SCHOOL OF ECONOMICS AND MANAGEMENT

Master's Thesis

The Role of Open-Innovation for Product Development: A Study of Swedish Biotechnology Small-Medium-Sized Enterprises in the Healthcare Sector

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Abstract

In the rapidly-evolving technological landscape of today, even established research and development (R&D) companies are struggling to keep pace with the demands of innovation. It creates difficulties for small-medium-sized enterprises (SMEs) with especially limited resources to maintain competitiveness within the market. This study argues that open innovation practices can provide a solution to this challenge by leveraging external knowledge and resources to accelerate the pace of internal innovation processes in product development.

The study is motivated by the projected growth in the healthcare sector in Sweden and the need for biotechnology companies to bridge the technology-demand gap. It highlights the challenges SMEs face in obtaining needed benefits, such as sufficient funding and attracting specialized talent. Moreover, it suggests that with a suitable approach, open innovation can provide SMEs with the necessary resources to unlock their full potential and contribute to the advancement of the biotechnology industry.

In this study, primary data was collected through interviews and surveys, and secondary data by a literature review. Prior to the interviews, a survey was used to ensure that relevant concepts would be discussed and further explored. While in the interview, a more in-depth answer was gathered based on the survey. Data was collected from biotechnology SMEs in the Swedish healthcare sector who have implemented open innovation, want to implement it, and do not plan to implement it. Targeted responders were those essential for the strategic decision (e.g., C-level and Business/Scientific Managers) that work in small-medium sized biotechnology companies in the Swedish healthcare sector.

This study shows that for biotechnology SMEs in the Swedish healthcare sector, protecting intellectual property (IP) is the most challenging factor when it comes to implementing open innovation. Moreover, partnership and collaboration are the most suitable open innovation approaches. Finally, gaining knowledge and funding represents the most significant benefits of implementing open innovation.

Keywords: Open innovation, Research and Development, Biotechnology, SMEs

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Abbreviations

AI - Artificial intelligence

GDP - Gross domestic product

IP - Intellectual property

R&D - Research and development

RBV - Resource-based-view

SME - Small and medium-sized enterprise

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1. Introduction

1.1. Background and Problem Description

In this fast-paced world, technology is becoming increasingly complex, requiring inventors to team up together in larger groups to stay ahead and accelerate the product development process. However, even major research and development (R&D) companies are finding it challenging to keep up with the demands and do not have all the necessary resources to maintain a competitive edge in the industry (Schuhmacher, 2018). Hence, there is a need for fresh approaches to fasten their innovation process and enable these companies to compete and thrive in the landscape of modern technology.

According to Chesbrough (2003), open innovation is a forward-thinking approach to innovation management that focuses on leveraging the power of external knowledge and resources to accelerate internal innovation processes. This practice involves actively seeking out new ideas, technologies, and resources from outside the company's boundaries, including academic institutions, research centers, other firms, and even customers. By embracing this approach, companies can utilize their resources in the most efficient and cost-effective way of production rather than relying solely on their internal R&D teams. This contrasts with the traditional "closed" innovation model, which assumes that innovation occurs primarily within the company's walls and relies heavily on internal R&D efforts (Chesbrough, 2003). Furthermore, the biotechnology industry is one of the industries that heavily rely on the R&D process to bring new products to market. Given that innovation is a crucial factor in the success of the biotechnology industry, examining the implementation of open innovation approaches within this industry is particularly relevant.

Moreover, the biotechnology industry is projected to continue its upward trajectory in the upcoming years, supported by the growing awareness of the sector's critical role (Le Deu & da Silva, 2019; Cancherini et al., 2021; Xiaofeng et al., 2021;). The biotechnology industry, particularly in the healthcare sector, is rapidly growing in Europe, contributing €34.5 billion to the gross domestic product (GDP) in 2018 (Le Deu & da Silva, 2019). Additionally, among European countries, Sweden has emerged as a top spender in the healthcare sector. Positioned as

the third highest expenditure in the EU, which constitutes approximately 11% of the country's GDP, the Swedish healthcare sector is expected to have a projected market volume of €238.20 Million in 2027 (Öhrn, 2021; Statista, 2022). Given the forecasted demand, Swedish biotechnology companies in the healthcare sector have the opportunity to become the driving force behind innovative solutions that bridge the technology-demand gap (McKelvey, Alm & Massimo, 2003; Swedenbio, 2023).

The biotechnology industry in the healthcare sector comprises companies that conduct research, development, manufacturing, and commercialization of pharmaceutical products made from biological resources (Bianchi et al., 2011). Currently, the biotechnology industry is gaining much public attention due to its role in the COVID-19 pandemic and has created a market demand for innovation in product development (Wozniak & Tyczweska, 2021; Xiaofeng et al., 2021). In response to the growing demand, biotechnology companies must have promising product development strategies and deliver high-quality products. Additionally, as stated by Regeringen (2023), the ability to meet this demand hinges on the strength of a company's R&D capabilities, as it is through such efforts that innovative solutions can be devised to bridge the gap. In light of this, biotechnology firms must prioritize allocating resources toward advancing their R&D strategic decision to stay competitive and meet the needs of consumers in a rapidly evolving market (Chesbrough, 2003; Regeringen, 2023).

Conversely, not all biotechnology companies possess the necessary resources to develop products successfully. This issue is particularly acute for small to medium-sized enterprises (SMEs), which often struggle with limited funding and specialized talent (Schuhmacher et al., 2018). According to OECD (2023a), small and medium-sized enterprises (SMEs) are defined as companies that have a workforce of fewer than 250 people. This raises the question of how to maximize product development in R&D with the available resources, regardless of company size, to receive adequate support in order to unlock their full potential and contribute to the advancement of the biotechnology industry as a whole. To fill this gap, open innovation is suggested to accommodate the needs of companies to get additional resources (Spender et al., 2017; Laermann-Nguyen & Backfisch, 2021)

1.2. Research Purpose and Research Questions

The purpose of this study is to provide insights into the role of implementing open innovation practices in the context of product development within biotechnology SMEs in the Swedish healthcare sector. Currently, many academic journals have talked about large biotechnology in healthcare sector companies' perspectives and how they can benefit from it (Schuhmacher et al., 2018; 2022). On the other hand, SMEs lacking many resources could benefit even greater from open innovation approaches (Hossain & Kauranen, 2016; Usman & Vanhaverbeke, 2017). However, there was not so much research conducted on SMEs' perspectives. This raises the question of what open innovation implementation is suitable for biotechnology SMEs in the healthcare sector. Furthermore, to understand the role of implementing open innovation in product development for biotechnology SMEs, we analyze the challenges and benefits that those companies might encounter. Therefore, we address the following **research questions:**

RQ 1: What are the benefits of open innovation for biotechnology SMEs in the Swedish healthcare sector?
RQ 2: What challenges in implementing open innovation might biotechnology SMEs in the Swedish healthcare sector face?
RQ 3: What open innovation approaches are the most suitable for biotechnology SMEs in the Swedish healthcare sector?

Our review of the existing literature has identified key factors influencing the implementation of open innovation. Therefore, we developed three hypotheses that will enable this study to answer the research questions by comparing the previous findings with our collected data from biotechnology SMEs in the Swedish healthcare sector.

(H1) Gaining **new knowledge and capital funding resources** are the most important benefits when implementing open innovation in biotechnology SMEs in the Swedish healthcare sector.
(H2) Protecting **intellectual property** is the most challenging factor when it comes to implementing open innovation in biotechnology SMEs in the Swtohcare sector.
(H3) Partnership and collaboration are the most suitable open innovation approaches for biotechnology SMEs in the Swedish healthcare sector.

2. Literature Analysis

2.1. Introduction to Open Innovation

2.1.1. Embracing a modern approach to innovation management

Open innovation is a modern approach to innovation management that recognizes the importance of both internal and external sources of valuable ideas and pathways to market. This model was introduced by Henry Chesbrough in 2003, and now the majority of the studies that research open innovation use this model (Bianchi et al., 2011; Usman & Vanhaverbeke, 2017; Pinarello et al., 2021; Schuhmacher, 2018; 2022) (**Fig. 2.1**). Open innovation involves actively seeking out ideas, technologies, and resources from outside the company, such as academic institutions, research centers, other firms, and customers. This approach challenges the traditional notion of centralized R&D silos that were common in the closed innovation era.

As Henry Chesbrough explains, in the open innovation paradigm, the knowledge landscape is depicted as a flow of ideas in and out of firms, both within and outside the company. External ideas are considered valuable and available for use, and the creators of these ideas are involved in the process of developing them. Embracing open innovation allows companies to accelerate their innovation processes and develop new products, services, or processes more efficiently and cost-effectively. It acknowledges the value of sharing ideas and collaborating with external partners to create new opportunities for commercialization (Chesbrough, 2003).

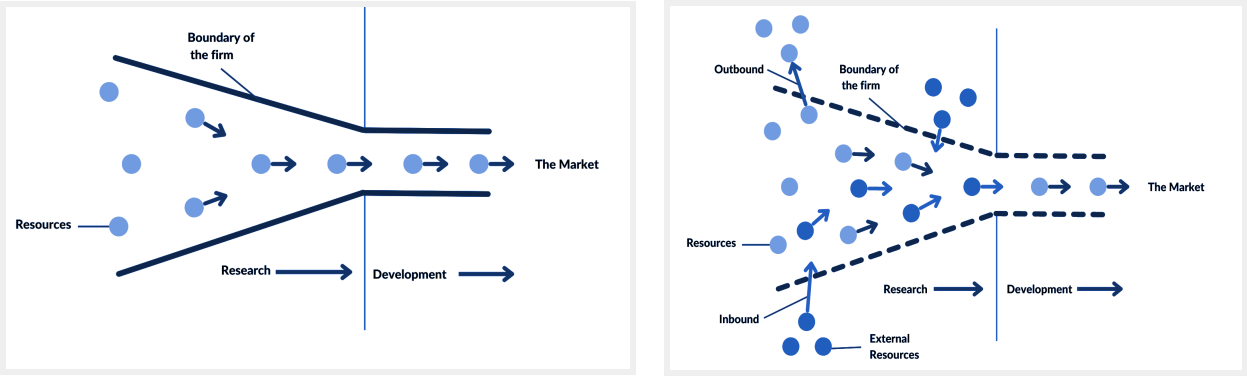

Figure 2.1 Closed Innovation and Open Innovation
Closed Innovation (Left) and Open Innovation (Right) adapted from Chesbrough (2003)

In the past, open innovation has mainly been associated with "high-technology" industries, with companies such as Lucent, 3Com, IBM, Intel, and Millennium Pharmaceuticals. While implementing open innovation concepts is still in its early stages in many industries, many industries have already adopted them. Open innovation can be a valuable framework for industrial innovation, even for traditional and mature industries beyond the high-tech sector. For example, chemistry, medical devices, and even aerospace industries could benefit by applying open innovation principles (Chesbrough & Crowther, 2006).

2.1.2. Dimensions of open innovation: inbound and outbound strategies

According to Chesbrough and Crowther (2006), open innovation can be broken down into two distinct categories: *inbound* open innovation and *outbound* open innovation. Inbound open innovation refers to collaborating with external organizations to gain access to their technical and scientific competencies and leverage their technologies and discoveries. On the other hand, outbound open innovation involves establishing relationships with external organizations to transfer proprietary technologies to another organization better poised to develop further and commercialize them (Chesbrough & Crowther, 2006).

Common methods that companies use to engage in inbound open innovation include partnerships (with universities, research institutions, other companies, or even customers), acquiring minority equity stakes, forming joint ventures, entering into R&D contracts, receiving research funding, purchasing technical and scientific services, joining incubators, IP-in licensing, and crowdsourcing (Bianchi et al., 2011; Pinarello et al., 2021).

On the other hand, when it comes to outbound open innovation, organizations typically engage in activities such as licensing out their intellectual property, spinning off new ventures, selling innovation projects, forming joint ventures to commercialize a technology, providing technical and scientific services, making corporate venturing investments (Bianchi et al., 2011; Pinarello et al., 2021).

2.1.3. Level of integration in inbound open innovation practices

As previously mentioned, there are several open innovation practices that a company can implement. However, as Pinarello et al. (2021) suggest, the level of open innovation approaches

varies in their integration level with an external partner. The range of possibilities varies from crowdsourcing, where the participant only submits their idea without further interaction with the company, to an acquisition that fundamentally alters the organization's structure (Pinarello et al., 2021). In **Figure 2.2,** open innovation practices are distributed on a scale from low to high integration, including crowdsourcing, IP-in licensing, partnerships or collaborations, venture capital and incubators, and acquisitions.

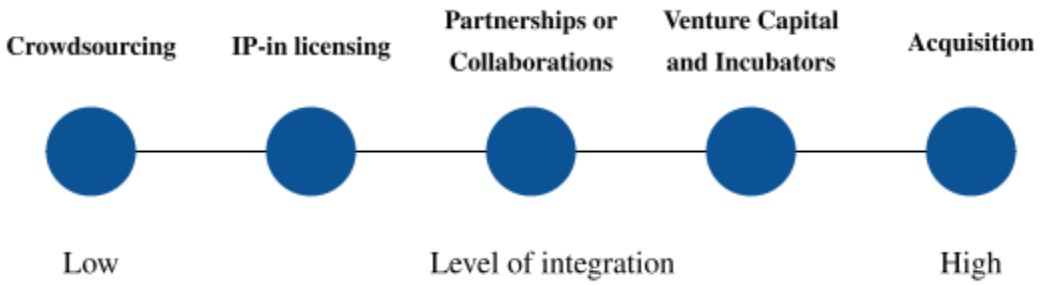

Figure 2.2 Levels of integration of various open innovation types and approaches
Figure adapted from Pinarello et al., 2021.

2.1.4. The shift from closed to open innovation paradigm

As mentioned before, the open innovation model was introduced by Henry Chesbrough in his initial book on open innovation. He describes the concept of open innovation as the opposite of closed innovation, where R&D is managed within the boundaries of individual firms (Chesbrough, 2003). In a closed innovation model, ideas enter these firms and are screened and filtered during the research process. The surviving ideas are then developed into products and services, which are eventually taken to the market (**Fig. 2.1**). This closed innovation paradigm is characterized by deep, vertically integrated R&D organizations within the firms, which create a knowledge landscape that is limited to within the walls of these firms (Chesbrough, 2003).

In this closed system, ideas are assumed to only come from within the firm, and products and services can only be developed and released within the firm. There is no leakage of ideas or products outside of the system. As long as the company maintains a continuous flow of new ideas in its R&D pipeline, it can create new products and capture their value, which allows for reinvestment in further research and development. This sustainable flow of ideas and products

within the closed innovation system is expected to result in future profitable products for the company (Chesbrough, 2003).

However, there are challenges in balancing the incentives of R&D. Research is focused on exploring new frontiers and making unexpected discoveries, while development aims to turn those discoveries into marketable products. Unlike research, development operates with a more predictable time horizon and focuses on meeting schedule targets and budgets (Chesbrough, 2003; Bianchi et al., 2011; Laermann-Nguyen & Backfish, 2021). Overall, research and development have different priorities and operate within different constraints, with research being more exploratory and development is more focused on bringing products to market efficiently, which under a closed innovation approach brings additional tensions (Chesbrough, 2003).

Chesbrough (2003) argues that the erosion factors, such as the increasing availability and mobility of skilled workers, the venture capital market, external options for ideas, and the increasing capability of external suppliers, in the closed innovation paradigm, have weakened the link between research and development. Additionally, Chaudhary et al. (2022) also argue that ideas can no longer be kept internally as they may leak out to the broader environment over time, and other firms may exploit similar ideas. This has transformed the innovation landscape from a closed, internal environment to an open one, where companies can access ideas from outside and within (Chesbrough, 2003).

2.1.5. Relationship between open innovation and other theoretical perspectives on competitive advantage

As we delve into the vast literature on open innovation, it becomes evident that this concept is closely related to other theoretical perspectives that firms can use to establish and maintain a competitive advantage, namely the Resource-Based View (RBV) of the firm, absorptive capacity, and exploration versus exploitation. However, despite the similarities, there are significant differences between these perspectives that are crucial to understanding.

The RBV of the firm emphasizes that a firm's resources and capabilities are the primary sources of its competitive advantage (Barney, 1991). Absorptive capacity refers to a firm's ability to acquire and assimilate external knowledge and apply it to its own operations (Cohen &

Levinthal, 1990). In this sense, both the RBV and absorptive capacity can be seen as related to the discovery phase of the innovation process. In this phase, firms seek out and experiment with new ideas, technologies, and business models to discover new opportunities for growth and competitive advantage (Deloitte, 2012; Grant, 2019).

Open innovation emphasizes the importance of collaborating with external partners to generate new ideas and technologies. This approach is related to both exploration and exploitation (March, 1991), as firms can use open innovation to explore new opportunities, knowledge, and resources more effectively. Exploration involves seeking out and experimenting with new ideas, technologies, and business models to discover new opportunities for growth and competitive advantage. Exploitation involves maximizing the value of existing resources and capabilities through incremental improvements and efficiency gains. Thus, exploration and exploitation are two complementary strategies firms can use to create and sustain a competitive advantage (March, 1991).

In comparing these different perspectives, we can see that absorptive capacity is more closely aligned with exploration and open innovation, while closed innovation is more closely aligned with RBV and exploitation (Bianchi et al., 2011).

2.2. Introduction to Biotechnology Industry

The COVID-19 pandemic has brought an urgent need for effective treatments and preventive measures in the healthcare sector (Cancherini et al., 2021). This condition has led to a shift in focus among the public, government, and investors toward the development of innovative healthcare solutions, with biotechnology emerging as a critical player in this field (Wozniak & Tyczweska, 2021; Xiaofeng et al., 2021). In the healthcare sector, biotechnology typically involves using living organisms or their active components and employs biotechnology techniques to produce such products as drugs, vaccines, and probiotics (Bianchi et al., 2011). Additionally, the growing availability of technology has led to the emergence of using artificial intelligence for biotechnology products in healthcare (Chapman, Truong & Cozzolino, 2022).

2.2.1. Research & Development of innovation: process and barriers

Innovation can be defined as the process of bringing new technology to market that offers customers new capabilities (Fetterhoff & Voelkel, 2006). Through innovation, the biotechnology industry is expected to bring new technologies and effectively address customer needs, thereby substantially contributing to the overall well-being of the global population (Fetterhoff & Voelkel, 2006; Xie & Hong, 2022; OECD, 2023b). Furthermore, R&D is vital in bringing innovation to the market (Laermann-Nguyen & Backfisch, 2021). In general, the product development process involves several stages, from the ideation phase to the launch of the final product.

While other industries may be able to produce a product quickly, product development in the biotechnology industry requires a high level of knowledge for innovation (Schuhmacher et al., 2018; Cherchem & Keen, 2022), which often results in longer product development timelines. In the case of product development in the biotechnology industry, the process can be further broken down into several stages, including discovery, pre-clinical development, clinical development, regulatory approval, and commercialization (Mohs & Greig, 2017). All of these stages usually take up to 8-9 years to complete, and only 1% of the company succeeds (Wong et al., 2022). Additionally, the significant regulatory oversight (Wong et al., 2022), high capital requirements (Usman & Vanhaverbeke, 2017; Wong et al., 2022), and ethical and social considerations (Bierer et al., 2020) further compound the challenges of product development in the biotechnology industry.

