TALLINN UNIVERSITY OF TECHNOLOGY
School of Information Technologies

Jörg Nink YVEM196459

Open Innovation in the European pharmaceuticals and medical technologies industry as well as effects of the use of virtual and physical practices for idea sourcing

Master's thesis

Supervisor: Priit Kruus

Tallinn 2021

TALLINNA TEHNIKAÜLIKOOL
Infotehnoloogia teaduskond

Jörg Nink YVEM196459

Avatud innovatsioon Euroopa farmaatsia- ja meditsiinitehnoloogiatööstuses ning virtuaalsete ja füüsiliste tavade kasutamise mõju ideede hankimisel

Magistritöö

Juhendaja: Priit Kruus

Tallinn 2021

Author’s declaration of originality

I hereby certify that I am the sole author of this thesis. All the used materials, references to the literature and the work of others have been referred to. This thesis has not been presented for examination anywhere else.

Author: Jörg Nink

29th of December 2021

Abstract

This thesis is written in English and is 50 pages long, including 6 chapters, 14 figures and 0 tables.

Background: European pharmaceutical and medical technology companies have to develop novel innovations with help of external stakeholders, in order to keep up with the high industrial competition. Additionally, the COVID-19 pandemic forced companies to deal with stakeholders virtually creating an atmosphere of advantages and disadvantages of innovation sourcing practices from the physical and virtual perspective.

Objective: This research aims to evaluate on the aspect of how Open Innovation is performed in the specific industry addressed and how each practice is perceived by market participants.

Method: The method to be chosen consisted of a mixed approach including qualitative analytics in form of expert interviews, which in combination with literature review were used to create the fundament for the quantitative analytics in form of a questionnaire to be distributed among market participants.

Results: Open Innovation and the use of external knowledge is seen as highly important for the creation of innovations and seems to be inevitable for companies, especially when it comes to specific stakeholders as e.g. the customers. There also is a preference towards physical idea sourcing practices over virtual ones, due to important aspects as trust, attention in meetings, shorter durations to find a consensus, etc. Nevertheless, the sample group decided that there will be a shift from a majority of physical meetings towards virtual meetings dominating or equalizing at companies making them more important and frequent to be used, due to their own advantages of less costs, diminished ecological footprint, convenience through avoidance of business travels, etc.

Discussion: The thesis included several hindrances limiting the extend and precision of the results, which are discussed to elaborate on possibilities and validity of the content addressed.

Conclusion: Depending on the needs and expectations of a company idea sourcing models have to be individualized, since operations, interests and resources vary from company to company. Nevertheless, information gathered from this research support the decision and composition to tailor an own model based on important aspects to be considered and viewed upon from other market participants.

Annotatsioon

Käesolev lõputöö on kirjutatud inglise keeles ja on 50 lehekülge pikk, sealhulgas 6 peatükki, 14 joonist ja 0 tabelit.

Taust: Euroopa farmaatsia- ja meditsiinitehnoloogia ettevõtted peavad arendama uusi uuendusi väliste sidusrühmade abiga, et pidada sammu tiheda tööstusliku konkurentsiga. Lisaks sellele sundis COVID-19 pandeemia ettevõtteid tegelema sidusrühmadega virtuaalselt, luues atmosfääri, kus innovatsiooni hankimise tavade eelised ja puudused füüsilisest ja virtuaalsest vaatenurgast.

Eesmärk: Käesoleva uuringu eesmärk on hinnata, kuidas toimub avatud innovatsioon konkreetses tööstuses, mida käsitletakse, ja kuidas turuosalised tajuvad iga praktikat.

Meetod: Meetodiks valiti kombineeritud lähenemisviis, mis hõlmas kvalitatiivset analüüsi ekspertintervjuude vormis, mida koos kirjanduse ülevaatega kasutati kvantitatiivse analüüsi aluse loomiseks turuosaliste seas levitatava küsimustiku vormis.

Tulemused: Avatud innovatsiooni ja väliste teadmiste kasutamist peetakse uuenduste loomisel väga oluliseks ja see näib olevat ettevõtete jaoks vältimatu, eriti kui tegemist on konkreetsete sidusrühmadega, nagu näiteks kliendid. Samuti eelistatakse füüsilist ideede hankimise praktikat virtuaalsele, mis tuleneb sellistest olulistest aspektidest nagu usaldus, tähelepanu koosolekutel, konsensuse leidmise lühem kestus jne. Sellegipoolest otsustas valimisrühm, et enamus füüsilisi koosolekuid ei ole enamuses, vaid virtuaalsed koosolekud domineerivad või võrdsustuvad ettevõtetes, mistõttu neid kasutatakse üha sagedamini ja olulisemalt, sest nende eelised on väiksemad kulud, väiksem ökoloogiline jalajälg, mugavus tänu ärimatkade vältimisele jne.

Arutelu: Lõputöö sisaldab mitmeid takistusi, mis piiravad tulemuste ulatust ja täpsust, mida arutatakse käsitletud sisu võimaluste ja kehtivuse täpsustamiseks.

Kokkuvõte: Sõltuvalt ettevõtte vajadustest ja ootustest peavad ideede hankimise mudelid olema individuaalsed, kuna tegevused, huvid ja ressursid on ettevõtteti erinevad.

Sellegipoolest toetab käesolevas uuringus kogutud teave otsust ja koostamist, et kohandada oma mudel, mis põhineb olulistel aspektidel, mida tuleb arvestada ja vaadata teistelt turuosalistelt.

List of abbreviations and terms

DPI	Dots per inch
EBITDA	Earnings Before Interests, Taxes, Depreciation and Amortization
EMA	European Medical Agency
GDPR	General Data Protection Regulation
IVDR	In-Vitro Diagnostic Regulation
LE	Large Enterprises
MedTech	Medical Technology
MDR	Medical Device Regulation
OI	Open Innovation
TUT	Tallinn University of Technology
PWC	PriceWaterhouseCoopers
R&D	Research & Development
SME	Small and Medium Enterprises

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Glossary

Open Innovation: A model where an organization doesn't just rely on their own internal knowledge, sources and resources (such as their own staff or R&D for example) for innovation (of products, services, business models, processes etc.) but also uses multiple external sources (such as customer feedback, published patents, competitors, external agencies, the public etc.) to drive innovation.

Absorptive Capacity: A firm's ability to value, assimilate, and apply new knowledge for improving organizational learning. The notion of absorptive capacity refers to the capacity of a recipient to assimilate value and use the knowledge transferred.

Technology Readiness Level: A measurement scale used to determine the maturity of technology components for a system. The measurement allows project personnel an understanding of how much development a certain technology needs before being utilized. A TRL rating helps in measuring the progress of a project.

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1. Introduction

Research on the open innovation paradigm has focused attention on how companies can benefit from interaction with external sources of knowledge. Being able to explore and ultimately use external knowledge for one's own purposes plays an important role in innovation and company growth by improving innovation capabilities (Cohen & Levinthal, 1990; Jansen, et al., 2005; Lane, et al., 2001; Tsai, 2001).

Expert interviews and a sample of 41 European companies from the pharmaceuticals and medical technologies industry were both used to explore behavior towards innovation activities with a specific focus on Open Innovation and which aspects of virtual or physical collaboration especially in early stages of the innovation process may be from interest to addressed parties. Recent findings and research related to innovation development and Open Innovation have already focused attention on techniques and approaches that promote successful interaction of companies with external knowledge sources (Chesbrough & Crowther, 2006; Dahlander & Gann, 2010). However, it is said that companies often struggle to successfully interact with external partners during the innovation process (Knudsen & Mortensen, 2011). Therefore, this work, by means of the survey, will connect to such research also including the aspect of change in innovation behavior due to the novel corona virus pandemic starting in 2020

The paper is organized as follows: In the next section, the theoretical framework of the paper is presented, which characterizes open innovation as external knowledge search, describes the forms of use of external knowledge sources, reveals the advantages and disadvantages of the OI principle, and establishes the related link to the medical device and pharmaceuticals industry. In the following section, the sample and the methodological procedure are described in more detail, so that the results of the evaluation can be presented and interpreted in the fourth section. The last section contains the summary of the work and its results.

1.1. Problem Statement

In this paper, the usage of open innovation practices is addressed in relation to medical technology as well as pharmaceutical companies. According to a 2018 study, the industries are undergoing significant change and are also experiencing a strong growth momentum. Trends such as demographic change and the advance of smart technology and artificial intelligence are stimulating the drive for innovation and make competition more difficult. Small and medium-sized enterprises therefore need to future-proof their actions, in order to be able to withstand the innovative power of other companies (Luther & International, 2018). Especially at this very moment the topic gains in importance even stronger, since during the impact on society caused by the novel corona virus pandemic companies were forced to switch from physical idea sourcing and innovation generation, face-to-face meetings and collaboration to solely interacting via virtual platforms, in order to maintain corporate ethics by avoiding physical contact (Forbes, 2020). This requires companies to change several processes and ways on how to handle specific situations (Roper & Turner, 2020). Another study conducted by PriceWaterhouseCoopers states that the importance of innovation in health care, will increase significantly in the coming years and is therefore seen as a competitive necessity, especially during virtual times and in the industries to be considered during this thesis (PWC, 2013). Therefore, this paper is dedicated to collecting data of European Pharma and MedTech companies conducting different types of open innovation practices and their effects. The information is collected via literature, quantitative analysis using a survey distributed to different companies in the industries as well as a qualitative analysis with highly involved stakeholders of the industry and the topic addressed in this master thesis.

1.2. Research Questions, Aim and Objectives

The overall research question focuses on finding out to what extend Open Innovation is practiced in the aforementioned industries and what practices are used for collaborative idea sourcing as well as which are more likely to be preferred based on advantages as well as disadvantages contributing to each effectiveness.

Objectives to achieve the overall aim or research question involves other research questions to be researched, which are separated in three sub-questions dealing with different aspects of the overall topic. This includes the following:

- How and with whom do aforementioned industries conduct OI?
- What is the impact of only-virtual times on OI and how did companies react on a sudden change in ways to operate?
- What is the general opinion on physical and virtual OI practices and how is absorptive capacity impacted by each practices' perceived advantages and disadvantages?

Using the answers as well as analysis of the aforementioned questions will provide detailed results on the overall research question.

1.3. Course of the Thesis

The paper is organized as follows: In the next section the theoretical framework is presented, which characterizes open innovation as external knowledge search, describes the forms of use of external knowledge sources, reveals the advantages and disadvantages of the principle, and establishes the related link to the medical technology as well as pharmaceuticals industry. In the following section, the sample and the methodological procedure are described in more detail, so that the results of the evaluation can be presented and interpreted in the fourth section. A discussion follows the evaluation of the results. Last but not least, the master thesis is roughly summarized and finally concluded in the final section.

2. Conceptual Positioning

2.1. Innovation

Innovation is a term that is defined or viewed differently by researchers in all areas of business today (Gopalakrishnan, 1997). Accordingly, there is no precise definition of innovation, especially when one compares the multitude of different findings. The measurement as well as the comparison of innovations are also not uniformly defined, so that no clear information can be given about the innovation power of a company (Zairi, 1994). This results in different conclusions about the term innovation:

"A new idea, method, or device. The act of creating a new product or process, which includes invention and the work required to bring an idea or concept to final form." (Kahn, 2012).

"...innovation is the process that turns an idea into value for the customer and results in sustainable profit for the enterprise." (Carlson C.C., 2006).

"Innovation is the process of making changes, large and small, radical and incremental, to products, processes, and services that results in the introduction of something new for the organization that adds value to customers and contributes to the knowledge store of the organization." (O'Sullivan, 2009).

"...the act of generating more value for the customer and the business by fulfilling a job to be done better than anyone else." (Silverstein, 2009).

"Innovation = Invention + Exploitation" (Roberts, 1988).

However, what should be noted in many definitions is the word "new", as used for example in the explanation of the term by the American economist Michael Porter: "to include both improvements in technology and better methods or ways of doing things. It can be manifested in product changes, process changes, new approaches to marketing, new forms of distribution, and new concepts of scope ... [innovation] results from organisational learning as much as from formal R&D." (Porter, 2011).

Indeed, communication theorist Everett Rogers mentions again that the novelty of an innovation depends on the mindset of the individual: "... is an idea, practice, or object that is perceived as new by the individual or other unit of adoption". The individual perception of novelty must therefore be taken into account, as some innovations may be considered

new by different parties, but at the same time be considered not new by another party (Rogers, 2003).

2.2. Types of Innovations

Types of innovation can also be viewed differently, depending on whether one considers the subject matter or the degree of novelty. Accordingly, innovations can be divided into four different groups with regard to the subject matter, although this can also differ depending on the perspective (Michael Hartschen, 2009):

On the one hand, there are product and service innovations, which can be distinguished from each other. While product innovations represent tangible objects such as Apple's Iphone, service innovations such as the music provider iTunes and its services are intangible (V. K. Narayanan, 2010).

Process innovations, on the other hand, represent new methods in relation to business processes and activities. They serve any optimisation of business processes in terms of cost reduction, productivity increase and other significant aspects (V. K. Narayanan, 2010). An example of the implementation of a process innovation was the introduction of the so-called "assembly line" in the production of vehicles, which increased the productivity of vehicle manufacturers enormously and thus enabled them to sell more (V. K. Narayanan, 2010).

Management innovations are concerned with changing and innovating management principles. They thus change the way managers deal with different situations, coordinate the work to be done and handle other crucial business activities (Review, 2006).

Innovations that deal with the social structure of a company and aim to solve social problems and satisfy diverse needs are called social innovations (Jürgen Howaldt, 2010).

Furthermore, innovations are also divided into four different groups with regard to the degree of novelty. On the one hand, there are innovations that are already based on something existing and are merely adapted or improved. On the other hand, there are innovations that are completely new and not based on something existing (Michael Hartschen, 2009). These four special types of innovation can therefore be made dependent

on their novelty and their impact on the market. Thus, the following types of innovation can be distinguished from each other with regard to these criteria:

There are incremental innovations, which build on existing knowledge and add additional components or characteristics. They use existing technologies to create added value in an existing market (V. K. Narayanan, 2010).

Furthermore, disruptive innovations use new technologies in an existing market. Through the use of new technologies consumers usually receive an increase in the value of the product, as these are often more advanced than their predecessors (Ekekwe, Ndubuisi, 2012). As a result, it can therefore be said that at a certain point, other companies are forced to upgrade old technologies so that they can withstand competition (CCT, 2015).

Architectural innovations are the use of already available technologies in a new market. That is, individual components of existing technologies are able to establish a new market for the company (V. K. Narayanan, 2010)

Rather rarely, innovations are classified as radical innovations because they are based on new technologies that result in a new market at the same time. The introduction of revolutionary innovation technologies usually has a significant added value for companies as well as consumers and therefore covers various market niches so that the new market can develop (V. K. Narayanan, 2010).

2.3. Technology readiness level

Technologies in terms of innovations can be differentiated according to their level of maturity in respect to their progress. The Technology Readiness Level is a system widely used in the field of product development to classify the development status of innovative technologies. According to this, the maturity of technologies can be described on the basis of nine ascending levels (TRL 1-9), which describe the development phases from the identification of basic technical principles to application maturity. Each phase is assigned specific task content in the framework concept (e. g. Conducting feasibility studies, laboratory tests, prototype tests, etc.). As development progresses the level of detail of the technology increases while uncertainties in terms of applicability and specification decrease. This is why those levels can be clustered in three different superordinated technology readiness stages (Mankins, 2004).

- Research
    - TRL 1: Observation and description of the principle of operation take place as well as basic scientific research has been completed.
    - TRL 2: Description of technology concept and/or application of a technology by e. g. formulating application and implementation criteria.
    - TRL 3: Demonstration of the viability of a technology, by developing the "proof of concept" to see whether it is feasible to realize at higher stages. Research and development start with initial laboratory as well as analytical studies.
- Development
    - TRL 4: Laboratory testing of various components.
    - TRL 5: Experimental laboratory testing is intensively conducted in relevant environment and tests are conducted more thoroughly.
    - TRL 6: Prototype is completed in operational environment.
- Deployment
    - TRL 7: Prototype is demonstrated in the operational environment.
    - TRL 8: Technology is qualified with proof of functionality in operational environment and is ready to be implemented.
    - TRL 9: Qualified technology with evidence of successful deployment (Mankins, 2004).

The scope of the thesis concerns early-stage collaboration for idea sourcing, which means that during the course of the paper the focus is on the research section including TRL level 1-3 of the Technology Readiness Level model.

2.4. Open Innovation

2.4.1. Definition of Open Innovation

The term "open innovation" has been studied in detail in innovation research for several years. The term refers to the opening of innovation processes to the outside world, which enables companies to use external resources and knowledge sources for their own purposes (Chesbrough & Crowther, 2006). Open innovation processes are therefore

distinct from closed innovation processes and will be distinguished again in more detail in the following section of this thesis.

