities, including social capital, leadership, and trust (Ambrosini & Bowman 2009, 42).

According to Teece (2007, 1347), “firms with strong dynamic capabilities are immensely entrepreneurial since they not only adapt to business ecosystems, but also shape them through innovation and through collaboration with other firms and institutions”. Thus, a company with robust dynamic capabilities can profitably develop new resources, assets, and unique competencies to use innovatively or create change in the market environment. However, companies need to decide which new capabilities are worth building and which existing ones are worth saving (Pisano 2017, 748). We can understand a goal either as generic goals presented above or influencing an organization's performance and creating a competitive advantage over competitors. A company with strong dynamic capabilities can improve performance in an agile way and better sense emerging developments and required resources. (Teece 2016, 31.) To obtain this agility, firms must identify and orchestrate their bundle of assets efficiently.

Despite the conflict over the outcomes associated with dynamic capabilities, there is a new focus on internal processes and, particularly, on individuals' role in creating, implementing, and renewing dynamic capabilities. It reflects that dynamic capabilities

can rest either at the organizational level, the individual level, or another analysis (e.g., the team level). (Di Stefano et al. 2014, 322; Helfat & Peteraf 2015.) However, the most prevalent perception is that dynamic capabilities in their broadest sense are organizational processes that change a firm's resources (Ambrosini & Bowman 2009, 33).

In a core of dynamic capabilities are intangible assets, such as the creation and enhancement of competencies. Competencies reflect both the individual's competencies and experience and notable ways of doing things in the company. (Augier & Teece 2009, 418.) Scholars Vanhaverbeke and Peeters (2005, 255) see innovation as an enabler of a company to develop and renew its competencies. Therefore, innovation itself is seen as a dynamic capability that thrives on long-term profitability and change.

2.4 Initial framework

This section summarizes the literature review to develop a theoretical framework for the study. It builds from the importance of understanding radical innovation, innovation management, and dynamic capabilities, and finally, competencies. To answer the main research question, "how do competencies help accelerate the radical innovation process in large companies", it is essential to understand what is behind the concept of radical innovation. Innovation can be radical or incremental, which most innovations are. In this work, radical innovation is explicitly explored, and it is understood by O'Connor and Rice (2013, 3) as "a product, process, or service with either unprecedented performance features or with such dramatic changes in familiar features or cost that new application domains become possible. Radical innovations transform existing markets or industries or create new ones". The theoretical framework (figure 10) guides the study.

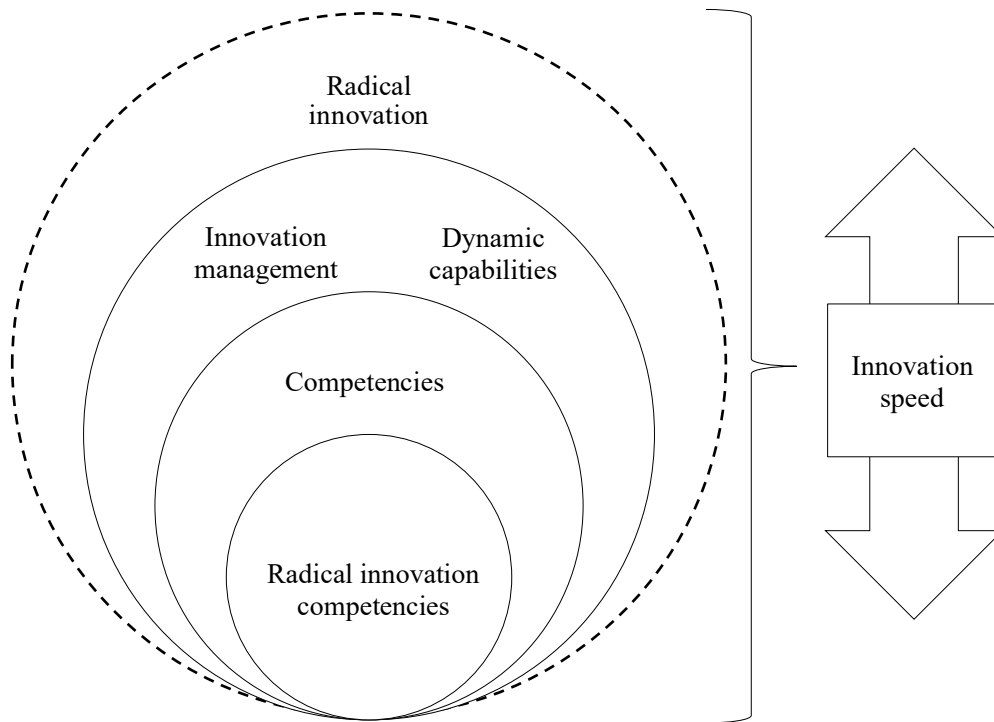


Figure 10 Initial framework of the study

Radical innovation is the outermost link of the circle, encompassing the innovation process. In this study, the innovation process is understood as an interactive system that emphasizes co-operation, networking, and duplication of development work. Even though the innovation process in real life is not as simple as in the paper, using a systematic innovation process can influence the time-to-market and speed of innovations as time is not wasted on reinventing the process (Cooper 2008, 217). A clear process provides a reasonable basis where more speed can be achieved by other means, for example, through competence development. Limited innovation and research resources force firms to focus on projects expected to deliver the best returns and results. On the other hand, in-house conclusions about market and revenue potential and its development may be misleading if a company lacks knowledge and competencies. (Cooper 2016.)

Radical innovations require organizing and recombining new knowledge and competencies (Colombo et al. 2017, 396), which require the deployment and structuring of tangible and intangible resources (Augier & Teece 2009, 412). Existing competencies may no longer be appropriate, while acquiring and developing new ones becomes a matter of urgency. Also, exploiting only the competencies needed to develop current products may hinder radical innovation's full potential. Also, exploiting only the competencies needed to develop existing products may hinder radical innovation's full potential. The contributions are high, and the path to radical innovation entering the market is not

straightforward; on the one hand, some routes can prove more valuable and others dead end. Thus, leaders face a difficult decision in targeting radical innovation – by leveraging existing skills while avoiding their rigidities by reforming and replacing them entirely with new competencies. This view strongly suggests that companies seeking radical innovation need to acquire specific competencies to speed up the process.

Large companies face the challenge of developing competencies for radical innovation that enable them to overcome the barriers inherent to activities. Those are commercialization (Chiesa & Frattini 2011), restrictive mindset, lack of discovery competencies, and unsupportive organizational structure (Sandberg & Aarikka-Stenroos 2014). The competence-based approach has taken a dynamic aspect that enables firms to approach the issue from the dynamic capabilities' perspective (Eisenhardt & Martin 2000; Teece 2007). As understood from previous studies, radical innovation's uncertainty brings ambiguity about goals and how to get there, particularly concerning this study on what competencies are needed. Previous research supports a positive relationship between future-oriented dynamic capabilities and firm performance (Day 2011, 183). Thus, dynamic capabilities are essential in developing existing resources to achieve to introduce radical innovation and competitiveness.

Dynamic capabilities are used to create and adapt business models to meet the external business environment's challenges. A firm's dynamic capabilities define the company's ability to develop and recombine its operational capabilities in ways that enable them to respond to changes in the market (Teece et al. 1997; Eisenhardt & Martin 2000). To attain higher achievement of radical innovations, companies should have the capability to combine resources, distribution channels, and network partners. Based on the literature, dynamic and innovation capabilities have commonalities in few regards: essential role of learning, characteristics of a firm-specific heterogeneous, the role of management, and nature of development seeking for a change and configure. With a higher innovation capability, companies can continuously transform knowledge and ideas into innovations to benefit the firm and the stakeholders (Lawson & Samson 2001, 348). The current literature distinguishes companies to have two innovation capabilities: operational and dynamic capabilities (e.g, Teece et al. 1997; Winter 2003; Helfat & Peteraf 2015). Both are essential, but especially in exploring radical innovations, dynamic capabilities are broadly discussed as they enable firms to renew companies' resources and competencies in response to environmental change. In principle, companies do not have all competencies that radical innovation requires, emphasizing the importance of this study.

Another matter is how to get various competencies together for co-operation in the different stages of the commercialization process and develop it simultaneously with the innovation. (Pynnönen et al. 2019, 342.) A company may accelerate a radical innovation by building or developing new competencies supported by dynamic capabilities. The assumption is that companies should constantly reconfigure their existing capabilities and competencies in three ways: (1) sense and shape opportunities and threats; (2) seize market opportunities; and (3) maintain competitiveness through developing, combining, and reconfiguring the company's intangible and tangible assets and resources (Teece 2007). Sensing capability is significant for foresight future and developing new competencies, while seizing capability helps to choose resources to meet the changes in opportunities. The third factor, reconfiguring or transform, helps modify, reduce, or increase company resources following the constant transition.

This study defines competence as “knowledge, skills, attitudes, experiences, and contacts that enable good performance in certain situations” (Sydänmaalakka 2003, 142). There is no clear and concrete theory on competencies, nor even a consensus on its concept. Some approaches emphasize the individual as the focus of initial analysis; others see the organization as the core of the analysis. Individual competencies have raised interest in and helped determine which types of people thrive in a particular environment that is most beneficial to the company. However, without individual competencies, there are no organizational competencies. In this work, competencies are divided into organizational competencies, including core competencies, and individual competencies (Murray 2003, Håland & Tjora 2006). Previous research has identified four important areas of competencies for radical innovation: discovery, incubation, acceleration, and commercialization (O'Connor & Ayers 2005, Stroy et al. 2009). Section 2.2.4 reviewed what they contain, e.g., conceptualization and experimentation. For this study, especially acceleration and commercialization are essential.

Innovation competence was defined as “a synonym for a set of personal characteristics, knowledge, skills (or abilities) and attitudes that are connected to creating concretized and implemented novelties via collaboration in complex innovation processes” (Hero et al. 2017, 104), which is in line with the definition of competence used in this study. This study utilizes the competencies framework with five dimensions proposed to assess the radical innovation process's key competencies in large organizations: experimentation and risk tolerance, social competence, leadership and entrepreneurial competence, and commercialization competence.

To conclude, radical innovation requires networking and the management of new operating environments, methods, and tools. The information must move rapidly and unhindered to remain competitive for individuals, companies, and organizations. Radical innovations are complex, and the speed of change is rapid; thus, competencies can also be understood as a process of dynamically changing and developing permanent and new competencies linked to changes in operating environments. The theoretical framework gives a good base for understanding radical innovation, competencies, innovation management, and dynamic capabilities and creating the research's empirical part.

3 RESEARCH DESIGN

The research design is the framework used to answer the research questions and show the readers the study's trustworthiness. This part aims to explain the chosen methodology and justify the choice. This chapter describes the empirical part of the research, presenting the research approach, which is qualitative, the data collection method, and the selected interviewees' description. For this research, a semi-structured interview was chosen, and the material was analyzed using themes analysis. Finally, the research material's data analysis and its trustworthiness are considered.

3.1 Research approach

A methodology is a philosophy of methods that clarify ways to produce information on a particular topic. They are generally divided into two different categories: quantitative and qualitative. (Eriksson & Kovalainen, 2008, 16.) This study uses the qualitative approach, which focuses on interpreting an in-depth understanding of a phenomenon and research topic. In contrast, quantitative research focuses on explanations, testing hypotheses, and statistical analysis. The qualitative research method is a comprehensive acquisition of information, where the collection of data is performed or occurs in real situations with people. Accordingly, it is suitable for complex, business-related phenomena in a real-life context as radical innovation processes in large companies. (Eriksson & Kovalainen 2008, 3–5.)

Qualitative research favors humans as an instrument for data collection. Moreover, it is typical for qualitative studies to make an appropriate selection of the target sample instead of using random sampling. (Hirsjärvi et al. 2004, 163–165.) The qualitative method is well suited for this thesis as the study aims to comprehensively describe how do competencies help accelerate the radical innovation process in large companies. The thesis's basis is not to make statistical generalizations but to find out more about the required competencies in commercializing a radical innovation in the manufacturing field. This is a typical basis for qualitative research that is not intended to measure or quantify data results. (Tuomi & Sarajärvi 2018.)

Some scholars have even questioned quantitative research's suitability for competencies and dynamic capabilities, which is often a more common mode of research. They see qualitative, smaller sample research better adapted to understanding resource

creation and modification's nuances and better understand more detailed microlevel factors. (Ambrosini & Bowman 2009, 37.) Thus, it also justifies the choice of the qualitative research method. The research process of the study is illustrated in figure 11.

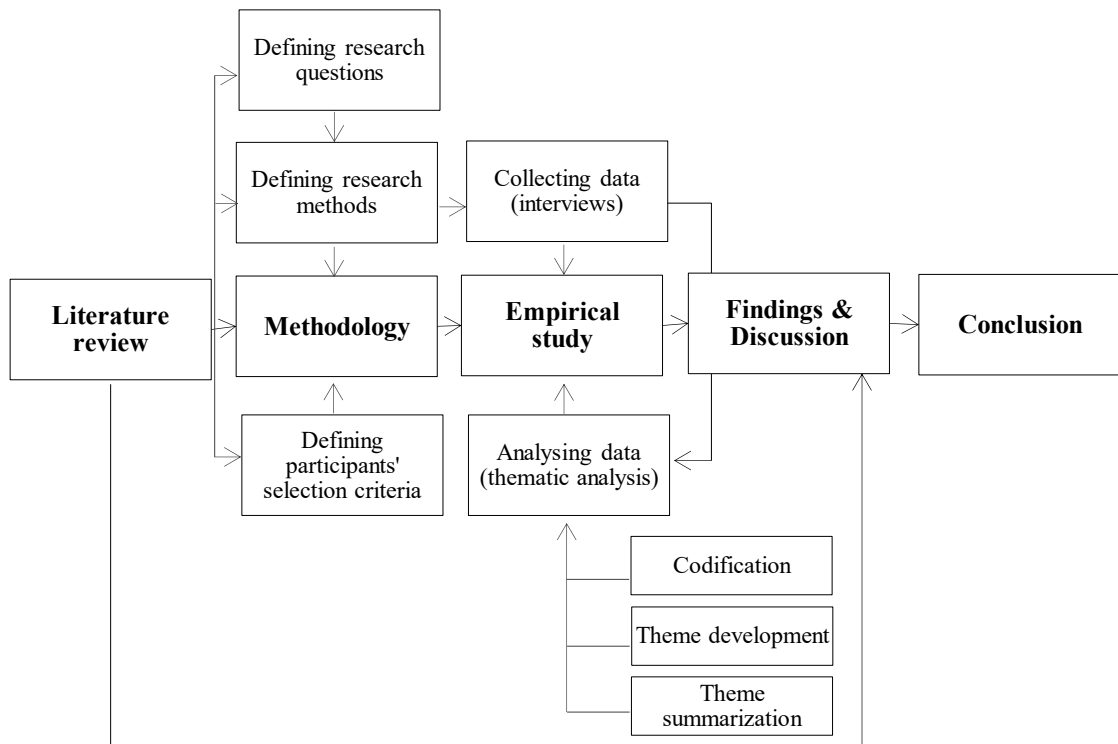


Figure 11 Overview of the research process followed in this study

The previous section presented observations and findings based on the literature that influenced the research questions and research method. The study's methodology is described more in detail now, and this section describes the selection criteria for the interviewees and how the empirical research was conducted. The data analysis is conducted with a thematic analysis, from which the findings of the study are eventually built. The study compares the data with the literature and presents the discoveries in the findings and discussion sections. Finally, the conclusion presents the theoretical implications and managerial contribution of this study and recommendations for further research topics.