Despite the challenges, for the past decades, many large biotechnology companies that focused on the healthcare sector have developed numerous innovative products that effectively tackled various health issues (Urias, 2017). An example of this is the development of COVID-19 vaccines by companies such as Pfizer, Moderna, Johnson & Johnson, and AstraZeneca, which have played a crucial role in preventing the spread of the virus (Bown & Bollyky, 2021). However, in the case of biotechnology SMEs, the challenges of product development can be even more significant (Spender et al., 2017; Usman & Vanhaverbeke, 2017). While these companies may be known for their innovative ideas, they often face internal challenges in supporting their R&D due to the considerable cost of product development (Usman & Vanhaverbeke, 2017; Wong et al., 2022). Additionally, their limited resources may make it

difficult to attract top talent and invest in the necessary technology and infrastructure required for product development (Usman & Vanhaverbeke, 2017; Wong et al., 2022). In order to address these challenges, SMEs can employ external resources, incorporate them with their current technology, and establish a competitive advantage, consequently facilitating the introduction of novel technologies into the market (Usman & Vanhaverbeke, 2017).

As previously stated in the introduction, the favorable innovation ecosystem in Sweden has paved the way for biotechnology SMEs to emerge as key players in developing innovative solutions that bridge the technology-demand gap in the healthcare industry. Hence, in this study, we focus our study on examining Swedish biotechnology SMEs in the healthcare sector.

2.3. Open Innovation in the Biotechnology Industry

Currently, studies have identified many types of innovation implementation (Grant, 2019). Open innovation is confirmed to be one of the approaches that benefit both small and large companies (Gassmann, Enkel, & Chesbrough, 2010; Usman & Vanhaverbeke, 2017). With its high R&D costs and lengthy development timelines, the biotechnology industry is considered an ideal candidate for open innovation (Gassmann, Enkel, & Chesbrough, 2010; Bianchi et al., 2011; Schuhmacher et al., 2018). Through open innovation, biotechnology companies can tap into external resources and expertise, which can help accelerate their R&D processes, reduce expenses, and improve the likelihood of commercial success (Usman & Vanhaverbeke, 2017). While research on the benefits and challenges of managing open innovation for large biotechnology companies is extensive, a research gap exists from the perspective of biotechnology SMEs (Hossain & Kauranen, 2016). Given that many SMEs experience resource limitations and rely on external sources in the R&D process (Spender et al., 2017), the open innovation approach has the potential to offer more significant benefits to such companies (Hossain & Kauranen, 2016). Thus, open innovation is a valuable framework for supporting innovation capabilities and maintaining market competitiveness (Bianchi et al., 2011; Spender et al., 2017).

2.3.1. Open innovation in biotechnology SMEs

As mentioned above, there is a need for SMEs to seek external resources. Hence, SMEs may perceive outbound open innovation as less favorable, as it exposes their technology to large corporations, potentially losing their ownership over products and competitive advantage as a private company (Usman & Vanhaverbeke, 2017). On the other hand, inbound open innovation presents a beneficial opportunity for SMEs. In this arrangement, the larger company contributes valuable resources such as time and expertise, which are crucial for the success of SMEs (Usman & Vanhaverbeke, 2017). While literature suggests that SMEs can benefit from inbound open innovation practices, some studies on inbound open innovation have shown adverse effects in some instances, attributed to reduced control over core competencies and weakened knowledge appropriability, as highlighted by Bianchi et al. (2015) and Cassiman & Veugelers (2006). To mitigate the risk of technology misappropriation by external partners, intellectual property (IP) protection mechanisms such as patents and licensing deals play a crucial role (Usman & Vanhaverbeke, 2017).

Recent research has focused on the internal challenges of R&D in SMEs (Spender et al., 2017; Usman & Vanhaverbeke, 2017) and highlights the advantages of implementing inbound open innovation in biotechnology SMEs (Gassmann, Enkel & Chesbrough, 2010; Usman & Vanhaverbeke, 2017). Incubators, venture capitalists, large corporations, and universities are the four main actors involved in open innovation approaches, which can support SMEs in their innovation process (Spender et al., 2017). Various types of inbound open innovation practices that SMEs can implement, such as collaboration (Hossain & Kauranen, 2016), partnerships (Bianchi et al., 2011), IP licensing agreements (Bianchi et al., 2011), and venture capital (Madill, Haines & Riding, 2005), have been suggested by numerous studies. However, acquisition and crowdsourcing practices are less commonly found in research on inbound open innovation in SMEs and more in the large or global companies context (Schuhmacher et al., 2022).

Furthermore, challenges in implementing open innovation practices for SMEs in different sectors are widely recognized by the research community (Gassmann, Enkel & Chesbrough, 2010; Spender et al., 2017; Chaudhary et al., 2022), but not many journals focused their studies on the challenges in implementing open innovation specifically for biotechnology SMEs in the healthcare sector. Furthermore, it is interesting to know that a number of researchers, including

Hossain & Kauranen (2016), emphasize the need to explore further open innovation potential for biotechnology SMEs in the healthcare sector.

To conclude, the research community widely recognizes open innovation practices in large biotechnology companies. However, the research gap exists in understanding open innovation's role and application practices in biotechnology SMEs in the healthcare sector.

2.3.2. Current success stories in the biotechnology industry

Many studies have proved that large biotechnology companies enhance their R&D productivity and efficiency by adopting open innovation strategies (Schuhmacher et al., 2018; 2022; Laermann-Nguyen & Backfisch, 2021). Selecting an appropriate open innovation model should align with the company's requirements and strategic goals, considering factors such as change, risk, and control management and aiming for mutual benefits when working with external partners (Schuhmacher et al., 2018). Companies operating in the biotechnology sector, including large pharmaceutical firms, actively embrace open innovation practices. These encompass a diverse range of strategies, such as collaboration, partnerships, acquisitions, IP-in licensing, crowdsourcing, and venture capital (Schuhmacher et al., 2018). Moreover, SMEs also demonstrate their involvement in similar open innovation approaches, as evident from the following examples.

Crowdsourcing

Crowdsourcing is an action that can be seen in two different approaches. In the first approach, the crowd supplies data that others can analyze. In the second approach, the crowd actively works together to solve a particular problem. For example, biotechnology companies usually create a research-driven challenge or competition and use the ideas from the participants (crowd) to address specific problems encountered within the organization (Saez-Rodriguez et al., 2016).

Large biotechnology companies have implemented various strategies to leverage the benefits of crowdsourcing, including establishing open innovation platforms. For instance, AstraZeneca operates an open innovation platform that provides access to cutting-edge discovery technologies (Schuhmacher et al., 2018). However, to our best knowledge, there are no studies acknowledging crowdsourcing implementation where SMEs initiate it themselves.

Intellectual Property (IP) licensing agreement

Technology companies often protect their research, technology, and processes through IP, thereby retaining control over their intellectual capital. One practical approach for sharing this intellectual property is through licensing agreements, which facilitate the exchange of proprietary information, technology, and processes protected by IP. IP license agreements are essential for outlining the rights being transferred between the parties, defining compensation for such rights, and establishing a risk management framework to ensure that each party assumes an equitable share of the associated risks (Drozdoff & Fairbairn, 2015).

For instance, Novartis, a multinational pharmaceutical company based in Switzerland, entered into an IP agreement with Camurus, a Swedish pharmaceutical firm (SME) related to drug delivery processes. By the terms of the agreement, Camurus received funding, while Novartis acquired a license for the commercialization of Camurus' technology (Camurus, 2016).

Nevertheless, SMEs could also benefit from licensing agreements. In-licensing agreements typically occur as part of an inbound open innovation approach, which allows SMEs to obtain the rights to use a specific product or process from another firm. Several benefits of implementing IP in-licensing agreements are that SMEs have tighter control and independence in the management process (Bianchi et al., 2011). However, the licensing fees might be costly, and the legal process might be difficult (Greco, Grimaldi & Cricelli, 2018).

Collaboration

Cambridge Dictionary defines collaboration as the process of two or more organizations working together to complete a task or achieve a goal (Cambridge, 2023). In open innovation, collaboration can include working with universities (Deschamps et al., 2013; Ivascu et al., 2016), other organizations, or corporations. In open innovation, collaboration is typically perceived as a means to engage in short-term and more targeted projects to develop specific products (Schuhmacher et al., 2018; 2022).

One well-known instance of open innovation in the biotechnology sector is the collaboration between Pfizer and BioNTech. The two companies worked together to create a vaccine for

COVID-19, utilizing BioNTech's mRNA technology and Pfizer's clinical development proficiency and widespread manufacturing and distribution capabilities. By collaborating and sharing their respective strengths, they were able to expedite the vaccine's development and bring it to market as quickly as possible (Pfizer, 2020; Lewis et al., 2023).

Collaborations between universities and SMEs can be beneficial by providing access to external knowledge through basic research in universities and complementary resources from companies, thereby promoting knowledge diffusion and collaboration among partners (Wirsich et al., 2016; Arant et al., 2019). These collaborations are typically initiated through scientists' networks, such as when researchers take industry positions or initiate spinoff ventures (Perkmann & Walsh, 2007). These collaborations are mainly initiated in the early stages of the firm’s growth (Spender et al., 2017). Moreover, collaborations have lower integration costs than other open innovation approaches (Guimaraes, Blanchet & Cimon, 2021).

Partnership

A partnership is an arrangement where parties, known as business partners, agree to cooperate to advance their mutual interests. In the context of open innovation, a partnership may involve joint research and development efforts, co-creation of new products or technologies, or sharing of intellectual property. Partnerships are typically characterized by a higher level of integration and commitment among the collaborating entities, with a shared vision and a formalized structure for cooperation (Audretsch & Feldman, 2003).

Novartis established a collaboration with Microsoft, a global technology company, in 2019 to develop and apply artificial intelligence (AI) solutions in medicine. The purpose of this partnership was to leverage Microsoft's expertise in AI and cloud computing to aid Novartis in advancing its drug discovery and development processes and enhancing patient outcomes. The partnership involved sharing data, resources, and knowledge and leveraging Microsoft's AI technologies to accelerate Novartis' research and development efforts in discovering innovative therapies (Novartis, 2019).

Strategic research partnerships hold significant importance for large corporations, and their significance is even greater for small firms. This is because small enterprises are more likely to

lack crucial capabilities, which can put them at a disadvantage in terms of competitiveness. As a result, small firms may rely heavily on strategic research partnerships to offset the competitive disadvantages of their smaller size (Audretsch & Feldman, 2003).

Venture Capital

The primary function of venture capital is to address the demand for funding during the developmental phase of innovation. Typically, investors involved in venture capital are affiliated with large institutions, including pension funds, financial firms, and insurance companies (Zider, 1998).

Bayer, a large pharmaceutical company, launched an initiative called "Leaps by Bayer" aimed at financing existing or new companies and enabling them to advance disruptive technologies. This program, initiated in 2015, has invested more than $1.7 billion in companies developing pioneering health-tech, biotech, and ag-tech innovations (Bayer, 2023).

From the perspective of SMEs, given the internal challenges of limited funds, venture capital can support the financial aspect of developing innovative technologies, help the commercialization process of the innovation, and provide a network (Spender et al., 2017). However, there might be a challenge in management control (Mullins, 2014; The Hartford, 2023).

Acquisition

In open innovation, acquisitions of a company are considered to be a higher-level integration. They are specifically beneficial when acquired companies' products are related to the firm's core business. Acquisition typically includes buying another company. Therefore, efficiency and control can be guaranteed while the firm exploits acquired technology (Pinarello et al., 2021). In the case of SMEs, the acquisition is not well implemented since this type of open innovation requires high integration and funds.

An example from a global pharmaceutical and healthcare company, Johnson & Johnson, employed an open innovation strategy by acquiring Actelion Ltd, a Swiss biopharmaceutical company focusing on rare diseases. This acquisition granted Johnson & Johnson access to Actelion's cutting-edge pipeline of rare disease drugs and advanced research capabilities,

strengthening their position in the rare disease market and accelerating their drug discovery and development efforts (Johnson & Johnson, 2017).

To conclude, the literature analysis on types of open innovation leads us to one of the hypotheses: **(H3) Partnership and collaboration** are the most suitable open innovation approaches for biotechnology SMEs in the Swedish healthcare sector.

2.4. Benefits and Challenges in Open Innovation: Biotechnology Industry

2.4.1. Benefits of open innovation

Numerous research works have demonstrated that companies adopting open innovation typically enhance their competitive advantage and economic output (Greco, Grimaldi & Cricelli, 2018; Chaudhary et al., 2022). In this chapter, we looked into the benefits that biotechnology might gain while implementing open innovation.

Gaining Knowledge

Open innovation can benefit companies in their R&D process by incorporating external knowledge to address innovation-related issues (van de Vrande et al., 2009) and utilize external competencies (Greco, Grimaldi & Cricelli, 2018). The knowledge companies aim to acquire falls into two categories: knowing about and knowing how (Grant, 1996). Knowing about is explicit, consisting of facts, theories, and instructions that can be communicated cheaply through information and communication technologies. On the other hand, know-how is tacit, expressed through performance, and acquired through practice. This type of knowledge cannot be directly articulated, and its management requires person-to-person processes (Grant, 1996).

Receiving Funds

Having an external partner involved in the innovation process helps to reduce the R&D costs of a project (Pinarello et al., 2021). It could be done if a company has a joint venture with another

company and shares the cost (Schuhmacher et al., 2022) or gains capital funds directly from a venture capital firm (Chesbrough, 2003).

Faster Development

Companies involved in open innovation benefit from gaining new insights into new technology (Chaudhary et al., 2022). The growing complexity of the external environment, technological advancements, and shorter product life cycles encourage innovation development by facilitating external knowledge (Enkel, Gassmann & Chesbrough, 2009).

Expanding Network

As previously stated, exploiting opportunities can provide a competitive edge to a company. By interacting continuously, firms can leverage resources in their networks, disseminating resources across network relationships (Tolstoy & Agndal, 2010). Such networks can serve as a foundation for innovation and allow SMEs to exploit opportunities by providing access to the latest information, know-how, and other resources (Tolstoy & Agndal, 2010; Grant, 2019). However, the impact of it may be less immediate and direct, and it may take longer for the company to gain tangible benefits. Hence, firms need to be proactive in order to seize opportunities within the network (Tolstoy & Agndal, 2010). Additionally, the position of a firm within its alliance network is crucial, as it determines the amount of knowledge that the firm is exposed to (Dong & McCarthy, 2019).

Obtaining Talents

The presence of talent provides specialized knowledge and skills needed for the company in product development. However, this can be challenging as these skilled individuals are often expensive to hire. Collaborating or partnering with external partners, such as academia, can solve this problem, as universities are known to provide individuals with such skills (Schuhmacher et al., 2018).

The explanation above about the benefits of implementing open innovation leads us to our hypothesis: **(H1)** Gaining **new knowledge and capital funding** resources are the most important benefits when implementing open innovation in biotechnology SMEs in the Swedish healthcare sector.

2.4.2. Challenges to integration in open innovation

Innovation is crucial for companies to succeed, and open innovation has become a popular approach to collaborating with external partners or adopting external resources to foster innovation. However, several challenges may arise when engaging in open innovation, including a lack of compatibility in goals, differences in organizational culture, and varying competencies within teams (Chaudhary, 2022). Additionally, intellectual property concerns and the high integration cost of gaining resources and capabilities can hinder the successful implementation of open innovation practices. Companies must carefully consider these factors to ensure the effective adoption of open innovation while balancing the benefits of openness with its potential challenges and associated costs (Chaudhary, 2022).

Lack of goal complementarity

In order to facilitate successful product development through sharing knowledge and resources, it is important for both partners to have aligned objectives and goals when negotiating agreements. Although partners may not have identical goals, they should be non-competing and complementary and can be achieved through the same business model. Conversely, when partners have incompatible goals, conflicts may arise and hinder the exchange of knowledge and information between the partners and the alliance (Pullen et al., 2012).

Differences in organizational culture

A company's culture plays a crucial role in shaping its employees' attitudes toward external knowledge and their willingness to exchange information with external parties (Pullen et al., 2012). An open corporate culture fosters the successful adoption of external knowledge by facilitating the resolution of common difficulties. Conversely, a closed corporate culture may impede the adoption process. To ensure the success of open innovation, both parties must

cultivate an open corporate culture. Such an approach acknowledges the value of ideas sourced from external resources and promotes a smoother adoption of open innovation. Having different cultural values between parties can hinder the successful implementation of open innovation processes, as one of the parties may not fully comprehend the benefits or potential outcomes (Alassaf et al., 2020; Chaudhary et al., 2022). Additionally, having a different culture could lead to the risk of knowledge leakage and create mistrust between both parties (Pullen et al., 2012).

Different competencies

Open innovation teams are established to facilitate collaborative innovation by individuals from different organizations. Such diversity is considered crucial for fostering innovation. However, the presence of individuals with varying competencies, including knowledge, attitudes, skills, and levels of trust, may lead to conflicts between team members. However, clear and effective communication can mitigate these conflicts, and diverse competencies can ultimately lead to high-performance teams by providing the team with various skills and experiences (Chatenier et al., 2010).

Sharing intellectual property

Open innovation practices require a certain level of openness and knowledge management within the organization, which can be challenging. Studies have shown that more than simply having access to external knowledge is required, and firms must develop an open environment culture that facilitates openness and knowledge exchange (Greco, Grimaldi & Cricelli, 2018). An open environment allows the company to gain a new network and learn external knowledge within the field. However, it could also lead to excessive sharing amounts of data, which can complicate efforts to generate insights and increase the cost of knowledge integration (Dahlander et al., 2021). Intellectual property concerns can also hinder knowledge exploitation, as legal issues related to ownership of data generated during open innovation can pose barriers to the utilization of newly acquired knowledge (Salge et al., 2013; Dahlander et al., 2021). Therefore, firms must balance the benefits of openness with their potential challenges and costs (Chaudhary et al., 2022).

Legal issues and agreements

Legal issues related to the ownership of data produced during open innovation can create barriers to effectively utilizing newly acquired knowledge. Companies usually require legal experts to draft necessary agreements for the involved parties, such as patent protection and license preparation, to ensure product ownership and precise distribution of responsibilities. However, these procedures can be costly, which adds to SMEs' challenges when engaging in open innovation (Dahlander et al., 2021).

High integration cost to gain resources and capabilities

According to Greco, Grimaldi and Cricelli (2018), acquiring new resources and capabilities from external partners can be costly and time-consuming. The success of open innovation hinges on the effective development and utilization of resources while exchanging knowledge. Therefore, firms must carefully consider their resources and capabilities when engaging in open innovation practices (Chaudhary et al., 2022). As we discussed earlier in *Section 2.3.1 on Open Innovation in Biotechnology SMEs*, it is common for SMEs to avoid expensive open innovation practices like acquisitions. This is because such practices require additional financial resources that these companies typically do not have. Instead, SMEs are inclined to engage in the open innovation approach as a means to obtain resources without spending much expenses (Usman & Vanhaverbeke, 2017).

From the text above, we can conclude our hypothesis: **(H2)** Protecting **intellectual property** is the most challenging factor when it comes to implementing open innovation in biotechnology SMEs in the healthcare sector.

2.5. Analytical Framework

Figure 2.3 concisely summarizes the literature analysis chapter, highlighting the potential advantages for biotechnology SMEs when adopting inbound open innovation strategies in their product innovation process. Nonetheless, these companies may encounter several challenges while integrating open innovation.