2.4.2. Open and closed innovation models

As illustrated in Figure 1, research and development projects can be generated and carried out from internal or also external sources, so this process can be called the open innovation model. Furthermore, the boundaries of the innovation process are always open. External as well as internal technologies and suggestions for improvement can thus, during the open innovation principle, be incorporated into any phase of the innovation process or leave the process and be released to the market (Henry Chesbrough, 2008).

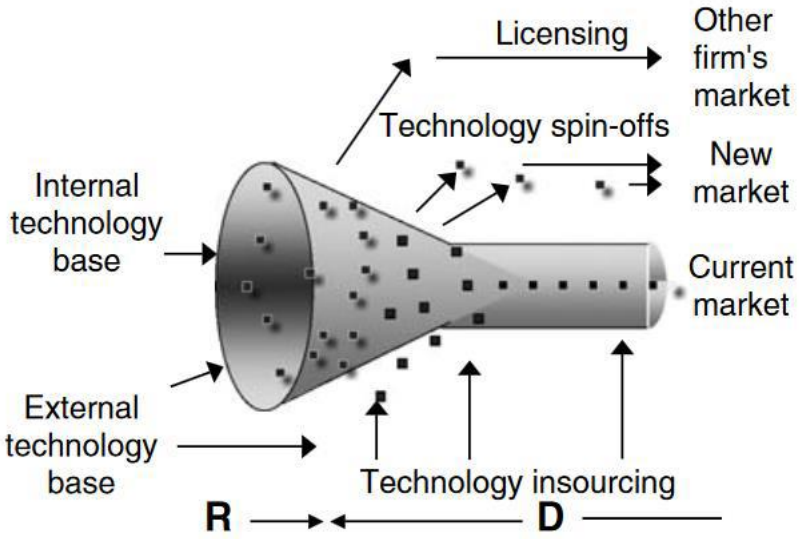

Figure 1: An Open Innovation Paradigm (Henry Chesbrough, 2008)

Figure 2 shows the closed innovation model, in which scientific research projects are only started and carried out internally. Here it is often the case that only a few projects are forwarded and therefore a large number of projects are not further involved (Henry Chesbrough, 2008).

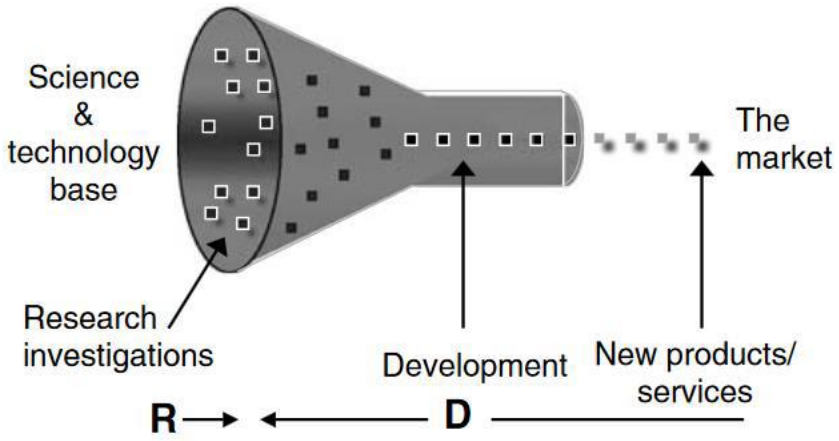

Figure 2: The current paradigm: A Closed Innovation Model (Henry Chesbrough, 2008)

In this respect, Henry Chesbrough defines the term "Open Innovation" on two different levels: "the antithesis of the traditional vertical integration approach where internal R&D activities lead to internally developed products that are then distributed by the firm. ... Open Innovation is the use of purposive inflows and outflows of knowledge to accelerate internal innovation, and expand the markets for external use of innovation, respectively" (Henry Chesbrough, 2008). The definition ultimately shows two different models of the open innovation principle. One is the outside-in process and the other is the inside-out process (Forbes, 2011).

In the inside-out process, the company's internally developed ideas and technologies go outside the company's boundaries to be integrated into various external innovation processes in the market (Forbes, 2011). By out-licensing or similar other techniques, external knowledge sources and market actors can therefore be included in the innovation process.

In the outside-in process, this is indicated differently. Here, the technologies and ideas are exclusively obtained from external sources, such as consumers or suppliers, and used for the internal development of the innovation.

In addition, there is also the coupled process, in which the outside-in and inside-out processes are combined and thus used together, so that knowledge from the environment is absorbed and also released back to the outside (OECD, 2008).

2.4.3. Drivers of the Open Innovation Principle

Many companies today are exposed to enormous competition. New, more innovative technologies are increasingly being incorporated into business processes and the process from the completion of a product to its delivery to the market has also been drastically shortened through the use of technologies or optimisation processes. This forces companies to invest more cost-intensively in innovation technologies and methods so that they can innovate faster and more efficiently.

One reason for this is rapid changes in market behaviour, which means that companies increasingly have to demonstrate greater adaptability and rapid reaction times in the market. Technological sophistication and integration are therefore a crucial factor in keeping up with market changes. Increasing product complexity is another driver for open innovation techniques, as the development of product innovations is becoming increasingly complicated. There is also a need for more and more extended know-how across different industries, as many innovations are made up of several industry sectors. Due to the technical complexity and the merging of several industries, companies are increasingly dependent on the help of outside actors (Gassmann, 2006; Pénin J, 2011). Another reason is the increase in the rate of globalisation, which leads to much more competition. The diffusion of knowledge increases the urge to pursue progressiveness and thus remain competitive. More and more external knowledge from other market participants is therefore demanded, in order to be able to cross company boundaries and optimise the inflow of knowledge (OECD, 2008).

2.4.4. Management Models of Open Innovation

In order to be able to practice Open Innovation, companies use a variety of models to allow external sources of knowledge to flow into the innovation process or to hand over internal developments to the market.

Models such as crowdsourcing, product platforming, collaborative innovation networks and innovation competitions therefore support the inside-out as well as outside-in processes of the open innovation principle.

As the English term "crowdsourcing" suggests, this is about sourcing external ideas and general knowledge from a group of people. Nowadays, this is usually initiated on online

platforms when tasks or projects of a company are outsourced and processed externally. This form of sourcing other knowledge has gained popularity in recent years, due to the high level of digitalisation (Anders Hjalmarsson, 2017).

Product platforming is about a product, such as software, being published on the market and being used by market participants as a basis for further designs, so that new products and services can also be created by the external participants. A certain toolkit is given, which participants can use, modify and even expand in some cases. Especially with gaming apps in particular, such a toolkit is used in order to have a clear basic structure for development (Anders Hjalmarsson, 2017).

Different from many models are collaborative innovation networks, where cooperation takes place through direct contact and information exchange. Here, an association of different members is defined, who exchange news or ideas with each other in order to support their own development process or that of another party (Anders Hjalmarsson, 2017).

Another very popular form of the open innovation principle are innovation competitions. Here, tasks, development projects or even just incentives for an idea are given to society, in order to expand the innovation pool and idea generation enormously. In such competitions, successful participants are able to win certain prizes in order to drive the motivation of innovation generation. This is usually done via certain online platforms or physical events. However, there are different types of innovation competitions. They can be distinguished on the one hand by their length and on the other hand by their type of participation. Accordingly, there are competitions that only allow selected parties to participate, such as entire companies or only individual persons, and also competitions that are only held over a short period of time or over a longer period of time. The definitions "Innovation Jam" and "Innovation Battle" refer to the time aspect and are again differentiated by the type of participation of the respective parties. In an Innovation Jam, usually everyone can participate, and in an Innovation Battle only a certain number of participants, who in many cases are explicitly selected. If an innovation competition is held for several weeks or even months, it is also called an "Innovation Cup" or an "Innovation Challenge". In the case of an Innovation Cup, the type of participation is also unlimited, while in the case of an Innovation Challenge it is specially selected, in order to have a precise target group for the innovation competition (Anders Hjalmarsson, 2017).

2.4.5. Advantages and Disadvantages of Open Innovation

Depending on how Open Innovation is practised by a particular party, advantages or disadvantages can become apparent depending on how the situation is handled. In the following lists those aspects are brought closer as they contain the general advantages and disadvantages of the OI principle.

The following enumeration contains advantages applicable when making use of OI in a business environment:

- Resource advantage

Through an OI cooperation, the resources of the respective partners can be used and thus enormous amounts of money can be saved. Synergy effects are thus made possible.

- Out-licensing

Unused technologies can be expanded or improved by out-licensing, so that ultimately a benefit can be achieved.

- Contact generation

OI projects open up new contacts with interested market players from different interest groups and industries.

- Expanded spectrum of innovation

Through the cooperation of different interested parties, knowledge sources from different areas and markets are connected and can thus have a positive effect on the innovation process (OECD, 2008; Anders Hjalmarsson, 2017).

Besides strong advantages for individuals as well as corporations, disadvantages might occur and might cause unexpected adverse effects through participation in OI practices. Therefore, following risks or disadvantages need to be taken into consideration and weighed against advantages for each case.

- Complexity increase

Due to the cooperation of several parties, processes usually become more confusing and can therefore be less controlled.

- Flexibility reduction

Companies are often dependent on each other, should they be in an OI cooperation, and are therefore less flexible, as decision-making processes or similar take up more time.

- Unwanted information output

Due to the close cooperation, important information and intellectual property of the company or individual can be leaked to the outside, which other companies or individuals could use as an advantage in competition.

- Contract risks

The fact that special circumstances and rights are not regulated or contractually stipulated in advance poses a further risk and can lead to disputes between the various parties (Anders Hjalmarsson, 2017; OECD, 2008).

2.5. Absorptive Capacity

Cohen and Levinthal describe absorptive capacity in their fundamental work on open innovation as: "ability to recognise the value of new external knowledge, assimilate it and apply it to commercial ends" (Cohen & Levinthal, 1990).

The impact of absorptive capacity on different areas of a company, such as business performance or innovative capacity, was already discussed several years ago (Koch & Strotmann, 2008; Matusik & Heeley, 2005). However, to deal with the topic in more detail, the definition of the term should be divided into the potential and the realised form of absorptive capacity. The former refers to the recognition of potential knowledge from external sources and its absorption, i. e. the front part of Cohen and Levinthal's definition. The realised form, on the other hand, refers to the back section of the definition and thus to the transformation and use of externally generated knowledge for one's own purposes in order to be able to create innovations. Thus, in order to be able to work with open innovation models and ultimately derive a benefit from their use, it is said that one should deal with both components. In consequence, one is able to specifically recognise the value of external knowledge sources, absorb them and ultimately use them for one's own innovation purposes (Zahra & George, 2002).

2.6. Medical Technology and Pharmaceutical Industry

Both the pharmaceuticals and the medical technology industry have been growing almost steadily for several years. Besides European inpatient and outpatient care expenditures amounting to 76.9% of total healthcare expenditure 7.2 % of the total healthcare expenditure in Europe is spent for medical technologies, from those 15.9% in-vitro diagnostic accounts for 0.7% and medical devices including imaging machines to the rest of 6.5%. Additionally, more than twice the amount of MedTech expenditures with 15.9% are spent for pharmaceuticals & other medical non-durables. With making up to 27% of the world MedTech market and being estimated at approximately 115 billion euros in 2017 the European medical technology industry is one of the most successful and innovative in its field right after the US (MedTechEurope, 2019). In total the global markets estimated worth is approximately 425.5 billion US dollar (Fortune, n.d.). With Germany being the biggest export country in Europe they alone made up to 26.604 million euros in MedTech exports in 2018 (MedTechEurope, 2019)With a global expenditure exclusively on research and development amounting to approximately 30 billion dollars per year, it can be said that the industry has developed strongly in recent years. As such, global medical technology R&D spending has nearly doubled in the last 15 years and is forecast to continue to grow at a linear rate in the coming years (Evaluate, n.d.). With a turnover of €433.7 billion in 2018, the turnover of the global medical technology industry has also doubled since 2005 (Evaluate, n.d.)

The growth in the pharmaceuticals industry is also tremendous and was estimated to be worth more than 1.25 trillion US dollar in 2019 (Mikulic, 2021). In Europe exports grew from 90.935 million in 2000 to more than 410.000 million in 2018 as well as there is still a significant growth in the European market concerning R&D expenditure, which has also grown from 17.849 million in 2000 to more than 36.000 million in 2018. Besides that, other metrics as employment units, trade balances as well as general production are continuously growing, which indicates another market with high potential for new innovations. The reason for such economic success is the high rate of innovation, especially of very young products. These developments can be realised through large sums of research investment and highly qualified personnel. This is necessary, in order to be able to assert oneself against the ever-increasing competition from abroad, because companies all over the world are currently also developing strongly and are able to

circumvent various regulatory provisions, in order to be able to operate more quickly (EFPIA, 2019).

In order to keep up with the growth and the resulting competition in the industry, it is therefore of great importance for those companies to go beyond internal borders and to draw a less cost-intensive benefit as well as a larger knowledge pool from external knowledge sources. (MPO, 2015).

2.7. Open Innovation in MedTech and Pharma

Within this chapter, the innovations and different types of innovations specifically tailored to the medical technology industry and the pharmaceuticals industry are explained. Subsequently, the benefits of intermediaries are described in more detail, as well as the hurdles to be considered when using open innovation in the aforementioned industries.

2.7.1. Innovations in MedTech and Pharma

Especially innovations in the MedTech as well as Pharma sector have contributed greatly to the improvement of the health care system. The demographic change and the increase in health awareness point to the urgent needs of society. However, the rapid increase and expansion of the healthcare system through numerous innovations comes with an increased degree of complexity, which companies and organisations cannot always keep up with. Nevertheless, companies do not want to do without it, as innovations can usually generate long-term cost savings or higher revenues for the industry and individual companies (Aspden, 2002).

Innovations in medical technology, pharma or health care in general are regarded as important as well as essential for society by highly respected institutions such as the World Health Organization and the World Trade Organization. They specifically ensure that health problems can be remedied and an increased quality of life in terms of holistic health can be achieved. Accordingly, a distinction should also be made at this point from

normal innovation. Medical technology and pharmaceutical innovations are defined by different circumstances (WHO, 2012)

The high awareness of ethics is of enormous importance in the context of medical technology and health, therefore regulatory measures are also given so that the quality and safety of the products can be guaranteed. They are also associated with very high costs, mostly due to research and development departments. For this reason, they are firmly linked to the public sector, whose funds are often used to finance projects or for general research purposes in society (WHO, 2012).

2.7.2. Innovation Disciplines in MedTech and Pharma

Innovations in many health care areas realized by customers and users in the health care sector can also be found in various disciplines. For MedTech and Pharma this mainly includes five different areas:

- Computerization
- Networking
- Personalization
- Miniaturization
- Biologization

The integration of information and communication technology into medical technology systems also referred to as computerization is used in both MedTech and Pharma companies as e. g. in computer tomography or accompanying software for medicinal products. The networking dimensions is closely related to the computerization dimension and deals with the integration of information technology into existing data and communication networks, e. g. networking of different technical devices in the operating room or networking of sensors in medicinal products with other systems. Coordination of treatments and tailored pharmaceuticals, medical technology components, devices and systems to the individual case as well as the course of a patient's illness is covered by the personalization dimension. Here, telemedicine is also a main aspect to be considered as well as the entire field of eHealth, which offers a large and very current area of innovation, especially in personalizing medicine (BVMedizintechnologie, 2014). This is because

sections of this innovation area, such as the use of artificial intelligence, electronic consultancies for patients, or even electronic health records are currently expanding strongly in the health care industry (Marlene Maheu, 2002). The reduction in size of technologies, non-durables or even systems e. g. in instruments for minimally invasive surgery or even sensors in specific drugs is part of the miniaturization dimension. Integrating biological and technical components, e. g. in "bioimplants" or the usage of biological components in medicine is considered as biologization (BVMedizintechnologie, 2014). This so-called process of biologization finds a use at many interfaces nowadays. It is not only in medical technology that this process is used to produce medical technology products, such as cell-tissue and organ-regenerating bioimplants. This innovation can also be found in other industries, such as pharmaceuticals or food, as the process bypasses chemistry and largely incorporates nature-based processes and ingredients (Fraunhofer-Gesellschaft, 2018). This process can therefore be seen as a trend towards progress, as biological products in medical technology in particular have a longer lifespan and are compatible with organs (VDE, n.d.)

2.7.3. The collaboration with third-parties

The application of health care innovation can be conducted internally by simply using internal resources as well as externally, by involving stakeholders from the external environment. Especially when working with external stakeholders and specifically with the customer side, virtual platforms are often used. In the external procedure, a company can either use created platforms and networks for open innovation practices or use their own communication channels. Pioneers in medical technology, such as Johnson & Johnson or Siemens Healthineers, as well as companies in comparable industries, provide such opportunities through their own open innovation practices, which have been internally developed by either own personnel or external service providers depending on the elaboration of the therewith associated sourcing strategy. Companies such as Johnson & Johnson or Bayer provide the opportunity to regularly let interested parties participate in innovation competitions or innovation projects. In such projects, certain information about the project is provided in many cases, such as:

- What is the project intended to achieve and what is being researched?