3.2 Data collection

According to Tuomi & Sarajärvi (2018), the most common data collection methods for qualitative research are interviews, surveys, observation, and information based on

various documents. Depending on the research problem, the resources used, and other factors, these methods can be used either as alternatives, in parallel, or in different ways, depending on the research problem. Conducting interviews on business-related topics is an effective and practical way to gather information, which is why the approach is relatively common. Furthermore, there may not be any published information on the specific topic, and thus, there is a need to produce some. (Eriksson & Kovalainen 2008, 94.)

Qualitative interviews can be roughly divided into three categories: structured interview, semi-structured or unstructured interview, and group interview (Myers & Newman 2007, 4). The structured interview would have been narrowly delimiting the interviews, and the group interview would not have been able to produce as in-depth view of the competencies in each company as in the individual interviews. A semi-structured interview, also known as a thematic interview, is a standard data collection method in qualitative research. The semi-structured interview method was chosen because the study wanted to make room for the interviewees' views and opinions to obtain the broadest possible material. It is suitable for this research due to its versatility and flexibility. (Kallio et al. 2016, 2955.)

The semi-structured interview is based on an in-depth and detailed discussion of the research topic, enabling a free-form discussion of the research topic. The approach takes on the informal nature of interviews, where the interviewer can apply and adapt her questions to the interview context, and on the other hand, to take a closer look at unforeseen trends in the interview situation (Yazan 2015, 144–145). Although the interview framework has been prepared in advance, there is no need to follow it blindly. The benefits of the interview method's flexibility are that it allows repeating a question and thereby correct misunderstandings, clarify expressions or concepts in questions, and have other discussions in addition to the actual questions. Thus, openness, flexibility and margin for improvisation are the strengths of the semi-structured interview. The order of the questions can also be changed and reacted to the situation, which increases flexibility. In exploring the key competencies needs within the radical innovation commercialization, this type of approach is essential as the researcher could indirectly encourage the informants to tell other hidden issues that might relate to the subject area. On the other hand, interviews are time-consuming and may be costly compared to surveys and email interviews; these are the considered research method's weaknesses or challenges. (Tuomi & Sarajärvi 2018, 63.)

This study aims to understand how competencies help accelerate the radical innovation process in large companies, especially in commercialization activities; thus, what are the key competencies. Different ideas, experiences, and perspectives were needed to obtain from various sources. The semi-structured interview is well suited for such a purpose, as the interviews were intended to address themes that had become central based on previous research. Simultaneously, the interviewees emphasized various issues according to their opinions and raised new themes. The semi-structured interview gives a light structured form, mainly to the interview framework, which addresses themes and topics in a particular order presented in this section. Thus, the interviewer's role is mainly to guide the discussion lightly and ensure that the interview themes are addressed. In the interviewer role, it is important to show empathy, listen in an interested yet relaxed manner, and reply appropriately (Myers & Newman 2007, 13). Quickly, an interesting interview turns into a discussion, but as have been learned from the first interviews, it is better to leave the interviewees to share their knowledge. On some occasions, only nodding or smiling was enough, while sometimes there was a need for more guidance from the interviewer.

The interviewer prepared the interview guide in advance, including the interview themes and questions (Appendix 1). A semi-structured interview consists of two-level questions: main themes and follow-up questions (Kallio et al. 2019). In the interview guide's development process, a commonly used method, field-testing, was used to test the interview with a potential study participant. The interview framework was tested, and the questions were clarified based on the gained experience. The activity aims to improve the data collection quality and help identify if the order and form of the questions should be reformulated to be more practical. (Kallio et al. 2016, 2960–2961.) Based on the feedback, the wording and the definition of concepts were clarified, and the themes were further refined.

Despite the flexibility of a semi-structured interview, Tuomi & Sarajärvi (2018) emphasize that it is not proper to ask whatever comes to mind. However, it seeks to find answers relevant to the purpose of the research and the research questions. This study's interview guide was formed theoretically based on the study's operationalization framework shown in table 4. The interview themes were (1) radical innovation, (2) innovation process, (3) commercialization, (4) the concept of competence, and (5) development of competencies. In the end, time was left for reflection questions, and the

interviewer could add comments if they felt something was left unanswered, which would be essential for the study.

Table 4 Operationalization framework

Research question	Sub-questions	Theme	Interview themes	
How do competencies help accelerate the radical innovation process in large companies?	What individual competencies are needed to speed up the radical innovation process, especially in commercialization activities?	Radical innovation	3, 4	
		Commercialization	3	
		Individual competencies	3	
	How can large companies ensure to have the competencies for radical innovation?	Innovation management	Innovation management	1,4
			Organizational competencies	4, 5
	How do dynamic capabilities foster the development of radical innovation competencies?	Dynamic capabilities	2, 4	

Operationalization framework shows which theme answers to which sub-questions. The first interview theme's goal was to find out the interviewees' perceptions of radical innovations. The idea is to map how each interviewee embraces radical innovation and what elements and features they attach to them. On the other hand, the theme also aims to determine the effects of interviewees' radical innovations. The next theme was the innovation process. The purpose of the theme was to map how, according to the interviewee, the process of radical innovation differs from incremental and evokes thoughts already related to competencies. Also, the theme deals with experiences of success at different stages of the process. The third theme relates to commercialization.

The purpose of the theme was to map what kind of competencies people who participate in commercialization activities have. The theme discusses the challenges to commercialization and the answers to exceed the challenges. The theme explores competencies and identifying those competencies that accelerate commercialization. The final themes deal with competencies and their development at both the individual and organizational levels. At the end of the interviews, all interviewees could raise issues outside the themes they felt were relevant to the study. Even though the themes were designed to answer certain sub-questions, the answers could also influence other questions and themes in many cases.

The persons from whom data is gathered must know as much as possible about the phenomenon under study, or at least they should have experience in the matter (Tuomi & Sarajärvi 2009, 85). Therefore, it is essential to reach the most suitable participants in the study, especially in this case, which deals with a topic that may be critical from the company's perspective (Eriksson & Kovalainen 2008). All interviewees represent large companies that operate globally and are in the manufacturing industries. The chosen interviewees were selected from different companies or units in Finland, while everyone worked closely with innovation to grasp the whole picture of accelerating radical innovation competencies. The companies operate in various industries where the importance of production and products is particularly emphasized. The interviewees' main selection criteria were that they work in large companies, the companies they represented operate in a dynamic manufacturing industry market and work closely with new business development and innovations. Directors are in the position that they are most likely to understand the development of competencies from the perspective of radical innovation, so gaining the most profound and most reliable view of the phenomenon thus justifies the choice for research.

A total of nine interviewees were selected for an interview from four different organizations who have been involved in developing something radical that requires an understanding of innovation management and competencies development. The number of interviewees was predetermined so that the data analysis could be ensured an appropriate or its timeframe. The interviewees, their positions in the organization, and the interview duration are described in table 5. Five of the interviewees work for the commissioner organization, all of whom operate in different sectors or businesses that have emerged from radical innovation. The rest of the interviewees all work for separate companies. One interviewee per company was selected from the other companies because

it was interested in collecting broader data from different companies. Different types of innovations are developed in these companies, but the main criteria are product innovations. However, a radical product innovation process can emerge, for example, process innovations and other incremental innovations. Therefore, more specific innovation projects are not defined, and those were not directly discussed in the interviews. Informants were free to discuss a specific innovation project if they wanted to, but it was unnecessary to know the innovation from the study's perspective. This study has been handled in good scientific practice, and to protect each informant, their names and companies are not visible in this study.

Table 5 Conducted interviews

Person	Position	Length (min)	Date
1	Vice President, Strategy	55	6.10.2020
2	Vice President, New Business Development	55	13.10.2020
3	Director, Business Development	55	12.10.2020
4	Director, New Business Development	57	9.10.2020
5	Director, New Business Development	50	12.10.2020
6	Director, Human Resources	55	16.10.2020
7	Director, Business Development	55	27.10.2020
8	Manager, Research & Development	55	27.10.2020
9	Head of Learning and Development	55	25.11.2020

In this context, it is good to consider saturation. Saturation means that the data starts to repeat itself, and the interviewees no longer produce new information for the research problem (Tuomi & Sarajärvi 2009, 87). Many of the same themes were repeated in the interviews, although new informants brought new perspectives on the topic. However, the number of interviews allowed a broad understanding of phenomena and the studied subject, and saturation was reached.

In this study, an individual interview was used, and each person was interviewed for the study in person so everyone could express their views confidentially. From the interviews, two were conducted face-to-face and seven via online platforms during October-November 2020. The reason for running most of the interviews virtually is due to the restrictions caused by the global Covid-19 pandemic. However, organizing the interviews through online platforms did not affect the quality of the interviews. All but one of the online interviews was conducted with a video stream to ensure the interviewee could freely and comfortably engage in the conversation.

All the informants were contacted by email, either directly by the interviewer or firstly introduced by the commissioner company. The research topic and the interview themes were told beforehand. The interviews proceeded so that the researcher initially described the topics that emerged from the interview and the estimated time. At this stage, it was also emphasized that this is a free-form, conversational interview, and all the interviewee's perspectives and ideas are essential, and there are no right or wrong answers. All the interviews were recorded, and it was also discussed before the first theme. During the interview, the researcher wrote down the keywords and key ideas from the interview and took notes in case of failed recording and to support future analysis. However, clear recordings for transcriptions were obtained from all interviews.

3.3 Data analysis

Data analysis is one of the essential steps in conducting research. By analyzing the material, the researcher seeks to interpret, structure, and formulate the research material so that it is possible to find answers to research problems. Processing the material usually carries on by describing and classifying the material towards the combination and explanation of its relevant parts. (Hirsjärvi et al. 2004, 209–211.)

The primary method of analysis of qualitative research is content analysis, which many other forms of analysis are based on. In this study, the analysis was carried out following content analysis to obtain a concise and general description of the phenomenon under study. In the first stage of the analysis, a decision had to be made about interest in the material. The material is reviewed, distinguishing, marking, and gathering things related to the subject under investigation. At this stage, it is also important to exclude everything else from the current study. The collected material is then either classified, themed, or typed, and finally, a summary is written and compiled. (Tuomi & Sarajärvi 2018.)

This study uses a thematic analysis for data analysis following Braun and Clarke's (2006) six-phase approach, which is now reviewed. One of the thematic analysis benefits is its flexibility: it is not as tied to specific theoretical frameworks as many other means of analyzing qualitative research, but it still allows for rich and detailed analysis of the data. The purpose of the theme analysis is to identify, analyze, and finally report the themes within the data. (Braun & Clarke 2006, 78–82.) A theme seeks to obtain something meaningful about the data concerning the research question, representing some level of pattern found in the data. Typically, there are several different sets of ideas under one theme. In the thematic analysis, it is the researcher's responsibility to decide what the theme will eventually form and how significant some theme is. It does not depend on how many mentions it gets in the material. Instead, what matters is whether there is something important about the theme in relation to the research question. (Braun & Clarke, 2006, 82.) Data has been analyzed with an open mind, and research questions are included in the analyzing process while themes that are important to the research emerge. Deciding on the final themes was not a quick process, as several different interesting themes that could have been highlighted and explored further emerged from the data. The transcripts were coded using NVivo, a text analysis software package specifically designed to enable coding. Figure 12 illustrates the thematic analysis process to coding and theme development that will be next discussed.

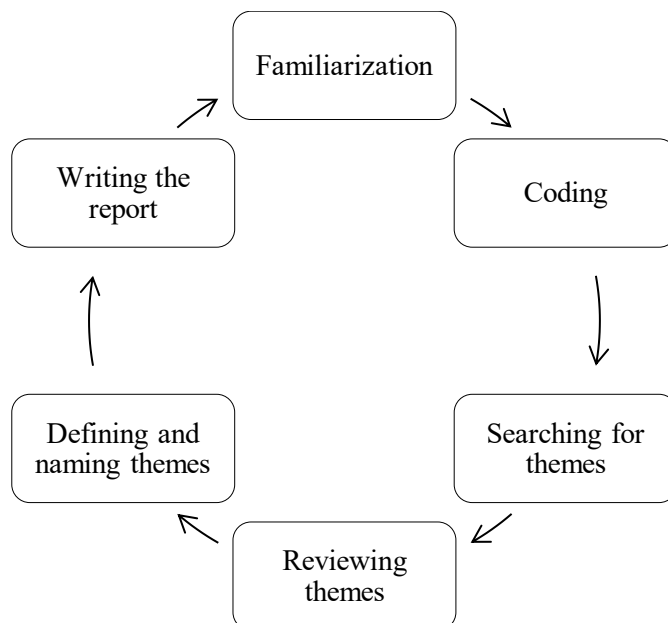


Figure 12 Thematic analysis process (adapted from Braun and Clarke 2006, 87)

According to Braun and Clarke (2006, 86–87), the first phase of the analysis, familiarizing yourself with your data, can start already in the data collection phase if the analyst begins to pay attention to recurring patterns. As can be seen from the picture, its endpoint reports the research results found in the data. All interviews were recorded, and the interviewer took notes during the interviews and made marks of other observations after them. Interview recordings were transcribed, which is part of the first phase (Braun & Clarke 2006, 86). When all the interviews were written clean, there were 68 pages of transcribed text in all. Transcriptions were written almost verbatim with a Word program and transferred to NVivo, a computer-assisted qualitative data analysis software program. After transcribing all the interviews, it was time to read the interviews and get familiarized with the content. Following Braun and Clarke (2006, 87) instructions, the material was actively read many times to obtain an overall picture of the data collected, but patterns were sought each time. Simultaneously, the author wrote notes in the NVivo program.