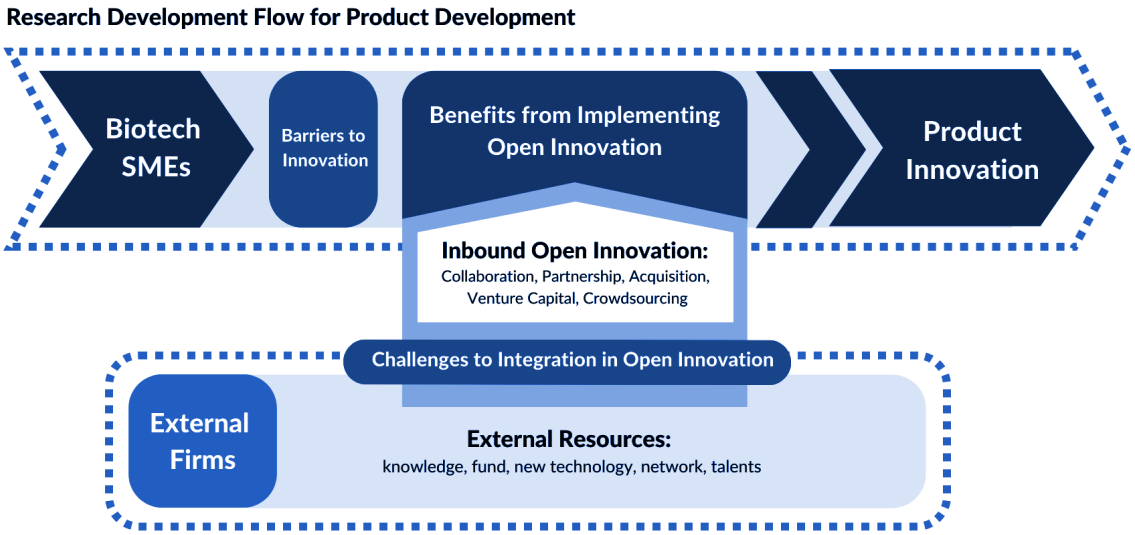

Figure 2.3 Analytical Framework

3. Methodology

3.1. Introduction

This study used a deductive research approach, meaning that the literature review on open innovation implementation for biotechnology guided the overall research process for data collection and analysis. To begin, the study developed research questions based on the problem statement and then conducted a literature review to gather some previous knowledge about the topic. Moreover, the literature review served as the foundation for survey and interview questions, which provided primary data for the study. The gained data help to see the current condition of open innovation implementation in the Swedish biotechnology SMEs in the healthcare sector. Furthermore, the quantitative data obtained from the survey and qualitative interview responses were analyzed and discussed, with theoretical concepts from the literature review used to support this analysis.

3.2. Research Design

To build on the existing knowledge about open innovation in biotechnology, a literature analysis was conducted as a basis for this study. From the previous studies, a research gap was identified in terms of understanding SMEs' perspectives on implementing open innovation in Sweden. Thus, the main objective of this study was to investigate the implementation of open innovation practices in the context of product development in biotechnology SMEs within the Swedish healthcare sector. To achieve this, this study utilized a mixed methods approach, combining both qualitative and quantitative methods. A mixed method is suitable for this study, as this approach provides a more comprehensive understanding of the research questions (Sekaran & Bougie, 2016).

Firstly, a survey was conducted to gather quantitative data on how biotechnology SMEs in Sweden in the healthcare sector currently use open innovation, the benefits and challenges they face, and why some companies may not be implementing it. Secondly, this survey aimed to categorize participating companies into three groups: those that have implemented open innovation, those that plan to implement open innovation, and those that do not implement open

innovation. This data provided the study with an overall view of the current status of open innovation implementation in biotechnology SMEs.

In addition to the survey, qualitative interviews were conducted to gain a more in-depth understanding of open innovation and why biotechnology SMEs see certain factors as benefits and challenges. Each company may have different challenges and benefits, so the in-depth interviews focused on a specific company's condition. More information on the specific aims of both methods will be provided in *Section 3.4. Primary Data: Survey and Interview*.

3.3. Secondary Data: Literature Analysis

3.3.1. Aim and scope

The literature review aimed to comprehend the central idea of implementing open innovation in biotechnology within the healthcare industry and to obtain the latest theoretical discussions of the topic. Moreover, this study utilized the literature analysis as a foundation for the hypotheses, which address the research questions. To achieve this, this study gathered and analyzed three primary categories of literature, including the concepts of open innovation, product development and innovation in biotechnology, and open innovation implementation in biotechnology.

This study centers on the definition of open innovation as explained by Henry Chesbrough, the originator of the concept (Chesbrough, 2003). Nonetheless, the study also used various studies that support Chesbrough's definition of open innovation. In addition, the data on open innovation implementation in biotechnology was collected from SMEs and larger companies to gain insights from varying viewpoints and ascertain the extent and depth of open innovation implementation in biotechnology for healthcare. Following this extensive data collection, the study narrowed its focus to examine the possible challenges, benefits, and types of preference in implementing open innovation for biotechnology SMEs.

3.3.2. Data collection

This literature review was developed using books and online articles databases. The study heavily relies on Henry Chesbrough's book "Open Innovation" as it provided valuable insights into innovation and a company's competitive advantage. In addition, for the online articles, this

study used the Google Scholar database and papers from Q1 publishers. The following keywords and/or combinations were utilized when searching online databases:

a) Open innovation:
    i) (“Managing”)AND(“Open innovation”)
    ii) (“Open innovation”)AND(“Product Development”)
    iii) (“Chesbrough”)AND(“Open innovation”)
    iv) (“Open innovation”)AND(“Start-up”)OR(“Small-medium-sized”)
    v) (“Open innovation”)AND(“Benefits”)OR(”Challenges”)OR(“Drivers”)
b) Biotechnology company:
    i) (“Biotech”)AND(“Sweden”)OR(“Europe”)
    ii) (“Biotech”)AND(“R&D”)OR(“Product Development”)
c) Open innovation in Biotechnology companies
    i) (“Open innovation”)AND(“Pharma”)OR(“Biotech*”)
    ii) (“Open innovation”) AND (“Implementation”)OR(“R&D”)OR(“Product Development”)AND (“Pharma”)OR(“Biotech*”)
    iii) (“Biotech*”)AND(“Open innovation”)AND(“Benefits”)OR(”Challenges”)
    iv) (“Open innovation”)AND(“Pharma”)OR(“Biotech*”)AND(“Case Study”)OR(“Review”)
    v) (“Open innovation”)AND(“Pharma”)OR(“Biotech*”)AND(“SMEs)OR(“Start-up”)
    vi) (“Open innovation”)AND(“Pharma”)OR(“Biotech*”)AND(“manag*”)

Using these keywords proved to be beneficial in providing an efficient method for analyzing existing literature and utilizing it to its fullest potential. This method enhanced the selection process of published papers in databases, ensuring optimal results.

3.3.3. Data analysis

Initially, we utilized Henry Chesbrough’s book *Open Innovation: The New Imperative for Creating and Profiting from Technology* and 20 articles as the primary articles for our research. Subsequently, it employed a snowballing approach to expand our understanding of various

discussions on the topics under investigation. At the latest stage of the literature, we utilized 74 sources.

Our selection process involved reviewing the abstracts of potential articles, and upon finding that the abstracts covered the relevant topic, we proceeded to undertake an in-depth analysis of the literature, with a specific focus on the discussion and method section. Each article was then summarized to extract the key points. This process helped us to categorize the context of the literature, including discussions on the general concept of open innovation, types of open innovation, benefits, and challenges of open innovation implementation for SMEs and biotechnology.

Following the literature review, we developed an analytical framework shown in **Figure 2.3** that allowed us to categorize and identify three sub-topics, including the concepts of open innovation, product development and innovation in biotechnology, and open innovation implementation in biotechnology. These sub-topics were extensively discussed in the literature review.

3.4. Primary Data: Survey and Interview

3.4.1. Sample collection

To achieve the research purpose, this study targeted biotechnology SMEs in the Swedish healthcare sector that have implemented, plan to implement, and do not implement open innovation. Different types of companies were chosen to provide diverse perspectives, which provided this study with a comprehensive analysis of the benefits and challenges of implementing open innovation for biotechnology SMEs in the healthcare sector. Furthermore, as our focus was to examine the perspective of SMEs, we selected biotechnology companies with an employee count ranging from 1 to 250.

The data were gathered from different regions in Sweden where biotechnology SMEs in the healthcare sector were present. Out of 230 companies that we reached out to, 22 companies answered the survey, and 10 participated in the interview. The data has been collected from 7 regions, including Lund, Stockholm, Solna, Malmo, Umeå, Uppsala, and Gothenburg. According to Swedenbio (2023), these regions are known for their innovation ecosystem; hence these areas

are a suitable target for this study. Additionally, since our research pertains to strategic decision-making in companies, we targeted respondents in leadership positions (C-Level, Directors, Managers) who could provide a valuable perspective. To select and validate our sources, this study used a quota purposive sampling approach (Sekaran & Bougie, 2016). **Table 4.1** lists the companies, locations, positions of interviewees, and details of the interview appointments.

3.4.2. Data collection

To collect data for our research on open innovation in biotechnology SMEs, we used Google Forms to conduct surveys distributed to the targeted participants through LinkedIn. This method was chosen because it effectively collects data from many participants and allows us to easily reach our target audience and see their position in the company.

Our survey questionnaire was designed to collect general information on the benefits, challenges, and types of open innovation in biotechnology SMEs (Appendix A). To ensure consistency, we used standardized survey questions based on the concepts described in the literature analysis and created by us. To understand participants' attitudes and opinions, we used a Likert scale ranging from 1 (not important/significant) to 5 (very important/significant) to measure the importance of each variable and concept, allowing for a quantitative evaluation of the data (Sekaran & Bougie, 2016). In this research, we treated the Likert scale as an ordinal scale, which enabled us to find the median in the collected data sets. We chose to use the Likert scale results as an ordinal scale rather than a numerical scale with an average, as it is more meaningful in this research to represent the frequencies of each answer and show tendencies. This approach allowed us to draw more specific conclusions based on the data. This method enabled us to draw general conclusions about the benefits, challenges, and types of open innovation in biotechnology SMEs.

In addition to collecting quantitative data, the survey invited participants to participate in an interview, allowing for a more in-depth and qualitative understanding of the topic. The data collection process began with contacting targeted participants on LinkedIn and asking them to answer the survey questions. Surprisingly, more participants wanted to participate in an interview, even though the survey should have taken no more than 10 minutes to answer. Before

an interview, we asked participants to answer the survey, which helped us organize our questions and adapt the conversation to their situation.

During the interviews, which were held on Zoom and lasted 20-30 minutes, we prepared three sets of interview questions tailored to each of the three company groups and asked them accordingly during the interviews (Appendix C). The interview questions were semi-structured and inspired by the literature analysis we performed beforehand (Pinarello et al., 2022). During the interview, the questions were adapted from participants' answers to the survey. Therefore, it was specific to their company's situation. We asked for participants' consent to record the interview and assured them that the data would be used only for our research purposes without using any participants' or their companies' names.

Overall, the combination of surveys and interviews allowed us to gain a comprehensive and nuanced understanding of the benefits, challenges, and types of open innovation in biotechnology SMEs.

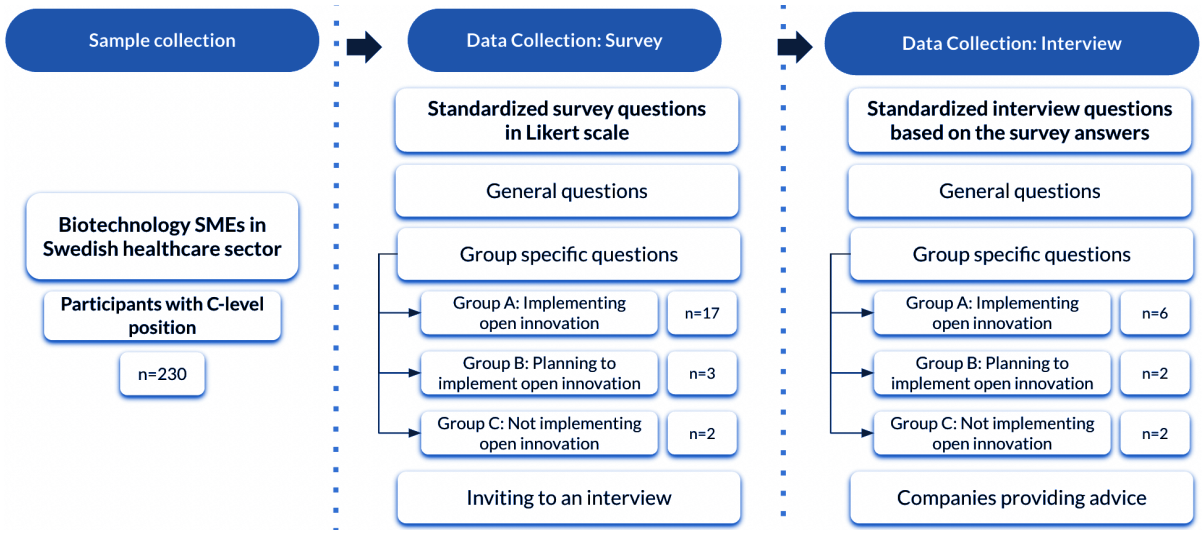

Figure 3.1 Summary of sample collection and data collection for primary data - survey and interview

3.4.3. Data analysis

Quantitative data: Survey

Collected data was analyzed separately in three different groups: companies that implement open innovation, companies that plan to implement open innovation, and companies that do not implement open innovation.

To analyze the importance of different variables used in the Likert scale, we considered our data to be ordinal, as we argue that each data point has its value and we cannot group them into intervals (Sekaran & Bougie, 2016). Therefore, we used the median value to find the most important (or least important) factors, which allowed us to rank identified variables by their importance. Furthermore, multiple-choice questions were analyzed by identifying the number of companies that selected that particular answer. This was also useful in identifying ranking between different variables as we were identifying frequencies.

To visualize the analysis of data collected in the Likert scale, we utilized a violin plot, which offers a visual representation of the distribution, frequencies, and median of the data by depicting the density of the plot. The width of the plot indicates the frequency of data points on the Likert scale, which includes categories such as not important, low importance, neutral, important, and very important (Labxchange, 2023). Moreover, we used a bar graph visualization tool to visualize the frequency distribution between specific variables in the multiple-choice questions. All the figures were made by using Prism 9 software (GraphPad).

Qualitative data: Interview

To analyze the data gathered from the interviews, this study employed a content analysis approach using thematic analysis, which involved coding the data and identifying recurring themes, patterns, and relationships (Sekaran & Bougie, 2016). The process was manually conducted in three steps, beginning with transcribing the recorded interviews into text. From there, the data was reduced by highlighting several key points and categorizing arguments with similar meanings. Lastly, the data was separated into five different codes: benefits, challenges, understanding of open innovation, managerial decision-making, motivation, and types of open innovation and organization (**Fig. 3.2**).

As explained by Sekaran and Bougie (2016), coding is the analytical process used to condense, rearrange, and combine qualitative data to form a theory. By utilizing this approach, the study aimed to identify the drivers, benefits, and challenges of open innovation in biotechnology product development and explore the various approaches used by small and medium-sized biotechnology companies.

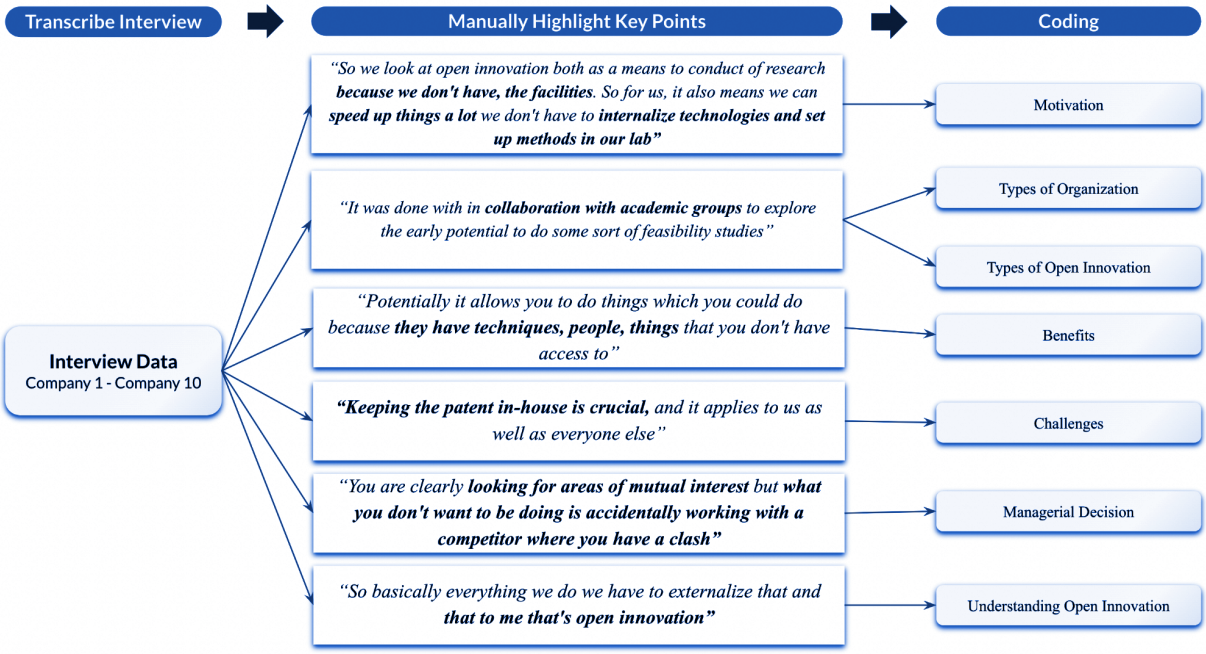

Figure 3.2 Examples of processing data analysis for qualitative data (interview)

3.5. Validity and Reliability

In the context of a research study, ensuring the study's validity was of utmost importance. The validity of a study was essential as it determined how well the results obtained from the study participants represented the true findings of similar research outside the study. The validity of a measure was also crucial as it determined whether the results accurately represented what they were intended to measure (Sekaran & Bougie, 2016). When doing a comprehensive literature review, we combined codes representing our study to systematically search relevant literature in online databases (*Section 3.2.2*). This approach enabled us to effectively identify and address gaps in previous studies, thereby emphasizing the importance of connecting these gaps to our research.

Moreover, we employed surveys and interviews to collect data to mitigate bias within our study. By utilizing these methods, we explored the correlation between the actual circumstances of biotechnology SMEs in Sweden and the information documented in the existing literature. We gathered data from three distinct categories, allowing us to obtain a more comprehensive and diverse range of perspectives. By incorporating these multiple perspectives, we aimed to ensure that our findings are representative of the overall situation within biotechnology SMEs in Sweden.

Furthermore, reliability in this study was also a crucial aspect that pertains to the consistency of a measure and the ability to reproduce results under the same conditions. We used Q1 academic journals for our literature analysis to ensure data reliability in our literature review. This approach allows us to access high-quality and reliable research data, enhancing our findings' dependability. Furthermore, the study's reliability would provide confidence in its replicability for future research (Sekaran & Bougie, 2016).