- Whom are the projects for (universities, start-up companies, research institutes, etc.)?
- What is the reward for successfully providing information?

Thus, participants know whether they are qualified and whether it will be worth working on the innovation project (Bayer, 2019; Johnson&Johnson, 2019; Healthineers, 2019).

The use of external service providers refers to so-called intermediaries that connect innovation project providers with innovation seekers. Nowadays, there are a large number of internet-based innovation intermediaries that support the matching of two parties and also play a supporting role during the innovation process (Schroll & Römer, 2011). Those intermediaries usually stand out through specific strengths, which companies, who fail to interact properly with external stakeholders concerning innovation do not possess. They are supporting and establishing collaboration between two market sides by providing an intermediary platform, which links innovation seekers with innovation solvers. In this case, the term "Innovation Solver" is referred to as research laboratories, entrepreneurs, students and in general scientific researchers as well as anyone else, on whom the innovation seeking process is aimed at. Additionally, they are providing a fair pricing stipulation for all parties, in which the intermediary is not exposed to paying neither innovation solvers for their ideas nor innovation seekers for their time and resource provision. In general, the innovation seeker pays the intermediary when an innovation acquired through an intermediary is about to be in-licensed and actually used as a product or service as well as the innovation seeker is usually responsible for offering a reward to the prospective innovation solver when his idea, prototype, or even product is chosen to be used. Besides that, innovation intermediaries also support innovation solvers to maintain an attractive platform for innovation stakeholders by offering them access to potential customers as well as to search for a great variety of other challenges throughout their portfolio. Additionally, they help innovation seekers to have access to other services, which include strategic advice on positioning recommendations and process drafting, technology-mapping, as well as services on how to implement and integrate technologies (Rochet & Tirole, 2003; Alstyne, 2005).

The following shows a list of important innovation intermediaries that operate within a wide range of industries and connect innovation stakeholders with each other in order to accelerate the innovation process:

- HYVE – www.hyve.net

Hyve formerly known as Atizo describes itself as an online brainstorming and idea platform. Ideas can be submitted on current issues, which in turn are commented on and evaluated by all users. The best ideas receive a bonus. There is a large community, especially in German-speaking countries (Schroll & Römer, 2011).

- Agorize – www.agorize.com

Agorize is well-known as an open innovation challenge platform, on which companies describe a challenge they would like to have solved or receive more ideas on by external stakeholders and focuses on bringing together start-ups, developers as well as students (Agorize, 2021).

- Ninesigma – www.ninesigma.com

Ninesigma does not offer a marketplace, but works as a consulting intermediary in the implementation of open innovation with a special focus on questions of patent and licensing law (Schroll & Römer, 2011).

- Yet2 – www.yet2.com

Yet2 connects technology seekers, patent owners and offers companies a platform for patent and license trading. In addition to the marketplace, Yet2 offers OI consulting services, supports through technology assessment and sourcing as well as licensing experts. In addition to that they also offer an OI platform (Schroll & Römer, 2011).

- Innocentive – www.innocentive.com

Innocentive is characterized by highly technical, complex tasks that can usually only be handled by experts. They are not only an idea platform, but a real marketplace for innovations and patents (Schroll & Römer, 2011).

- Ennomotive – www.ennomotive.com

Ennomotive is known as an open innovation platform, which focuses on connecting various industries and stakeholders with each other. It is similar to other OI platforms as Agorize, where a innovation seeker offers a deal as well as topic for innovation solvers to work on (Schroll & Römer, 2011).

2.7.4. Barriers to Open Innovation in MedTech and Pharma

Barriers for the innovation process of a company in MedTech and Pharma can be found in many different areas and exceed general barriers of the Open Innovation principle. Nevertheless, general barriers impeding proper idea generation through external sources are identified in the list below and will then be completed through slight changes that apply specifically to the MedTech and Pharma industry:

- Monetary assets
- Innovation
- Knowledge
- Market
- Organization
- Strategy
- Society
- Technology
- Regulation

The lack of monetary assets addresses another project management aspect, which simply means that enough monetary resources should be available to cover generally budgeted costs applying to the project or even contingency costs (Idexlab, 2014).Those monetary assets include own equity or financial support from the outside as in public funds, venture capitals or generally investors (Hjalmarsson, 2014) .

The aspect of innovation simply concerns the risk of the innovation as well as imitability, which might cause revenue to not develop as expected (Hjalmarsson, 2014).

Moreover, the lack of competences in fields as management, innovation experiences, or even technical knowledge is also from high importance to assure that the innovation can actually be build and does not need additional resources apart from requirements accounted for in advance (Hjalmarsson, 2014). A lack of marketing competences, due to insufficient information in different departments other than Research & Development also result in inhibition of innovation capabilities, since other departments as e. g. marketing might not be able to do their job properly without having all information required for their tasks. Therefore, it is important to always maintain healthy communications between important departments (Idexlab, 2014).

The market aspect is mostly concerned with consumers and their behaviour concerning the actual demand of the innovation as well as competitors and their motivation to become competitive (Hjalmarsson, 2014).

When it comes to the aspect of organisation time is a crucial factor and it is meant that innovation projects, especially in cooperation with external stakeholders can take a long time to be fully effective, so that in early stages proper project management phase planning should be considered (Idexlab, 2014). Apart from this, appropriate attitudes towards the process from the corporate culture as a whole is important. Acquiring fitting partners for innovation competitions or other OI practices are also seen as a great barrier in organization, which is addressed when working with external stakeholders (Hjalmarsson, 2014). Therefore, the ability of the departments involved with external stakeholders should be internally audited and evaluated whether it will result in effective work or should rather be switched with different partners or even placed on hold until all stakeholders are equally sure that the project will provide an added value (Idexlab, 2014).

Also, strategy might become a barrier when the strategic fit was not evaluated properly or the innovation strategy is too weak or unclear to what needs to be achieved (Hjalmarsson, 2014).

Society and the level of public acceptance concerning the innovation is also from high importance and can also be addressed in the market aspect (Hjalmarsson, 2014).

Technology can also become an intense barrier, because it is important to always have technology in place and available, which is needed for the innovation or accompanied processes as well as to keep up with state-of-the-art requirements (Hjalmarsson, 2014).

Last but not least, regulations made by the government or even on European level have an enormous impact on corporate processes and can be considered as a strong inhibitor in the MedTech and Pharma industry. Regulation of medical technologies as well as pharmaceuticals varies from country to country and is highly important. Depending on how barriers are established in the respective market, processes such as licensing or generally enabling market access for specific products can be delayed for several years. Consequently, such lengthy processes would increase the resulting costs to realise the innovation, which would count towards the cost of production and thus result in an increase in price (Nesta, 2017).

In Europe laws as the MDR, IVDR, GDPR as well as further Directives and Regulations by the EMA and many more have to be considered and followed, in order to adhere to the regulations, especially when dealing with medical products. Regulations as the aforementioned ones enable safety and security when it comes to medical as well as medicinal products. Nevertheless, those intense regulations and thorough market surveillances slow down innovation capabilities (MDCG, 2019).

Conservatism can also be seen as a barrier, especially in the health care industry, so that industry participants, especially in the health care sector may be sceptical of technologies or medications from other countries or industries, which have not been locally implemented before (Nesta, 2017).

Thus, in order to take advantage of open innovation strategies and gain external knowledge from stakeholders such as customers or suppliers for their own purposes, these barriers specific to the MedTech and Pharma industry need to be taken into account in addition to the general disadvantages and barriers to the development of innovations (Nesta, 2017).

3. Methodological Approach

This chapter shows already existing research, which will be complemented by this paper, the methods used for data collection and the specific methods used.

3.1. Existing research

In 2020 COVID19 came to Europe, so that especially in recent research publications this topic is addressed. The pandemic caused numerous employees as well as employers to work from home via digital communication tools causing an enormous disruption in many companies. They will now have to reconsider and change processes, adapt to changing customer needs as well as change the plan for e. g. innovation strategies etc. For some individuals or corporations this can be considered as an enormous challenge when having to manage virtual teams. Employees considering their company as innovative in respect to products and services has dropped from almost 60% to 40% during the virtual-only time. This shows that individuals realize the change currently happening in the world and that those digital times seem to have an impact on innovation (Forbes, 2020). In a survey from McKinsey conducted in 2020 it shows that nearly all industries have a decreased focus on innovation since the pandemic. Except from the Pharmaceuticals and Medical Technology industry, who both have enhanced their focus on innovation by almost 15% due to a higher need of healthcare solutions (McKinsey, 2020). Nevertheless, there is no research on whether they are able to accomplish being or becoming this innovative also when only using virtual communication instead of physical meetings or a mix of both. This is where this paper will continue the research to provide an overview of how companies across Europe are currently handling the situation of being forced to interact virtually. The search for similar literature concerning the topic addressed in this thesis was conducted via online databases as e. g. IEEE Xplore, PubMed and Springer Link where different terms were used as search criteria in order to receive publications related to the topic. After careful consideration of variations of search terms only a few research articles could be found. Nevertheless, those articles were not addressing the topic even closely. Therefore, it can be concluded that there is insufficient literature demonstrating a gap for the hereby addressed topic. This also makes the conduct of qualitative expert interviews as well as the use of quantitative information gathering instruments meaningful to acquire new knowledge for the topic dealt with in this paper.

Search	Actions	Details	Query	Results	Time
#8	···	›	Search: **(((Open Innovation) AND (virtual or physical)) AND (pharmaceutical)) AND (medical technology)** Filters: **Free full text, from 2020 - 2021**	6	14:15:17
#7	···	›	Search: **(((Open Innovation) AND (virtual or physical)) AND (pharmaceutical)) AND (medical technology)** Filters: **from 2020 - 2021**	7	14:14:49
#6	···	›	Search: **(((Open Innovation) AND (virtual or physical)) AND (pharmaceutical)) AND (medical technology)**	20	14:14:42
#5	···	›	Search: **(Open Innovation) AND (virtual or physical)**	1,604	14:14:21
#4	···	›	Search: **(((Open Innovation) AND (Online or Offline)) AND (Pharmaceutical)) AND (Medical technology)**	5	08:56:20
#3	···	›	Search: **(((Open Innovation) AND (Online or Offline)) AND (Pharmaceutical)) OR (Medical technology)** Filters: **from 2020 - 2021**	83,778	08:55:55
#2	···	›	Search: **(((Open Innovation) AND (Online or Offline)) AND (Pharmaceutical)) OR (Medical technology)**	345,371	08:55:22
#1	···	›	Search: **Open Innovation**	16,683	08:54:17

Figure 3: PubMed search results of existing literature (PubMed, 2021)

3.2. Methods used for data collection

In order to gain specific information about the topic addressed several expert literatures in form of journals, books and additional online sources have been researched to deliver general content concerning the topic. These illustrate different points of view as well as aspects concerning the topic. Through thorough combination of statements and further relational actions a fundamental creation and support for the proper development, execution and analysis of a quantitative analysis could be established. Furthermore, it was chosen to conduct a mixed method including both qualitative and quantitative methods. In both cases the method of convenience sampling used was a non-probabilistic sampling technique applicable to qualitative or quantitative studies (Andrade, 2021). The use of a qualitative analysis with industry experts was intended to support the development and optimization of the quantitative material through expert knowledge. The specific approach of a quantitative analysis was chosen because the intention was to provide crucial hard data information (e.g. numbers, statistics, graphs) of this very recent topic. This data is based upon a great number of industry participants' experiences to quantify and measure real facts. By focusing on the approach of a quantitative analysis, it is possible to gain as much situation-specific knowledge as available from a great number of different stakeholders. Especially, considering the novelty of the topics' importance a clear statement about the real-world evidence based upon the majority of answers from the questionnaire can be concluded (Symeou, 2008). Therefore, it can be concluded that both scientific approaches, the quantitative and qualitative method, will be used in this paper in order to receive the desired outcome through a mixed approach. In consequence, qualitative insights will be

enriched by additional and crucial in-depth knowledge from efficiently developed quantitative instruments (AHRQ, 2013).

3.2.1. Qualitative Analysis

For the qualitative approach of the work, an investigation belonging to the primary research was carried out in the first step in form of an expert interview. The goal is to gain further relevant knowledge on the topic based on personal experiences as well as opinions and ideas the experts have constructed in their minds (Symeou, 2008). The stakeholder theory provides the theoretical basis to analyse the relevant stakeholders or experts to conduct the interview with and what factors determine whether involvement becomes successful (Preston, 1995). The focus group will exclusively be internal employees of companies in the medical technology and pharmaceuticals industry with strong involvement in innovation activities across company borders. Their legitimization to be considered such relevant stakeholder roots on the fact that they are directly affected by any possible change, but also are initiating the change itself (Reed, 2008). Therefore, any employee of a company involved in searching for innovations in the medical technology and pharmaceuticals industry through external sources can be considered as a relevant stakeholder for the focus group. This analysis includes three different industry experts who were approached personally and also known on a personal level. Each expert was chosen for a specific reason and to cover different aspects of the thesis. The division was therefore conducted on their area of expertise and industry they work in:

Klaus Suwelack, former New Business Development and Innovation Management Lead as well as current member of the Germany Supervisory Board of Janssen Cilag GmbH (Johnson & Johnson) located in Germany. The interview with this expert was specifically chosen to give an overview of the pharmaceuticals industry.

Dr. Michael Hein, current Head of Innovation Delivery, Innovation & Research of medical technology / diagnostics at Roche Diagnostics International located in Switzerland. The interview with this expert was specifically chosen to give an overview of the medical technology industry.

Prof. Dr. Andreas Braun, Chief Executive Officer at Innovation HUB Institute teaching professor at the Business School Berlin and author of several published research papers focusing on innovation management with specialization on aspects of Open Innovation Management as well as Absorptive Capacity. The interview with this expert was specifically chosen to give an overview of how Open Innovation is affected by only-virtual times.

Each interview was conducted virtually via Microsoft Teams and lasted about 40-50 minutes. In order to be able to extract information most efficiently and in a structured manner the interview was conducted using a predefined guideline. With the participant's consent, the interview was audio recorded in Microsoft Teams allowing for post-session evaluation and analysis of the answers. In order to obtain as much detailed information as possible, almost exclusively open-ended questions were asked (Becker, 2020). In addition, a PowerPoint presentation was presented during the interview in order to show the questionnaire to the interviewee and therewith facilitate the procedure of reprocessing spoken words by the interviewer. The PowerPoint can also be viewed in the Annex. The virtual face-to-face conversation also made it possible to observe facial expressions and slight gestures during the interview. Despite the intended purely objective presentation of the current situation, it was possible to record initial conclusions and assessments of the interview partner's subjective attitude to the main topics addressed. Moreover, the interview was transcribed. Nevertheless, linguistic peculiarities, sentence breaks, stuttering, etc. have not been taken into account. Afterwards, an evaluation based upon the outcome of the interviews was conducted in order to see whether current literature findings could be extended with findings from the expert interviews. This enabled the optimization of the quantitative instrument based upon a reflection of the interview and the experts' recommendations on the topic addressed.

3.2.2. Quantitative Analysis

The first aspect considered was the form in which the study or the survey method was conducted. The survey method described the way in which data was collected. Basically, there is a distinction between primary and secondary data collection. In primary data collection, new data is generated, whereas in secondary data collection, existing data is used for evaluation. For primary data collection, there are again different possibilities,

namely the three main forms of questioning, observation and experiments. Most frequently, a survey is conducted. This can take place as a personal or telephone interview, in writing or as an online survey. Which survey method is chosen depends on the content of the research question, the financial means to cover costs and the personal situation or access to the data (Becker, 2020). Since the thesis was written outside a company, observation or experiments were difficult to implement. Therefore, a survey was conducted. The form of an online survey was chosen, because it can be disseminated quickly, conducted without high costs and the collection of data is usually done by the provider. In addition, participants can fill out the questionnaire when they want or have time for it and do not have to coordinate this with the interviewer as it would be the case, for example, with a conversation or telephone call. As soon as the survey method was determined, the questionnaire could be created. Herein, an extensive literature research is the first step. From this, an understanding of the issue to be investigated can be gained and the questions can be designed so that the answers can be compared to the results of the research. The next step is usually to consider which question types will be used. Questions must be distinguished between open, closed and semi-open questions. Depending on how the question is formulated, it offers the respondent more or less freedom in answering. In the case of open questions, the participant is not given any suggestions or guidelines for the answer. The participant formulates the answers independently and as long or short as he or she likes. In this way, more substantial statements can be obtained than with closed questions. It is normally recognized if the respondent does not understand the question or even understands it incorrectly. In addition, the conception of open questions is easier since no answer possibilities must be pointed out. A disadvantage of open questions, however, is that the evaluation takes longer and is more complicated. Closed questions, on the other hand, offer respondents various possible answers to the question posed, from which one or more must be selected. This creates more effort in the development phase, because the choices must be meaningful and reasonable. Furthermore, there is the risk that participants either guess or do not read the question at all and randomly select an answer. On the other hand, there are some advantages. One is hand the unambiguousness of the answers; they leave no room for interpretation. Another is that answers are directly comparable and easy to evaluate. Yet another option is the semi-open question. Here, the characteristics of an open and a closed question are combined. The participants are offered answer options. However, they also have the possibility to write their own answer (Becker, 2020).