The next phase was generating initial codes. The codes are used to identify and reach features of the data that interest the author of the analysis. At this stage, the focus was on coding the data as comprehensively and extensively as possible, considering even non-mainstream themes. When all the data were coded, the third phase started with the organization and combined codes into potential themes. (Braun & Clarke 2006, 88–89.) Themes do not arise from the data by themselves but are always formed by the researcher and reflect the researcher's choices. The researcher can develop themes either deductively or inductively. In the deductive approach, the themes are mainly formed based on previous research and theory while in the inductive method, the formation of themes takes place entirely based on the data. It is also possible to combine approaches. (Braun & Clarke 2006, 83.) This has also been done in shaping the themes of this study. The theoretical framework has guided the construction of themes already when planning semi-structured interviews. Interview themes have continued to be utilized in forming analysis themes. Themes were first explored using NVivo but outlining on physical paper also helped to draft initial themes. Themes and sub-themes were drawn as an initial thematic map recommended by Braun and Clarke (2006, 90).

The fourth phase of the analysis looked at the themes found. Following Braun and Clarke's (2006, 91) advice, it was examined whether the themes were truly internally consistent and coherent and different from each other. At this point, a few preliminary themes merged, thus forming a new theme. The thematic map developed as a combination of themes, after which it was considered how the themes work with the entire data set.

The material was read once more to make sure that everything relevant was noticed. (Braun & Clarke 2006, 91.) Coded themes and categorization of codes regarding competencies and characteristics for radical innovation competencies as perceived by informants are shown in table 6.

Table 6 Coded themes regarding competencies as perceived by informants

Competencies	Characteristics
Social competence	Co-creation
	Collaboration
	Communication
	Customer orientation
	Empathy and emotional intelligence
	Negotiation and sales skills
	Network competence
	Social intelligence
	Trust
	Entrepreneurship and leadership competence
Curiosity, courage, passion	
Enabling mindset	
Entrepreneurial attitude	
Project management	
Solution-centric	
Tolerance of failure	
Commercialization competence	Agility
	Business acumen
	Customer intimacy
	Ecosystem thinking
	Intellectual property rights
	Positioning in the future market
	Value chain understanding
Value proposition	

In short, the data was compared and analyzed for competence categories and codified. Simultaneously, this study reviewed the literature on radical innovation, dynamic

capabilities approach, and competencies. This iterative analysis process resulted in a set of three competencies. As a result of the empirical data analysis, recurring themes were found in the interviews: (1) social competencies, (2) entrepreneurship and leadership competencies, and (3) commercialization competencies. It was attempted to organize themes according to the themes presented in the literature (Sydänmaalakka 2003; Hero et al. 2017; Pisano et 2019). The themes describe the attitudes and skills that emerged most clearly and most often in the interviews, which influence how radical innovation is commercialized in the target companies.

3.4 Evaluation of the study

This study exploits the evaluation criteria by Lincoln and Guba (1985), which is widely used in qualitative research. Researchers distinguish four different criteria for assessing research trustworthiness: credibility, transferability, dependability, and confirmability (Lincoln & Guba 1985, 300).

Credibility measures a researcher's ability to provide research outcomes that correspond to reality (Lincoln & Guba 1985, 296). For instance, the use of an operationalization table strengthens the study's credibility. Eriksson and Kovalainen (2008, 294) reveal three essential questions when evaluating the credibility that the researcher should ask: (1) is there enough knowledge about the topic and enough evidence behind the observations made from the material, (2) are there strong enough logical links between the observations and categories, and (3) could another researcher come relatively close to the same interpretations. Radical innovation and competencies are widely studied, as well as dynamic capabilities in the innovation management literature. Thus, both the theoretical and empirical data give a proper amount of material to study. This study aims to make the theoretical part reliable by looking at phenomena and essential concepts from many different perspectives using several various sources. Trustworthiness is also enhanced by the fact that older literature is also used as sources in addition to contemporary literature. The data analysis method was also carefully chosen. The reliability of the analysis was confirmed by the fact that the researcher acted as an interviewer and transcriber. The reliability of the analysis was also increased using an NVivo analysis program. The time spent on the analysis was relatively long, and it was done carefully.

Attention was paid to the trustworthiness of the study throughout the research process. It was considered by carefully selecting literature sources and using publications and databases that are considered reliable. The quality can be improved by using an appropriate and carefully drafted interview framework. The development process of the interview guide followed a framework by Kallio et al. (2016). This study followed a five-step process to make it trustworthiness: (1) identifying the prerequisites for using semi-structured interviews; (2) retrieving and using previous knowledge; (3) formulating the preliminary semi-structured interview guide; (4) pilot testing the interview guide; and (5) presenting the complete semi-structured interview guide. (Kallio et al. 2016, 2959.) Transcribing the material as soon as possible after the interview will improve the study's quality (Hirsjärvi & Hurme 2008). In this study, the interview framework was carefully prepared, basing it on the literature review and theoretical framework. The body of the interview was tested in the first interview and then any necessary corrections were made.

Transferability evaluates the broader probability and applicability of research results (Lincoln & Guba 1985, 296–297). This means that it is the researcher's responsibility to show the consistency of the research results, at least some of them, with previous research. The idea of transferability is not to replicate research results but rather to express whether there could be similarities in other research contexts. (Eriksson & Kovalainen 2008, 294.) In this thesis, the intention is not to study the interviewees' companies, although they naturally shape the respondents' views. If the aim had been to investigate companies, the study would have been carried out through a case study. Instead, this thesis focuses on the competencies that accelerate radical innovation's commercialization, which is attempted to be described, analyzed, and understood.

Dependability refers to the researcher's ability to produce a truthful and reliable picture of the phenomenon under study (Lincoln & Guba 1985, 299). The researcher is responsible for providing information on the logical, transferable, and documented way of the research process, strengthening the research's trustworthiness (Eriksson & Kovalainen 2008, 294). In this thesis, attention was paid to dependability by providing a detailed description of the research process and interview guide (Appendix 1). The generated data from nine management level interviews and a large amount of transcription material support the study's trustworthiness.

Confirmability measures the researcher's objectivity to the subject under study (Lincoln & Guba 1985, 300). Thus, it refers to integrating research findings and interpretations into the material in a way that is easy for the reader to understand. The aim

is to show that the researcher's interpretations are not just a product of their imagination (Eriksson & Kovalainen 2008, 294). However, efforts can be made to minimize obstacles related to conformability. For instance, in this study, all the interviews were first recorded and transcribed afterward. Now, when is evaluated the credibility, transferability, dependability, and confirmability of the research process, the next section explores the key findings.

4 COMPETENCIES TO ACCELERATE INNOVATION PROCESS

This section examines the empirical part of the study, which aimed to map the prevailing attitude towards radical innovations and determine how competencies help accelerate the radical innovation process in large companies. Three sub-questions guide the study to find an in-depth answer: (1) what individual competencies are needed to speed up the radical innovation process, especially in commercialization activities, (2) how large companies can ensure to have the competencies for radical innovation, and (3) how dynamic capabilities foster the development of radical innovation competencies. This section reviews the results of the study, first introducing radical innovation from the informants' point of view, followed by the themes of competencies that emerged in the analysis of the data. Finally, the development of competencies is discussed, and how dynamic capabilities influence the development.

4.1 Radical innovation

For convenience, it is essential to explore how respondents perceive radical innovation to analyze the data meaningfully. Therefore, the first theme concerns the definition of radical innovation and the interviewees' views on the conditions and requirements that radical innovations need to emerge along with opinions on the differences between radical innovations and incremental innovations, especially concerning required competencies. Because commercialization is the focus of this study, the understanding and challenges associated with commercialization are also reviewed.

4.1.1 Radical innovation in target companies

The first theme, radical innovation, addressed the respondents' understanding of radical innovation in their company. The purpose of the discussion was to form an understanding of the attitude the target companies and interviewees had towards commercializing radical innovations and discuss the main differences between radical and incremental innovation. Perceptions of radical innovation were mainly in line with the definition that this study uses; innovation is radical when its commercialization affects the market and the firm, but it can also be radically new only from a company's perspective (Bessant et

al. 2010; Sandberg & Aarikka-Stenroos 2014). Thus, the level of impact was often viewed from the firm's perspective, meaning everyone classified an innovation as radical if the innovation is completely new to the firm. Hence, innovation projects are radical when operating in new value chains and markets where the company has not previously operated. It was also viewed that radical innovation may significantly change the operations of a company, industry, or society. Few of the informants described it in the following way:

“Radical innovation break something traditional and turn it into a new way. It does not have to be new to the whole world; for example, if we figure out how we would have a process not lasting three days but only three hours, it would be radical for us.” (Director, Human Resources)

“In some dimensions, things are done in a new way. We can change some manufacturing concepts, how something has been done in the past. For example, it has been done in way A before, and now it would be done in a whole new way, way B. The more radical innovation becomes when you take a process, a product and a market, and operating models and processes. The more these dimensions are thought through in a new way, the more radical the product becomes.” (Vice President, New Business Development)

Incremental innovations are built into the large companies' system, as most informants note. Similarly, a few stated that their innovation process is designed to improve existing products, which is typical for large companies (Assink 2006; Matthew & Brueggemann 2015). Radical innovation was described as risky and long-term, and thus, it is essential to have both radical and incremental innovation projects in the portfolio. The results suggest that instead of focus on individual innovations, portfolio thinking is more important, and the firm should invest sufficiently in a particular area (Tidd 2006; Tidd & Thuriaux-Aleman 2016). There should not be too many target areas but few road map areas to invest in. As most of the respondents mentioned, even a large company could not have many development projects simultaneously. One of the respondents suggests that this way, a firm gets three or four projects in the same portfolio, and this way, they get new ideas and at least one or two projects forward (Director, Business Development B).

Many of the companies the informants represent are involved with making big equipment and factories, both physically and financially, which is already a challenge. A long-term project, up to 10–15 years, requires strong commitment and investments from a company.

Besides long-term commitment, nearly everyone highlighted the element of uncertainty in radical innovation like O'Connor (2008) with other scholars. Among long lead time and building an organization's competence profile, there are many elements in an organization that require patience and commitment from management. Compared to incremental innovations, where the targeted result is known, it is clear how it should be achieved. Many interviewees explained that while developing radical innovations, it is often impossible to accurately describe the development process's course; thus, it involves failure and nonlinearity and not much predictability. The description of a process also fits Cooper's (2014) updated the Next Generation Stage-Gate model. Like the model, respondents explained that if the desired result is not achieved in one way, the project team goes back into the process and tries a new way. Indeed, experimenting with different things was strongly associated with a radical innovation process (e.g., O'Connor & DeMartino 2006; O'Reilly & Tushman 2004, 8; McLaughlin et al. 2008). One informant emphasized the importance of patience, which goes hand in hand with uncertainty:

“In a radical innovation, the risk is higher, but the reward is more elevated. The risk-reward curve, so in a different quantum course, is the big challenge. It requires certain patience from the firm.” (Manager, Research and Development)

All the companies have had to develop and introduce radical innovations, and it is thought of as an enabler for company transformation (Colombo et al. 2017). However, it was felt unlikely to start to build something that the company does not have any connection or competence base. A common understanding was that in radical innovation projects, in the beginning, they seldom have enough experience in a new area. When a radical idea emerges, the majority believed that the company does not initially have a sufficient competence level. Therefore, the lacking competencies must be found from outside, even though the team must have some basis. They must acquire externals and direct people in the company with potential competencies and capabilities to the project. All representative companies are engineering-focused manufacturing companies that use

many resources to develop new businesses. The key is to find a needed building block from a company that fits the invention, as two of the informants describe:

“One good example could be our X business. We jumped into a whole new business area; an industry completely dominated by oil companies. We found a suitable angle for us and wanted to implement it independently and participate in the game.” (Director, New Business Development A)

“Often, drop-in solutions are sought, i.e., there should already be a value chain for which the product is suitable. Radical innovation may seem quite distant, but we can seek to build something radical when taking a responsibility perspective.” (Director, Business Development A)

Previous research emphasizes different competencies according to innovation, and the general perception is that radical and incremental innovation requires different competencies (e.g., OECD 2011; Riel 2011; Colombo et al. 2017; Schilling 2019). However, informants had different opinions on whether competencies differ between the innovation types. Only one informant was strict that there is no difference between competencies in radical and incremental innovations, but rather important is the orchestrating of resources:

“In terms of competencies, I may not see a difference in these. For me, competence is how to gather those competencies around innovation. We need to think about the output we need to achieve and then gather the competencies.” (Director, Human Resources)

However, many saw even significant differences in competence requirements even though other respondents also thought that the allocation and orchestration of resources are important (cf. Teece 2016; Schoemaker et al. 2018).

“When developing an existing one, it is enough to take a few engineers or researchers and then teach it to others. It can be quite a quick process. In radical innovation, that competence is not in the house at all. For example, we can see that there were only engineers in our house initially. Now, little

by little, there are more people with the right background for innovation X." (Director, New Business Development B)

Finally, the informants were almost unanimous that technical know-how and competencies are not a problem for the emergence of radical innovations, which they believed is strong in these engineering-focused firms. There is a need for commercialization competence alongside technical competencies, where shortcomings have been noted. Commercialization and its challenges are briefly explored as interesting things emerged from the data that are beneficial to understand before looking into the key competencies.