Regarding the survey and interview methods, we conducted questionnaires by reviewing relevant literature and identifying factors that could apply to our study. The survey questionnaires were categorized into three distinct groups, each with questions tailored to their specific needs, enabling us to conduct a comprehensive analysis. Additionally, we interviewed the participating companies to follow up on their responses and better understand their unique situations. We optimized our interview questions so that each group received questions relevant to their circumstances. We also recorded all the interviews to ensure we got all the crucial information.

Our study focused on biotechnology SMEs, specifically in the healthcare sector. As we had contacted 230 companies to participate in our study, we obtained responses from 22 who had voluntarily answered our survey. Out of these 22 participants, we conducted 10 interviews. This ensured that the selection of responders was random and that we were not biased toward any specific group of respondents.

3.6. Limitations

This study acknowledges several limitations that impacted the scope of the research. Primarily, the time constraint hindered our ability to extensively measure and discuss the impact and

success rate of product development for each company following the implementation of open innovation.

Moreover, we recognize that a larger number of participants representing each sample category, particularly those intending to implement open innovation and those not implementing it, would have enriched the study by offering a more comprehensive perspective. For example, in the group that has not implemented open innovation, we gained two samples in the survey and followed both companies for the depth-interview questionnaire. However, it limits our bigger understanding of the general perspective in the companies that do not implement open innovation. Consequently, it would have been advantageous for our study to have more survey data available for analysis in each category compared to the interview data.

In certain instances, we have observed limitations in the responses provided by our survey participants. Specifically, some of the respondents tended to answer questions with the assumption that they were being regarded as a potential resource for open innovation, or what is commonly referred to as *outbound open innovation*. However, our research intention was to see examples from the inbound open innovation perspective of biotechnology SMEs in the Swedish healthcare sector. This highlights the need for caution when interpreting survey results related to open innovation, as some respondents may have differing interpretations of the terminology used or may provide responses based on their own experiences and perceptions. Therefore, it was crucial to conduct additional follow-up interviews or verification processes to ensure a clear understanding of the responses provided, especially when they appeared to be ambiguous. By doing so, we could have obtained more accurate insights and a better understanding of the open innovation landscape.

Additionally, when doing an interview, we minimized bias by asking diverse questions tailored to different sample categories. It is crucial to acknowledge the possibility of bias stemming from previous studies or literature, which could have inadvertently influenced the interview process. To mitigate this, we outlined our view on open innovation at the start of each interview. It is important to note that there are multiple perspectives on open innovation, and this study presents a balanced and nuanced understanding throughout our research.

4. Data Findings and Analysis

4.1. Demographics of Participants

In this subsection, an outline of the study participants is provided, focusing on data collected from the survey among Swedish biotechnology SMEs in the healthcare sector. In total, we received 22 survey responses. Additionally, for a more comprehensive visual representation of the survey data, please refer to **Appendix B.**

Location of the company

Of the 22 participants that answered our survey, 6 were located in Stockholm. Meanwhile, 5 out of 22 were located in Lund, 3 out of 22 were located in Södertälje, 2 out of 22 were situated in Solna, and an equal number were located in Malmö. Additionally, 1 out of 22 of the participants were located in Umeå, Uppsala, and Gothenburg, respectively.

Role of participants in the company

To analyze the situations, we selected participants with positions important to strategic decisions. Most participants, accounting for 13 out of 22 participants, held positions at the C-level. Moreover, 5 out of 22 participants were in managerial positions, while 2 out of 22 held the director position. Furthermore, 1 out of 22 participants held the position of vice president.

Status of Open Innovation Implementation

Out of the total participants, 17 out of 22 participants were implementing open innovation. Meanwhile, 3 out of 22 participants were planning to implement open innovation, and 2 out of 22 were not implementing open innovation.

Interview Participants

In this study, from 22 survey respondents, 10 of the respondents participated in the interview. Moreover, to protect the privacy of the interviewees, the names of the interviewees and companies have been removed. The list of interviewees and information about interviews are listed below:

Table 4.1. List of interviewees

Name	Category of the Company	Location	Role of Participants	Date of Interview	Interview Duration	Status
Company 1	Pathogen Diagnostics	Lund	Chief Scientific Officer	29.03.2023	30:34’	Implementing Open Innovation
Company 2	Probiotics and Biotechnology	Lund	Business Development Manager	30.03.2023	20:25’	Planning to Implement Open Innovation
Company 3	Wound healing technology	Umeå	Chief Executive Officer	31.03.2023	25:22’	Implementing Open Innovation
Company 4	Medical Equipment	Stockholm	Chief Executive Officer	31.03.2023	26:19’	Implementing Open Innovation
Company 5	Drug Development	Stockholm	Chief Scientific Officer	04.04.2023	27:02’	Implementing Open Innovation
Company 6	Drug Development	Gothenburg	Business Development Director	04.04.2023	15:30’	Implementing Open Innovation
Company 7	Drug Development	Stockholm	Project Manager Pharmaceutical Development and Supply	13.04.2023	23:17’	Not Implementing Open Innovation
Company 8	Drug Development	Stockholm	Director, Translational Science	13.04.2023	23:16	Implementing Open Innovation
Company 9	Diagnostic Tool Development	Solna	Chief Scientific Officer (CSO)	18.04.2023	29:19’	Planning to Implement Open Innovation
Company 10	Pharmaceutical Device Development	Lund	Senior Scientific Advisor	27.05.2023	32:38’	Not Implementing Open Innovation

4.2. Understanding of Open Innovation

In our data analysis, we examined each variable using the survey data. Furthermore, we supported our findings by conducting comprehensive interviews to validate the insights we gained from the survey. We first started with the data analysis of participants' understanding of open innovation.

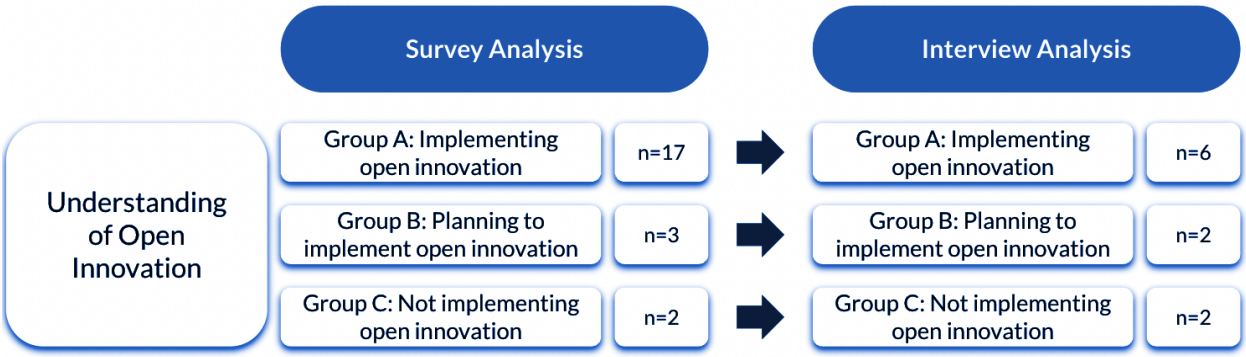

Figure 4.1 Summary of data collection and analysis of understanding open innovation

Quantitative Data: Survey Analysis

In the survey, we asked the participants about their understanding of the open innovation concept. The majority, equivalent to 19 out of 22 (86.4%), were familiar with the concept. The remaining 3 out of 22 (13.6%) participants were not familiar with the concept of open innovation.

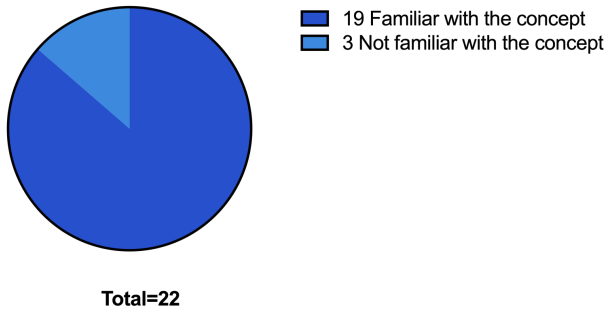

Figure 4.2 Participants' familiarity with the concept of open innovation (n=22)

Qualitative Data: Interview Analysis

In the interview, we asked interviewees about their perspectives on open innovation. Both companies implementing open innovation and those planning to implement it shared the same understanding of the concept. They view open innovation as a strategy to bring tangible and intangible resources from external companies into internal development, intending to create a product that meets market demands.

> Company 6: *"Open innovation is utilizing external technologies in order to make a product viable for the market [...] so that you can find and satisfy the end users' demands and needs."*

Moreover, several companies made an interesting point that open innovation provides essential benefits for small and medium enterprises as this approach helps them fill the resource gap they encounter.

> Company 9: *"For small companies, in particular, it helps quite a lot to have the know-how of bigger players sometimes to develop parts of the complete product development."*

4.3. Motivation for Implementing Open Innovation

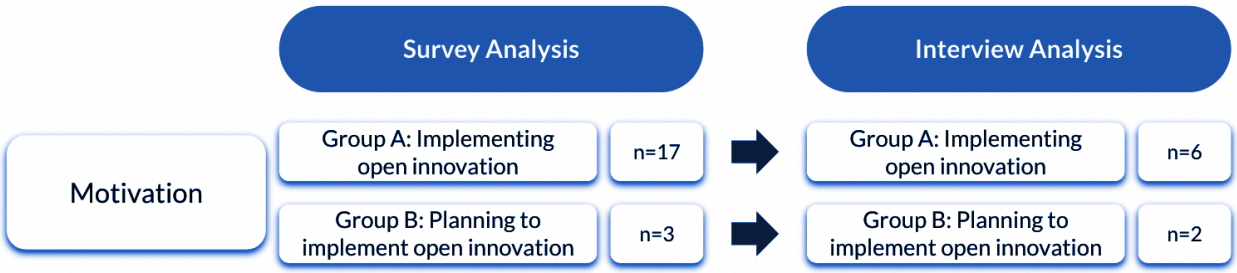

Figure 4.3 Summary of data collection and analysis in the motivation of open innovation

4.3.1. Companies implementing open innovation

Quantitative Data: Survey Analysis

In analyzing quantitative data, we used a *violin plot* that enabled us to visualize the data distribution, frequencies, and median through the density of the plot. The wider part of the plot

indicates a higher frequency of data points in the Likert scale (not important, low importance, neutral, important, very important) (Labxchange, 2023). In order to assess the participants' view of the importance of each factor, we presented the data by the median value. The median is represented by a black line in the plot, allowing for a visual representation of the central tendency of the data. Moreover, to identify each variable, companies were provided with questions allowing them to select multiple factors and evaluate their importance on a scale from 1 to 5.

In the context of companies that adopt open innovation, *funding,* and *expertise* were identified as very important factors. The data collected from 17 respondents showed that 9 of them considered *funding* and *expertise* as highly significant motivation, with a median score of 5. On the other hand, 7 out of 17 respondents found other factors, such as *technology*, *network*, and *market*, to be important drivers of open innovation adoption, with a median score of 4. However, there was a slight tendency for *networks* and *markets* to be ranked lower in terms of importance as motivational factors. Specifically, 5 out of 17 respondents ranked *network* as a low-importance driver, and 4 out of 17 respondents indicated that the *market* was not an important driver for open innovation implementation, as shown in **Figure 4.4.**

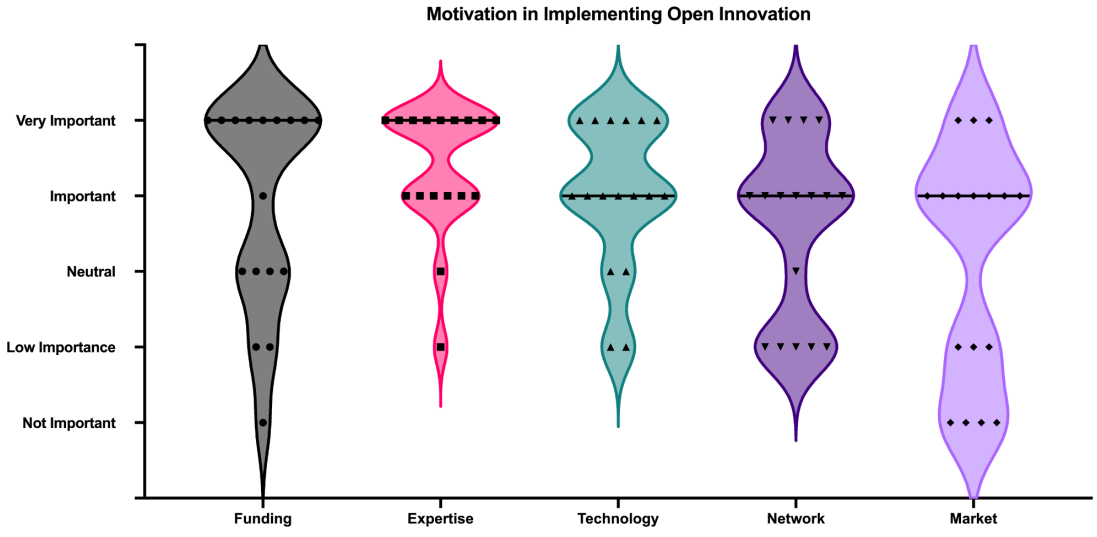

Figure 4.4 Motivation for implementing open innovation for companies that adopt open innovation
X-axis: identified motivation, *y-axis*: the importance of each factor ranged from 1 (not important) to 5 (very important), n=17

Qualitative Data: Interview Analysis

When considering the driving factors behind open innovation adoption, companies expressed a common motivation rooted in the recognition of resource limitations. These companies embrace open innovation to address these constraints and enhance their competitive edge within the industry. By acknowledging the need for additional resources, they actively seek out external parties to access capabilities beyond their own organizational boundaries.

> Company 8: "*We look at open innovation as a means to research because we do not have the facilities. We don't have to internalize technologies and set up methods in our lab [..] We currently work with a contract research organization that acts as an extension of our lab and provides us with access to research tools for animal models that we cannot obtain elsewhere. Their expertise in this area has been instrumental in developing our project."*

Several companies, including Company 3 and Company 4, identified funding as an important factor when implementing open innovation. These companies perceive a shortage of financial resources as a barrier hindering their ability to acquire other necessary resources for the continued development of their products. By addressing this funding challenge through open innovation, they aim to secure the necessary financial support to fuel their growth and innovation initiatives.

> Company 3: "*Financial is one of the reasons that motivate us to implement open innovation as we do not have sufficient funds, we do not have financial possibilities to recruit all of the key competence that we need."*

Interestingly, Company 5 and Company 6 emphasized acquiring knowledge as a key motivator in implementing open innovation practices. They believe that the gained knowledge plays a crucial role in enhancing the quality and advancement of their projects. By leveraging external knowledge sources, they are able to tap into fresh insights and expertise, ultimately driving the improvement and success of their projects.

> Company 6: *"The motivation (to do open innovation) is to utilize other companies' knowledge and combine our internal knowledge with theirs to have a more successful project."*

Furthermore, for some companies, such as Company 8, the inability to access technology internally was a driving force behind their decision to collaborate with external partners.

> *Company 8: "So for us, it also means we can speed up things a lot. We don't have to internalize technologies and set up methods in our lab."*

Lastly, as numerous companies find themselves in the early stages of product development, they prioritize their efforts and resources accordingly. Particularly for SMEs with limited resources and capability, recognize the need to concentrate on one aspect at a time. Given their current circumstances, these companies place less emphasis on the market factor and instead direct their attention toward other critical aspects of their operations.

> Company 6: *"We are not focusing on the market at the moment because our focus is very much to get something we do not have now, for instance, sufficient data. Thinking about gaining a new market for the product for me is five-plus years away. Our initial focus is technology development, and the market is a future goal."*

4.3.2. Companies planning to implement open innovation

Quantitative Data: Survey Analysis

According to the responses of all participants who plan to implement open innovation, *market,* and *network* were considered the most important motivators, with a median score of 5. Furthermore, 2 out of 3 participants identified *technology* and *expertise* as important drivers of open innovation implementation, with a median score of 4. However, *funding* was found to be of low importance in motivating companies to adopt open innovation, as indicated by the responses (**Fig. 4.5**).

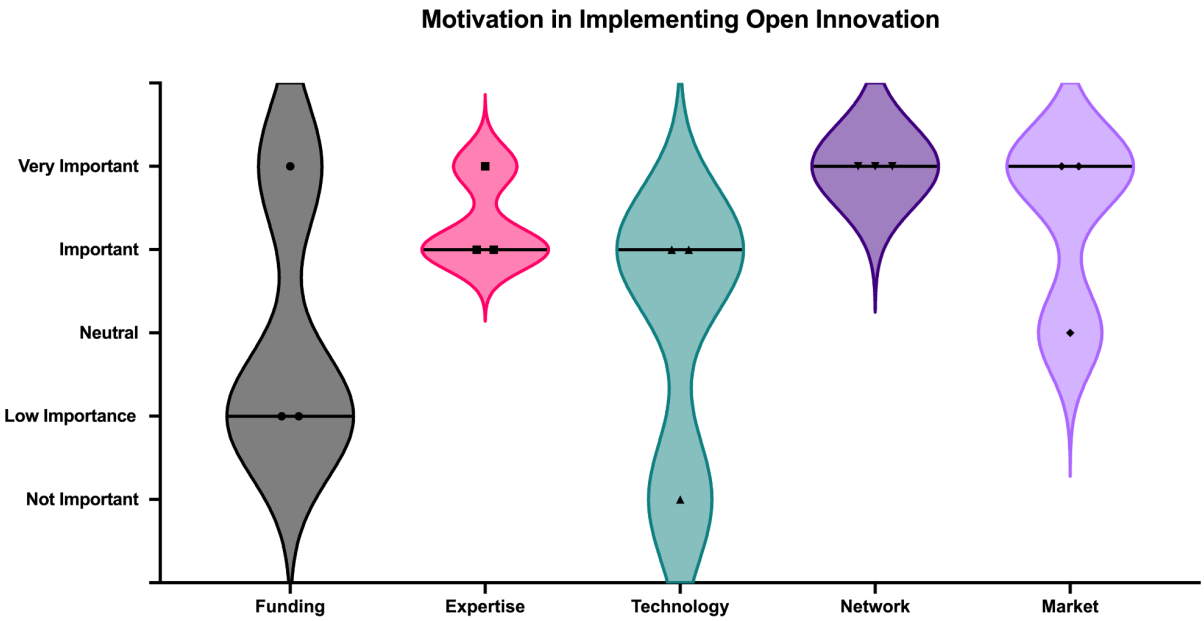

Figure 4.5 Motivation for implementing open innovation for companies that plan to implement it
X-axis: identified motivation, *y-axis*: the importance of each factor ranged from 1 (not important) to 5 (very important), n=3

Qualitative Data: Interview Analysis

In the case of Company 2, their strategic objective of market expansion served as a significant driving force behind their decision to adopt open innovation practices. By leveraging the expertise and resources of external parties, Company 2 aimed to gain a competitive edge in untapped market segments.

> Company 2: *"The motivation is to reach new markets with new products leveraging what is out there in the community because we are a small or medium-sized company with a very niche-oriented offering."*

In addition, Company 2 understood that developing a network with new partners is crucial for adapting to the current situation and expanding the market.