In order to keep the time needed to answer the questionnaire within limits and still obtain content-rich results, a mostly semi-open question collection was created. It consisted of predominantly closed questions with occasional open answer options in order to stimulate the thinking ability with already given answer options and at the same time to leave free space for own thoughts. Asking each question in detail as an open question would have increased the information content considerably, but with some drawbacks. The time required for potentially lengthy answers would have been increased and would also have left the free thinking ability out of scope (Becker, 2020). The quantitative instrument comprised different question styles for which each style has its own reason to be used. The different question styles and their intentions are listed in the following:

- Likert Scale: Used when the outcome is expected to vary between several oppositional levels. The Likert scales were set up to represent seven different answer possibilities in order to enable higher precision on the outcome.
- Single Choice: Used when only a single choice for more than two answer possibilities was allowed.
- Multiple Choice: Used when several choices for more than two answer possibilities were allowed.
- Dichotomous: Used when only a single choice for less than two answer possibilities was allowed.
- Free-form: Used when answer opportunities varied strongly and other questions types would not fit in.

Due to the reduction of the number of questions to a minimum, the survey processing length is supposed to come close to the 10-15-minute ideal survey length (Revilla, 2017).

The collection of questions was divided into four dimensions and put into an order based on an expert approved sequential logic. This first draft of the questionnaire was then consulted with the supervising professor. It was then subsequently revised based on the professors' recommendations as well as knowledge gathered from qualitative interviews. The dimensions, their associated questions and the intention behind each dimension is listed in the following:

Dimension 1: General company information

The first chapter deals with general facts about the company:

- In which industry is the company you are working for? (Multiple choice)
- How big is the company you are working for concerning employee numbers? (Single choice)
- Is your company a subsidiary of another company? (Dichotomous)
- Where is your company located? (Single choice)
- What is the approximate annual revenue of your company (in million €)? (Free-form with limitation to numbers-only entries)

Dimension 2: General information on OI conduct

In this chapter the general importance of Open Innovation is evaluated to show the importance of the topic addressed and what specifically contributes to it:

- Do you have an own R&D department? (Dichotomous)
- Who is responsible for open innovation projects and scouting new ideas or partners in your company? (Multiple choice)
- How do you rate the importance of collaborating with external stakeholders for idea sourcing in your industry? (Likert scale)
- Does your company collaborate with external stakeholders for idea sourcing? (Dichotomous)
- How do you rate the importance of following external collaboration partners for idea sourcing? (Multiple choice)

Dimension 3: Effects of only-virtual times on OI

The second chapter deals with the impact of solely being able to innovate virtually as during a viral pandemic and the therewith associated force to avoid maintaining usual habits as e. g. physical meetings. The change of innovation generation during such time as well as the reasons behind the change can herewith be addressed:

- Was it easier for you to gain access to external knowledge and scout for projects with external stakeholders VIRTUALLY? (Dichotomous)
- How many early-stage innovation concepts did your company usually generate in collaboration with external stakeholders in a year before 2020? (Single choice)

- Did the amount of innovation ideas generated in collaboration with external stakeholders decrease since COVID-19 pandemic affected Europe in 2020? (Dichotomous)
- How much did the amount of innovation ideas generated in collaboration with external stakeholders approximately decrease (in percentage)? (Free-form with limitation to numbers-only entries)
- Did your company stop or continue to source ideas with external stakeholders during COVID-19? (Dichotomous)
    - If "Stop": Why did you stop collaborating with external stakeholders for idea sourcing? (Multiple Choice)

Dimension 4: Effects of physical and virtual OI practices

In the third chapter physical and virtual Open Innovation principles are juxtaposed, so that each methods' importance as well as influencing characteristics can be evaluated to determine individual efficiency of the processes:

- How did you MOSTLY deal with external stakeholders for idea sourcing before the year 2020? (Single Choice)
- What do you think has been the ratio of virtual and physical meetings at your company whilst sourcing ideas (the ratio is defined as virtual/physical in %)? (Single Choice)
- Did you switch to solely virtual communication for idea sourcing, because of physical meeting restrictions caused by COVID-19? (Dichotomous)
- How would you rate the importance of the following aspects during idea sourcing processes? (Likert scale)
- Did you realize any negative or positive impacts when solely dealing with external stakeholders VIRTUALLY during idea sourcing processes? (Likert scale)
- What do you prefer in terms of sourcing ideas with external stakeholders in order to increase innovation capabilities? (Single Choice)
    - If virtual - Why do you prefer virtual meetings over physical meetings in terms of idea sourcing? (Multiple Choice)
    - If physical - Why do you prefer physical meetings over virtual meetings in terms of idea sourcing? (Multiple Choice)

- What do you think will be the approximate ratio of virtual and physical meetings at your company when sourcing ideas in the future (the ratio is defined as virtual/physical in %)? (Single Choice)
- If you like to receive the results of the survey, please enter your e-mail address in the text field below. (Free-form)

As soon as the content of the questionnaire was finalized, a solution to develop and distribute the questionnaire online was required. "Microsoft Forms" provides all necessary requirements in order to create and distribute the questionnaire. It was easily to be obtained due to its inclusion in Office 365 which has been personally available at the time of this thesis. There is a selection of question representations, e. g. choice questions, text inputs, scales or also the possibility of uploading files as an answer. As soon as the questionnaire was created, a link was created with which the survey could be distributed. The associated questionnaire can be found in the Annex. It was distributed in the period from August 2nd, 2021 until October 3rd, 2021 and sent to companies located in Europe with specialization in the Pharmaceutical or Medical technology industry. A reminder mail to answer the questionnaire was sent to the potential participants three weeks after the first email had been delivered. For the selection of countries to be included in this research only the ten most successful European export countries in the fields of Medical Technology and Pharmaceuticals were listed (Workman, 2021; Stewart, 2021). For each country, twelve MedTech and another twelve Pharma companies located in the respective countries were chosen to be researched making up to a total of 240 companies for the expected study group of the survey. There are many more companies in the associated industries, since Germany already accounts for approximately 1500 MedTech and Pharma companies not including other countries in Europe which have similar, but also lower numbers (Bolkart, 2021; Radtke, 2020). Nevertheless, it was decided to not exceed personal capabilities which is why 240 companies equally distributed over 10 export strong countries in the respected industries were chosen to gather contact information. Those companies received the request to participate in the survey. Companies were only included once and not be added to the list a second time, even if they were located in a different country in order to gather as much information from a great number of different market participants as possible. Nevertheless, the selection criteria for companies were not restricted to a specific type of company, since both SMEs and LEs have individual intentions and benefits concerning innovation capabilities, flexibility or even market

responsiveness. For that reason, it cannot be concluded whether one is more effective than the other when it comes to successfully innovating with external stakeholders (Spithoven, 2012). The hierarchical target group inside the company refers to someone with a managerial function in the fields of cooperating with external sources for generating innovations. Concerning the target sample, the following information was collected via the internet and then entered into an Excel spreadsheet, accordingly:

- Company name
- Country
- Industry
- General email address of the company
- Email address of a specific department or individual of a company gathered through internet research or personal relationships and communication.

Once the relevant information was identified, an email was sent to the companies' email address with an invitation link created by “Microsoft Forms” to complete the questionnaire anonymously.

Subsequently, 41 companies across Europe participated in the survey. The average time to complete the survey was 23 minutes and 29 seconds. Through the answers of the analyses, it was possible to provide more precise information about the way of how open innovation is handled at MedTech and Pharma companies and what is actually preferred based upon a holistic approach of investigating individual experiences of a great number of participants.

4. Presentation of results and interpretation

Consequently, several dimensions of the conducted survey are listed and set into relation to one another, so that more accurate information about innovation management as well as the approach and actual management of open innovation in both industries can be concluded. Dichotomously answered questions were not depicted graphically due to their transparency. All other types of questions with more than two answer possibilities are shown in a variety of different figures. Before presenting the actual results, however, the socio-demographic characteristics are to be considered:

- Industry

In order to see the ratio of pharmaceutical and medical technology companies participating in this survey the results of the first question show that there have been approximately 41% of participants working in pharmaceuticals and 59% working in medical technologies.

- Company size (number of employees).

In question two most respondents, and thus 51% stated, that they work in companies with employee numbers of 250 or more, while another 42% work in medium-sized enterprises with employee numbers between 50 to 249. Small enterprises with employee numbers of 10 to 49 accounted for only 3% of the survey and there has not been any micro enterprise with less than ten employees participating in this survey. There have been disproportionately bigger companies answering the questionnaire. Conclusively this means that the subsequent results mainly relate to medium-sized and large enterprises.

- Subsidiary

In question three it is shown that 27% of the participating companies are subsidiaries of another bigger company, whereas the other 73% can be overarching companies of other subsidiaries or only themselves, which means that more than 1/3 of the participants are overarching companies of other subsidiaries or do not have any subsidiaries.

- Location

As indicated in the target group restrictions the potentially participating companies have been chosen to be from Europe’s export strongest countries in terms of pharmaceuticals and medical technologies exports. Most participants clearly came from Germany and Switzerland followed by the UK and Denmark, so that it can be concluded that they have been the most supporting countries with regards to participating in the herewith interpreted questionnaire. The whole distribution of answers by country can be viewed in the following figure 4.

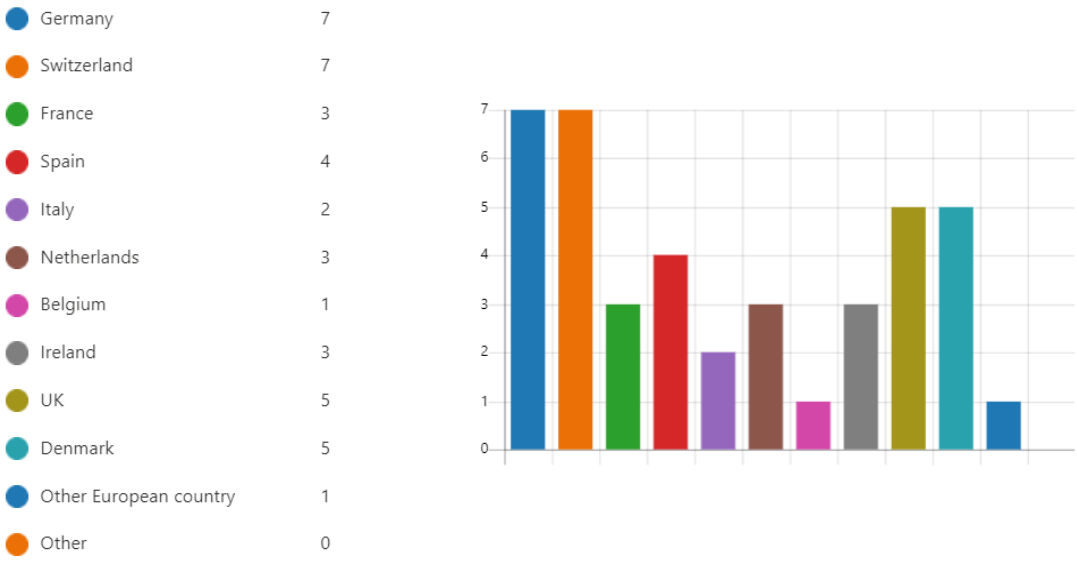

Figure 4: 4. Where is your company located?

The revenues of the companies participating have been asked for in question six of the survey. Nevertheless, not all companies entered this information, since it has not been a mandatory part of the thesis to be answered, due to the uncertainty of the revenues and a thereby associated surplus in time spent on finding out this information for the survey. The average revenue entered was 3955.85 million euros.

After the sociodemographic characteristics and general company information from the first dimension of the questionnaire has been determined the state and general importance of conducting Open Innovation is addressed in the second dimension, which is evaluated in the following paragraphs.

Dichotomously answered results of question five show that almost 83% of the participating companies have an own R&D department, which means that they themselves are involved with the creation and collaboration of new innovations. Additionally, it confirms the importance of an R&D department especially in the pharmaceutical and medical products sector, since in those specific industries the global private sector R&D spending is higher than in any other sector making up to 52% as a share of the EBITDA by industry. This also concerns total global private sector investments, in which the pharmaceuticals and medical products sector is the second

highest investing sector with 178$ billion right after the high tech, media and telecom industry with 182$ billion (McKinsey, 2020).

Question seven distances from the general creation of innovation by dealing with which instance has the responsibility for open innovation projects as well as scouting new ideas or partners via multiple choice. Here, three of the five possible answers have been selected most often. The highest selection rate was that this specific responsibility is in the inhouse innovation departments with 68% or 28 choices of all participants' votes. Inhouse R&D departments as well as external companies for idea/innovation sourcing each received 46% or 19 choices of all votes, so that it can be said that besides solely sourcing for new innovations and ideas through internal measures the use of external companies specialized in idea and innovation sourcing are used as well. Inhouse external collaboration departments were selected by less than 5% or two choices stating that there are companies using this term or department functionality, but not as often as they use other constellations. Figure 5 illustrates the results in a circle diagram.

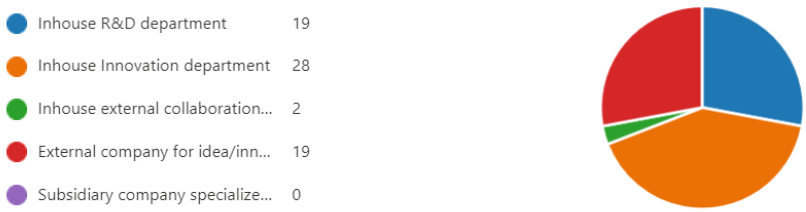

Figure 5: 7. Who is responsible for open innovation projects and scouting new ideas or partners in your company?

In question eight it is elaborated whether it is considered important to collaborate with external stakeholders for idea sourcing. It was clearly answered by a great majority tending towards high importance in figure 6. The answers were provided based on a 7-dimensional Likert scale reaching from "not important at all" to "very important". Approximately 49% of the participants selected that this collaboration is very important, another 34% answered that it is important and further 7% that it is rather considered important than neutral or unimportant. This makes up to 90% stating that with no doubt the majority considers the collaboration with external stakeholders as crucial.

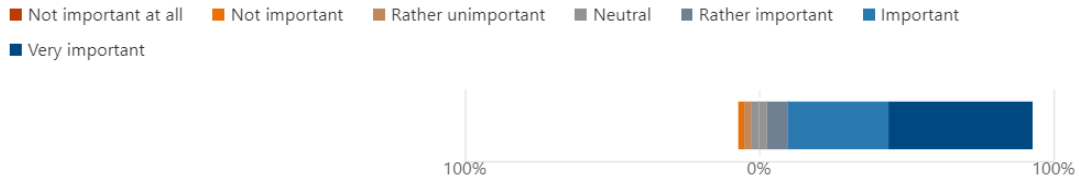

Figure 6: 8. How do you rate the importance of collaborating with external stakeholders for idea sourcing in your industry?

Also, the results of question nine based on dichotomous selection shows a clear tendency when it comes to the open innovation behavior, because approximately 88% stated that they collaborate with external stakeholders for idea sourcing. Question nine as well as question eight highlight the importance of the topic addressed, since they show an almost completely unilateral opinion in favor of the topic researched in this paper.

To illustrate with whom medical technology and pharmaceuticals companies actually deal with and whom they consider crucial for idea sourcing, figure 7 of question ten depicts the results in stacked bar charts. Each stands for a potential collaboration partner and is based on a seven-dimensional Likert scale from “not important at all” to “very important”. This enables the outcome to be more precise than e. g. by using a 5-dimensional Likert scale. Comparing the statements about the importance of each potential collaboration partner for the two industries addressed, the charts clearly show that collaborating with customers is considered as most important. In fact, almost 54% of the votes stated that it is very important. The other dimensions of the Likert scale were also addressed, even the ones stating e. g. “not important”, since there have also been companies involved in the survey which do not practice open innovation and collaboration with external sources. Further important partners to be considered are suppliers, start/ups, universities, research facilities, venture capital firms and open innovation platforms/competitions, because the tendency was leaning strongly towards the side of being important for each one of them almost completely leaving out the aspect of unimportance. Except from the aspect of competitors for collaboration where the tendency is slightly leaning towards not being important for external idea sourcing. In a nutshell this means that from all partners in the selection they were considered

important, especially customers. The exception, but not exemption, are the competitors, where answers varied strongly and a dissent can be seen.