4.1.2 Commercialization and its challenges

One of the main themes interview themes was commercialization. This section explains how commercialization and its activities are understood in different companies and its challenges related to the required competencies. At the end of this section, the challenges are summarized in one table. Nevertheless, it is already good to mention that commercialization has been identified as the biggest challenge in the innovation process (Chiesa & Frattini 2011). Based on the data, there is a growing interest within the large companies, how to understand and maximize commercialization efforts.

All the informants have a common impression that commercialization had previously been perceived to occur at the end of the innovation process. It gave the impression that changes in the commercialization process, activities, and attitudes have taken place in recent years. For instance, one of the organizations is building a separate campus where the idea is to innovate and develop even radical innovation with different networks; thus, the new project affected the informant way of talking about the new and old form of commercialization. Furthermore, one respondent stated that taking commercialization account in the early phase still is a challenge in an engineering organization (Head of Learning and Development). He brought up an example where the customer had been forgotten over the technical features prioritized to develop them as diversely as possible. Similarly, another informant thought that customer involvement is critical, but it has not always have happened:

“In Finland, the product is often implemented and tested and only then presented to customers who say: “this is good, except...”. Thus, we need to have a customer from the beginning and push the team to look at the market value and opportunities. Look at what kind of slice we could get from it, with the customer sparring, and then start thinking about whether there is something here that should be protected.” (Director, New Business Development B)

Despite the challenges, the unanimous opinion was that commercialization should begin already in the early phases. The customers must be part of the process to understand the real value of a new product or service, as the comment above already suggests. Another respondent compares the new and the old process:

“In the old process, commercialization starts at the point where the product is in the pilot phase. It does not work when you think about making even a new engine for seven years and then presenting it to the customer, and the world easily change in the meantime. In a new way, the customer is involved from day one. There is a quick reassurance as to whether this is worth doing.” (Director, Human Resources)

Nevertheless, the customer’s role is well understood and thought of as a key for successful innovation. Informants were asked about the best successes or experiences in commercializing radical innovation. They mentioned the best commercialization experiences in projects where when the customer has been involved from the very beginning. One of the respondents mentioned a collaborative innovation project, which also emphasizes the importance of co-creation.

Each interviewee expressed that their principle is to work with the customer on development projects from the beginning; also, commercialization is done by involving the customers. Thus, the overall view is that the customer is part of the whole process, and feedback is collected on an ongoing basis. As part of the commercialization activities, informants emphasize that feedback needs to be gathered to build an understanding of the value chain. In radical innovation, companies often go into a value chain that is a bit foreign to them, and in that sense, development and commercialization need to move

forward at the same time. A representative from another company also tells how collecting feedback is ongoing and valuable.

“In everything you do, customer focus is emphasized, and the customer value. We have recently explicitly invested in striving to systematically gather from across the market systems and databases to meet these requirements for our customers’ expectations. It allows them to be integrated into the innovation process.” (Head of Learning and Development)

Most interviewees identified clear levels for the different stages of commercialization, similarly to Aarikka-Stenroos and Lehtimäki (2014). Commercialization was seen to start when there is proof of concept (Director, Business Development B), when the customer is involved (Director, New Business Development B), or when the decision is made to begin to drive innovation forward (Director, Human Resources). Some informants explained that commercialization does not always mean that must go to discuss with the customer, but an understanding of the needs can be created, for example, with a consultant’s help. This is what one of the interviewees suggested, as it minimizes the risks of the idea moving forward (Director, Business Development A). He believes that without a conversation with the customer, companies can create a surprisingly accurate value proposition.

The importance of commercialization and the challenges associated with it are recognized and summarized in table 7. Some of them came up in this part, but all of them will somehow occur in the following sections. Only by understanding these challenges and taking them into account, respondents believed they could positively impact the commercialization process.

Table 7 Challenges in commercialization

Quote from informants	Theme
The KPIs in sales organizations do not often face when they begin to sell a new product. How does it become a priority for the entire organization and what is the incentive in it? (Director, Business Development B)	A commitment of the whole organization
We may have lacked techno-commercial expertise. You should have an adequate understanding of the commercialization side, even if you are a technology person. (Director, Human Resources) There is much focus on engineering skills and technical competencies, but Finnish engineers are not that well at selling themselves or our competencies or products. (Manager, Research and Development)	Commercialization competence
Understanding the customer, the customer's needs, and customer focus. (Director, Human Resources)	Customer centricity
Schedules can be stretched or too tight, and then they can be constrained, for example, by a test matrix, through which an attempt is made to create something, and even then, some options may be closed to succeed. (Director, Business Development A)	Flexibility of schedules
The commercial viability and the strategic level must be done well enough, not only among your team. (Director, New Business Development A) Market creation is always the biggest and challenging part. (Director, Business Development B)	Market creation
How to ensure that everyone's competencies and ideas serve the business? (Head of Learning and Development)	Resource allocation
Understanding the challenge and importance of commercialization; its complexity, market presence, credibility, customer relationships – all these. (Director, New Business Development A)	Understanding the complexity of commercialization
Understand the role in the value chain and market competition. (Vice President, Strategy)	Value chain understanding

To date, an understanding has been built on how the interviewed companies understand radical innovation and its commercialization. It has become clear that commercialization is perceived as a challenge that is to be addressed. Commercialization

is an ongoing process starting from the beginning of the innovation process. Finnish manufacturing companies have strong technical competencies, as noted, and thus, the next section approaches other competencies that emerged from the interviews.

4.2 Key competencies in radical innovation

This section explores the key competencies in radical innovation, answering the first sub-research question. Based on the results, companies lack a definition of competencies and a more specific framework of radical innovation competencies. Some companies have defined critical competence areas for new product development, and they have separate innovation competencies that are also used in radical innovation projects. Nevertheless, numerous competencies emerged in the interviews, classified into four distinct areas: (1) cross-functional competencies, (2) social competencies, (3) entrepreneurial and leadership competencies, and (4) commercialization competencies. All the competence groups were identified as important for commercialization, but the first three, also for the whole radical innovation process.

4.2.1 Cross-functional competencies

One of the key differences between radical and incremental innovation is cross-functional teams and competencies, which the informants agree (O'Reilly & Tushman 2004, 8; McLaughlin et al. 2008). In radical innovation, the project is in an area that may not be the company's core area. By combining different competencies and perceptions, it is possible to build a clearer picture, for instance, of the target market, value chain, or a customer need, respondents suggested. Scholars also concur that cross-functional competencies may lead to accelerated innovation outcomes (O'Connor 2008; Ellwood 2016; Cooper 2019). One of the companies has defined the competencies for commercializing radical innovation as follows, highlighting cross-functional competencies:

“You have the ability to be and function in a matrix organization, you are able to operate in all areas flexibly. You have both technical and

commercial competencies, as well as business acumen type expertise.”
(Director, Business Development B)

Many believed the innovation process could be accelerated when there is a combination of competencies but also with a team in which people have both bits of knowledge of the technical side and commercial side. In addition, at the very core of the team must be people with an interface to the field. One of the informants suggests that the innovation team should build from fearless young people who are easier to form into the team, experienced people from the field they aim for, and more experienced people inside the house (Director, New Business Development B). The challenge may be to get them to operate within the new activity that may not follow the same rules as in the organization. However, instead of individual people or competencies, the importance of the team was emphasized:

“More important today than individual competencies are the capabilities of the team. How competencies and team work together and how our innovation, product development or product management processes work across many functions.” (Head of Learning and Development)

No one underestimated the importance of a team; on the contrary. However, cross-functional teaming has been discussed for a long time in R&D (e.g., Chesbrough 2003), but besides looking at competencies on a team level, individuals with cross-functional competencies are needed. Various multidisciplinary talents whose expertise is not limited to one narrow area were considered essential for radical innovations' success. Although often, a company would have already found solutions to problems if found in their area of expertise. Every informant notes the need to think about links to other areas and look for a multidisciplinary solution. The connections that enable an interdisciplinary solution are not visible to everyone, but a creative and open-minded pioneer can take advantage of them. Thus, to succeed in global competition and ever-changing markets, networking with companies and people in the same and different industries has already risen and likely to increase in coming years.

4.2.2 *Social competence*

Social competencies emerged from the interviews as one of the main themes. Some of the interviewees were clearly on the side of soft skills, which are also emphasized in global studies (OECD 2011). Radical innovation often follows open innovation activities that emphasize social competencies and require social interaction and networking. Therefore, all the informants raised the importance of network competence and supported previous studies' unanimous opinion that network competence is one of the most important competencies (Pisano 2019). In addition to that, co-creation and collaboration, customer orientation, and sales and negotiation skills were identified as critical competencies (figure 13). Some of them are building blocks of some of the companies' innovation culture and main drivers in the innovation process, especially commercialization.

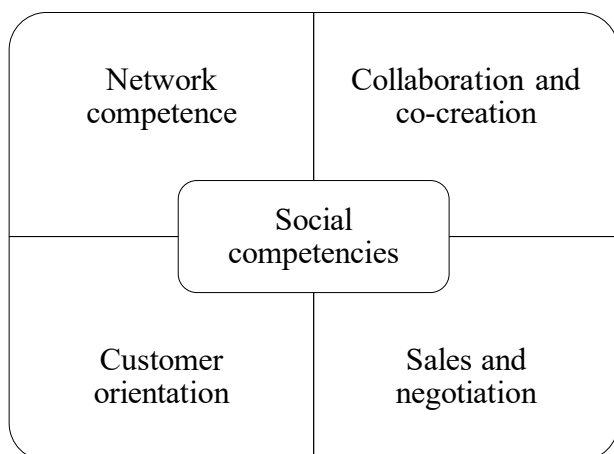


Figure 13 Key social competencies based on the interview data

When interviewees were asked what has accelerated commercialization, most of them referred to network competence. It was believed to be one area of expertise that will help bring innovation to market faster. In terms of networks, collaboration and co-creation are essential for the emergence of radical innovations (Sawyer 2006; Menzel et al. 2007; Tidd & Bessant 2013). Respondents considered that especially in the initial stage, external information is vital to form an overall picture. It responds to one identified challenge and problem, namely, to comprise the value chain and a company's place in it. External contacts are essential sources of innovation and the stimulation of new ideas but also beneficial throughout the process:

“Co-operation between several actors and a certain number of external stimuli is needed to generate innovation. Networking across company and community boundaries brings a variety of ideas and information to be utilized to achieve common goals. The importance of networks is emphasized at different stages.” (Vice President, Strategy)

Furthermore, one of the informants relies on the great amount of expertise they have in different countries and markets and thus, believes that it speeds up the go-to-market. They probably have a service or product that is close to some new radical innovation, and in that sense, they can utilize the knowledge and best learnings from that. Thus, social skills play an important role in networking, collaboration, and communicating internally across the business units. A few informants thought that efficient networking, including customers, suppliers, and various ecosystem networks, is essential, which they should probably make more use of.

“You need partners and startups to build a radical innovation, and then you start together to build what no one could do alone. That is a meaningful change. Sometimes, they come from within individual firms, but many times it has multiple players building it.” (Head of Learning and Development)

Many respondents have spent almost their entire careers in a particular field and admitted that it is one of their trump cards and key competencies, the networks they have built. Creating relationships and trust between parties does not happen overnight. Thus, the ability to build trust is essential related to network competence. The radical innovation process requires recruitment from outside the company, and the interviewees remind that in addition to hired people, they bring with them networks. Thus, it favors recruiting more experienced individuals.

Radical innovations emphasize the co-creation and collaboration of different disciplines and competencies, and when a collision happens, the ideas of doing something in a new way emerge. While in incremental innovations, the number of disciplines or coexistence was already considered more familiar. Thus, networks are a necessary condition for innovation, especially for radical innovations. As noted in the literature review, the lifeblood of ecosystems is open and two-way communication to share and

acquire information. Informants were in line with scholars that open innovation activities are a key for successful innovation (Chesbrough 2003; Meissner & Kotsemir 2016; Cooper 2019). A dynamic environment that generates radical innovation is a complex network of interactions between many actors. Utilizing external help in the process as early as possible is a great asset, and companies should not be afraid of it (Chesbrough 2003). Informants argue that the company does not have to do everything themselves, which is good to acknowledge.

Collaboration is needed with various types of entities, such as startups, other companies, institutes, and universities, noted by several informants. Innovations are made in collaboration, and one informant tells how they have turned some of the sales meetings into joint innovation workshops. Instead of pushing something already existing, they think together about how their activities could be developed, and such ideas give rise to ideas for radical innovations. In many cases, companies face problems and challenges that a company alone cannot solve but often require an ecosystem. Collaboration and co-creation were thought more open than they used to be. Surprisingly, the universities' role was not perceived as essential as it used to be when co-creation between companies has taken a more significant role. One of the respondents referred to as follows:

“Through that, the university’s role as a function other than continuous development is perhaps old-fashioned to become the best help. When you can speak with a company that potentially works with the same thing on the same position of the value chain, I have noticed that at that point will be reached quickly, a proof of concept with agility.” (Director, Business Development A)

However, there were differing views on co-operation with universities. For example, one of the interviewees explained that co-operation with universities is a very purposeful job:

“We have a global collaboration network with research institutes from different universities. The aim is always to identify where the best experts can be found and work with them.” (Manager, Research and Development)

As discussed, customer orientation is one of the most important social competencies in commercializing a radical innovation. Recent studies also suggest the same (e.g., Bonesso et al. 2020, 59). One informant (Director, Business Development A) suggested a Design thinking approach to innovation processes, which he sees as increasingly important today and in the future for new product and business development. Empathy is the first part of the process, and according to him, it is feared, and hence the mistake happens even before the project gets underway. Overall, companies have become much more customer centric. Thus, they should do ideation and new business development customer oriented, through empathy, which few other informants agreed.