> Company 2: *"And right now, the whole industry is becoming increasingly mature, meaning that we need to change and adapt if we are to grow with the business. [..] new partners with new offerings and allows us to approach new types of businesses."*

Interestingly, Company 9 recognized that by engaging with external parties, they could get access to the technology and expertise that may not be readily available within their organization.

> Company 9: *"In the case of developing a new product, we see that open innovation helps to test different applications to then later focus on the one that is the most profitable."*

4.4. Benefits of Implementing Open Innovation

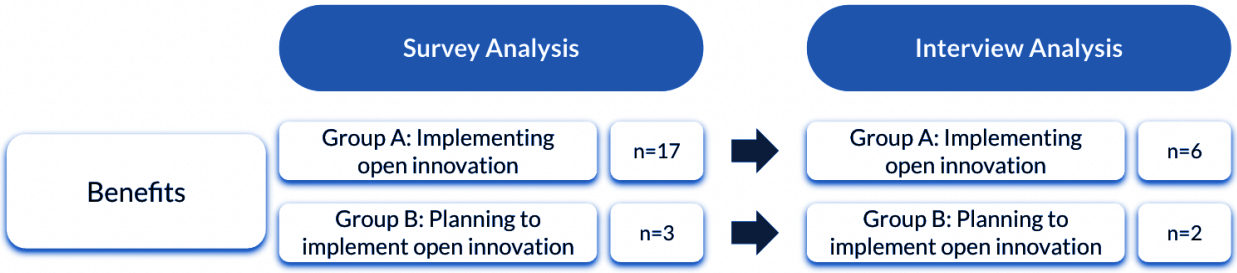

Figure 4.6 Summary of data collection and analysis on the benefits of open innovation

4.4.1. Companies implementing open innovation

Quantitative Data: Survey Analysis

Based on the survey answer, out of the 17 respondents who implemented open innovation, 9 identified *gaining knowledge* and *receiving funds* as the most significant benefits, with a median score of 5. In addition, 6 respondents considered *faster development* an important benefit, with a median score of 4. Moreover, *obtaining talents* were found to be of low importance, with 9 out of 17 respondents ranking it with a median score of 2. Additionally, 9 out of 17 respondents indicated *expanding the network* as important or very important. However, 7 out of 17 respondents ranked it as a low-importance factor, making it difficult to make a definitive conclusion about its impact (**Fig. 4.7**).

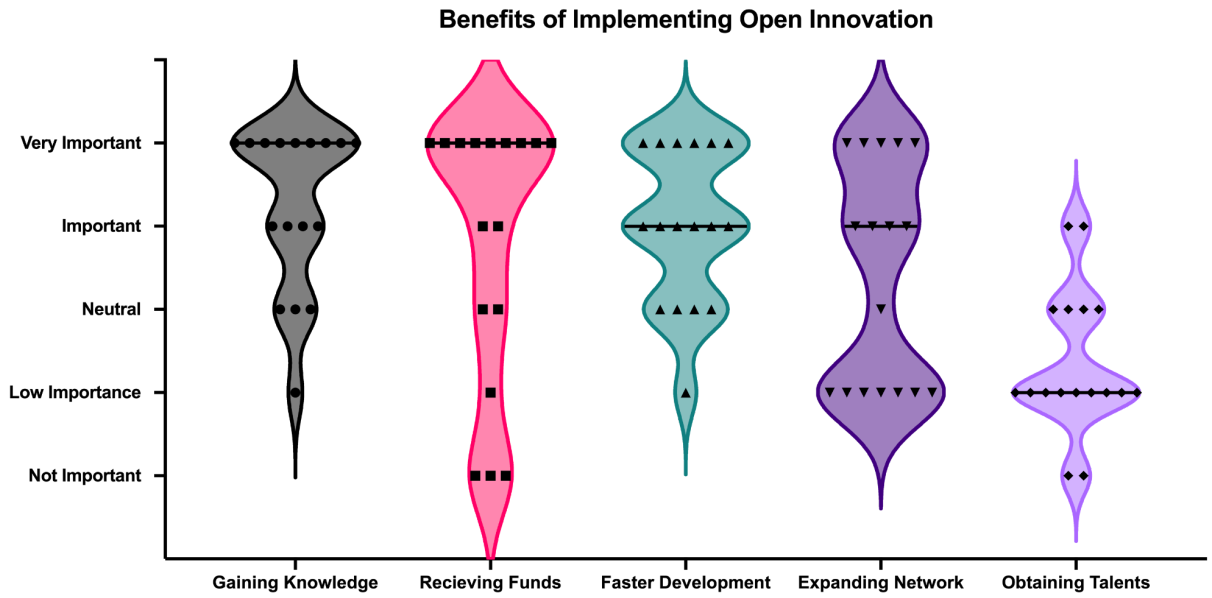

Figure 4.7 Benefits of implementing open innovation for companies that implement open innovation
X-axis: identified benefits, *y-axis*: the importance of each factor ranged from 1 (not important) to 5 (very important), n=17

Qualitative Data: Interview Analysis

In general, all the companies that have implemented open innovation agreed that open innovation had provided them with benefits that they previously did not have access to and helped them develop their business.

Company 5 and Company 6 emphasized the importance of gaining knowledge as a significant benefit after implementing open innovation. Interestingly, these companies emphasize that being involved in informal and formal scientific discussions help them to gain new insights to improve their product.

> Company 5: *"Our data produced and shared in publications plays a crucial role in stimulating discussions about taking action and doing more."*

According to Company 6, it is interesting to note that since biotechnology is a highly specialized field, implementing open innovation has been beneficial for them to gain insights and understanding in this area.

> Company 6: *"In our case, we have found a partner that can provide us insights into our field, which is quite narrow in their technology, so there is this new expertise in that."*

Moreover, several companies recognized that although talent acquisition is a significant factor in an overall business strategy, it is not the foremost advantage gained from implementing open innovation. They recognized that open innovation brings other important benefits that outweigh the sole focus on gaining new talent.

In summary, implementing open innovation has shown to be instrumental for numerous companies in addressing their motivation and fostering the advancement of their further product development.

> Company 5: *"Potentially, it (implementing open innovation) can allow you to do things which you could do because they have techniques, people, things that you do not have access to."*

> Company 4: *"I think that an open and open innovation atmosphere does create excellent opportunities for us as a company to help them prosper and develop."*

4.4.2. Companies planning to implement open innovation

Quantitative Data: Survey Analysis

All three participants planning to implement open innovation identified *gaining knowledge*, and 2 out of 3 respondents considered *faster development* as the most important factor that attracted them, with a median score of 5. Additionally, *expanding networks* and *obtaining expertise* were found to be important motivators, with a median score of 4. *Receiving funds* was perceived as a neutral factor that attracts companies to implement open innovation, with a median score of 3 **(Fig. 4.8)**.

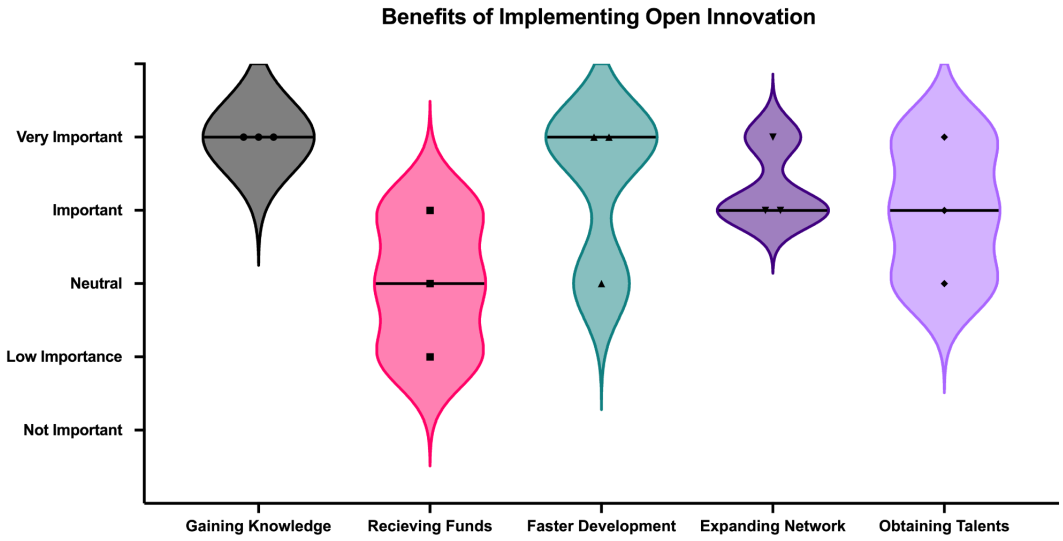

Figure 4.8 Benefits of implementing open innovation for companies that plan to implement open innovation
X-axis: identified benefits, *y-axis*: the importance of each factor ranged from 1 (not important) to 5 (very important), n=3

Qualitative Data: Interview Analysis

As Company 2 goal is to develop products that are well-suited to the market, they believe that gaining knowledge for faster product development is the key to tapping into the market.

> Company 2: *"By leveraging our ingredients and their capabilities (e.g., knowledge), we can develop new product concepts together or through an agreed go-to-market."*

4.5. Challenges in Implementing Open Innovation

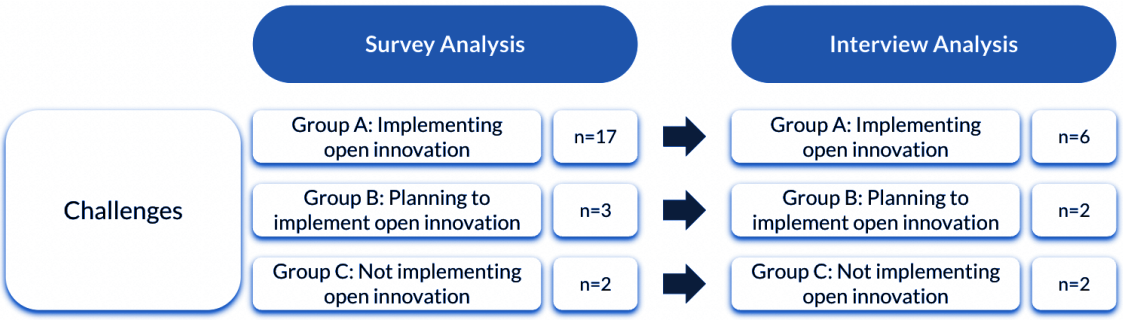

Figure 4.9 Summary of data collection and analysis in open innovation challenges

4.5.1. Companies implementing open innovation

Quantitative Data: Survey Analysis

Companies implementing open innovation identified *sharing intellectual property* as the main challenge. In fact, 10 out of 17 respondents answered that *sharing intellectual property* is an important or very important challenge (Median: 4). On the other hand, *differences in organizational culture*, *different competencies,* and *high integration costs* were the least important challenges when implementing open innovation. To illustrate it, 10 out of 17 respondents answered that *high integration costs* have low importance (Median: 2). 9 out of 17 respondents said that *differences in organizational culture* are not important or have low importance (Median: 2). 10 out of 17 respondents answered that *different competencies* are not important or have low importance when it comes to challenges in the company when they implement open innovation (Median: 2). Nevertheless, lack of *goal complementarity* and *legal issues* seemed to be a neutral challenge in the overall evaluation of the companies, as answers are distributed through the range from 1 to 5 (Median: 3) (**Fig. 4.10**).

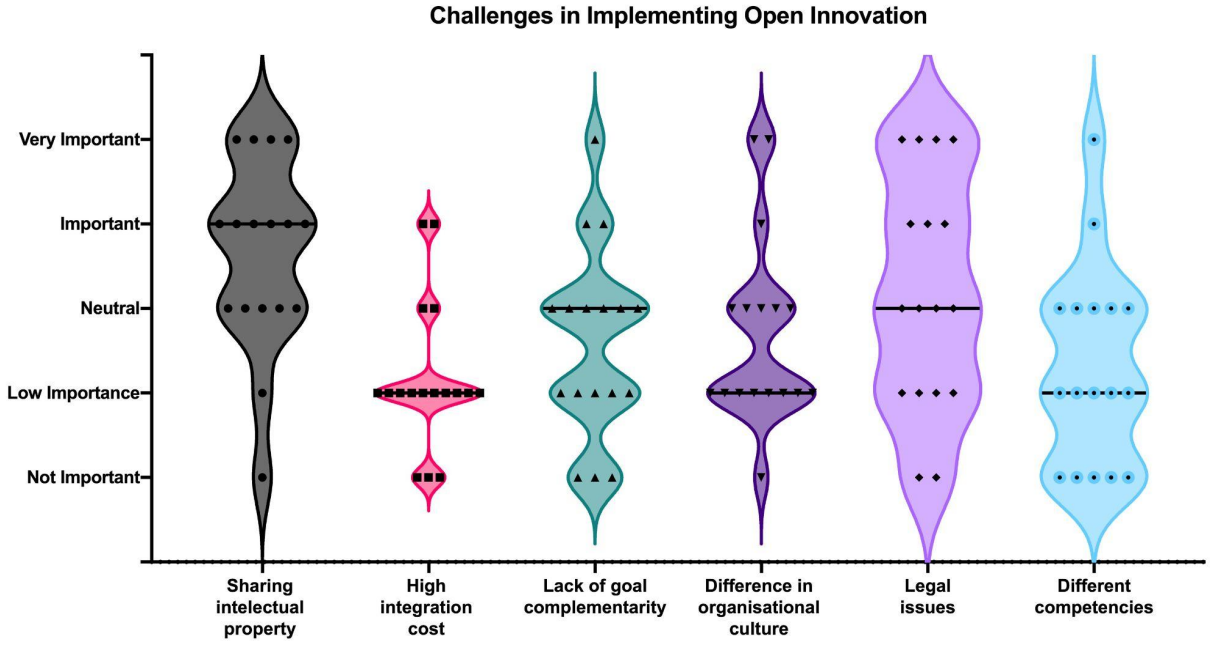

Figure 4.10 Challenges identified in companies that implement open innovation
X-axis: identified challenges, *y-axis*: the importance of each factor ranged from 1 (not important) to 5 (very important), n=17

Qualitative Data: Interview Analysis

When asking questions about challenges, we saw the tendency of companies to be primarily concerned about protecting their intellectual property. Therefore, throughout the interview, companies clarified why sharing intellectual property is an important challenge when implementing open innovation. In fact, all the companies identified it as a crucial point to mitigate while assuring their company's growth and success. On the other hand, they highlighted that companies do not have to be overly secretive about their research project, as in an open innovation environment, it is important to share your ideas and thoughts freely.

> Company 1: *"Before we could start any practical work, we had to ensure that we had a strong intellectual property case. Protecting intellectual property is crucial for a small company. You could be in trouble if another party works on the same thing."*

During the interview, we noticed that companies view the lack of goal complementarity not as a challenge but as a neutral point. This is because having similar goals might result in companies competing. This aspect will be further discussed in *Section 4.7. Managerial Approach to Support Open Innovation Implementation.*

4.5.2. Companies planning to implement open innovation

Quantitative Data: Survey Analysis

Companies planning to implement open innovation (3 out of 3 companies) identified *sharing intellectual property* as a factor that challenges them before implementing open innovation. In addition, 2 out of 3 respondents identified a *lack of goal complementarity* and *legal issues* as two challenging factors preventing companies from implementing open innovation. Moreover, only 1 company out of 3 answered that *high integration costs* and *differences in organizational culture* play a role in challenges preventing the implementation of open innovation. Interestingly, in line with companies that implement open innovation practices, companies that are planning to do so did not see *different competencies* as an important challenge (**Fig. 4.11**).

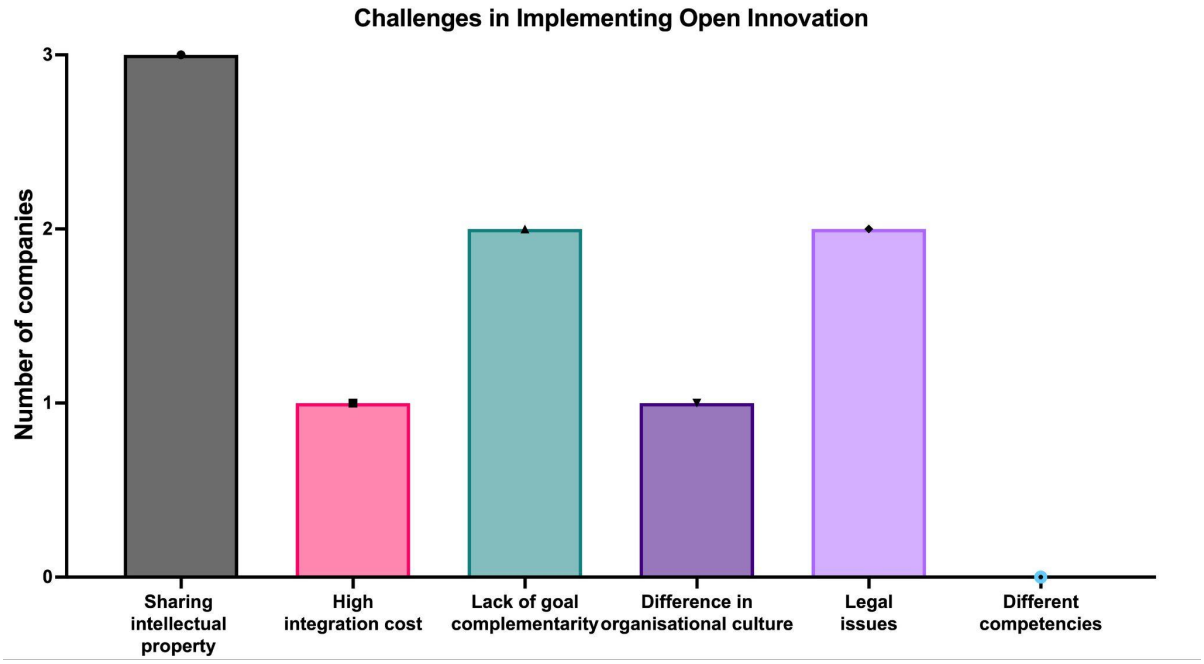

Figure 4.11 Challenges identified in companies that are planning to implement open innovation

X-axis: identified challenges, *y-axis*: number of companies that identified it as an important challenge, n=3

Qualitative Data: Interview Analysis

It is worth mentioning that companies that aspire to adopt open innovation strategies often view sharing intellectual property as one of the main challenges. They also identified it as an almost limiting factor for further collaboration. Interestingly, they believe that open innovation is rare in their field, as they see companies as very protective of new ideas and research due to the involvement of patents and substantial financial investments.

> Company 2: *"The idea of being open contradicts what you are trying to accomplish in a protective environment like the biotechnology industry."*

4.5.3. Companies not implementing open innovation

Quantitative Data: Survey Analysis

In companies that do not implement open innovation, sharing intellectual property was the main identified reason preventing them from implementing it. Indeed, both companies that answered

the survey identified it as a very important reason (Median: 5). The other factors, such as *high integration cost*, *lack of goal complementarity*, d*ifferences in organizational culture*, *legal issues*, and *different competencies,* are identified as neutral or low-importance challenges (**Fig. 4.12**).