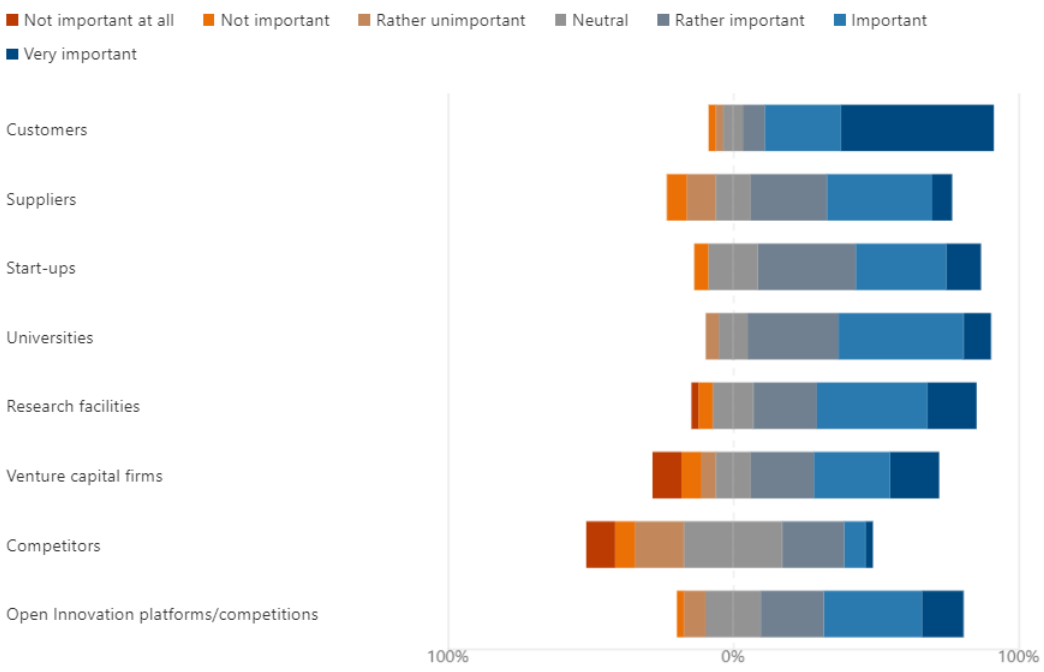

Figure 7: 10. How do you rate the importance of following external collaboration partners for idea sourcing?

The results of the questions from the third dimension are analysed in the following paragraphs to elaborate on the effect of only-virtual times on Open Innovation and its different ways of sourcing ideas from the environment.

Question 11 asked whether it was easier to access external knowledge and scout projects with external stakeholders only virtually. In this dichotomously answered question 59% of the participants voted that it is easier to do this virtually and 41% that it was not easier, so that it can be concluded that the majority was able to make use of remote-only times for idea sourcing.

How many early-stage innovation concepts a company usually generated in collaboration with external stakeholders in a year before 2020 was asked in single choice question 12 and is illustrated in figure 8 as a pie chart, to see which proportions make up the most of the total distribution. At first glance, it can be seen that 44% answered 0-5 early-stage innovation concepts a year, which is the smallest range in the

selection list. Another big proportion of the pie chart includes the answer 6-10, which is the second lowest range from the selection list and was answered by 27%. Another 10% selected 11-20 and further 2% selected 20 or more. Besides that, 17% answered that they are not sure about the amount of early-stage innovation concepts generated. This means that most companies participating usually generated between 0 and 10 proper early-stage innovation concepts in a year before 2020 in regards of the Technology Readiness Level scale and its initial dimension concerning research of innovations (TRL 1-3).

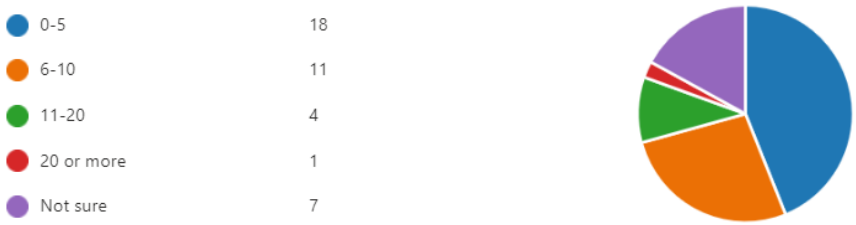

Figure 8: 12. How many early-stage innovation concepts did your company usually generate in collaboration with external stakeholders in a year before 2020?

When COVID-19 affected Europe in 2020 and physical meeting restrictions had to be implemented, many companies suffered from the consequences due to the fact that operations had to be put on hold or even had to be cancelled at some point. In question 13 it is asked whether the amount of those innovation ideas generated in collaboration with external stakeholders from question 12 decreased during this time. In this question 71% answered that there has not been any effect on the amount, which means that the majority of both industries were able to cope with the abrupt change and was not as strongly affected as other industries. This is due to the healthcare sectors necessity during this specific time. (McKinsey, 2020). The other 29% answered that there has been a decrease in the amount of innovation idea concepts from an average of approximately 28%, which could be determined through the answers of the sequential question 14, in which the decrease in percentage was asked for.

In question 15 it was asked whether the companies participating in this survey stopped or continued to source ideas externally during COVID-19 and the results were 100% clear and unanimous that every participating company was able to continue external idea sourcing during this time. This shows that those companies in the pharmaceuticals

and medical technologies industry were able to overcome the issues of only dealing virtually through a sudden change in daily operations.

The 100% one-sided answer majority of question 15 lead to no answers of question 16, since the question was set to only appear when a participant would have selected that they stopped sourcing ideas with external stakeholders in order to find out whether the stoppage was caused by various reasons.

To elaborate on effects of physical and virtual idea sourcing practices the results of the fourth dimension provide crucial information on the topic addressed and are analysed in the following paragraphs.

The majorly used strategy of whether the companies dealt with external stakeholders virtually or rather physically before 2020 was determined in question 17. 78% answered that they mostly sourced ideas physically by e. g. approaching on physical innovations events, conducting physical testing group meetings or generally face-to-face meetings. Nevertheless, 17% of all participants stated that they sourced ideas mostly virtually through e. g. virtual innovation events or platforms, which shows that even before the mandatory force to shift towards working virtually some pharmaceuticals and medical technologies companies already conducted business mostly via virtual solutions. Another 5% stated they do not collaborate with external stakeholders for idea sourcing.

Building upon the results of question seventeen the ratio of virtual and physical meetings whilst sourcing ideas in the past is elaborated in question 18 and shown in figure 9. The ratio in the following representations is defined as virtual/physical. The majority with 54% stated that the ratio was 25/75 meaning that to 75% they mostly collaborated physically in the past. The ratio 0/100 was only selected by 2% of the participants showing that there has only been little use of solely sourcing ideas physically without support through other virtual methods. Another 24% of the participants selected 50/50, showing that there has already been a balance between the use of physical and virtual innovation methods. On the other end, 15% voted for 75/25 and also another 5% for 100/0, which when combined show that 20% of the sample was already used to meet in virtual meetings rooms and replace physical practices by digital tools.

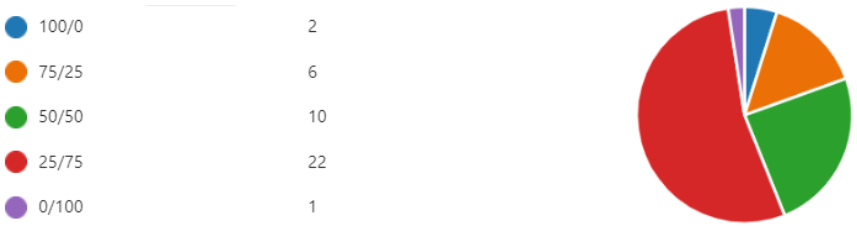

Figure 9: 18. What do you think has been the ratio of virtual and physical meetings at your company whilst sourcing ideas (the ratio is defined as virtual/physical in %)?

Furthermore, 93% of the sample group switched to solely communicating virtually with external parties as soon as the COVID-19 pandemic hit Europe and therewith associated physical meeting restrictions had to be implemented, in order to prevent the virus from spreading as indicated in question 19. This shows that during this time companies were basically forced to try and change their traditional operations towards a more digital perspective as provided by the answers of question nineteen.

In subsequent paragraphs advantages and disadvantages of the two different idea sourcing practices are evaluated, so that in question 20 the importance of various aspects chosen to determine their advantages and disadvantages are listed and to be classified according to their level of importance. The results are illustrated on a Likert scale shown in figure 10. As most important aspect to be considered, trust was chosen with a 98% tendency towards being important, from which 66% voted for trust being very important. This makes the two industries participating in this survey appear as reliant on trust when it comes to collaborating during the initial innovation steps. For two other aspects the Likert distribution is also obvious at first sight. This includes the duration of decision-making processes with an 81% and the attention in meetings with an 88% majority to tend towards the side considering them as important. Nevertheless, it can be seen that for both aspects the variable of being very important was less considered in difference to being rather important to important, which makes it less important than trust, but is still more important than other aspects listed in the following. For the aspects costs, amount of innovation generated and the ecological footprint the distribution is rather spread, but still with a clear trend towards being rather important to very important. Here, the ecological footprint scored with 64% and costs as well the amount of innovations generated with 59% each making them rather important than neutral or not important. Nevertheless, especially the ecological footprint was chosen to be not important at all by 7% of the participants, showing that there are still

individuals with a disinterest or extreme aversion concerning the importance of environmental damages created by the industry. Less important aspects include linguistic communication barriers, equality in terms of power representation and meeting documentation for reprocessing activities. For those three aspects the propensity was chosen to be more important than unimportant, but also with a great amount of oppositional feedback, almost balancing the distribution. Last but not least, the aspect waiting time for meeting confirmations was chosen to be least important, since it is the only aspect for which the propensity is towards being rather unimportant to not important.

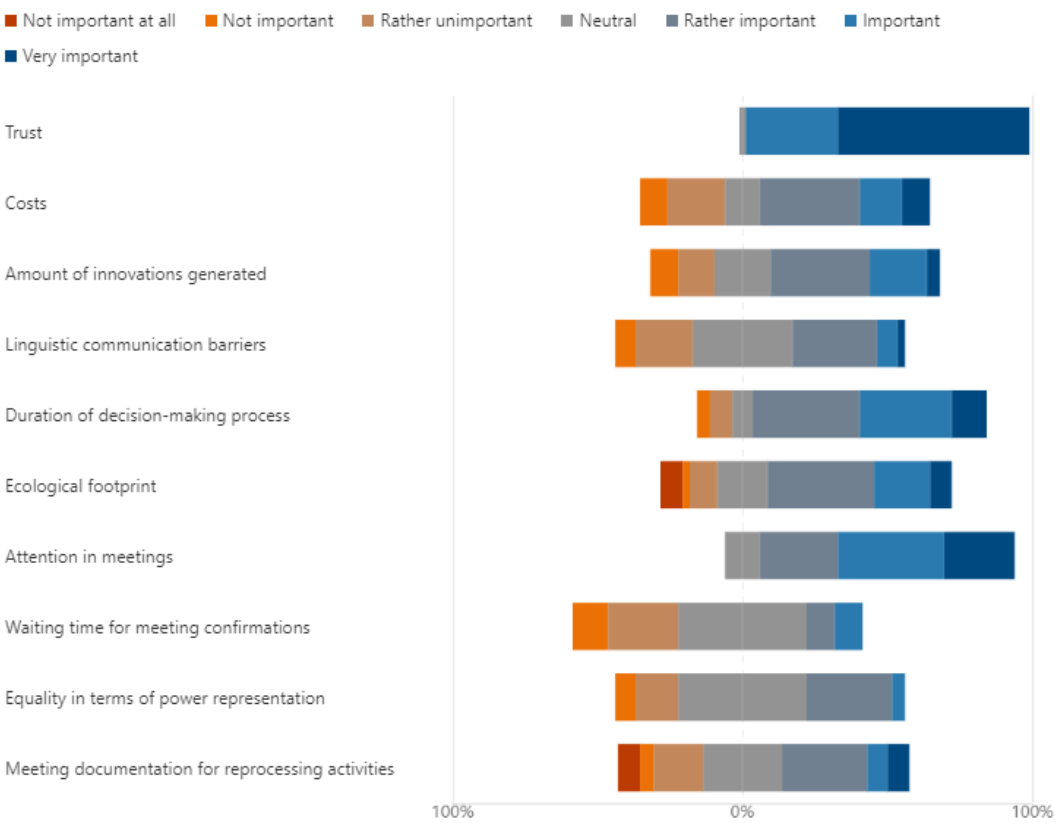

Figure 10: 20. How would you rate the importance of the following aspects during idea sourcing processes?

Building upon question 20 question 21 features whether there has been any negative or positive impact on the aspects chosen whilst solely dealing with stakeholders virtually during idea sourcing processes. The answers were also shown on a Likert scale in figure

11. Three selection criteria were provided concluding that each criteria is weighed with 33.3% of share, which is to be considered during the subsequent evaluation of the results. Analyzing the impact on each aspect, the most negatively impacted aspect with a 63% majority in votes was chosen to be trust as well as with a 59% majority it was voted that there has been a negative impact on the attention in meetings whilst conducting them virtually instead face-to-face. The rest of the distribution mainly stated that there has been no impact on the aspects, still making it a minority. Additionally, several other aspects were selected to be affected rather negatively by the virtual change. This includes the number of innovations generated, linguistic communication and duration of consensus finding. For the duration of consensus finding and decision-making processes 49% of the sample selected it to become affected negatively by the virtual change, which still makes up the majority, since other votes were distributed between the two other selection criteria. The number of innovations generated with 68% and the linguistic communication with 61% were chosen to have not changed by the majority, but with a stronger tendency towards being negatively impacted. The same was decided for the duration of the innovation process with 41% even though there has been a tendency towards the aspect as being positively affected by the virtual change. This may be due to less travelling as well as waiting for physical cross-country or – location meetings to take place (Forbes, 2019). Moreover, equality in terms of power representation with 61% as well as meeting documentation for reprocessing activities with 66% were mostly chosen to have not changed with another 34% each leaning strongly towards being impacted positively by the virtual change. For the aspect of meeting documentation for reprocessing activities this may be due to recording programs, which can be used to document meetings very easily and efficient (The European Business Review, 2020) . For the aspect of power representation the diminished perception and representation of hierarchical authorities during virtual meetings may be a reason as also indicated in one of the qualitative interviews of this paper (Suwelack, 2021). The selection of virtual collaboration having a positive impact on costs with 78% as well as the ecological footprint with 71% stands out as well when looking at the evaluation graphs. This may be due to less travelling, which saves time and reduces costs as well as the ecological footprint, since the use of virtual tools does not require physical transport and especially business class trips with much higher ecological footprints are used less frequently (Forbes, 2019; Clark, 2010). Besides that, costs may also have been reduced, due to less travel costs as well as companies shutting

down physical work spaces, since the concept of home office and virtual meetings has been pushed during the pandemic in 2020/21 and less employees are physically present at the actual offices (Broughton & Trentmann, 2021).

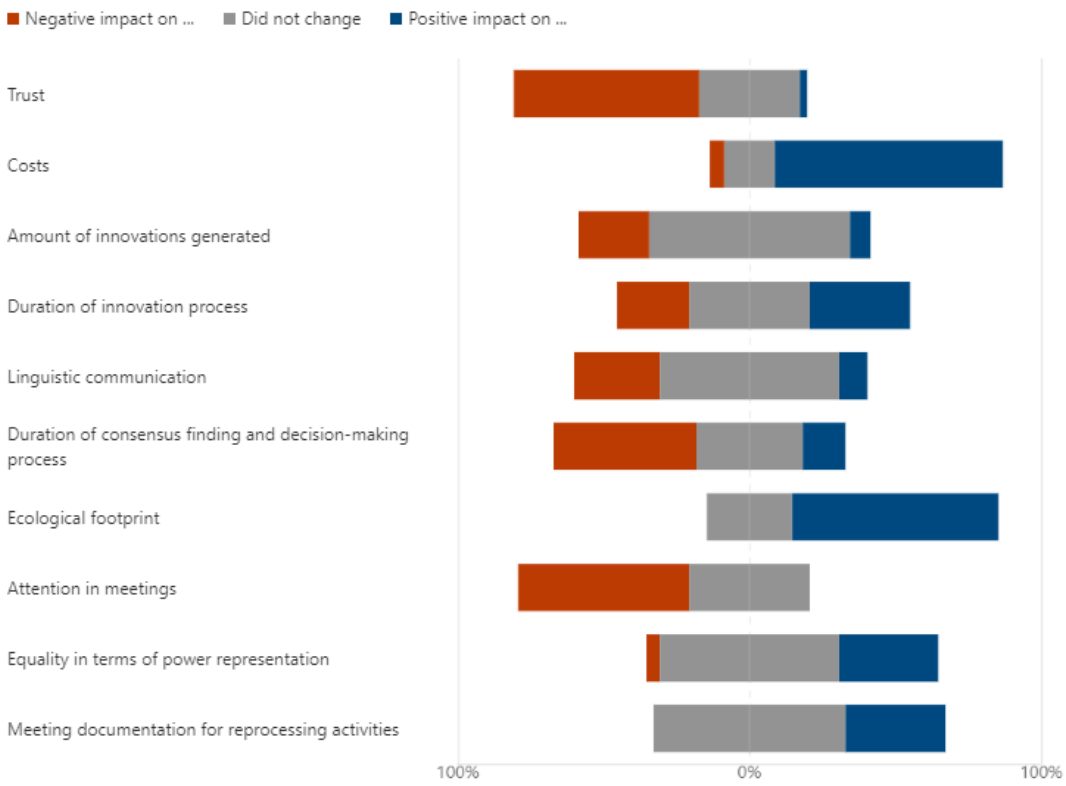

Figure 11: 21. Did you realize any negative or positive impacts when solely dealing with external stakeholders VIRTUALLY during idea sourcing processes?