Different social competencies appeared in interviews, such as sales and negotiation, communication, the ability to understand and use a foreign language, and the ability to read between the lines emerged in the interviews. The former was often mentioned in connection with commercialization. According to one of the respondents, negotiation skills could be improved on the research side of the team. She expresses it could speed up the innovation process. Sales and negotiation skills are valuable at different stages of the innovation process, from the very beginning to the end. It happens both inside and outside the company. One respondent convinces that the ability to sell is critical. When one has an idea, they must be able to sell it through the organization, even to start a project toward innovation. Often good ideas fail if a pitch is not good, and the presenter lacks presentation and sales skills. Whoever comes up with the idea must sell it and not be discouraged by the first or second attempt:

“The fathers and mothers of an idea do not necessarily be at the top. First, they must get that message out there, and a dialogue begins on how to do it. (–) To some extent, it requires the courage of the innovator to go through the resistance that always happens. Unfortunately, the first reaction is often that it is killed and buried to six meters. You must be able to get up from there.” (Director, New Business Development A)

Briefly from this section, it can be concluded that social competencies and intelligence are considered to play a crucial role in carrying out radical innovation and commercialization activities. Competence is accumulated and developed through experience, for example, building networks. However, there are differences in people, and some are inherently more socially talented than others. The next subsection examines

the entrepreneurial and leadership competencies that emerged as one of the key themes in interviews.

4.2.3 *Entrepreneurial and leadership competence*

Entrepreneurial behavior is challenging in a large organization (Director, Business Development B), but it is seen as a key competence in radical innovation as well as leadership (Hanel 2008). It was also regarded as a behavior, trait, and way of doing things. The informants did not always use the word entrepreneurial or intrapreneur, but they referred to similar traits and behavior, such as courage, passion, and intrinsic motivation. However, it was surprising that the term was not mentioned in more than four out of nine respondents. In the literature, entrepreneurial competencies are among the main differences between incremental and radical innovation (e.g., O'Reilly & Tushman 2004; McLaughlin et al. 2008).

The entrepreneurial behavior and attitude are emphasized in the data. It was clear that entrepreneurial competencies are the main drivers for some informants and can accelerate the process. Radical innovation was described to require people who have courage, the ability to combine big things and a strong will to implement, and the ability to make big turns. A leader must have a strong will to implement the project and execute significant twists and turns, which some respondents call entrepreneurial behavior. According to one of the respondents (Director, Business Development B) involves an organizational model, entrepreneurial activity, and the ability to organize new activities to create conditions for innovation. Carrying out radical innovation projects requires different ownership. Enthusiasm was perceived as a passion, just like an entrepreneur's desire towards one's own company. In other words, ownership is a critical aspect of the radical innovation process what two of the respondents described as:

“It would not have been born without ownership across borders. Company X was committed to doing it, but they may not have believed in it so much until we created that belief together on how great it is. Believing that it is possible is the key to everything. There was much in-depth expertise in the teams, but then when everyone felt ownership and a desire to do something

others had not been able to do, that was the biggest thing.” (Director, Business Development A)

“You must have the desire and hunger to take things forward. That is perhaps the most significant thing. Also, having the feeling you are involved as if it is your baby – similar like being an entrepreneur. Customers will see if you have a burning passion.” (Director, Business Development B)

When a company intends to take an idea forward, it requires the right type of people, competencies, and leadership culture. An essential aspect of a leader’s role is to create a culture and environment where innovation can arise where people feel psychologically safe and connected (McLaughlin et al. 2008; Pisano 2019). In the beginning, the idea does not necessarily have to be concrete. Some even preferred that the will or set direction for the project gives room for maneuver. One of the interviewees described interestingly that the target is like a lighthouse; it should be visible all the time, but sometimes the light is brighter and sometimes foggier.

In line with entrepreneurial behavior, leadership competence in radical innovation requires a visionary, involvement and exploration, and strong leadership and project management skills (Sydänmaalakka 2003; O’Reilly & Tushman 2004; McLaughlin et al. 2008). Many of the respondents described themselves as leaders as participatory, people-oriented, informal, and non-hierarchical, as well as attempting to be present, sparring, and supporting, but not providing direct answers. While pushing the organization flatter, leadership is needed. Both things and people need to lead while creating a positive environment (Pisano 2019). Leadership competence was also underlined to motivate, empower, and engage both the project team and the management team and partners (Sydänmaalakka 2003). A leader must have the ability to inspire others and to create visions in which interpretations are born. In a large company, easily radical ideas are skipped or discontinued if a certain will to implement, and desire cannot be built. Similarly, most informants thought that the projects might end too early without strong leadership.

A few informants highlight the mindset that they see as even the most significant difference compared to incremental innovation. In a radical innovation process, the team must even try to bite too big a piece than they are able to and operate over the boundaries.

Similarly, many scholars find the mindset as a difference between radical and incremental innovation and often as a barrier for a large organization (Assink 2006; Menzel et al. 2007; Sandberg & Aarika-Stenroos 2014). Interviewees remark that mindset may not be a problem at the individual level, but at the organizational level, there may be obstacles. One of the companies has listed enabling mindset as one of their three critical competencies. It consists of competencies relevant for radical innovation and its commercialization, such as developing self and others, empowering and charismatic, solutions-focused, leading skills, and curious and high performance. Finally, many respondents thought that entrepreneurial behavior is also a key to commercialization and, in that sense, to commercialization competence that is next discussed.

4.2.4 Commercialization competence

The characteristics and competencies described in the previous sections are vital to commercialization, but this section looks at competencies directly related to commercialization. Only one of the informants answered that they had defined commercialization competencies (Head of Learning and Development). They use a process model that involves the competencies and tools of specific steps quite accurately. However, this section will review emergent competencies such as value chain expertise, value proposition, positioning in the future market, ecosystem thinking, business acumen, and customer intimacy.

Respondents approached commercialization competence through their understanding of a commercialization process. For instance, one of the informants mentions using a four-step commercialization model, while the others use a three-step model. Both embrace that the first step is to build an understanding of customer value. To provide an accurate presentation of current knowledge and needs of commercialization competencies, the commercialization competence model presented by Aarikka-Stenroos and Lehtimäki (2013) was utilized to identify key competencies. Figure 14 illustrates a revised version of the commercialization competence model (see section 2.2.4), where added competencies have a colored background.

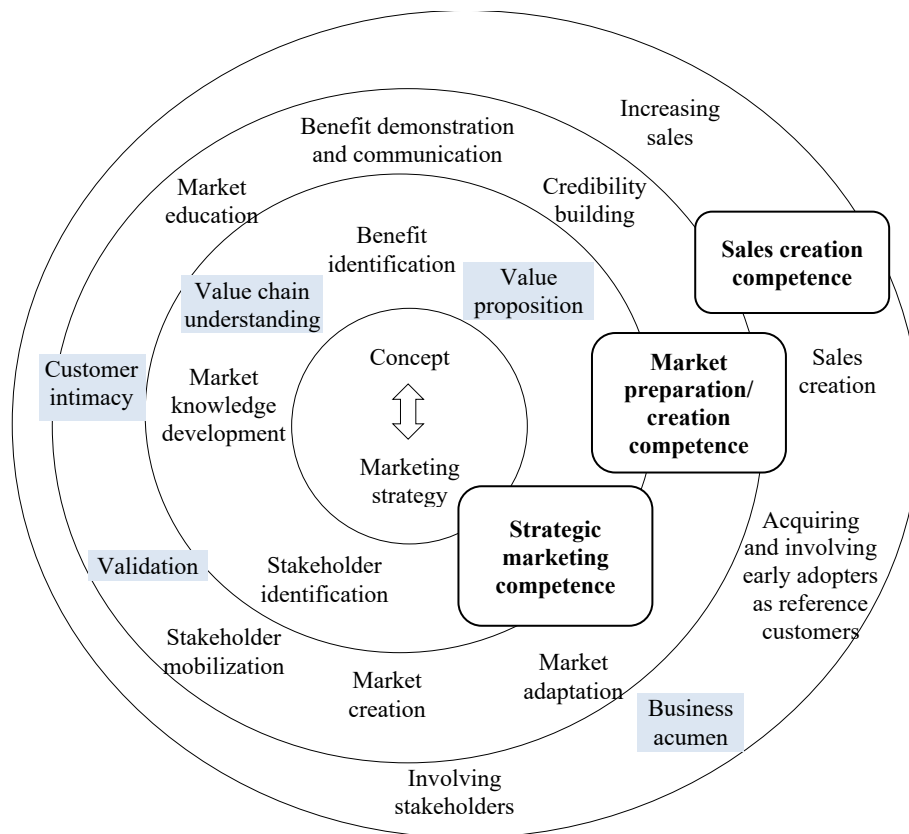


Figure 14 Revised version of dynamic commercialization process competence development (adapted from Aarikka-Stenroos & Lehtimäki 2013, 192)

The model is divided into three zones: strategic, market creating and preparation zone, sales creating, and development zone. Somewhat similar levels emerged in the data; thus, the names are kept the same in the figure. Respondents described the following levels:

- 1) Understand the market that the company is aiming for. How the product and offer serve the market needs and what is the competitive advantage; why the customer would specifically choose this product.
- 2) The other side of commercialization is the validation of its assumption. It includes discussing with customers, discussing with different actors in the value chain, and piloting.
- 3) The third level is implementation. Things are implemented based on assumptions and hypotheses. This stage emphasizes the concrete implementation capabilities to make the factory work and produce the right quality product at the correct cost to correctly argue one's value proposition, price the product accurately, and deliver as the customer expects.

Before the strategic level, as part of the marketing strategy, it is necessary to identify why the customer should choose this product, what is the distinguishing factor. It is

important to identify the benefit of the product at the strategic level, i.e., the value promise given to the customer, as also the scholars note (Aarikka-Stenroos & Lehtimäki 2013). The interviewees agree that it can no longer be built at a late stage but must begin from the start with customer understanding. Customer intimacy and customer understanding were perceived as a key part of commercialization competencies. The potential customer needs to be known right from the start, and the development work is performed in collaboration, as discussed in the previous section. The commercialization competence is concerned with assuring that customers are satisfied with production (Story et al. 2009):

“Commercialization starts from customer need – customer need and value thinking and modeling. It is related to the substance competence of understanding the customer as well as operational and strategic goals and understanding the added value of its customer process. We need to assess the value and where there are places where something new can potentially be found.” (Head of Learning and Development)

In the early stages of the radical innovation process, the final product is not precisely known, or its characteristics and the fit in the value chain are not exactly understood. Thus, many respondents believe that value chain competence is one of the most important commercialization competencies. It requires an understanding of the value of radical innovation in the chain and through it. In the figure, value chain understanding is in the first level, in the strategic zone of commercialization, including the ability to develop knowledge on the market, customers, ecosystems, and positioning in the future market. Knowledge of it develops during the process, but understanding it could, in the view of many respondents, speed up the process of radical innovation.

“We do not understand that value chain at an early stage. Therefore, we may not know how to position ourselves, whether we are just a raw material supplier or whether we have any chance of being a player in the extended value chain. It affects a lot of the total potential.” (Vice President, Strategy)

“Once the project begins, it is impossible to know which value chains we will finally end up with because we do not have competencies or specific

technologies in those areas. If you could guess earlier, the lifecycle could be shorter. It is therefore important to involve more experts from new areas as soon as possible." (Director, Business Development A)

The commercialization of radical innovation requires an understanding of the ecosystem and courage, as one informant describes:

"Radical innovation requires a truly holistic vision, the courage to see the world's twists and turns, to seize them, and a relatively broad understanding of our ecosystem. What to do, what can be done, and in which direction you want to take projects." (Director, New Business Development A)

Interviews revealed that commercialization activities involve people from different units to combine different perspectives, business, and science. Research and Development Manager explains that they aim to form consortia and, if possible, with the whole value chain as part of the commercialization process. For instance, raw material suppliers, equipment suppliers, customers, and possibly even end customers. Sustainability is a significant driver for many of the companies, and thus it should be considered well and acquire people from that area. Other areas of expertise involved in the discussion were mentioned to be people with technical competencies, sourcing, supply chain, and logistics related knowledge, and regulatory issues, product safety, and legal and intellectual property rights (IPR) competencies. When entering a new area, being able to protect own work and innovation creates a competitive advantage in that business area in the long run. Therefore, it cannot be said unambiguously from the results that certain people were involved in commercialization.

However, there were somewhat conflicting views on who should all be involved in commercialization activities. Another interviewee stated that the primary responsibility should be with the launch manager who orchestrates the commercialization (Director, Business Development B). He explains that sales have an important responsibility in commercialization, but more as an orchestra conductor, backed by the entire organization. Only one informant response differed when asked who is involved in commercialization activities. On the other hand, the answer suggests that there is co-operation with many,

but he is responsible, and perhaps because of that, he felt it would take the process alone quite a long way.

“I often drive a project to a certain point, validate it at a strategic level, and manage expectations on both sides. It is one of the prerequisites for radical innovation in commercialization, to manage both sides’ expectations.” (Director, Business Development A)

However, the more general view was that everyone should have commercialization competencies and participate in different activities:

“The basic attitude must be that everyone is a commercialist and can have discussions with customers from their own area of expertise. The role of being commercialists and technical is, I think, a bit old-fashioned.” (Vice President, Strategy)

The importance of business acumen and business understanding in commercialization activities became evident from the interviews. Thus, many suggested that the process could be accelerated, for instance, if the researchers use a business model canvas and analyze critical areas of a particular product and idea – and in some companies, it was mentioned they use. Utilizing these types of tools in the project team is quite critical. Besides, people could be trained for areas that are foreign to them. One of the respondents suggests that, for example, researchers could be educated to network with potential clients.

“We have more targets on the list than we are currently able to handle. At the beginning of the funnel, there must be many people to talk to. On the way, part drops, and the next step, when they get to the pipeline, is to do a demo or physical product that requires people who can do it. Teaching a businessperson to the industry X is easier than get a researcher who can talk about sales – they are rarer.” (Director, New Business Development B)

To conclude, understanding the required competencies and activities to commercialize radical innovation is essential in the acceleration process. This study represents that radical innovation benefits from cross-functional competencies, social competencies such as networking competence and collaboration, entrepreneurial and leadership competencies, and commercialization competence such as value chain expertise, ecosystem thinking, and business acumen. These key competencies have some similarities and are supported by each other. For instance, network competence combines with entrepreneurial behavior, which has many characteristics necessary for commercialization. The next section explores how large companies can ensure the essential competencies and what is the role of dynamic capabilities. A relevant element to consider that emerged in the interviews is an organizational culture that will be first explored.