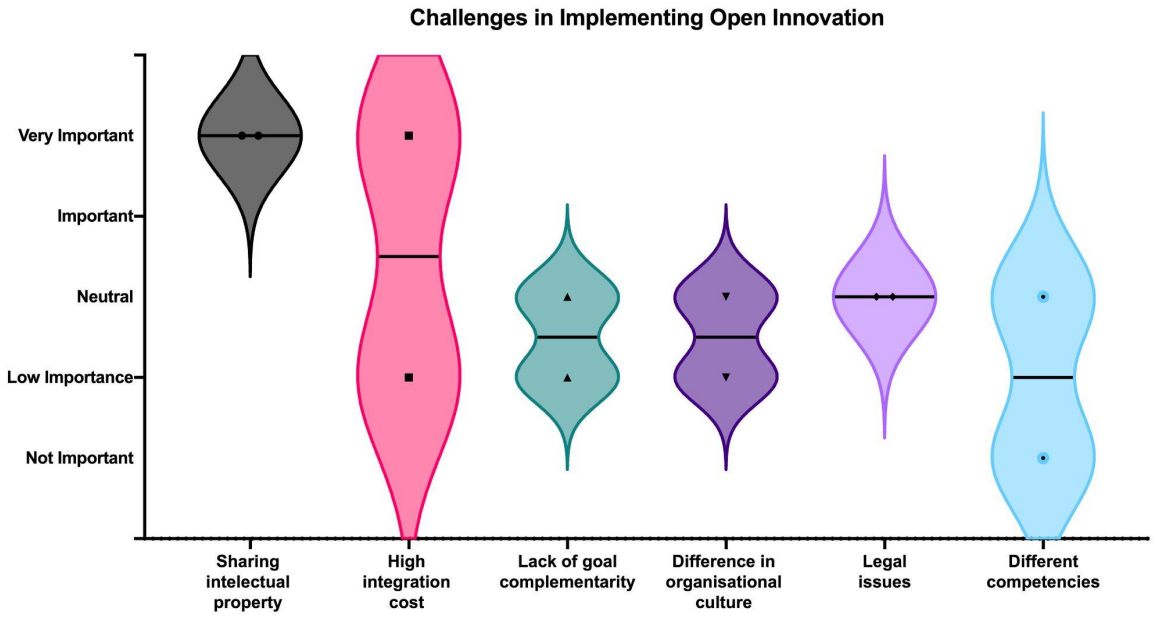

Figure 4.12 Reasons preventing companies from implementing open innovation
X-axis: identified challenges, *y-axis*: the importance of each factor ranged from 1 (not important) to 5 (very important), n=2
Qualitative Data: Interview Analysis

Companies that are not planning to implement open innovation tend to view sharing intellectual property as not only a challenge but also a significant barrier to their participation in open innovation activities, similar to the companies that intend to implement open innovation. They stressed that the cornerstone of their business model is owning their product's intellectual property, which holds immense value and importance for them.

> Company 7: "*Our company considers sharing intellectual property to be a sensitive matter, and we prioritize the security of our project and product development."*

Furthermore, companies that do not intend to adopt open innovation often point out that this approach may require different methods, some of which may not be financially feasible. For example, as a small company, they cannot acquire other companies for their products.

Company 10: "*As a small company, we are always mindful of the costs and benefits of engaging in open innovation, as well as the potential impact on our network.*"

4.6. Types of Open Innovation

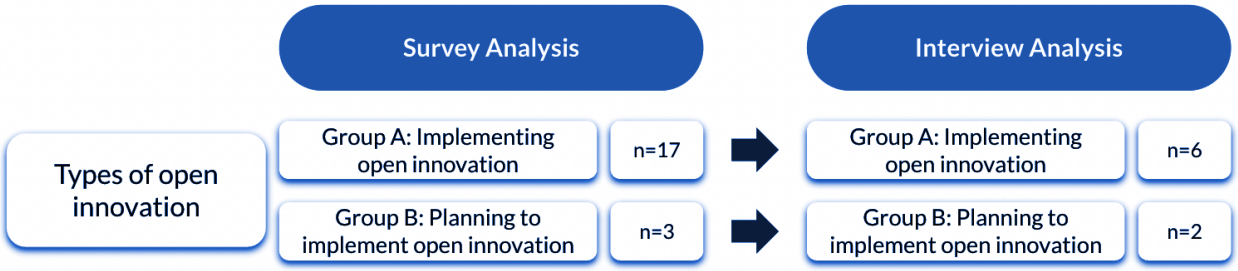

Figure 4.13 Summary of data collection and analysis in the types of open innovation

4.6.1. Companies implementing open innovation

Quantitative Data: Survey Analysis

To identify what types of open innovation companies implement, in a survey, companies were offered to select several options of types of open innovation offered in the list. *Collaboration* with other institutions proved to be the most used type of open innovation among companies that implement open innovation. In fact, 16 out of 17 respondents identified this type of open innovation as their primary approach. Following, *partnerships* were identified by 13 out of 17 companies as another type of open innovation that they are involved in. Furthermore, 10 out of 17 companies answered utilizing *IP licensing* and *venture capital* approaches, accounting for 5 out of 17 companies in each type of open innovation. Lastly, the *acquisition* was practiced by 4 out of 17 respondent companies (**Fig. 4.14**).

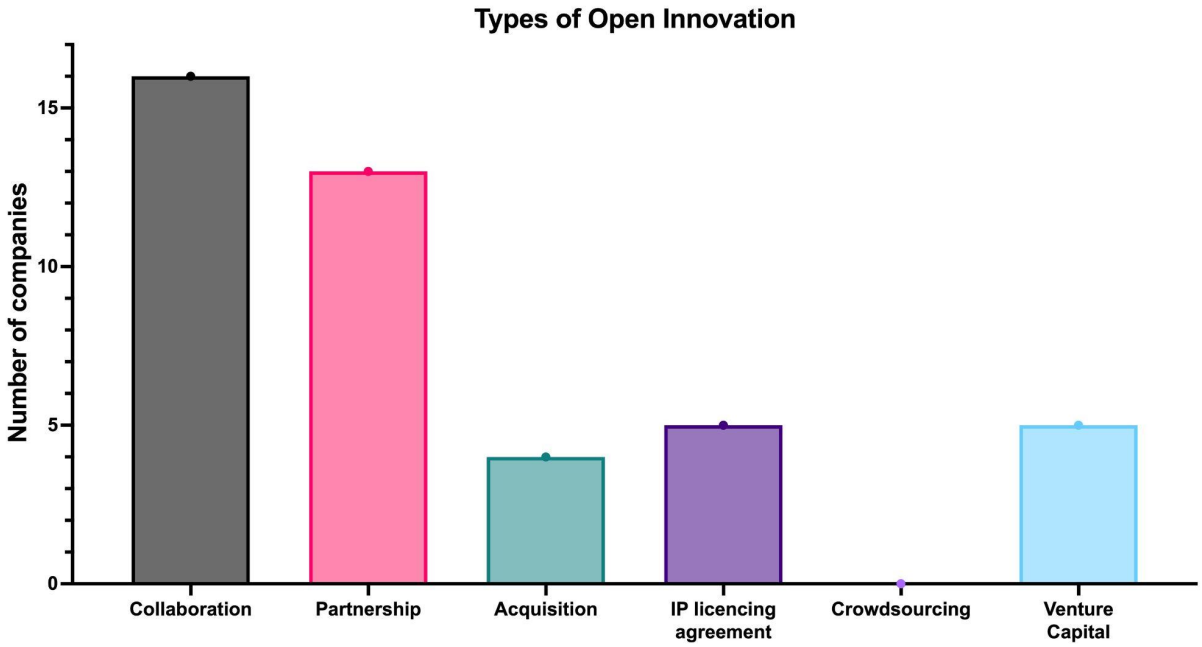

Figure 4.14 Types of open innovation implemented by companies

X-axis: types of open innovation, *y-axis*: the number of companies identifying participating in this type of open innovation, n=17

After identifying the types of open innovation in which companies participate, we intended to understand the kind of organizations with whom they tend to work for open innovation purposes. The majority of the companies, 11 out of 17, identified working with *other small-medium enterprises*, 9 out of 17 companies identified working with *higher education institutions*, and 7 out of 17 with *large corporations*. Lastly, *governmental institutions, venture capitals, business incubators, and contract research organizations* were identified by 5, 4, 4, and 1 companies out of 17, respectively (**Fig. 4.15**).

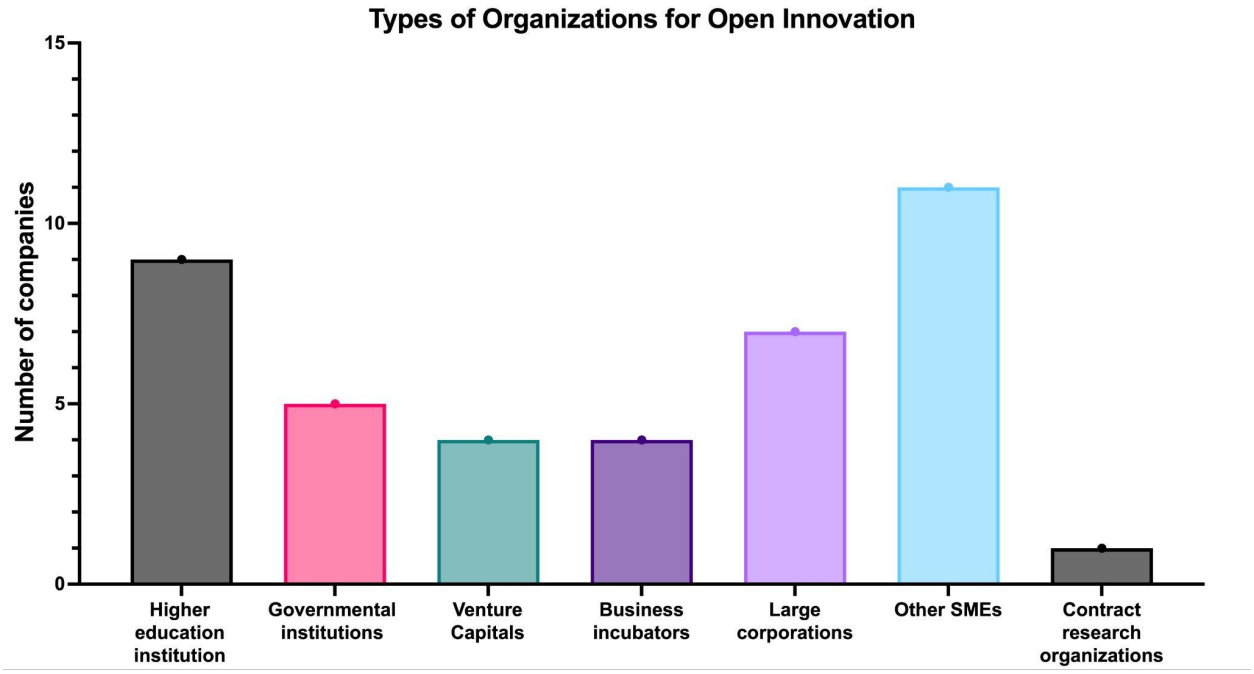

Figure 4.15 Types of organizations companies work with for open innovation purposes
X-axis: types of organizations, *y-axis*: the number of companies identifying participating with this type of organization, n=17

Qualitative Data: Interview Analysis

Our interview analysis confirmed that the majority of companies view collaborations and partnerships as the most common types of implementing open innovation approaches within their organizations. Especially, most of the companies emphasized universities and academic groups as their partner in collaboration, as it provides specialized research techniques or equipment, as well as materials that they would not have access to otherwise.

> Company 6: "*We have a collaboration with a university where we utilized their technology to help us answer specific questions related to our target and product design.*"

Surprisingly, although survey data showed that most respondents work with other SMEs, however in the interviews, as seen from the analysis above, it was noted that academic groups in universities are often the preferred collaborators. However, some interviewees pointed out that universities are not always the best option for collaboration. Even though universities are valuable partners in terms of knowledge and intellectual power, relying solely on them may not

lead to success in business. To succeed, it is important to combine their knowledge with the commercial and healthcare sectors, as well as with governmental structures and other organizations such as NGOs.

> Company 8: *"Commercial collaborators' ability to generate data in a goal-oriented and efficient manner makes them an attractive alternative to academic collaborators. Unlike academic groups, private companies have stricter goals and focus more on delivering results."*

Furthermore, we explored how venture capital could be utilized as an open innovation practice, as some companies had mentioned in the survey. However, our findings revealed that companies view venture capitalists as leveraging open innovation through SMEs rather than the opposite scenario. For example, big pharma companies could use venture capital funds as a means to nurture startups and foster innovation, which they can later incorporate if it proves successful. However, from a small company's perspective, receiving money from venture capitalists is not the main objective of open innovation.

> Company 8: *"The perspective on venture capital and open innovation is not just from our companies' point of view but also from the venture capitalists. Working with venture capitalists is just a way to acquire capital to keep the company running."*

Finally, none of the interviewed companies were engaged in acquisitions or considered it a valuable form of open innovation. Although we did come across some companies in our survey that viewed it as an approach to open innovation.

4.6.2. Companies planning to implement open innovation

Quantitative Data: Survey Analysis

Out of three companies that plan to implement open innovation, all three identified that they would like to be involved in *collaborations* and *partnerships*, and 2 out of three said they were planning to implement *acquisitions* and *IP-licencing agreements*. However, none of the three respondents identified *crowdsourcing* or *venture capital* as a type of open innovation that they would like to implement (**Fig. 4.16**).

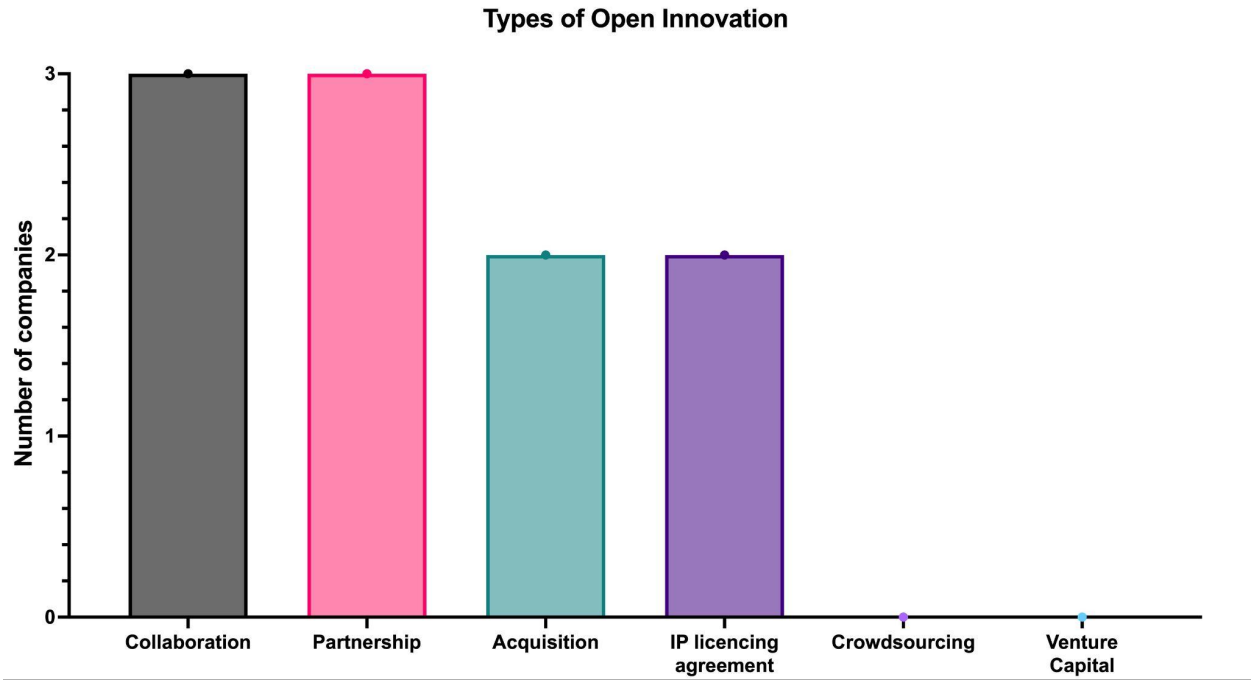

Figure 4.16 Types of open innovation companies aiming to implement
X-axis: types of open innovation, *y-axis*: the number of companies aiming to participate in this type of open innovation, n=3

Furthermore, we asked these companies to specify what kind of organizations they are planning to work with as an open innovation. Results showed that all of them (3 out of 3) intend to work with *higher education institutions*, 2 out of 3 of them are planning to work with *large corporations* or *other SMEs*, and finally, 1 company would like to work with *government institutions* or *business incubators* (**Fig. 4.17**).

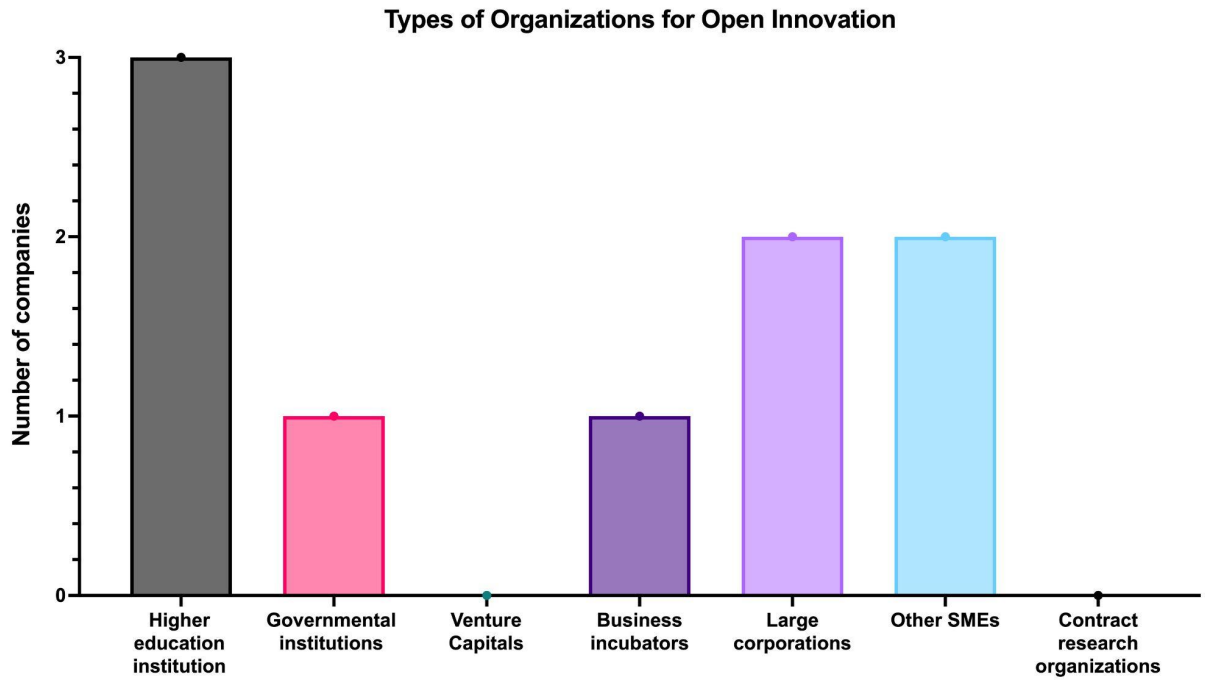

Figure 4.17 Types of organizations companies are planning to work with for open innovation purposes

X-axis: types of organizations, *y-axis*: the number of companies identifying planning to work with this type of organization, n=3

Qualitative Data: Interview Analysis

The interviews uncovered that companies that intend to adopt open innovation share similar aspirations for the types of open innovation approaches they would like to pursue, as well as the potential partners they wish to work with. In fact, they consider collaborators in academia and other private organizations (SMEs and larger companies) to work together for joint concept development. Nevertheless, partners were identified as essential in obtaining materials and knowledge for product validation.