Whether it is preferred to source ideas in collaboration with external stakeholders virtually or physically is asked in the dichotomously answered question 22. The majority with 71% stated they would prefer physical over virtual meetings. The residual 29% stated they would prefer virtual over physical meetings. The reasons why each selection was chosen to be preferred is determined in the following context.

In multiple choice question 23 the reasons for why virtual meetings are preferred are listed and shown as a column chart in figure 12 in numbers of participants voted for the respective aspects. From the 29% of votes 67% mentioned that one of their preferences is that there are less costs when collaborating virtually. This may be once again due to less costs spent on traveling as well as hosting employees in company-owned buildings,

which cover a great amount of expenses paid by the companies (Forbes, 2019; Broughton & Trentmann, 2021). Another 58% mentioned the environmental awareness by stating that there has been a lower ecological footprint through virtual meetings making face-to-face meetings more and more obsolete. 42% stated that at first there has been a shorter duration to find consensus during discussions and as second that there have been other preferences not listed in the provided selection list. Other preferences included the spontaneity to meet as well as the avoidance to travel for face-to-face meetings, so that precious time can be saved by the use of virtual tools. A quarter or less of all participants included in answering this question selected the other aspects as e. g. a higher number of innovations generated, less linguistic communication barriers, higher attention in meetings, higher equality in terms of power representation, more sufficient meeting documentation and no preference, which makes them rather less likely to be considered.

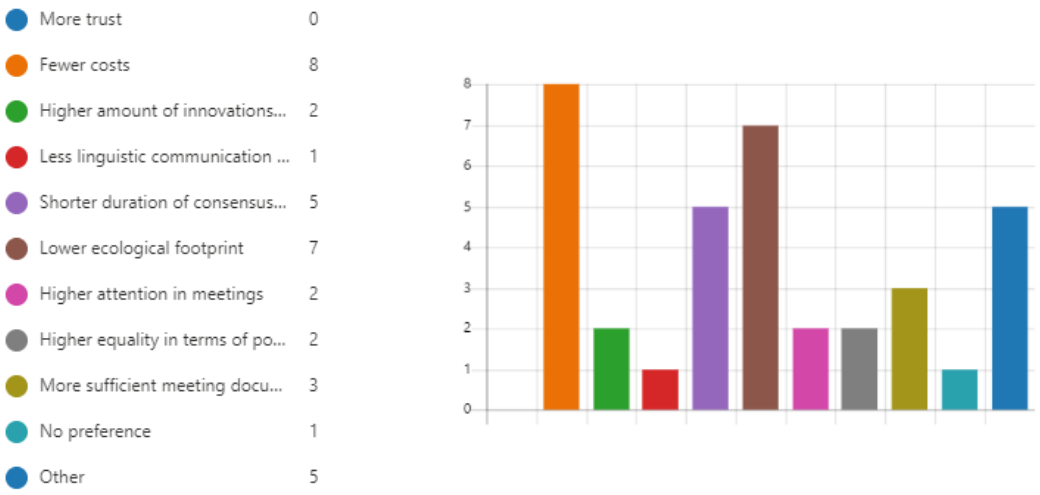

Figure 12: 23. Why do you prefer virtual meetings over physical meetings in terms of idea sourcing?

The answers of multiple-choice question 24 shows why physical meetings were preferred over virtual ones and are illustrated as a column chart in figure 13 in numbers of participants voted for the respective aspects. From the 71% of votes preferring physical meetings 83% voted that there is more trust developed during physical meetings making this specific aspect the most popular one amongst the answers of question twenty-four. Another 66% stated that in physical meetings attendees have a

higher level of attention as well as it takes less time to find a consensus via face-to-face meetings. In addition to that 35% share the opinion that there are fewer linguistic communication barriers, due to technical problems or non-existence of proper gesticulations, which eases understanding in conversations and are mostly lacking during virtual conversations. Also, the higher number of innovations generated as well as other reasons not included in the provided list were chosen by 31% each. Those other reasons stated by participants of the questionnaire included that there are better results of face-to-face discussions, technical problems occur less frequently, social interaction and relationship building is given. This is especially valid when it comes to going on business trips in other locations, which enables collaboration with individuals from different backgrounds and projects making innovation processes more efficient. Besides that, below 25% higher equality in terms of power representation was selected with 14% as well as 3% think that there is a lower ecological footprint and another 3% do not have any preference, which makes them rather unusual preferences to be considered.

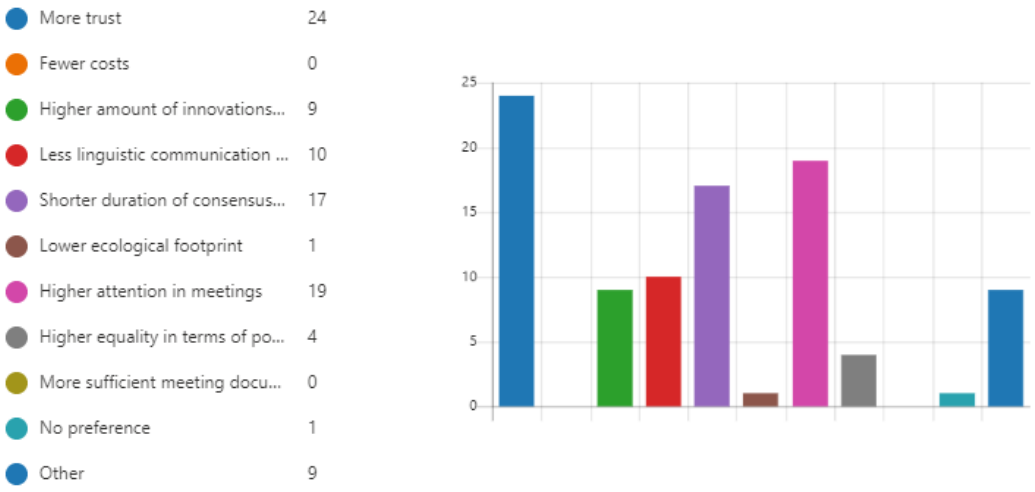

Figure 13: 24. Why do you prefer physical meetings over virtual meetings in terms of idea sourcing?

Last but not least, the answers of single-choice question 25 in figure 14 show what the ratio of virtual to physical meetings will be for idea sourcing with external stakeholders in the future. The ratio in the following representations is defined as virtual/physical. The majority with 49% stated that the ratio was 75/25 meaning that 75% of the companies will mostly collaborate virtually in the future. Nevertheless, a similar

response was given for 50/50 with 41%, which makes it obvious that most probably the distribution in the future will be between 50-75% of virtual collaboration. And since there have also been only 10% answering 25/75 and no vote on 100/0 or 0/100 extreme models are less likely be used in the future. Comparing the results of this question to question 18, it is visible that in the past physical meetings as well as a mixed approach were rather common. Nonetheless, the future is considered to be rather centralized in a mixed approach stepping away from extremes as 100% physical or virtual and leaning strongly towards making use of virtual meetings rather than physical ones as it was stated in the past view of this question in question eighteen.

Figure 14: 25. What do you think will be the approximate ratio of virtual and physical meetings at your company when sourcing ideas in the future (the ratio is defined as virtual/physical in %)?

5. Discussion

This section delves into the relevance and questioning of results, since results have been interpreted in the last section. It is focused on how the results relate to the aim of the thesis and its research questions, as well as on making statements on limitations concerning the interpretation of results.

This chapter is divided into discussions for each the qualitative and quantitative analysis. Starting with the qualitative analysis, the expert interviews are elaborated on their limitations as well as its contribution.

Limitations in this research with regards to the qualitative analysis refer to weaknesses that are out of control for the researcher. Convenience sampling of this thesis is a limitation itself, since subjects more readily accessible to the researcher were more likely to be included and chosen on their ease of availability and willingness to participate in the interviews. The subjects chosen were appropriate with regards to the topic addressed. Thus, their expertise may be focused on the specific area they are dealing with and not the overarching corporate view, since they were not part of the hierarchically highest instance (Andrade, 2021).

Apart from this, ethical as well as behavioral aspects have to be taken into consideration. Researchers must remain factual and not get influenced by personal preferences which could falsify or distort research results. Subconsciously, it may occur that the focus on those aspects is lost, even though this was consciously not noticed, so that it is to be believed that there hasn't been any kind of influence through personal interests during the interviews leading to falsification of the results.

Key takeaways from the quantitative analysis are to be discussed in the following paragraph taking into account the overall research question and its sub-questions stated in the beginning of this thesis. Subsequently, limitations of result interpretation and conduct of the information gathering tool are scrutinised.

The question "How and with whom do aforementioned industries conduct OI?" can be concluded from the results given by saying that most companies have an own inhouse innovation department taking care of OI related topics and that also in many cases R&D departments as well as external companies for idea and innovation sourcing are used. Here, it might be relevant to mention that terms or definitions for departments and their

respective tasks vary from company to company and that some also have merged or even highly divided departments for some activities, so that at some point it could be doubted that all of those answers are 100% accurate, since they cover not every single scenario to be found on the market. Conducting collaborative idea sourcing customers are to be considered as most important partners for many companies. Here to be mentioned is that customers may also include start-ups, suppliers, venture capitals, etc., which were also listed as possible collaboration partners. This means that once again the definition of the terms may cause some misunderstandings and therefore provide a possibility of unintended false answers. Besides that, OI and initial idea sourcing practices have been conducted mostly physical in the past. Supposedly, this is to be changed to become rather virtual in the future, even though those are only speculations and cannot provide a definite picture, since it is only forecasted.

For the research question "What is the impact of only-virtual times on OI and how did companies react on a sudden change in ways to operate?" it has been clear that the majority thought virtually gaining access to external knowledge is easier, but there has still been 42% voting that it is not easier. Therefore, this specific result may not be very powerful. It might have had more expressive power by asking for the reasons of why they think it is easier as well as it could have been asked whether and why they think physically gaining the external knowledge is easier. Moreover, the number of innovations generated was considered to have not changed during the only-virtual times except from 29%, which answered that there has been an average decrease or approximately 28%. The problem with the percentages mentioned is that they may only be rough estimates also not taking into account all ideas sourced. As seen in the results, not a single company stopped innovating with external stakeholders during COVID-19 making the question on why a participant would have stopped collaborating unnecessary and diminished the power of making a statement in this dimension. A further question concerning the reason of why companies were able to continue innovation with external stakeholders may have changed this aspect and increased the expression power at this point as well.

In the analysis of the questions contributing to the discovery of answers for research question "What is the general opinion on physical and virtual OI practices and how is absorptive capacity impacted by each practices' perceived advantages and disadvantages?" mostly the aspects influencing virtual and physical idea sourcing practices were elaborated. In question twenty and twenty-one each aspects importance

and affected impact was examined. From expert interviews and own research aspects were chosen to be included in the research. Nevertheless, since there have been three expert interviews whose results unlikely cover each possible aspect, another field "other" could have been included in those questions as it has been in question twenty-three and twenty-four. Therewith, it could have enabled the expansion of insights which through intrinsic thinking could not have been achieved. Additionally, for each of the two questions subsequent questions elaborating on the reasons why selected aspects are considered important or not as well as through which factors a positive or negative impact rose could have been extremely interesting for industry participants to know. At this point, important findings could have been gathered, but including additional questions could have exceeded the intended scope and overstrained participants by making the survey too time consuming. In addition to that, taking into account question twenty-three, twenty-four and twenty-five physical meetings are clearly preferred by the majority of participants, even though in question twenty-five it is predicted that virtual meetings will dominate the ways on how to collaborate with external stakeholders during idea sourcing processes. Moreover, aspects which have been identified to be the advantages of physical meetings have been selected to be more important than most others which would mean that physical meetings should rather be conducted than virtual ones according to the votes distributed in the questions. Nonetheless, virtual meetings are predicted to be used more often than physical ones in the future. This means that aspects as the costs or ecological footprint might be subconsciously more important than it was stated in answers given. Especially the two aforementioned aspects have been impacted positively through virtual operations as shown in question twenty-two and selected to be most preferred aspects from the group choosing question twenty-three over twenty-four. To receive further information and create a clearer picture it might have been interesting to once again include another question on the reasons for the participants' decision in question twenty-five stating that virtual meetings will be more popular in the future.

Besides the relevance and limitations of research question related aspects overall aspects need to be taken into consideration in order to elaborate on the qualitative and quantitative tool used in the thesis.

One of those aspects also involves the convenience sampling method and the anonymization of survey participants. Anonymization does not reveal status or hierarchical position of participants which may impair the evaluation on whether the

results were answered legitimately by experts in the field of innovation collaboration across corporate borders or not.

As another overall limitation concerning the validity of answers the scope of innovations considered by the participants during their participation in the questionnaire might have affected their decisions and led to subjective decision-making. In the questionnaire solely initial steps of the innovation process concerning the sourcing of ideas were intended to be in scope. Yet, it is difficult to draw the exact line on where the concept of sourcing ideas ends and thereby may not have been applied correctly by each participant.

Besides limitations concerning the content-related results of the analysis the average time to complete stated 23 minutes and 29 seconds, which makes the survey seem to be either long or difficult to be answered considering that the average time to complete shall converge towards the optimal period of time of 10-15 minutes. Nevertheless, when looking at individual times to complete the survey it showed that there have been five answers taking up to almost 90 minutes each which was considered during the calculation of average time to complete. Pausing the survey was not considered during time recording making it impossible to find out whether the average time to complete the survey is the actual time, not including breaks or power shut-downs for example. Nevertheless, if those excessively exceeding completion times were left out the average time to complete would be 15 minutes and 41 seconds, which comes closer to the expected as well as scientifically suggested time of 10-15 minutes.

6. Conclusion

The framework of this master thesis provides a far-reaching overview regarding Open Innovation practices in the Medical technologies and Pharmaceuticals industry.

The hereby conducted research is based on a great variety of topic-specific knowledge from various online and offline sources, opinions from different industry experts as well as statistics conducted in scope of this paper. Nevertheless, the most informing factor for this paper are the opinions and experiences from industry experts from the qualitative as well as quantitative research, due to real-life experiences and in-depth knowledge of changes arising from such recent and insufficiently researched topic of remote-only times during open innovation practices. Especially, in the pharmaceuticals and medical technology industry SME and LE enterprises alike are highly impacted during those times, since early-stage innovation and a high level of physical involvement, communication and trust between different individuals and departments is usually inevitable. Especially whilst opening up company borders in order to keep up with the competition in terms of idea sourcing, the collaboration aspect in cooperation with external stakeholders becomes essential. Even though there is no clear recipe to success from involving external parties in the innovation process it is important to recognize that this way of sourcing ideas has many advantages and also opportunities in terms of expanding the pool of ideas and the area of operation. With the large number of barriers to innovation and industry-specific hurdles mentioned, it is beneficial to have multiple sources to work with and to innovate across company borders. Especially, since ever evolving technologies and also the need for innovation, especially in health care, demand innovation development in cooperation with external sources and intermediaries, so that synergies, cross-industry or simply cross-border knowledge can be acquired.

Whether this collaboration takes place via virtual or physical paths, a company has to decide on its own depending on their prioritized aspects to be considered during idea sourcing. Physical meetings are rather preferred, due to their positively contributing aspects, but virtual meetings are expected to be conducted more often, which demonstrates their level convenience and flexibility making them another powerful option. Solutions will have to be developed, in order to cover the aspects, which may not be given at one of the practices or a tailored mixed approach based on the requirements and expectation of a company has to be implemented individually to fit their needs.

This paper provides an overview of a great number of different market participants in the industry and their opinions on the Open Innovation paradigm and its advantages and disadvantages concerning virtual and physical collaboration as well as the virtually evolving trend. Therewith, market participants are aware of the current industry-specific societal opinion and expectation and can prepare for future operations by conglomerating scientific knowledge to use it for own purposes.