4.3 Competence building as an enabler for radical innovation

This section answers two sub-questions: how large companies can ensure to have the competencies for radical innovation, and how do dynamic capabilities foster the development of radical innovation competencies. The literature and data support the idea that radical innovation promotes an organization to build new competencies, and thus, the development of competencies was one of the interview themes. However, it needs an appropriate climate and culture for adopting, learning, and developing new competencies, but also for a radical innovation to emerge. Thus, this section first discusses the findings in organizational culture, including innovation culture. Later, the outcomes in the development of competencies and the role of dynamic capabilities are discussed.

4.3.1 Organizational culture fostering competencies development and radical innovation

The interviews revealed that organizational culture plays a significant role as a part of the development of competencies and radical innovation. Literature supports the idea that culture and climate are assumed to significantly impact the competencies and performance (Boyatzis 2007) and an organization's ability to lead innovation (Smith et al. 2008, 663; Cooper 2019; Pisano 2019). At the heart of innovation is a company's

culture. It acts either as an enabler and accelerator of the innovation process or, conversely, as an obstacle. The innovation process requires the right conditions; in other words, its culture (Director, Business Development B). The literature supports the idea that organizational culture influences an organization's innovativeness and innovation capability (Lawson & Samson 2001) and gives a reason to consider it in this section.

Especially in radical innovation, climate should make people feel involved and take responsibility for both failures and successes. According to respondents, the culture needs to encourage experimentation, take a risk, and even fail (Assink 2006; Pisano 2019). It requires an enabling mindset and the ability to fail, informants note. Some proposed that failures could be rewarded because there must be a certain number of attempts that emerge as one radical. The word failure may have a negative sound, but culture should encourage experimenting with its risk. Some interviewees perceived that the culture of experimentation and especially failures are not discussed as openly as it could and should be. One of the informants pondered that it may be due to the engineering education most of them have in their company, where the entire education is structured to avoid risks. Education most likely has changed over the years, and probably entrepreneurship has begun to be favored. However, this work does not take a position on it. The respondent explained his perspective about how their education may affect actions:

“If you go to sell something and have a small chance of failing, you do not even go and try.” (Head of Learning and Development)

Culture is slow to change, especially in large companies. However, the informants were almost unanimous, relying on own doing and experimenting even at the risk of failure would be advisable and something that should not be embarrassed:

“We should trust ourselves more in commercialization. I have come across too many times in engineering companies when people say “not yet” – but yes, we can! If it fails, it should not be ashamed.” (Director, Business Development A)

The interviewees experienced the organization's innovation culture in two ways. There was a consensus that opportunities are being given to try something new, and all companies are investing heavily in innovation and the development of new businesses. It

is in focus, and empowerment gives people confidence that everyone can bring new ideas (Director, Human Resources). There is a strong desire and will to push for innovations, both incremental and radical. For instance, when interviewees were asked what has gone well in previous radical innovation processes in which they have been involved, the state of mind and strong will were thought of as major drivers. In other words, they have had the company's support and culture behind their innovation project:

“It has been possible to create will and desire, a goal, or a vision, which is aimed at. It was realistic, attractive, and built on our expertise and strategy, which is a bit like a lighthouse that has been a reminder that this is essential for the company.” (Vice President, New Business Development)

“The will and desire were present, and the company wanted this to be done. It was one of the biggest things if we think of the whole project. Another thing that was found was the framework, the solution we looked at. We quickly made it a concept and found that own way that could challenge traditional actors.” (Director, New Business Development A)

However, six of the nine interviewees felt much room for improvement in terms of culture supporting innovation activities. For example, some felt that the organization's traditional operating and areas of activity delimit activities. Innovation is often reflected in management's presentations and strategy, but it could be more visible. According to the respondents, the organizations are performance-driven, which they did not criticize, but they explain that it does not produce innovations on its flip side. These organizations are good at continuous improvement, incremental innovation that is typical for large companies (Chandy & Tellis 2000; Assink 2006; Matthew & Brueggemann 2015).

The challenge is how people can be activated more specifically through their experiments and what interests them, and through their projects, one informant explains. Entrepreneurship is interpreted in the literature as part of innovation culture (e.g., Apilo & Taskinen 2006), and many respondents agreed. Based on results, the challenge is to promote internal entrepreneurship or the development of internal startups, and that type of culture beneficial for radical innovation. Innovation projects start from a very small, but in large organizations, the problem is how to get a radical idea into a big business and

make it scalable in a controlled way. It requires a whole organization, right down to management, support, courage, and a mindset. In a large organization, project size requirements are usually high, and the scale should be significant from the outset, which may be a challenge:

“In many cases, the culture is that there must be a billion or ton of class business immediately. Although that added value is precious, the market is so small that it is feared. (–) Even management might need to develop competencies and think in this regard. There are no magic tricks for it.”
(Head of Learning and Development)

Agility is one of the cornerstones of innovation culture among most the study’s large companies. It was also described in terms of knowing the organization adequately, knowing how to get ideas forward quickly, and readiness to work past processes when the opportunity arises. The agility approach guides the projects, and companies look at agility and validate the projects all the time, helping them stop early enough and change direction when needed. Many companies have attempted to build an agile process for innovations, minimize bureaucracy, and make faster decisions, commonly thought of like a big house challenge. However, one of the informants notes that often rigid processes are barriers they face, and often there becomes an opportunity very quickly for which their process does not work. Therefore, the agility is not working at its best (Director, Business Development A). When change is happening rapidly, confirmed information is often not available, and when it is finally available, it is usually too late.

Companies had different ways of developing and promoting culture. It can be boosted by different agile operating models and teams that know how to change direction better and more agilely in a new operating model. Another interviewee talked about their weekly meeting where they review old cases, and she trains the team on the possibilities of IPR, for example. One of the respondents also highlighted promotion through example and demos. They strive to promote even small successes and lift the people behind them, for instance, on the intranet. Some interviewees felt that the fee for invention and patent applications promotes innovation and culture. Many companies describe themselves as innovative, but apparently, it is not always visible to the entire organization, even if there is an interest in innovation. One of the respondents explains how they promote innovation culture:

“A fee is paid to individuals for invention notifications and patents. Sure, we monitor innovation activities in our R&D function, but the rest of the organization may not hear about them. However, we have popular R&D days or technology info about these projects.” (Manager, Research and Development)

Many stated that fostering innovation culture starts vastly from leadership and a model of action with strong encouragement, motivation, and trust that are also main innovation culture factors presented by Apilo and Taskinen (2006). Nonetheless, none of the interviewees thought they should have separate innovation culture programs, although its development is essential. After all, culture does not develop by itself, but it must be nurtured all the time. One respondent argued that even though companies’ value other important matters, innovation should be a prior too:

“However, it is also the top management’s job to feed it and care how it is fostered. For many companies, safety is the first thing; of course, it is, but innovation is just as important. Not that innovation is the responsibility of a particular organization or Business Development or R&D, but innovation should be in that company’s DNA. The companies that have it in their DNA are continually innovating, and it is part of that everyday life.” (Director, Business Development B)

In the interviewees, an interesting notice emerged. A few interviewees talked about the importance of generalists in the work community, which they identified as themselves. Generalists play an important role as drivers of innovation culture, but also, they can be a vital link between substance experts and at the interfaces of different organizations and organizational cultures. Because of their ability to adapt, a generalist can take on different roles and manage entities in a rapidly changing situation when needed, and thus, it is favorable in radical innovation. One of the interviewees felt that generalists had not previously been valued for the worth that their role brings:

“For me has never mattered at which table I sit. Boldly bringing generalists to the table and innovating is today. For a long time,

generalists' role in R&D innovation organizations has been downplayed in Finnish technology companies. However, they have a place today, and they often play a much more important role than is thought." (Director, Business Development A)

To conclude, innovativeness in an organization requires a supportive culture where people dare to experiment, question, and make mistakes (Apilo & Taskinen 2006; Pisano 2019). The results indicate that organizational culture is a key determinant for innovation and, thus, the development of innovation competencies. In terms of organization and innovation culture, many interviewees felt that there was room for improvement. Agility, trust, encouragement, entrepreneurship, and risk tolerance were mentioned to foster an organizational culture for innovation. Old routines and homogeneous organizations are perceived as obstacles, and thus, people with different backgrounds were emphasized to break old habits. For example, in engineering organizations, generalists can act as a promoter for a more innovative culture. Building the culture is an ongoing process for which managers and supervisors are primarily responsible, but everyone has their role in learning and supporting the development.

4.3.2 Development of competencies

The study results suggest that one aspect of the innovation's radicalism comes from the fact that a company's core competencies do not match; thus, external competencies and development of competencies are needed. Innovation projects are long-term and require companies to acquire and develop competencies and capabilities continuously. In the face of radical innovation, companies must have a basic level of competence that must be developed. It can be related to, for example, raw material or a certain familiar aspect, informants explained. However, competence development is twofold: (1) acquiring competencies from outside to have the necessary competencies and (2) developing the existing competencies. In this subsection, we first go through what kind of competencies is sought and where. It is then reviewed how the development has been taken into action to enable the most desirable competencies for emerging innovations.

None of the respondents thought the best people should be found within their organization. They want to find the best talents, but it did not matter where they come from. When innovation arises, companies put the best people around it: customers,

subcontractors, or startups (Director, Human Resources). Building competencies around innovation is a combination of internal competencies and relevant external ones (O'Connor 2008). Thus, the company must know how to put the right people together. The mix has different needs in different phases, and for instance, often external technical competence is required in the early phases, and partner for a short period only, one respondent explained (Pynnönen et al. 2019). One company works by looking at the people in certain projects and how well their competencies match their needs. Once the competence gap has been identified, it is possible to assess whether it can be filled internally or whether an external is needed. It is necessary to think about the fundamental competencies and identify competence gaps on a project-by-project basis despite the future needs. They are answered through internal training and external recruitment and co-operation. Often organizations buy a smaller company or license to a technology, which is how the learning happens. One of the informants notes that at that point, the team acts like a small startup that requires to learn of external knowledge.

Nonetheless, there are no ready-made competence packages in the face of radical innovation, and companies can build competencies in several different ways. The challenge is identifying what competencies and capabilities are needed to achieve a competitive advantage with the best value-generating mechanism (Director, New Business Development A). Respondents emphasize that people coming to the project should have a basic competencies and experience. These two comments summarize the results:

“At first, I would look at people with a basic capability to read a game (in that specific area) and an adequate experience base to read the market and understand the soul life associated with it. But also, to have an understanding and ability to look at the ensemble and analyze some aspects of the market, and then process it mathematically. By combining the right general competencies with a solid experience base that we already have inside the house, the right competence mix can be made. Then you must know how to lead that competence development process correctly.” (Director, New Business Development A)

“People need to have basic competencies, which means education or experience. Connecting external expertise to it is very important. There

are many ways to do it; for example, through collaboration or recruiting people for our company.” (Vice President, Strategy)

The development of competencies is continuous. All companies conduct annual or continuous talent reviews and development discussions, which serve as a basis for competence development. According to the respondents, the most common and proven model for competence development is through work outside one’s comfort zone. Besides, co-learning is used, including mentoring, coaching, and participation in various events or conferences. When a need for new competencies arises, formal education is considered slow and not as beneficial as work-based and co-learning. Traditional competence development has shifted from classrooms to the practical level, and the best development has been found to take place with other people. One company has competencies development built more into innovation programs. When they have an innovation program, they can develop the competencies of the teams and thereby see what kind of competencies they need. He commented on the program as follows:

“The integration of innovation programs and competence development is the direction we are heading for more and more. It means that the development of competence takes place through doing. For example, people work as teams on new customer innovation and develop skills as part of that project. Instead of developing competencies in a specific area, our team is integrated into the job demands.” (Head of Learning and Development)

As earlier discussed, a company should have several but not too many projects in its portfolio simultaneously. From the point of view of competencies development and sensing new opportunities, some need to be in unfamiliar areas to identify new competencies that can be adopted and developed into the company’s core competencies in the future. Figure 15 illustrates how strategy, foresight, and competence development should support each other based on the findings.

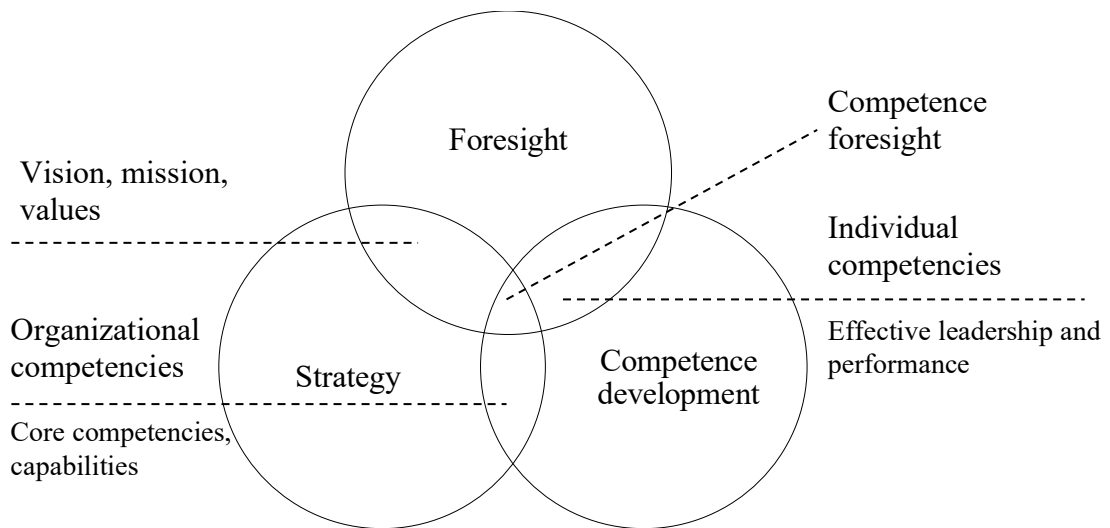


Figure 15 Development of competencies

The above figure distinguishes three crucial factors for competence development: foresight, strategy, and competence development. They are all critical for the development of radical innovation, especially when studying the components that affect the pace of innovation. Foresight is about preparing for the future and understanding it better. The company's vision, mission, and values drive the direction of the future to which the strategy responds, which competencies and capabilities will be in focus in the future. As respondents noted, individual competencies are a continuous object of development, influenced by effective leadership and performance. Companies understand future oriented development, a static view is not enough, and a company must have dynamic capabilities that will be reviewed in the next section.