> Company 2: *"Leveraging their (other SMEs) product development expertise and combining it with our ingredients, we can jointly develop numerous new product concepts through an agreed go-to-market approach."*

4.7. Managerial Approach to Support Open Innovation Implementation

During the interview process, it became apparent that companies emphasized the importance of different managerial approaches. Therefore, in this section, we will examine various managerial approaches that play a crucial role in facilitating open innovation and can assist in addressing the issues that arise when engaging in open innovation with multiple parties. The data was collected during interviews with the companies.

4.7.1. Goals and objectives alignment

Several companies emphasized the importance of investing adequate time in determining whether a potential collaborator can truly complement their business or if they are a direct competitor. This is seen as a critical managerial decision when pursuing open innovation initiatives and aligning goals.

One way to achieve this is to seek collaborations with parties with aligned interests but no interest in competing with a company, such as academics. Another approach is to identify potential partners whose interests complement their own and invest enough time in deciding if a potential collaboration is beneficial or if it is a competitor. In any case, the focus should be on working towards a common goal without competing with each other.

> Company 3: *"It is important to be cautious about partnering with the right companies or organizations. If you do not have good partners, it can actually delay the project. Therefore, it is essential to carefully choose the right product partners before entering into any collaboration."*

4.7.2. Managing agreements

Other companies emphasized the importance of having agreements before entering into any kind of collaboration or partnership. Some companies noted that proper agreements are crucial to avoid complications throughout the process. By aligning on project goals and ownership of rights, they are able to make the collaboration work smoothly. Finally, without these agreements, it would have been extremely challenging for them to use the IP for their company's profitability.

> Company 1: *"You can enter into agreements that outline a payback or licensing arrangement if the innovation is launched. This can be an effective way to ensure that both parties benefit from the collaboration. Ultimately, it all comes down to effective negotiation between the parties involved."*

Entering into agreements between two parties could also provide mutual benefits for both sides. For instance, if an SME works with a higher education institution, the latter can request to publish their scientific work, which also proves advantageous for the SME. This is because they may receive publications that enhance their credibility in the industry.

> *Company 5: "The publications about our products are an important means of demonstrating that these ideas are not just mere thinking but are backed by credible, peer-reviewed data that carry significant weight."*

4.7.3. Team management

When it comes to open innovation, there could be a condition of integrating external teams with internal ones. Company 8 identified a challenge in effectively managing this condition, as various teams may hold different perspectives regarding quality and standards of work.

> Company 8: *"When working with people within your team or department, you know them well and can trust them to work according to the same standards. However, when working with external partners, it can be challenging to ensure you have the same quality standards."*

4.7.4. Managing innovative culture

Interestingly, when it comes to managing the innovation culture, several companies argued that the physical location of their organization and its surroundings considerably impact how they adopt open innovation. Certain companies have discovered that participating in this environment of innovative atmosphere provides them with several advantages, including networking opportunities, potential partnerships or collaborations, and access to new knowledge.

> Company 4: *"Medicon Village (in Lund) is another area that was created where they were talking about the Triple Helix collaboration, and that is a collaboration between academia, industry, and government [...] So I would say the Medicon Village is an excellent example of an open innovation atmosphere."*

4.8. Advice from the Companies

Qualitative Data: Interview Analysis

At the interview's end, we asked interviewees to provide some insights or recommendations for companies planning to implement open innovation. The responses were diverse, but a common theme was encouraging involvement in open innovation and the potential benefits companies get.

> Company 8: *"Currently, being part of a small biotechnology company that practices open innovation is exciting as we can collaborate with top-notch academic partners and contract service organizations worldwide. It is fascinating to work with experts in their fields, and I see no reason why we should not leverage this opportunity."*

Another important recommendation was to consider intellectual property rights carefully and develop agreements and contracts that clearly define ownership and use of any resulting IP. It was emphasized that this should be done early in the collaboration process to avoid potential conflicts later on.

> Company 6: *"Make sure that the agreements are signed and be clear on who owns what and do not expose too much, to begin with."*

Overall, the companies providing advice were generally positive about open innovation and recommended that other companies should adopt open innovation practices to support their business development.

5. Discussion

According to the survey findings, many biotechnology companies in Sweden demonstrate a strong understanding of the open innovation concept. In fact, 19 out of 22 (86.4%) survey participants acknowledged their familiarity with the concept of open innovation, indicating a high level of awareness within the industry. Moreover, 17 out of 22 (77.3%) respondents reported that their companies implement open innovation practices, indicating the widespread adoption of an open innovation atmosphere among Swedish biotechnology SMEs.

This observation aligned with the findings from SwedenBio (2023), which highlighted the integrated system of the innovation ecosystem in Sweden. The innovation ecosystem in Sweden comprises diverse components, including research infrastructure, innovation hubs, service companies, and science parks, which collectively promote the integration of academic research with the commercialization of product development (SwedenBio, 2023). The alignment between the survey results and previous studies further supports the argument that Sweden fosters a conducive environment for open innovation in the biotechnology industry for the healthcare sector. Hence, biotechnology SMEs are positioned to enhance innovation capabilities and drive successful product development by actively engaging in open innovation practices and leveraging external resources.

In this section, we will examine more profoundly the role of open innovation in product development within the biotechnology industry. To gain a clearer understanding, we will address the following research questions regarding the benefits and challenges Swedish biotechnology SMEs in the healthcare sector may encounter. Furthermore, we will explore the most appropriate forms of open innovation suitable for these companies.

5.1. Research Question 1: What are the benefits of open innovation for biotechnology SMEs in the Swedish healthcare sector?

Based on prior studies and our research findings, it has been shown that SMEs that adopt open innovation practices experience positive outcomes. Our findings indicated that these companies affirm the numerous advantages the biotechnology industry could gain from implementing open innovation, particularly regarding knowledge acquisition, access to capital, and technology

utilization. The research conducted by Greco, Grimaldi & Cricelli (2018) and Chaudhary et al. (2022) revealed that implementing open innovation effectively addresses the shortcomings of their previously inadequate resources, thus highlighting the practical advantages of this approach. Furthermore, among these advantages, our survey findings showed that knowledge and funding represent the most important benefits derived from the adoption of open innovation.

Given the knowledge-intensive nature of the biotechnology industry (Schuhmacher et al., 2018; Cherchem & Keen, 2022), the findings from our survey indicated that knowledge is a very important resource acquired through open innovation. Based on the interviews conducted, it was revealed that the adoption of open innovation by biotechnology SMEs enables them to actively acquire external knowledge, providing valuable perspectives for enhancing products and fostering innovation. This finding aligned with the research conducted by van de Vrande et al. (2009), which suggests that open innovation allows companies to adopt external knowledge to address innovation-related challenges effectively.

Additionally, according to previous studies, developing biotechnology products often requires substantial initial funds (Usman & Vanhaverbeke, 2017; Wong et al., 2022). In several instances from the companies we interviewed, during the initial stages of product development, many biotechnology SMEs focus on prioritizing their R&D rather than product commercialization. Consequently, a significant investment is necessary during the initial phases of product development as they rely heavily on R&D to start selling their products to the market.

Our findings showed that open innovation provides a viable solution for companies to reduce their R&D expenses. To begin with, one strategy they employ involves establishing collaborations or partnerships with other SMEs that share similar approaches, aiming to reduce technical aspects and talent acquisition costs. This finding is consistent with the research findings of Pinarello et al. (2021), which indicate that the involvement of external partners in the innovation process can lead to a reduction in R&D costs. Secondly, according to Chesbrough (2003), implementing open innovation enables companies to secure capital funds from venture capital sources, which is essential to secure funding for the overall product development process. Not to mention, through engaging in venture capital, these companies can build networks and gain mentorship from those who are experts in the field (Spender et al., 2017). In *Section 5.3.*

Types of open innovation: venture capital we will further discuss our research findings regarding how biotechnology SMEs perceive venture capital as a form of open innovation.

Interestingly, companies implementing open innovation consider obtaining talent a relatively less important factor, which they classify as a secondary benefit. Contrastingly, findings from the study conducted by Schuhmacher et al. (2018) suggest that partnering and collaborating with external firms can offer companies access to highly skilled individuals. On the other hand, we noticed a difference in how companies that have implemented open innovation and those that plan to implement open innovation perceive the significance of the additional advantage brought by implementing open innovation. For companies planning to implement open innovation, obtaining talent is one of the most crucial factors they expect to gain. From our analysis, we argue that this difference is likely to happen because those companies who plan to implement have already secured their primary benefits, such as funding or knowledge, by using other approaches. They are now focusing on obtaining new talent to take their business to the next phase.

5.2. Research Question 2: What challenges in implementing open innovation might biotechnology SMEs in the Swedish healthcare sector face?

Previous research indicated the existence of several challenges that companies may encounter when adopting open innovation, including differences in organizational culture, different competencies, and high integration costs (Alassaf et al., 2020; Chaudhary et al*.,* 2022). However, our findings showed that these factors are relatively manageable. It may be easier for biotechnology SMEs involved in this study since they have several ways to address these issues. We will discuss this further in *Section 5.3.* under *Managerial approach to support open innovation implementation.*

Furthermore, despite the primary objective of open innovation being openness towards external entities, certain companies interviewed in this study expressed concern regarding the need to be open to external parties. For those who have implemented it before, the challenge they faced revolved around the notion of *'being too open to others.'* In the biotechnology industry,

knowledge is the foundation for all business operations (Schuhmacher et al., 2018; Cherchem & Keen, 2022). Thus, enterprises in this industry prefer to prioritize safeguarding their knowledge, particularly regarding intellectual property (IP). The reason behind this emphasis is the recognition that excessive openness to other companies may pose a significant risk to the overall business. The findings aligned with the viewpoints of Dahlander et al. (2021), who emphasized that sharing intellectual property leads to excessive data exchange. This, in turn, can complicate gaining insights and escalate the costs associated with integrating knowledge.

For this reason, when it comes to challenges, our survey data showed that biotechnology SMEs that implement open innovation identified the sharing of intellectual property as the primary challenge when implementing open innovation. This concern was also raised by those companies considering or currently not implementing open innovation, as they perceive it as a barrier to implementing open innovation. Consequently, despite their awareness of the potential benefits of open innovation, these companies chose not to pursue this approach. This raises the question of how to minimize the risk of sharing too much with external parties but still able to gain benefits from implementing open innovation.

Managerial approach to mitigate intellectual property risks

Based on our findings, many companies addressed intellectual property risks by adopting strategic approaches to develop formal agreements in the first stage of the open innovation process. These agreements play a crucial role in this regard, providing a framework that clearly defines the benefits and rights of each party, especially concerning intellectual property. Such agreements are vital in avoiding complications down the line, particularly in terms of clearly establishing ownership and boundaries. This enables companies to find the balance between gaining the advantages of open innovation and mitigating its potential challenges and associated costs (Chaudhary et al., 2022).

5.3. Research Question 3: What open innovation approaches are the most suitable for biotechnology SMEs in the Swedish healthcare sector?

As mentioned in the literature analysis, biotechnology SMEs face significant resource constraints which make it difficult for them to access the resources and to compete effectively in the market

(Usman & Vanhaverbeke, 2017). Given these constraints, it is crucial to carefully consider their motivation and goals when deciding which type of open innovation approaches to pursue. As such, we begin our discussion by examining motivation and how it is integrated into their chosen types of open innovation. Additionally, we will explore various managerial approaches that can support SMEs in successfully implementing open innovation.

Motivation to implement open innovation

Based on our data analysis, we have found that for biotechnology SMEs that implement open innovation, a critical motivation to adopt it is to acquire funding and expertise. According to the literature analysis, adopting open innovation for funding and expertise is widely recognized as a significant motivation for biotechnology SMEs, as highlighted by Spender (2017). Given the significant resource constraints these companies face, open innovation can provide a means of accessing external resources that may not be available in-house.

Interestingly our data analysis showed that companies that plan to implement open innovation indicated their most crucial motivation as network and market. Consistent with the findings of our study, Spender et al. (2017) emphasized in their literature review on open innovation that networks have consistently been recognized as vital for attaining successful innovation processes. Following our interviews with the participants, it became evident that their motivation to build a network is driven by long-term goals like seeing contacts and relationships with other companies primarily for inspiration rather than solely for obtaining specific knowledge and funds. It aligns closely with the perspective of Usman and Vanhaverbeke (2017). They indicated that SMEs often embrace open innovation strategies as a means to expand their network of contacts and build relationships with key players in their industry. This can facilitate knowledge sharing, create new business opportunities, and enhance the company's reputation and credibility within the industry. However, Spender et al. (2017) found that these networks are highly valuable for acquiring essential resources, such as knowledge or financing, and effectively introducing new products to the market. Consequently, we believe these motivations might appear more closely tied to whether a company is actively implementing open innovation or planning to do so.

On the other hand, our data analysis aligned with the findings of Spender et al. (2017) regarding market factors. Spender et al. (2017) study indicated that open innovation could offer significant

benefits for SMEs in understanding customer needs and preferences, identifying untapped market opportunities, and developing more effective marketing strategies. Through collaboration with external partners, SMEs can acquire valuable insights into emerging trends and technologies and gain access to new distribution channels and customer segments.

There were notable differences when comparing the motivations for open innovation between companies that have already implemented it and those that are still in the planning stages. Funding and expertise were typically the most critical factors for companies already implementing open innovation. This is because these companies have likely identified specific projects or initiatives that require external resources to succeed and seek those resources through open innovation initiatives. On the other hand, for companies still in the planning stages of open innovation, the most important motivation may be expanding their network of contacts and gaining access to new markets and customer segments. Our data analysis suggests this is because these companies are more likely to already have the necessary in-house resources, such as close contact with their parent company or sufficient funds from investors. In this case, the primary motivation for open innovation is to explore new business opportunities and enhance the company's overall competitiveness. Based on the findings, we observed that the primary motivation is the necessity for specific resources not available internally within the company. This finding aligned with the perspectives of Spender et al. (2017) and Laermann-Nguyen & Backfisch (2021), who suggested that open innovation can effectively address the requirements for additional resources in product development.

Types of open innovation

Furthermore, it is essential that a company's initial motivation for implementing an open innovation approach is aligned with its overall strategy in order to choose the right partner and type of open innovation initiative. This is particularly important for SMEs, who often have limited time and resources to experiment with different strategies (Usman & Vanhaverbeke, 2017; Torchia & Calabrò, 2019).

Types of open innovation: collaboration and partnership

Our data indicated that both companies that implement open innovation and plan to do so see collaboration and partnership as an approach to achieve their goals and align with their

motivation. This finding is not unexpected, as open innovation in SMEs is widely recognized as fostering collaboration and partnerships, as indicated by numerous studies, such as Usman and Vanhaverbeke (2017). In this specific study, the authors emphasized collaboration and partnership as an especially effective strategy for biotechnology SMEs with the appropriate initial conditions and motivation. We believe there are several reasons for this. Firstly, as Arant et al. (2019) highlighted, collaboration with higher education institutions, such as universities and research centers, enables SMEs to gain access to knowledge and expertise that would be too costly to develop in-house but can still provide significant benefits to the company. Additionally, Usman and Vanhaverbeke's (2017) case studies showed that by collaborating with other companies (either large biotechnology companies or other SMEs), SMEs can reduce their reliance on in-house production and benefit from the resources and capabilities of their partners. This can ultimately lead to increased competitiveness and better positioning in the market (Usman & Vanhaverbeke, 2017). Nevertheless, Schuhmacher et al. (2022) research showed that these open innovation approaches hold true even in global biotechnology companies such as Johnson & Johnson or Novartis. Therefore showing the importance of these types in open innovation practices.

Types of open innovation: crowdsourcing

In contrast, our study revealed that none of the SMEs examined had implemented crowdsourcing as their chosen approach to open innovation. According to the categorization proposed by Pinarello et al. (2011), crowdsourcing falls under the low-integration type of open innovation. Our findings further indicated that SMEs were more likely to implement medium integration types rather than low or high integration types. This is an exciting finding because while it is understandable why biotechnology SMEs do not often engage in high integration open innovation, such as acquisition, due to its high cost, it is less clear why SMEs do not opt for low integration types.

From our perspective, crowdsourcing can be a beneficial way to implement open innovation if the company's goal is to expand its network and find new partners to collaborate with. However, we argue that even though crowdsourcing is a low-integration practice, it can still be quite costly and may not necessarily provide the benefits of knowledge and funding that SMEs require. For instance, as seen in Schuhmacher and Kuss's (2020) study, organizing events, attracting

participants, and providing benefits are expensive. Therefore for SMEs, this approach might seem too costly. Nevertheless, Schuhmacher and Kuss (2020) highlighted that crowdsourcing necessitates that a company articulates a transparent challenge it is currently facing internally in order for the crowd to participate in the process. This poses a challenge for SMEs that may not have established a strong market position to engage with a large number of companies in such an extroverted manner. Moreover, in the same study, Schuhmacher and Kuss (2020) indicated that crowdsourcing primarily enhances individual performances rather than strategically boosting R&D efficiency and effectiveness. As a result, it may not hold as much appeal for SMEs.

Types of open innovation: venture capital

Furthermore, our data analysis revealed an intriguing finding regarding venture capital as an approach to open innovation. Surprisingly, a majority of the biotechnology SMEs we interviewed did not perceive working with venture capital as an open innovation approach. This discovery calls for further investigation to understand the reasons behind this perspective better. We proposed venture capital as one of the open innovation types, as it is widely recognized in the literature. Namely, Pinarello et al. (2021) and Spender et al. (2017) researched startups and open innovation to underscore the importance of venture capital in terms of funding, transferring expertise and knowledge among new companies, and cultivating relationships with external entities. Specifically, Spender et al. (2017) emphasized venture capitalists and their role in sharing knowledge through their network of connections, which includes financial, commercial, and technology-based contacts. However, a potential reason for our interviewed companies not considering venture capital as a form of open innovation could be their perception of it as a financial investment in exchange for equity ownership rather than a collaborative approach to innovation. This highlights an intriguing disparity between the perspectives of academia and business. However, our interviewed companies did acknowledge that venture capital can provide more than just funding, such as mentorship for their business plan and help in finding product development expertise.

Managerial approach to support open innovation implementation: aligning goals and objectives

To enter various open innovation approaches successfully, managerial units in the company might mitigate a number of issues. Regarding selecting partners, our data analysis revealed a

fascinating insight. Having divergent R&D goals can actually act as a catalyst for establishing collaborative or partnership arrangements. Consistent with findings from our study, Cassiman and Veugelers (2006) suggested that divergent R&D goals can create a situation where both parties operate in distinct market segments, thereby avoiding direct competition. The authors argued that such divergence could bring about complementary insights or expertise into the product development process. Moreover, while this process may require significant time and effort to understand the business model of potential partners thoroughly, it serves as a means to mitigate the risk of losing a company's core assets. Interestingly, this finding contradicts the perspective put forward by Chaudhary et al. (2022) in our earlier literature analysis, which suggested that having complementary goals with external companies is critical. From our perspective, these findings suggest that having shared interests and working styles is important. However, it is crucial to recognize that if both companies share the same product development goal, they risk becoming direct competitors. This can have a detrimental impact on the effectiveness of both companies in the long run.