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Annex

Open Innovation in the MedTech and Pharma industry

41	23:29	Active
Responses	Average time to complete	Status

1. In which industry is the company you are working for?

Medical Technologies	24
Pharmaceuticals	17

2. How big is the company you are working for concerning employee numbers?

Insights

Micro Enterprise (Fewer than ...	0
Small Enterprise (10 to 49 em...	3
Medium-sized Enterprise (50 t...	17
Large Enterprise (250 or more ...	21

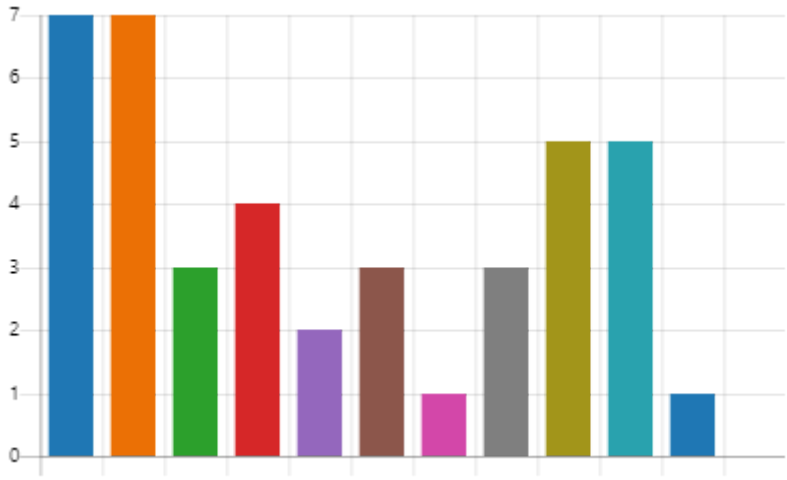
3. Is your company a subsidiary of another company?

Insights

Yes	11
No	30

4. Where is your company located?

Germany	7
Switzerland	7
France	3
Spain	4
Italy	2
Netherlands	3
Belgium	1
Ireland	3
UK	5
Denmark	5
Other European country	1
Other	0



5. Do you have an own R&D department?

Insights

Yes	34
No	7

6. What is the approximate annual revenue of your company (in million €)?

17

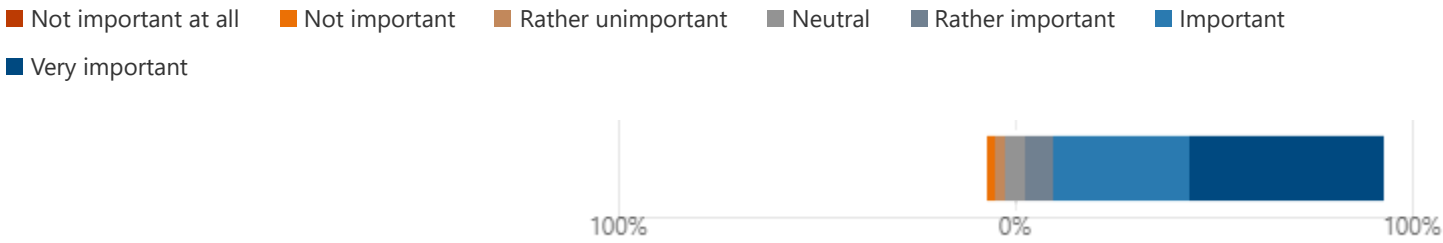
Responses

Latest Responses

7. Who is responsible for open innovation projects and scouting new ideas or partners in your company?

Inhouse R&D department	19
Inhouse Innovation department	28
Inhouse external collaboration...	2
External company for idea/inn...	19
Subsidiary company specialize...	0

8. How do you rate the importance of collaborating with external stakeholders for idea sourcing in your industry?

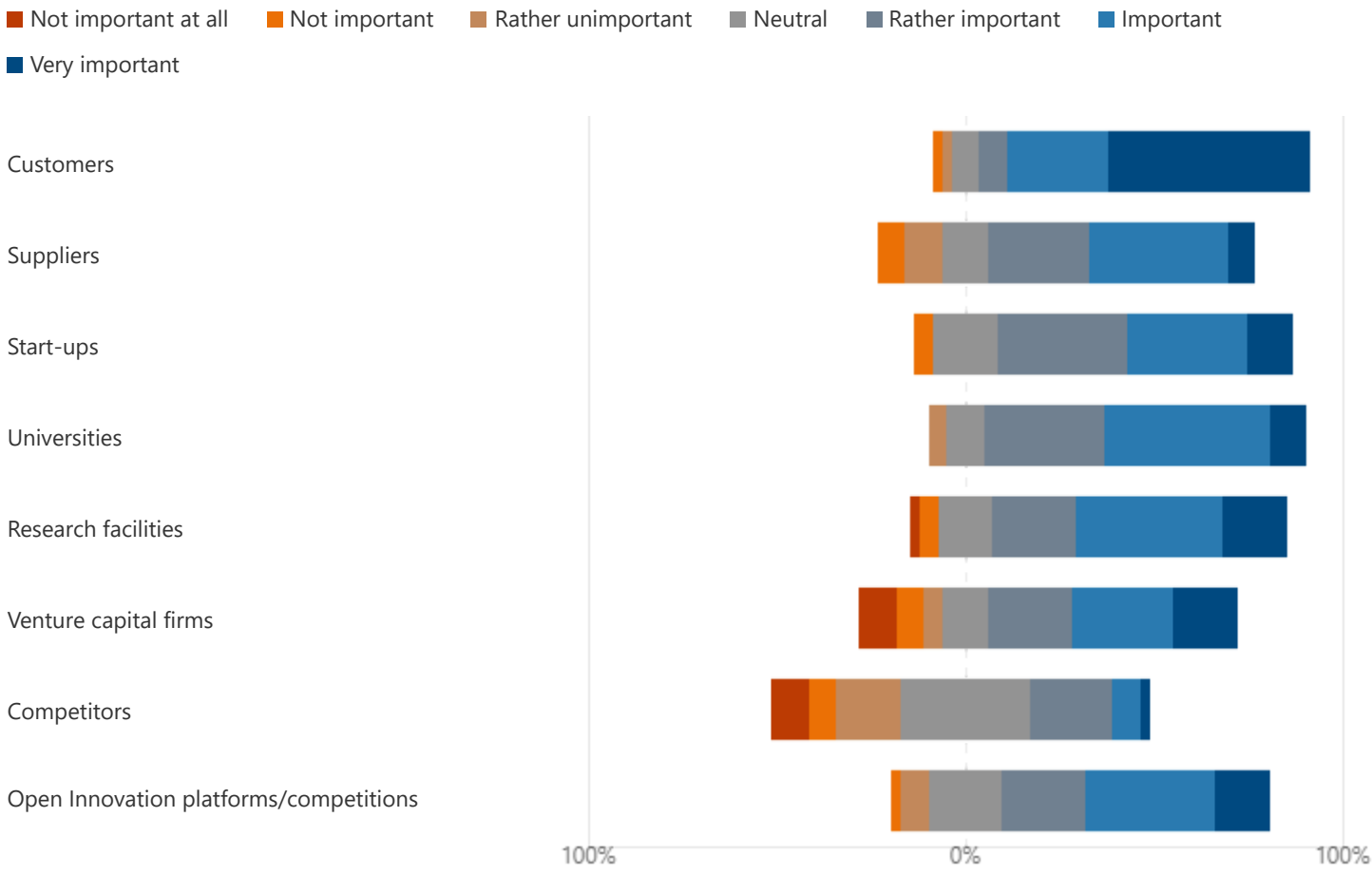


9. Does your company collaborate with external stakeholders for idea sourcing?

Insights

Yes	36
No	5

10. How do you rate the importance of following external collaboration partners for idea sourcing?



11. Was it easier for you to gain access to external knowledge and scout for projects with external stakeholders VIRTUALLY?

Insights

Yes	24
No	17

12. How many early-stage innovation concepts did your company usually generate in collaboration with external stakeholders in a year before 2020?

0-5	18
6-10	11
11-20	4
20 or more	1
Not sure	7

13. Did the amount of innovation ideas generated in collaboration with external stakeholders decrease since COVID-19 pandemic affected Europe in 2020?

Insights

Yes	12
No	29

14. How much did the amount of innovation ideas generated in collaboration with external stakeholders approximately decrease (in percentage)?

12

Responses

Latest Responses

"20"

"20"

15. Did your company stop or continue to source ideas with external stakeholders during COVID-19?

Insights

Stop	0
Continue	41

16. Why did you stop collaborating with external stakeholders for idea sourcing?

Monetary reasons	0
Long-lasting innovation proje...	0
No progress seen without any...	0
Existential anxiety	0
Change in priorities, because t...	0
Change in priorities, because t...	0

17. How did you MOSTLY deal with external stakeholders for idea sourcing before the year 2020?

Insights

Virtually (at e.g. virtual innovat...	7
Physically (at e.g. physical inn...	32
No collaboration with stakeho...	2

18. What do you think has been the ratio of virtual and physical meetings at your company whilst sourcing ideas (the ratio is defined as virtual/physical in %)?

Insights

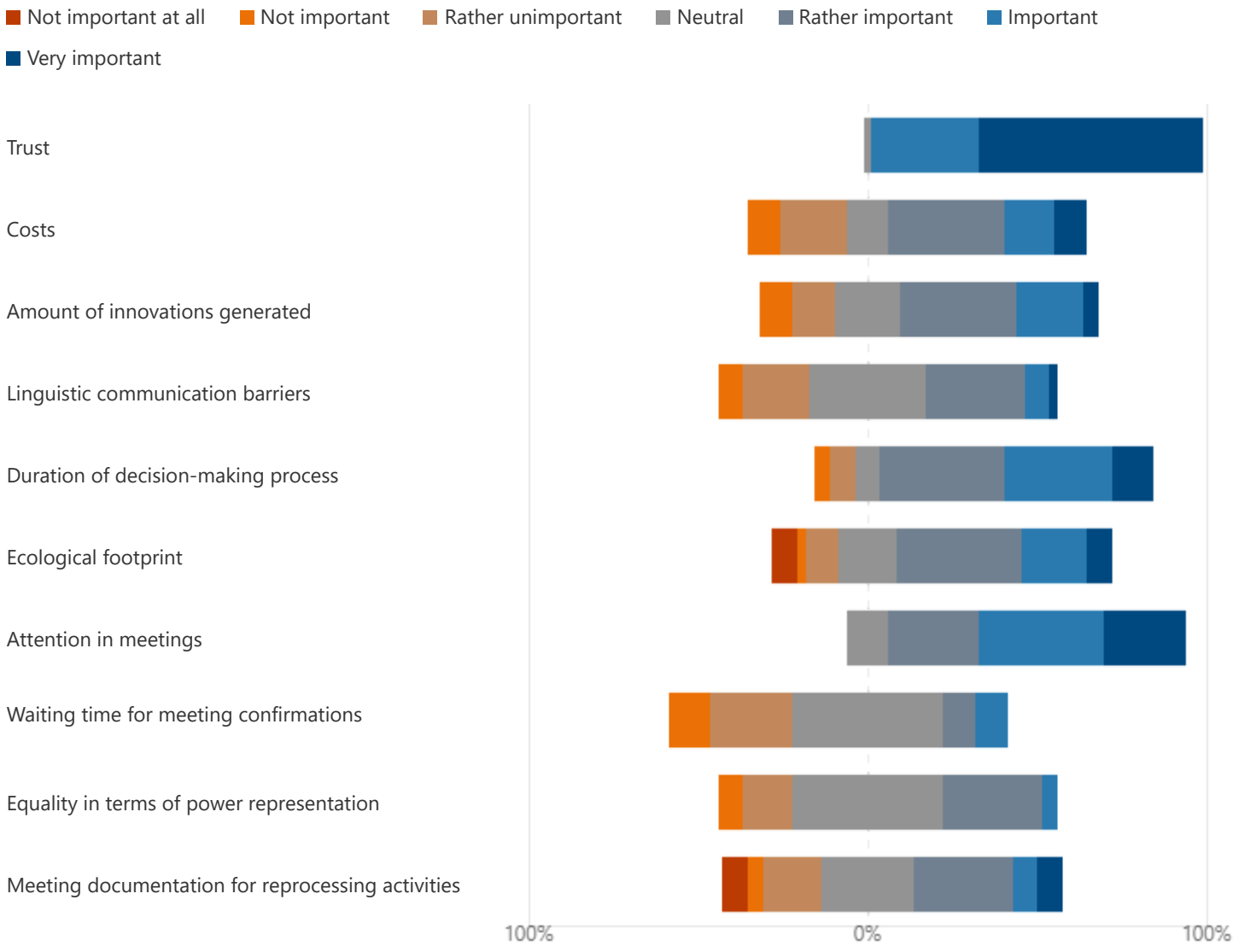
100/0	2
75/25	6
50/50	10
25/75	22
0/100	1

19. Did you switch to solely virtual communication for idea sourcing, because of physical meeting restrictions caused by COVID-19?

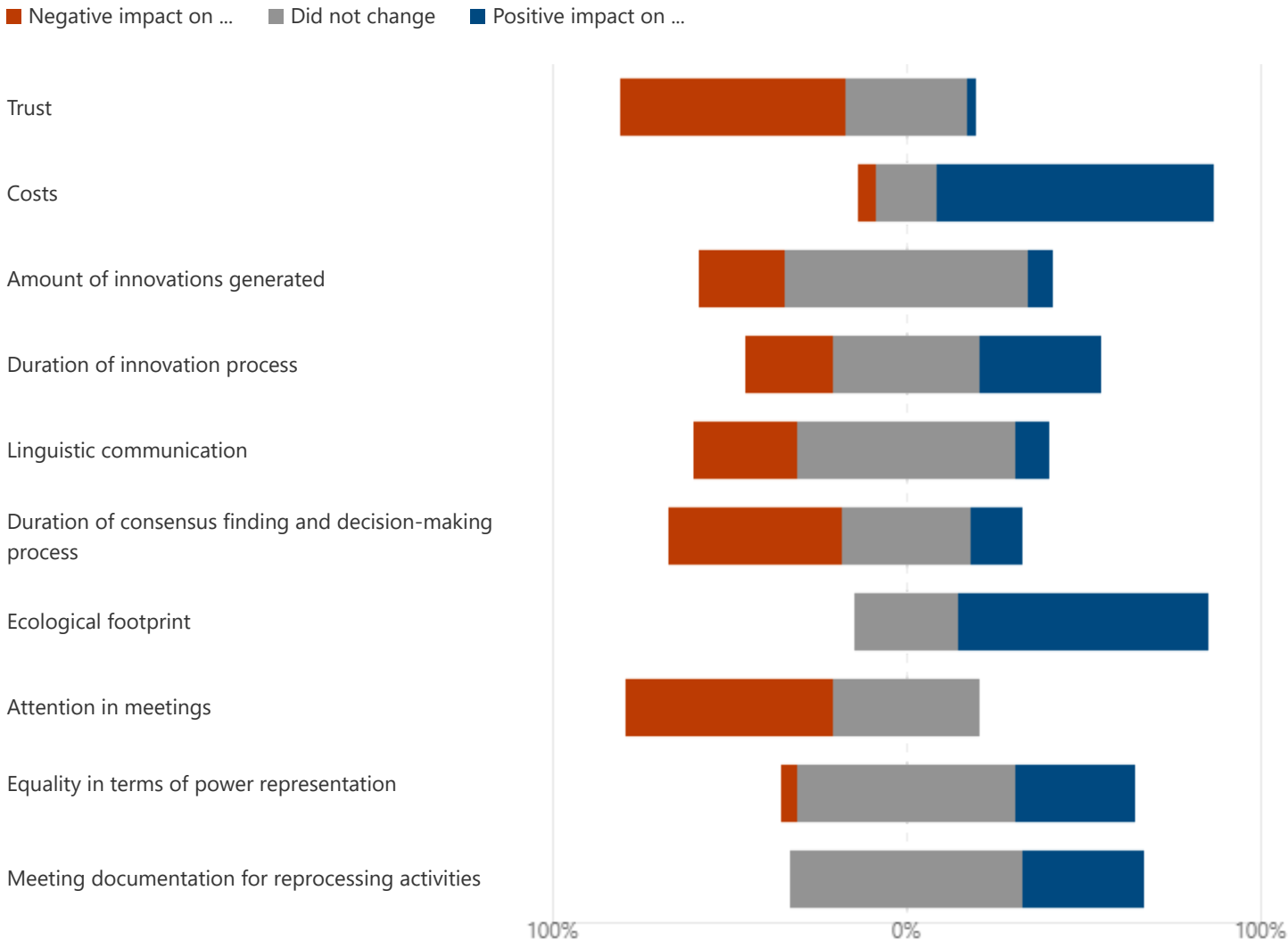
Insights

Yes	38
No	3

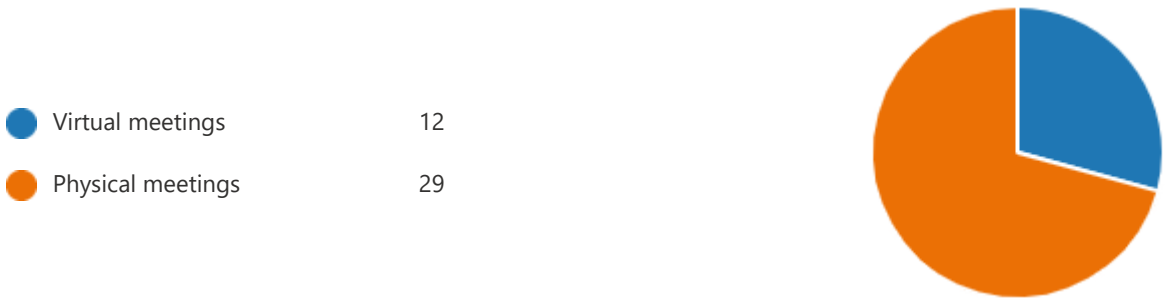
20. How would you rate the importance of the following aspects during idea sourcing processes?