4.3.3 *The role of dynamic capabilities*

Concrete examples of dynamic capabilities were presented in previous sections, such as agile methods, networking, finding new customers, industries, and technologies, and responding to a new kind of customer need that all the representative companies stress and utilize. The interviews proved that networks make it possible to combine different competencies to achieve the desired result. It reflects the dynamic nature of the capability, which also strongly reflects Teece's (2007) reconfiguring capability. The respondent companies mainly introduce radical product innovations, albeit, in their innovation projects, different innovations emerge, such as process innovations. Eisenhardt and Martin (2000, 1107) argue that "product innovations are real dynamic capabilities, as they

permit the renewal and reconfiguration of a firm's resources". Similarly, the study results show radical innovation as an enabler for competence development and renewal.

Respondents had an equal perception that, especially when exploring radical innovations, a company's resources are dynamic, which scholars agree with (e.g., Teece 1997; 2007; Eisenhardt & Martine 2000; Wang & Ahmed 2007). It is not enough to view competencies as static but dynamically review them and identify future competencies companies can utilize to benefit their innovation projects.

"The setup should by no means be static but should be dynamic that is constantly being considered and evaluated. (-) In other words, the balance and portfolios of expertise are adjusted as necessary." (Vice President, New Business Development)

According to the results, the identification of competencies and the development process is not only the task of the human resources unit but of everyone. However, one interviewee highlights a few points when considering it at the organizational level:

"Development of competencies and capabilities requires people within the company whose role is to develop the organization. Those abilities do not arise by themselves, and we must have good processes. First, identify those required capabilities from the outset of the strategy. On the other hand, we must have a talent learning organization's development programs that enable development." (Head of Learning and Development)

Scholars have argued that large companies had dominated stable markets that have evolved into complex ones (Roberts & Grover 2012). A few of the respondents also pointed out that many companies have enjoyed relatively simple markets so far, but they predict a change to a more complex future. Significant changes in the market have been slow and have given companies time to react, but it is more likely that the pace of transformation will be more rapid. Based on the findings, the development of competencies is changing in an increasingly dynamic direction. As the future becomes more complex, it is not enough to monitor capabilities statically, but companies should always explore trends, seize new opportunities, develop innovations and dynamic

capabilities. According to one respondent, the pool of competencies with which companies control and guide innovation projects will change radically.

In line with the theoretical part, agility has become one of today's critical dynamic capabilities (Roberts & Grover 2012), which is how companies are adopting and preparing with future requirements. Many described using a revised version of the Stage-gate system enabling them to use agile approaches to cope with markets and customer requirements (Cooper 2014). Nonetheless, as noted, many felt room for improvement, and it is hard to tell the actual level of their dynamic capabilities. Strong dynamic capabilities could improve performance in an agile way and better sense emerging developments and required resources (Teece 2016), where companies aim. To obtain this agility, firms must efficiently identify and orchestrate their bundle of assets, which was recognized as one of a leader's most important tasks.

In terms of a company's innovation and transformation, a company must have foreign competencies areas that are evaluated and studied. These projects can identify new areas of expertise and business opportunities to the innovation pipeline (Vice President, Strategy). As the previous section expressed, informants believe that learning takes place experimentally by doing and learning. Also, there is a common understanding that learning through mistakes and failures is essential to developing organizational competencies and radical innovation, which is in line with scholars' perception (Eisenhardt & Martin 2000). Based on the results, it can be concluded that by supporting competence development and, for example, a culture of experimentation, large companies would have even more potential to present radical innovations faster to the market. Indeed, many respondents hope that companies will embark more boldly to experiment in the future, as it can open new doors and develop organizational competencies.

5 CONCLUSIONS

In this section, the findings of empirical research with the academic literature and theoretical framework are presented. This conclusion section is divided accordingly. Theoretical contribution mirrors the empirical research results to the theoretical framework of the factors influencing the innovation speed from the perspective of competencies and presents an updated version of the framework. Besides, this section discusses the implications of the research findings for previous research literature. The managerial implications present findings of key competencies in radical innovation and their development that the commissioner company and other large companies may find useful in the radical innovation process. At the end of this section, the limitations of this study and suggestions for future research are discussed.

5.1 Theoretical contribution

Given the importance of radical innovation projects for large companies (Tidd & Bessant 2013, 9), it is essential to define and develop competencies to enable companies to accelerate the innovation process. Based on the results, many companies may have had a chance to enjoy relatively simple markets. However, the pace of change is persistent, and companies must have the ability to commercialize radical innovation into the markets faster. Commercialization is a stumbling block or a challenge for large companies (Chandy & Tellis 2000; Assink 2006; O'Connor & DeMartino 2006), which gave motivation to further focus on it. This study examined the competencies in radical innovation through literature and empirical validation that will be compared in this section. Additionally, things that foster radical innovation: culture, development of competencies, and the role of dynamic capabilities, are discussed.

Competencies play a decisive role in identifying innovation potential, finding opportunities, generating ideas, and finally transforming them into innovations (Teece et al. 1997; Eisenhardt & Martin 2000; Zollo & Winter 2003; Helfat et al. 2007). The most important means for developing competencies in the literature are continuous experimentation and learning through experiences (Teece et al. 1997; Eisenhardt & Martin 2000; Zollo & Winter 2002; O'Connor et al. 2008, 20) that eventually will lead to the emergence of radical innovation (Garcia & Calantone 2002; 121). This study regards competencies at the organizational and individual levels (Murray 2003; Håland & Tjora

2006). Empirical data mainly showed individual competencies even though the results highlighted that a team and its competencies are more important than individuals. Individual competencies affect the organizational competencies, which in recent decades have been strongly linked in the literature to companies' innovation capability (Lawson & Samson 2001; Saunila 2016, 162–163). It has also raised interest towards the speed of innovation (Ellwood et al. 2017; Matthew & Brueggemann 2015, 80).

The iceberg model of competence created by Spencer and Spencer (1993) supports the importance of attitude in the elements of competencies, as they are the invisible or sub-surface factors of competencies, including individual motives, self-perception, and individual characteristics, that provide a basis for individual competencies. This study also confirms that motivation plays a significant role in terms of radical innovation and how an individual is willing to act to their full potential. In addition to management's commitment (Tidd & Bessant 2013, 86), radical innovation requires each participant's dedication to distinguish itself from incremental innovation (Kristiansen & Ritala 2018, 34). Nonetheless, *according to this study, management's trust, commitment, and strong will to implement are essential in radical innovation projects.*

Scholars have named four radical innovation competencies: discovery, incubation, acceleration (O'Connor & Ayers 2005; O'Connor & DeMartino 2006), and commercialization (Story et al. 2009). This study does not differ from these but focused on the latter two and examined the required competencies. The contradictions between the results and the theoretical framework do not refute the literature but instead specifies it, as illustrated in figure 16. *This study suggests that key competencies in radical innovation projects are cross-functional competencies, social competence, entrepreneurial and leadership competence, and commercialization competence.* The study findings support the common understanding that teams of highly multifunctional individuals lead for better and more agile results in radical innovation (O'Connor & McDermott 2004; O'Connor 2008). Social competencies are undeniably also one of the critical competencies based on previous research (e.g., Dyer et al. 2009; OECD 2011; Hero et al. 2017; Ellwood et al. 2017; Pisano 2019). Entrepreneurship has also been perceived as essential for radical innovation in previous studies (O'Reilly & Tushman 2004; O'Connor & McDermott 2004; O'Connor 2008; Riel 2011). Similarly, commercialization competencies also (Story et al. 2009). Pisano (2019, 5) suggested two further competencies, tolerance for failure and willingness to experiment. This study

perceived them to be organizational competencies that are understood to consist into a culture.

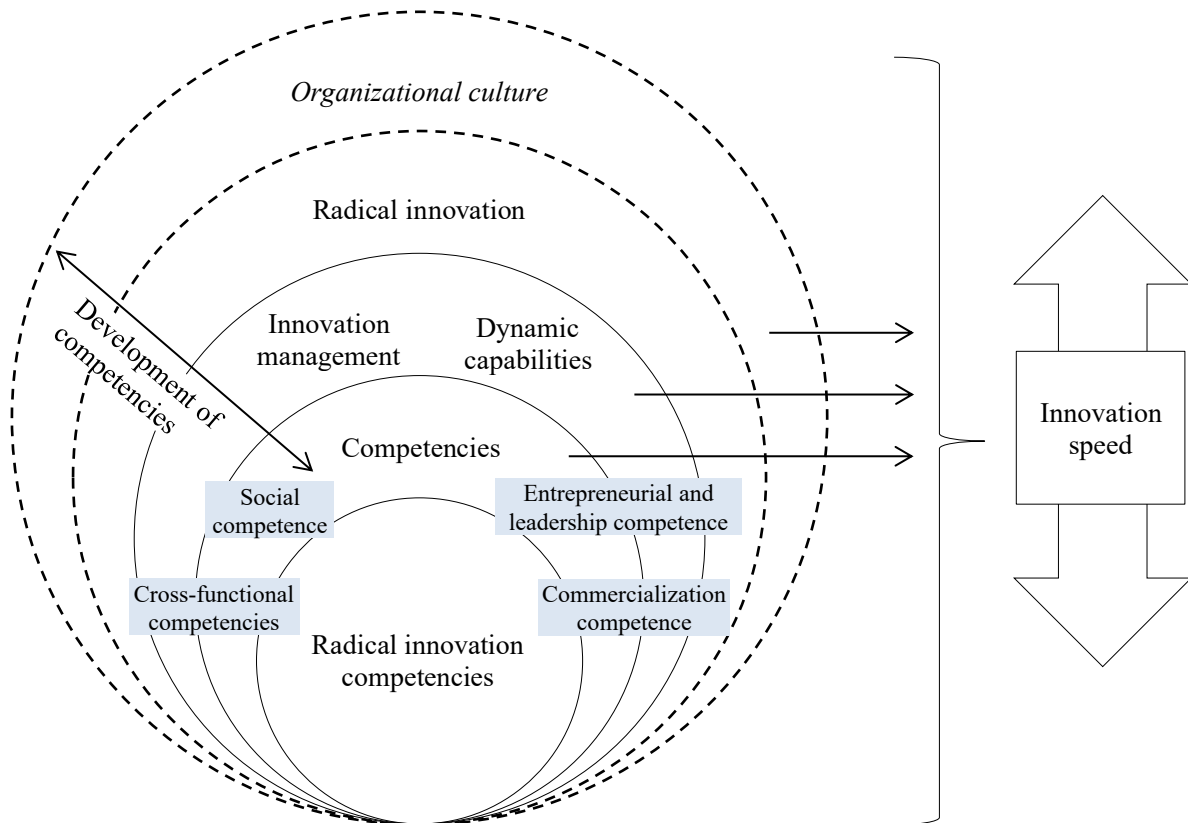


Figure 16 Revised version of the theoretical framework

The initial theoretical framework was updated, and additions were made to both the inner and outer layers. This study supports the view of the previous literature on the importance of organizational culture and climate (e.g., Pisano 2019, 5–7; Smith et al. 2008, 663; Matthew & Brueggemann 2015, 24; Cooper 2019). The literature emphasizes the role of the right kind of environment and culture in developing employees' skills, knowledge, and creativity and promoting innovation (Apilo & Taskinen 2006). Large companies understand the need and have the desire to develop the innovation process and identify the essential competencies to accelerate it. Organizational culture inevitably plays an important role and positively impacts many aspects of the innovation process. Scholars emphasize that culture should encourage a try-and-fail attitude (Assink 2006; Pisano 2019), which, according to this study, is lacking in many large companies. *This study shows that there may often be a lack of self-confidence or suspicion of failure at the time of commercialization, resulting in the firm abandoning the pursuit to commercialize innovation. The examples of this study suggest that one of the most important matters in*

the implementation of radical innovation projects is to achieve a suitable climate and culture and a certain state of mind to implement the project.

This study confirms that within-firm competencies, even in a large company, are not adequate to develop and commercialize radical innovation (Chesbrough 2003). The contribution of actors outside the firm in radical innovation is critical (Story et al. 2009; Aarikka-Stenroos & Sandberg 2012), and this study supports combining both internal and external experts. In today's open operating environment, radical innovations are not created by just one person or even a company. They need a heterogeneous group of experts and talents in different fields to emerge (O'Reilly & Tushman 2004; McLaughlin et al. 2008). This study contributes to a clear understanding that the collision of different perspectives plays a significant role in the co-operation of experts. Consequently, various thoughts, ideas, views, and multiple industries must come across. In the creation of radical innovations, knowledge alone does not suffice, and it must be accompanied by creativity and the encounter of different angles of entry.