Managerial approach to support open innovation implementation: team management

Furthermore, our analysis of interviews revealed that team management holds significant importance in implementing open innovation, particularly when integrating both internal and external teams. In fact, certain SMEs expressed concerns about potential discrepancies in quality standards between different teams, which could impact their company's effectiveness. As highlighted by Lavrynenko et al. (2018) in the literature on open innovation management, it is vital for managers to possess the necessary skills to bridge the gap between diverse groups with different backgrounds and experiences. This skill is crucial in ensuring that teams remain focused on developing solutions that align with the organization's strategic ambitions and visions.

Managerial approach to support open innovation implementation: innovative culture

Our study findings highlighted that SMEs demonstrated a clear preference towards positioning themselves within innovation ecosystems, primarily due to the advantages it offers in facilitating seamless connections with collaborators and partners. During our interviews, companies emphasized the crucial role of geographical positioning in shaping their engagement within the

open innovation landscape, fostering a positive attitude towards collaboration and streamlining the process of identifying suitable partners. In addition to that, Tolstoy and Agndal (2010), as well as Grant (2019), have emphasized the significance of continuous interaction between firms in establishing network relationships. These networks form the foundation of open innovation, enabling SMEs to leverage opportunities through access to current information, expert knowledge, and other invaluable resources. Therefore, based on our analysis, we argue that locating a company within a thriving innovation ecosystem facilitates the smoother establishment of such networks.

Summary of the key finding and discussion

To summarize, in this study, we have identified three key findings regarding the implementation of open innovation in biotechnology SMEs within the healthcare sector: (1) Gaining knowledge and funding is the most significant benefit; (2) Protecting IP is the most challenging factor; (3) Partnership and collaboration are the most suitable open innovation approaches. Our research suggests that to gain significant benefits from open innovation, SMEs should adopt various managerial approaches to mitigate potential risks. The managerial focus should encompass effective agreements management, aligning goals and objectives, professional team management, and fostering an innovative culture. These insights are summarized in **Figure 5.1.**

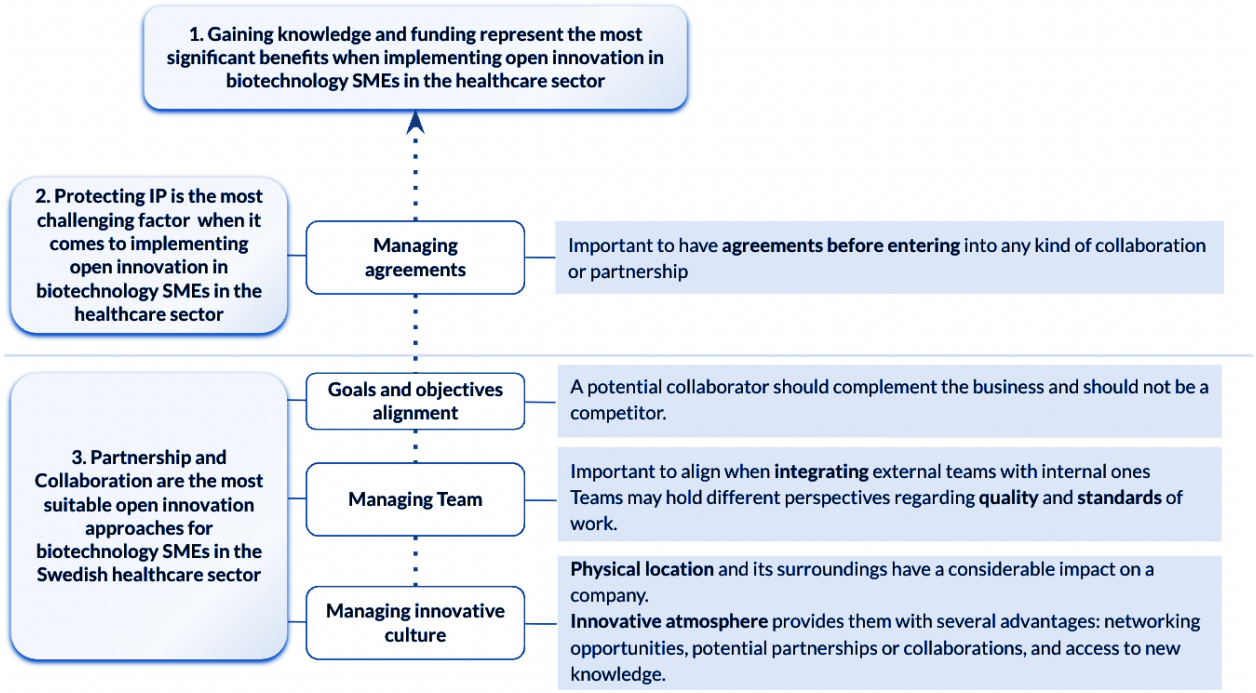

Figure 5.1 Summary of key findings and discussion

Numbers on the left 1-3 indicate key findings related to the research questions and hypotheses. In the middle and on the right of the figure, managerial decisions are indicated for each key finding to support open innovation implementation

6. Conclusions

Open innovation implementation allows biotechnology SMEs to tap into external resources. Additionally, it helps to reduce development costs and improve the speed and efficiency of the product development process. This study offers valuable insights into the implementation of open innovation practices for product development in biotechnology SMEs operating in the Swedish healthcare sector.

Our findings demonstrate that Swedish biotechnology SMEs perceive open innovation as a highly advantageous approach, resulting in significant benefits such as acquiring new knowledge and securing funding. This aligns with our first hypothesis **(H1)**: Gaining new resources in knowledge and capital funding are the most important benefits when implementing open innovation in biotechnology SMEs in the Swedish healthcare sector.

Despite the benefits, these companies also encounter challenges, particularly in maintaining a balance between openness to external firms and safeguarding their core knowledge, which is of utmost value in the biotechnology industry. Furthermore, our second hypothesis **(H2)** aligns with this observation, suggesting that: protecting intellectual property is the most challenging factor when it comes to implementing open innovation in biotechnology SMEs in the Swedish healthcare sector.

Furthermore, our research indicates that collaboration and partnership are the most suitable forms of open innovation for Swedish biotechnology SMEs. Similarly, our third hypothesis **(H3)** corresponds to this finding, indicating that: partnership and collaboration are the most suitable open innovation approaches for biotechnology SMEs operating within the Swedish healthcare sector.

Lastly, it is important to recognize that the true potential of open innovation can only be realized through collective effort. It is crucial for companies operating in similar industries to work together toward fostering an innovative environment to ensure the success of open innovation practices. As one insightful interviewee from Company 1 expressed: *"Cooperation is essential, and it is crucial to consider how actions can benefit not only yourself and your company but also others. By prioritizing mutual benefits, everyone involved can achieve satisfaction and success"*.

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Appendix A

Survey Questionnaire

1. What is your current position? *

   Mark only one oval.

   - ◯ CEO (Chief Executive Officer)
   - ◯ CTO (Chief Technology Officer)
   - ◯ CSO (Chief Scientific Officer)
   - ◯ CMO (Chief Medical Officer)
   - ◯ Research and Development Manager
   - ◯ Other: _____

2. How many employees are there in the company? *

   Mark only one oval.

   - ◯ Micro enterprise (<10 employees)
   - ◯ Small enterprise (10 - 49 employees)
   - ◯ Medium size enterprise (50 - 249 employees)
   - ◯ Large size enterprise (> 250 employees)

3. What type of company are you considering yourself? *

   Mark only one oval.

   - ◯ Start-up
   - ◯ Small-Medium sized company
   - ◯ Other: _____

4. Location of the company *

Mark only one oval.

- Bromma
- Brunna
- Danderyd
- Göteborg
- Gothenburg
- Hägersten
- Helsingborg
- Höganäs
- Horby
- Huddinge
- Hudiksvall
- Karlskoga
- Kista
- Lidingö
- Limhamn
- Linköping
- Lund
- Malmö
- Sodertalje
- Sollentuna
- Solna
- Stockholm
- Strängnäs
- Sundbyberg
- Tullinge
- Umeå
- Uppsala
- Vännäs
- Viken

5. Are you familiar with this concept of open innovation? *

Open innovation is a model that the company uses to commercialise both its own ideas as well as innovations from other firms and seeks ways to bring its in-house ideas to market by deploying pathways outside its current businesses. This can be done through: partnerships, collaborations, acquisitions, IP licensing, crowdsourcing, and venture capital.

Mark only one oval.

- ◯ I am familiar with the concept
- ◯ I am not familiar with the concept

6. Do you implement one of these approaches in your company: Partnerships, Collaborations, Acquisition, IP licensing, Crowdsourcing, Venture Capital ? *

Mark only one oval.

- ◯ Yes, we are implementing it *Skip to question 7*
- ◯ We are planning to implement it *Skip to question 18*
- ◯ No, we are not implementing it *Skip to question 27*

Implementation of Open Innovation in your company

7. What form of open innovation do you engage in? *

You can choose more than one type of open innovation that you engage in

Check all that apply.

- ☐ Collaboration
- ☐ Partnerships
- ☐ Acquisition
- ☐ IP licensing agreement
- ☐ Crowdsourcing
- ☐ Venture Capital
- ☐ Other: _____

8. What type of organisations do you work with for open innovation purposes? *

Check all that apply.

- [ ] Higher education systems
- [ ] Governmental institutions
- [ ] Venture Capitals
- [ ] Business incubators
- [ ] Large corporations
- [ ] Other small-medium enterprises (SME)
- [ ] Other: _____

9. What are the advantages for your company of implementing open innovation practices? *

In a scale from **1 (Not Important)** to **5 (Very Important)** please select the advantages of implementing open innovation for your company

Mark only one oval per row.

	1	2	3	4	5
Gaining new knowledge	◯	◯	◯	◯	◯
Receiving additional funds	◯	◯	◯	◯	◯
Faster product development	◯	◯	◯	◯	◯
Expanding new network	◯	◯	◯	◯	◯
Obtaining new talents	◯	◯	◯	◯	◯

10. Are there any additional advantages that you could identify?
If yes, please specify in the text below

_____

11. What types of resources do you typically seek from partners in open innovation collaborations? *

On a scale from **1 (Not Important)** to 5 **(Very Important)** please select the importance of resources that you seek from your partners when implementing open innovation.

Mark only one oval per row.

	1	2	3	4	5
Funding	◯	◯	◯	◯	◯
Expertise	◯	◯	◯	◯	◯
Technology	◯	◯	◯	◯	◯
Network	◯	◯	◯	◯	◯
Market	◯	◯	◯	◯	◯

12. Are there any additional resources that you seek for?
If yes, please specify in the text below

13. How important is it for your company to align with partners that share similar values and culture when engaging in open innovation partnerships? *

Mark only one oval.

Not important

1 ◯

2 ◯

3 ◯

4 ◯

5 ◯

Very important

14. What are the challenges encountered when implementing open innovation? *

On a scale from **1 (Not Significant Challenge)** to **5 (Very Significant Challenge)** please select the challenges encountered when implementing open innovation for your company

Mark only one oval per row.

	1	2	3	4	5
Sharing intellectual property	◯	◯	◯	◯	◯
High integration cost	◯	◯	◯	◯	◯
Lack of goal complementarity	◯	◯	◯	◯	◯
Difference in organisational culture	◯	◯	◯	◯	◯
Legal issues	◯	◯	◯	◯	◯
Different competencies	◯	◯	◯	◯	◯

15. Are there any additional challenges that you could identify?
If yes, please specify in the text below

16. How important is intellectual property protection to your company when engaging in open innovation partnerships? *

Mark only one oval.

	Not important
1	◯
2	◯
3	◯
4	◯
5	◯
	Very important

17. Have you ever experienced any intellectual property disputes or legal issues as a result of engaging in open innovation partnerships? *

Mark only one oval.

◯ Yes
◯ No

Skip to question 30

Implementation of Open Innovation in your company

18. What form of open innovation do you plan to do? *

Check all that apply.

- [ ] Collaboration
- [ ] Partnerships
- [ ] Acquisition
- [ ] IP licensing agreement
- [ ] Crowdsourcing
- [ ] Venture Capital
- [ ] Other: _____

19. Which types of organisations do you believe are best suited to adopt open innovation with your company? *

Check all that apply.

- [ ] Higher education systems
- [ ] Governmental institutions
- [ ] Venture Capitals
- [ ] Business incubators
- [ ] Large corporations
- [ ] Other small-medium enterprises (SME)
- [ ] Other: _____

20. What interest you the most in implementing open innovation? *

On a scale from **1 (Not Important)** to **5 (Very Important)** please select what interests you the most in implementing open innovation for your company

Mark only one oval per row.

	1	2	3	4	5
Gaining new knowledge	◯	◯	◯	◯	◯
Receiving additional funds	◯	◯	◯	◯	◯
Faster product development	◯	◯	◯	◯	◯
Expanding new network	◯	◯	◯	◯	◯
Obtaining new talents	◯	◯	◯	◯	◯

21. Are there any additional interests that you could identify?
If yes, please specify in the text below

22. What types of resources do you typically seek from partners in open innovation collaborations? *

On a scale from **1 (Not Important)** to **5 (Very Important)** please select the importance of resources when implementing open innovation for your company

Mark only one oval per row.

	1	2	3	4	5
Funding	◯	◯	◯	◯	◯
Expertise	◯	◯	◯	◯	◯
Technology	◯	◯	◯	◯	◯
Network	◯	◯	◯	◯	◯
Market	◯	◯	◯	◯	◯

23. Are there any additional resources that you seek for?
If yes, please specify in the text below

24. How important is it for your company to align with partners that share similar values and culture when engaging in open innovation partnerships? *

Mark only one oval.

	Not important
1	
2	
3	
4	
5	
	Very important

25. What factors have prevented you from implementing open innovation? *

Check all that apply.

- [ ] Sharing intellectual property
- [ ] High integration cost
- [ ] Lack of goal complementarity
- [ ] Difference in organisational culture
- [ ] Legal issues
- [ ] Different competencies
- [ ] Other: _____

26. How important is intellectual property protection to your company when engaging in open innovation partnerships?

Mark only one oval.

Not important

1 ◯

2 ◯

3 ◯

4 ◯

5 ◯

Very important

Skip to question 30

Implementation of Open Innovation in your company

27. What are the reasons preventing you from implementing open innovation? *

On a scale from **1 (Not Significant Reason)** to **5 (Very Significant Reason)** please select the reasons preventing you from implementing open innovation for your company

Mark only one oval per row.

	1	2	3	4	5
Sharing intellectual property	◯	◯	◯	◯	◯
High integration cost	◯	◯	◯	◯	◯
Lack of goal complementarity	◯	◯	◯	◯	◯
Difference in organisational culture	◯	◯	◯	◯	◯
Legal issues	◯	◯	◯	◯	◯
Different competencies	◯	◯	◯	◯	◯

28. Are there any additional reasons that prevented you from implementing open innovation? If yes, please specify in the text below

29. How important is intellectual property protection to your company when engaging in open innovation partnerships? *

Mark only one oval.

	Not important					Very important
	1	2	3	4	5	

Skip to question 30

Availability for the interview and additional comments

30. Would you be interested in having an interview to talk more about open innovation *

The interview would be conducted **online** with a maximum duration of **30 minutes.** The call would be arranged throughout a period of the following 3 weeks.

Mark only one oval.

- I am interested *Skip to question 32*
- I am not interested

31. Do you have additional comments or questions about this research study?

Personal information for interview

32. What is the name of your company? *

33. For contact purposes, please provide us with your active email *

34. Please clarify your availability for the interview

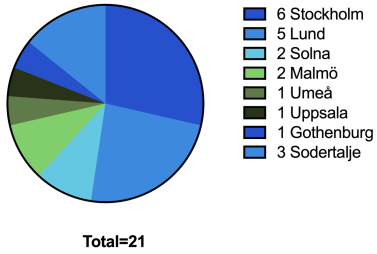
Check all that apply.

	Week 13	Week 14	Week 15	Week 16
Monday	☐	☐	☐	☐
Tuesday	☐	☐	☐	☐
Wednesday	☐	☐	☐	☐
Thursday	☐	☐	☐	☐
Friday	☐	☐	☐	☐
Not available	☐	☐	☐	☐

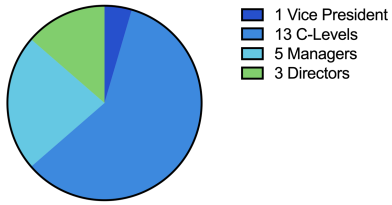
Appendix B

Visual representation of demographics of participants from the survey data.

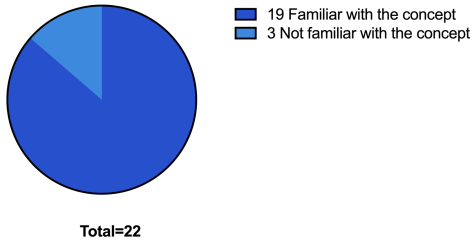
1. Location of The Company



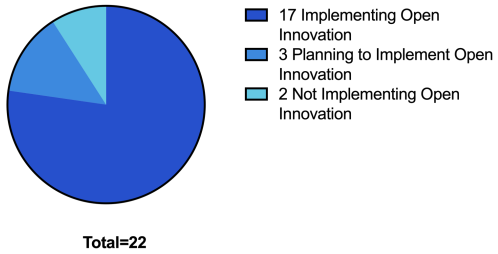
2. Current Role or Position



3. Familiarity with the Open Innovation Concept



4. Status of Open Innovation Implementation



Appendix C

Interview Questions

General Questions:

1. Would you like to share a brief explanation about yourself and your company?
2. What are your company's R&D goals?
3. Could you identify any inhibitors in your product development?
4. What are your personal thoughts/understanding about open innovation?

Group-Specific Questions:

Group A (SMEs who implement open innovation):

1. Can you provide examples of successful open innovation implementation your company has participated in?
2. Could you explain more about your motivation for implementing open innovation?
3. How do you ensure intellectual property protection and ownership when engaging in open innovation partnerships?
4. What trends do you see in the biotechnology industry regarding open innovation, and how is your company adapting to these trends?
5. Do you think [type of open innovation] was effective for your product development? And why?
6. *An additional question(s) related to their survey answers*
7. Closing: What advice would you give to other biotechnology startups and small companies looking to implement open innovation strategies?

Group B (SMEs who are considering implementing open innovation)

1. Can you give an example of an open innovation implementation that you are thinking about? And how does open innovation help to build a better product?
2. Could you identify any solutions to overcome your R&D challenges, and do you have experience in mitigating challenges?
3. What motivates your company to implement open innovation?
4. What is the initial expectation in implementing open innovation?
5. What trends do you see in the biotechnology industry regarding open innovation, and how is your company adapting to these trends?
6. *An additional question(s) related to their survey answers*
7. Closing: What advice would you give to other biotechnology startups and small companies looking to implement open innovation strategies?

Group C (SMEs who are not implementing it):

1. Are there any reasons why your company did not consider implementing open innovation?
2. From previous research, it is known that many companies implement open innovation to secure resources such as knowledge and funds. What are your approaches to securing these sources?
3. What other innovation approaches keep your company competitive?
4. What trends do you see in the biotechnology industry regarding open innovation, and how is your company adapting to these trends?
5. *An additional question(s) related to their survey answers*
6. Closing: Now that you know about the concept of innovation, would you plan to implement it in the future?