The literature on innovation management has shown interested in soft skills (OECD 2011) and behavioral competencies for innovation (Chatenier et al. 2010; Bonesso et al. 2020). In line with that, social competencies emerged as one of the key competencies. According to Bonesso et al. (2020, 59), the most important social competencies in commercialization are persuasion, teamwork, and customer orientation. This study suggests networking, co-creation and collaboration, customer orientation, and sales and negotiation competencies, which do not exclude the competencies mentioned above, but rather complement the understanding them. Considering this study and based on previous studies in a collaboration-centric approach to innovation, especially networking competence is among the key competencies in radical innovation (e.g., Dyer et al. 2009; Hero et al. 2017; Pisano 2019; Bonesso et al. 2020). This study's informants thought the networking competence like Sydänmaalakka (2003, 118), as "the ability to continuously build and maintain friendly contacts and networks with people". When a company aims to a new, unknown market, it is critical to have people who already have networks and an interface to the field. *From the perspective of large companies, networking competence also means the experience and networks inside the company, the ability to know how to speed up processes, and whom to contact in each situation.*

The results of this study build on existing evidence of perception that radical innovation teams are constructed from cross-functional people with entrepreneurial qualities (O'Connor & McDermott 2004; O'Connor 2007). Initially, the concepts of

entrepreneurship and innovation were combined (Schumpeter 1943), which this study supports among other scholars (O'Reilly & Tushman 2004, 8; McLaughlin et al. 2008; Kelley et al. 2011, 261; Ringel et al. 2020). In an innovation environment, competencies consist of a mixture of leadership and entrepreneurial competencies, leading to various capabilities and functions. Both organizational and individual competencies can be described as entrepreneurial, even though none of the companies called themselves as that, but more often as innovative. Large companies are built to develop pre-existing, incremental innovations (Assink 2006; Menzel et al. 2007; Matthew & Brueggemann 2015), as the respondents also noted. Thus, the difference in entrepreneurial behavior is clear. For a company to present something completely radical, it takes courage, passion, and the ability to take the innovation project forward. Many respondents believed that innovation teams should apply entrepreneurial capabilities and mindset and that it is even a cliché. Entrepreneurial competencies were described as the courage and curiosity to find new ways to create value, taking ownership of the project, having intrinsic motivation, facing the failures, and persistently trying again. Thus, it is in line with scholars Tidd and Bessant (2013a, 8), who described entrepreneurial characteristics as “passion, planning with vision, tools with the wisdom to use them, strategy with the energy to execute it and judgment with the propensity to take risks”.

Chiesa and Frattini stated (2011) that commercialization is one of the most significant challenges in the radical innovation process, and the claim did not differ in this study's results. Understanding and attitude towards commercialization have changed. The process is seen as an iterative process, similarly as Aarikka-Stenroos and Lehtimäki (2014) and Cooper (2014) in the next-generation stage-gate model suggested. All respondents emphasized the focus and development of competencies in the early stages of commercialization. The competencies mentioned above were perceived as necessary in commercialization activities. Still, *this study identified the following competencies in addition to these: business acumen, customer intimacy, ecosystem thinking, positioning in the future market, value chain expertise, and ability to make value propositions.* Nonetheless, this study supports the commercialization competence model by Aarikka-Stenroos and Lehtimäki (2013) and merely specified it.

While previous research has argued that competencies required for commercialization are different from those required for scientific research and R&D (Hanel 2008, 9), these results demonstrate that perspective to be old-fashioned. This study suggests that *everyone should have commercial capabilities and have discussions with customers from*

their area of expertise. Without sharing roles in commercialization and other activities, the premise would be that everyone is involved somehow. What was not discussed in the literature is the importance of generalists. This study suggests that they act as links between different commercialization activities and can quickly understandably present even the most incomprehensible technical issues. This study also proposes that generalists play a crucial role in developing an innovation culture.

The development crosses the figure, and an arrow is drawn separately from it for dynamic capabilities because it directly affects it. For large companies that have operated for a long time, the question is how to shift between current competencies and those needed in the future. They benefit from a vast talent pool (Chandy & Tellis 2000, 4) that the informants agreed, and companies intend to direct people to radical innovation projects with the right background. Innovation activities balance between the strengthening of existing activities and creating new activities emphasizes the development of existing activities and innovations that incrementally renew products and markets. Augier and Teece (2009, 411) emphasize that the development of competencies is not a linear, straightforward process. Jacob (2019, 166–167) also highlights the continuous learning journey and suggests that companies question familiar practices for radical innovation to emerge. An organization's ability to renew means innovating and finding ways to do things more efficiently and conquer new markets with new competencies. It requires achieving goals that are not possible without the ability to question and change thought patterns and methods. All large companies thought that competencies development starts much from people's motivation and activity, although large companies offer tools for it. There was no discrepancy in the results as to what would be the best way to learn – people learn best by doing and outside their comfort zone.

The orchestration of resources to ensure long-term success has attracted many scholars' interest in dynamic capabilities (e.g., Augier & Teece 2009; Ambrosini & Bowman 2009). Although dynamic capabilities are widely discussed in the innovation management literature and often mentioned in studies about radical innovations, the term was not used by the respondents. Only one of them spoke more broadly about dynamic capabilities using the right term. He thought that large companies need to have people whose role is to develop the organization as suggested by dynamic capabilities. Nevertheless, dynamic capabilities are widely exploited in large companies. Schoemaker et al. (2018, 17) define dynamic capabilities as a firm's capacity "to identify profitable

configurations of competencies and assets, assemble and orchestrate them, and then exploit them with an innovative and agile organization". Large companies strive to respond to the changing environment with agile methods and develop new competencies that fit Schoemaker et al. (2018) definition. Scholars suggest dynamic capabilities enable better creation, integration, and reconfigure internal and external competencies (Teece 1997; Schoemaker et al. 2018). Thus, *this study suggests those are crucial in developing competencies for radical innovation*. Teece (2018) indicated that companies with dynamic capabilities are strongly entrepreneurial as they not only adapt to business ecosystems but shape the system through innovation and collaboration. Thus, all the large companies that develop radical innovation should be entrepreneurially oriented. The results build on existing evidence that successfully commercialized innovation acts as an organizational enabler for new competence building (Vanhaverbeke and Peeters (2005, 255).

To sum up, this study's empirical findings largely support this thesis's theoretical framework presented in section two. The contradictions between the results and the theoretical framework do not disprove the literature; instead, it specifies it as presented and illustrated in this section. These results should be considered when considering how to accelerate the radical innovation process in large companies.

5.2 Managerial implications

For large companies' management, this thesis provides insight into the competence categories that positively affect the speed of the innovation process. Competencies management and dynamic development will become increasingly important in the future, as competencies will become even more critical in today's ever-changing and competitive market. Competencies can mean many things, and therefore before discussions extend to a broader audience in the company, the definition of competence should be clarified and crystallized. All people working in the company should understand what elements the concept of competence entails and what it means to succeed. This study has shown that competencies should be considered holistically, as well as competencies that large companies today recognize as necessary for the commercialization of radical innovation.

As a result of this study, it can be illustrated that dynamic capabilities can deliver success to a firm in many ways and in many different contexts. The global Covid-19 pandemic was a reminder that a company's capabilities and competencies cannot be

static, and companies must be able to make even significant changes in a short period. The most important is to explore unfamiliar areas of competencies and to strive to develop them and integrate agile methods into the systems. The purpose of dynamic capabilities is to guide and support the organization in future challenges and enable future success. It offers a toolkit for coping with challenges.

In addition to a good idea, innovation requires the right environment and culture to develop ideas and drive innovation projects to commercialization. It is often thought in large companies that innovation means a new way of doing something more cost-effectively. There is much more in innovation, and often it may not show across the company. Willing to learn, be open, and agile enough to embrace radical innovation requires different dedication and internal motivation to make the best possible contribution. Even the smallest successes need to be highlighted and rewarded in a pleasing way to the individual or team. As the interviewees of this work suggested, large companies should boldly try out completely radical ideas and give them a chance.

Related to the culture and driving radical innovation, managers should be aware of the value generalists bring with them. They are valuable in R&D, and companies should consider the balance between them and specialists. They act as a vital link between substance experts and at the interfaces of different organizations and cultures. Because of their ability to adapt, a generalist can take on different roles and manage entities in a rapidly changing situation when needed.

The final suggestion for management is related to intrapreneurship, a topic of discussion today in both literature and corporate communications, even though for radical innovation, entrepreneurial characteristics have been recognized for a long time ago (Schumpeter 1943). Based on the results, entrepreneurship could be much broader than just the people driving innovation projects. Innovation work develops the ability to adopt a new way of thinking that helps to see opportunities and solutions instead of constraints and challenges. Companies should develop a culture of intrapreneurship and startup-like activities to get people activated to experiment, where a radical innovation may emerge. Efficiency-thinking might take to another direction, which is a dilemma. Besides, the role of cross-border co-operation will be further emphasized, and in addition to the beneficial resources companies gain, closely work with startups can foster a culture of innovation.

On the other hand, this study's target audience is also experts involved in innovation projects. The results of the thesis provide an analysis of which competencies the

management considers to be the most important of all. In this way, they can direct their attention and supplement their competence portfolio with relevant capabilities.

5.3 Limitations and future research suggestions

This study was conducted as a qualitative study in which a semi-structured interview was chosen as the data acquisition method. Considering the method choices made in the light of the research results, the choice can be regarded as successful as it served to settle the research problem and its answer. The thematic analysis of the material also produced the expected new perspectives on the topic, and the selection can therefore be considered successful. The results refined the innovation competence research for large companies and provided a basis for further research topics.

This research provides theoretical and managerial implications; however, it does have its set of limitations. First, this study is based on large Finnish companies that develop and introduce radical innovations. Second, although all companies operate globally, the responses could have been different if the interviewees had been from several countries. The interviews compared processes or the level of competence to other countries a few times, so even if the target companies are global, the results would have differed if the interviewees had been from different countries. Thus, one possible topic for further research could be the differences between countries regarding radical innovation competencies.

Based on this study, it would be interesting to continue to study the factors influencing the innovation capability and speed of processes of large companies by selecting companies with different innovation processes. As the study results explained, there are changes in large companies in terms of radical innovation projects, such as attitudes and culture and even the operating environment. On this basis, it would be interesting to carry out a further study comparing similar companies operating in different ways. On the other hand, it would also be interesting to compare large companies with small and medium-sized companies to determine whether company size impacts a company's ability to innovate and differences in what competencies are emphasized.

6 SUMMARY

Innovation has long been recognized as a crucial factor in determining companies' growth and competitiveness, and by any measure, academic and business interest in the field of innovation is growing. Similarly, the importance of competencies is continuously increasing in today's competitive global environment. Organizations' operating environment is changing rapidly, requiring examining the organization's current state and competencies to keep pace with the changing markets. They must, therefore, define what the needed competencies are and how to relate existing competencies with future requirements. Firms must have a functioning and continuously evolving process that requires creating and adapting new competencies and identifying the current gap. The concept of innovation is complex because it not only includes a new idea or invention but also refers to organizational, technical, and market aspects as well as commercialized products that succeed in the market. The success of commercialization measures its performance. A rapidly changing and unpredictable operating environment requires new ways of working, capabilities, and competencies.

Two forces drive the innovation process and gave motivation for this study. First, competition forces firms to accelerate the innovation process to ensure competitive advantages in the market. Second, success in introducing new radical innovation depends on competencies and the accumulation of capabilities that can foster innovation processes and positively impact innovation performance. This study set out to explore how do competencies help accelerate the radical innovation process in large companies. The sub-objectives were to find out the key competencies, especially in commercialization activities, analyze how large companies ensure the necessary competencies for radical innovation, and how dynamic capabilities foster the process. The initial framework was constructed from existing literature. Different building blocks of radical innovation were found in innovation management, dynamic capabilities, and competencies.

The empirical research was collected by applying a qualitative research method with open-ended semi-structured interview questions based on the theoretical framework. Nine informants from large companies, all of which are expected to have efficient radical innovation commercialization practices, were selected for the interview. All the interviews were recorded, which enabled the detailed transcription process afterward. The data was analyzed using the themes in the operationalization table and the ones emerging from the results.

The theoretical and empirical literature has shown a link between competencies and firms' innovative functions to understand what factors influence firms' propensity to innovate and their ability to acquire external knowledge. The empirical research supported the existing findings to a large extent but also provided new insights on the level of understanding of key competencies and organizational culture's role in radical innovation and competencies development. Results revealed that all representative companies understand the importance of commercialization but understand it as the most critical challenge. It was concluded that key competencies in radical innovation are cross-functional competencies, social competence such as networking competence and customer orientation, entrepreneurial and leadership competence, and commercialization competence, including agility, ecosystem thinking, and value chain understanding. Radical innovation requires interaction, trust, stimuli from the outside environment, and the right kind of culture that encourages entrepreneurial act and experimentation. Moreover, competence development is a critical, ongoing activity, but only developing internal competencies alone does not produce the desired results in the face of radical innovation. The findings predict that the role of dynamic capabilities will increase as large companies prepare for more complex markets, want to achieve agility, and ensure the best possible level of competencies and capabilities.

The results of this study are beneficial for large companies' management, providing insight into the competence categories that have a positive effect on the speed of the innovation process. On the other hand, people interested in radical innovation projects in large companies may find valuable knowledge on how they should develop their competencies.

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APPENDIX

Appendix 1 Interview guide

Background

- Could you give a brief introduction of yourself? Also, tell your professional background and current position briefly.
- How long have you worked for the company and how long have you been in a supervisory position?
- How would you describe yourself as a manager?
- What does the word innovation mean to you? How is it perceived in your organization?

Theme 1 – Radical innovation

- How do you define radical innovation in your company?
- What differences in competencies can be seen between radical and incremental innovations?

Theme 2 – Innovation process

- Can you shortly describe the innovation process within your company?
- What specific features does the radicalization of innovation bring to the innovation process?
- In that process, what worked well and what did not?
- What should be developed and how?

Theme 3 – Commercialization

- How would you describe commercialization?
- When does it start?
- Who is involved in the commercialization activities?
- What competencies do these people have that are particularly useful in commercialization?
- What are the main challenges in the commercialization of radical innovation?
- Which competencies you think could speed up the commercialization activities?

Theme 4 – The concept of competencies

- How have you defined competencies?
- How have you defined competencies for commercialization?
- From where the new competencies are acquired?
- What methods are used to identify competencies?
- Based on your experience, what are the most critical competencies to accelerate the innovation process?

Theme 5 – Development of competencies

- How can those competencies develop in your team or company?
- How does the company's strategy consider the learning and development of competencies?
- How do you promote innovation culture in your company?

Reflections

- What has been your best achievement regarding commercialization?
- What have you learned about those?
- What are typically major challenges in the innovation process?
- Can you identify what competencies could tackle these challenges?
- Based on this interview, could you name three critical competencies for commercializing radical innovation?
- If you have anything else on your mind, feel free to share.