21. Did you realize any negative or positive impacts when solely dealing with external stakeholders VIRTUALLY during idea sourcing processes?

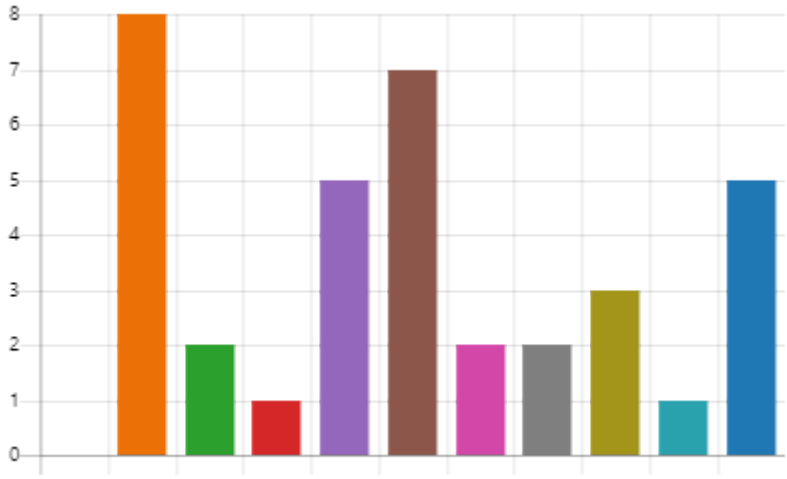


22. What do you prefer in terms of sourcing ideas with external stakeholders, in order to increase innovation capabilities?



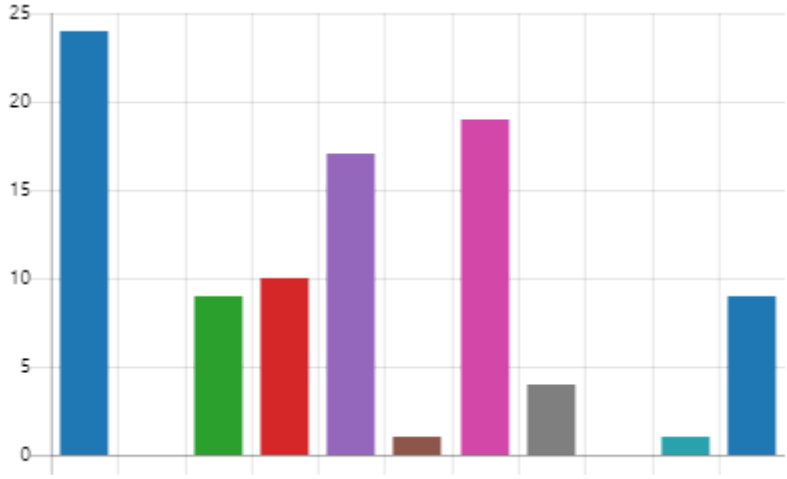
23. Why do you prefer virtual meetings over physical meetings in terms of idea sourcing?

More trust	0
Fewer costs	8
Higher amount of innovations...	2
Less linguistic communication ...	1
Shorter duration of consensus...	5
Lower ecological footprint	7
Higher attention in meetings	2
Higher equality in terms of po...	2
More sufficient meeting docu...	3
No preference	1
Other	5



24. Why do you prefer physical meetings over virtual meetings in terms of idea sourcing?

More trust	24
Fewer costs	0
Higher amount of innovations...	9
Less linguistic communication ...	10
Shorter duration of consensus...	17
Lower ecological footprint	1
Higher attention in meetings	19
Higher equality in terms of po...	4
More sufficient meeting docu...	0
No preference	1
Other	9



25. What do you think will be the approximate ratio of virtual and physical meetings at your company when sourcing ideas in the future (the ratio is defined as virtual/physical in %)?

Insights

100/0	0
75/25	20
50/50	17
25/75	4
0/100	0

26. If you like to receive the results of the survey, please enter your e-mail address in the text field below.

Insights

41

Responses

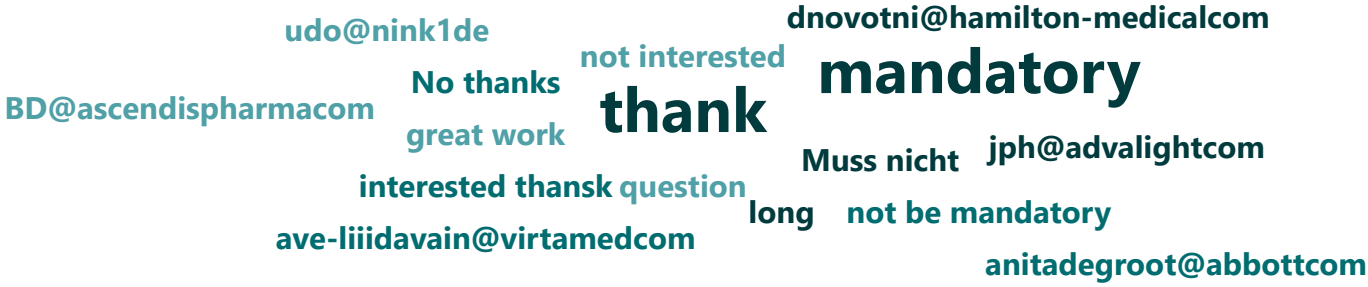
Latest Responses

"*No*"

"*?*"

"*?*"

2 respondents (**5**%) answered **thank** for this question.



Open Innovation in the MedTech and Pharma industry

* Required

* This form will record your name, please fill your name.

General questions concerning your company

1. In which industry is the company you are working for? *

- [ ] Medical Technologies
- [ ] Pharmaceuticals

2. How big is the company you are working for concerning employee numbers? *

- ( ) Micro Enterprise (Fewer than 10 employees)
- ( ) Small Enterprise (10 to 49 employees)
- ( ) Medium-sized Enterprise (50 to 249 employees)
- ( ) Large Enterprise (250 or more employees)

3. Is your company a subsidiary of another company? *

- ◯ Yes
- ◯ No

4. Where is your company located? *

- ◯ Germany
- ◯ Switzerland
- ◯ France
- ◯ Spain
- ◯ Italy
- ◯ Netherlands
- ◯ Belgium
- ◯ Ireland
- ◯ UK
- ◯ Denmark
- ◯ Other European country
- ◯ Other

5. Do you have an own R&D department *

- ◯ Yes
- ◯ No

6. What is the approximate annual revenue of your company (in million €)?

The value must be a number

7. Who is responsible for open innovation projects and scouting new ideas or partners in your company? *

- [ ] Inhouse R&D department
- [ ] Inhouse Innovation department
- [ ] Inhouse external collaboration department
- [ ] External company for idea/innovation sourcing
- [ ] Subsidiary company specialized in idea/innovation sourcing

8. How do you rate the importance of collaborating with external stakeholders for idea sourcing in your industry? *

Not important at all	Not important	Rather unimportant	Neutral	Rather important	Important	Very important
○	○	○	○	○	○	○

9. Does your company collaborate with external stakeholders for idea sourcing? *

- ○ Yes
- ○ No

10. How do you rate the importance of following external collaboration partners for idea sourcing? *

	Not important at all	Not important	Rather unimportant	Neutral	Rather important	Important	Very important
Customers	◯	◯	◯	◯	◯	◯	◯
Suppliers	◯	◯	◯	◯	◯	◯	◯
Start-ups	◯	◯	◯	◯	◯	◯	◯
Universities	◯	◯	◯	◯	◯	◯	◯
Research facilities	◯	◯	◯	◯	◯	◯	◯
Venture capital firms	◯	◯	◯	◯	◯	◯	◯
Competitors	◯	◯	◯	◯	◯	◯	◯
Open Innovation platforms/competitions	◯	◯	◯	◯	◯	◯	◯

11. Was it easier for you to gain access to external knowledge and scout for projects with external stakeholders VIRTUALLY? *

- ◯ Yes
- ◯ No

12. How many early-stage innovation concepts did your company usually generate in collaboration with external stakeholders in a year before 2020? *

- ◯ 0-5
- ◯ 6-10
- ◯ 11-20
- ◯ 20 or more
- ◯ Not sure

13. Did the amount of innovation ideas generated in collaboration with external stakeholders decrease since COVID-19 pandemic affected Europe in 2020? *

- ◯ Yes
- ◯ No

14. How much did the amount of innovation ideas generated in collaboration with external stakeholders approximately decrease (in percentage)?

The value must be a number

15. Did your company stop or continue innovating with external stakeholders during COVID-19? *

- ◯ Stop
- ◯ Continue

16. Why did you stop collaborating with external stakeholders for idea sourcing? *

- [ ] Monetary reasons
- [ ] Long-lasting innovation project duration
- [ ] No progress seen without any physical meetings
- [ ] Existential anxiety
- [ ] Change in priorities, because the focus is/was on COVID-19 measurement implementations
- [ ] Change in priorities, because the focus is/was on the adaptation of new EU regulations

17. How did you MOSTLY deal with external stakeholders for idea sourcing before the year 2020? *

- ◯ Virtually (at e.g. virtual innovation events)
- ◯ Physically (at e.g. physical innovation events, testing group meetings or general physical meetings, etc.)
- ◯ No collaboration with stakeholders

18. What do you think has been the ratio of virtual and physical meetings at your company whilst sourcing ideas in the past (in %)? *

	0-20%	21-40%	41-60%	61-80%	81-100%
Virtual	◯	◯	◯	◯	◯
Physical	◯	◯	◯	◯	◯

19. Did you switch to solely virtual communication for idea sourcing, because of physical meeting restrictions caused by COVID-19? *

- ◯ Yes
- ◯ No

20. How would you rate the importance of the following aspects during idea sourcing processes? *

	Not important at all	Not very important	Rather unimportant	Neutral	Rather important	Important	Very important
Trust	◯	◯	◯	◯	◯	◯	◯
Costs	◯	◯	◯	◯	◯	◯	◯
Amount of innovations generated	◯	◯	◯	◯	◯	◯	◯
Linguistic communication barriers	◯	◯	◯	◯	◯	◯	◯
Duration of decision-making process	◯	◯	◯	◯	◯	◯	◯
Ecological footprint	◯	◯	◯	◯	◯	◯	◯
Attention in meetings	◯	◯	◯	◯	◯	◯	◯
Waiting time for meeting confirmations	◯	◯	◯	◯	◯	◯	◯
Equality in terms of power representation	◯	◯	◯	◯	◯	◯	◯
Meeting documentation for reprocessing activities	◯	◯	◯	◯	◯	◯	◯

21. Did you realize any changes when solely dealing with external stakeholders VIRTUALLY during idea sourcing processes? *

	Worsened	Did not change	Improved
Trust	◯	◯	◯
Costs	◯	◯	◯
Amount of innovations generated	◯	◯	◯
Duration of innovation process	◯	◯	◯
Linguistic communication barriers	◯	◯	◯
Duration of decision-making processes	◯	◯	◯
Ecological footprint	◯	◯	◯
Attention in meetings	◯	◯	◯
Waiting time for meeting confirmations	◯	◯	◯
Equality in terms of power representation	◯	◯	◯
Meeting documentation for reprocessing activities	◯	◯	◯

22. What do you prefer in terms of sourcing ideas with external stakeholders, in order to increase innovation capabilities? *

- ◯ Virtual meetings
- ◯ Physical meetings

23. Why do you prefer virtual meetings over physical meetings in terms of idea sourcing? *

- [ ] More trust
- [ ] Fewer costs
- [ ] Higher amount of innovations generated
- [ ] Less linguistic communication barriers
- [ ] Shorter duration of decision-making process
- [ ] Lower ecological footprint
- [ ] Higher attention in meetings
- [ ] Shorter waiting time for meeting confirmations
- [ ] Higher equality in terms of power representation
- [ ] More sufficient meeting documentation for reprocessing activities

24. Why do you prefer physical meetings over virtual meetings in terms of idea sourcing? *

- [ ] More trust
- [ ] Fewer costs
- [ ] Higher amount of innovations generated
- [ ] Less linguistic communication barriers
- [ ] Shorter duration of decision-making process
- [ ] Lower ecological footprint
- [ ] Higher attention in meetings
- [ ] Shorter waiting time for meeting confirmations
- [ ] Higher equality in terms of power representation
- [ ] More sufficient meeting documentation for reprocessing activities

25. What do you think will be the ratio of virtual and physical meetings at your company when sourcing ideas in the future (in %)? *

	0-20%	21-40%	41-60%	61-80%	81-100%
Virtual	◯	◯	◯	◯	◯
Physical	◯	◯	◯	◯	◯

26. If you like to receive the results of this questionnaire, please enter your e-mail address below

Interview with Dr. Michael Hein

Jörg Nink:
Alright, everything works then I would basically share my screen right now, because I prepared a PowerPoint presentation. First of all, before we start, is it possible for you to just introduce yourself very quickly?

Michael Hein:
Yeah, my name is Michael Hein. I spent over 30 years in the meantime in the research, early development or innovation of Böhringer Mannheim and Roche Diagnostics in diabetes care, but on noninvasive and continuous glucose monitoring technologies, launched some products there, especially in the field of painless blood sampling, then moved to Switzerland with Roche and started the Micro Technology Center for the Diagnostic division of Roche. Then I was running several innovation early research. Sorry early development departments or teams like Advanced Systems Group. Consumable ITA aspect, wherein Roche the business areas usually have an R&D, which is strong in in the biochemical part, so we were complementing the non-biochemical part to create a solution or system. Now I'm in Roche Information Solutions and many projects are now addressing patient journeys etc.

Jörg Nink:
Perfect. Thank you very much. That's a great introduction. Then I think we could already start with the interview. Thank you very much for participating at first and well, let's start then. So my topic is basically open innovation management in the European medical technology and pharmaceuticals industry and accompanied effects of physical as well as virtual innovation practices. It sounds more complicated than it is probably. But we'll get into more detail in the following agenda. At first we will discuss the aim of the thesis and the aim of the interview. Then we'll clear questions. If you have any questions about the topic or in general. Then we continue with what is the scope of my project and we will clear that, so we'll discuss that in this point and then we will get actually to the questionnaire because my questionnaire consists of four different dimensions which will go into. The first dimension is basic information about the company, how many people they have etc. Dimension 2,3 and 4 are

more topic related, which is why we also need to look at the Readiness level model. I don't know if you've heard of it before.

Michael Hein:
Oh yeah.

Jörg Nink:
Yeah probably, but I will just explain the extent very quickly to show the scope of my thesis, because it does not concern all levels and at the end there is the final question as well. OK, to go through the beginning is very quickly. The overall research question focuses on how open innovation is conducted, the extent of how remote only work affects innovation management and the juxtaposition of physical and virtual innovation practices in collaboration with external stakeholders this. All this does concern the medical technology and pharmaceuticals industry in my thesis. And the end of the interview is basically to gain expert knowledge on the topic addressed through those interviews and use this expert knowledge to conceptualize and create this quantitative instrument. So the questionnaire or survey that will be a questionnaire with approximately 15 questions. It does not sound that much, but they have loads of answer possibilities already, so sometimes there are twenty answer possibilities, so I think this is totally enough considering that the perfect average of answering a questionnaire should be between 10 and 15 minutes. Well the questions are grouped in 4 dimensions and will be sent to 270 companies across Europe which are already sorted in an Excel file.

Jörg Nink:
Yeah, are there any questions so far?

Michael Hein:
Yes, so I just wonder why just Europe, because 270 is a lot?

Jörg Nink:

This is actually a good question. The problem is if we consider all different continents they all handled it differently. In Europe there was at least a little alignment between the restrictions etc. OK yeah, alright so let's start with dimension one. Let's say I'm not sure, if there are any

questions as well, but it generally deals with the general facts about the company. Where is your company located? How many employees do you have? Which industry are you in? Which department are you in? I also will add a subsidiary question, because especially in pharmaceuticals and medical technologies is probably the case. Yeah, is there anything? I mean you don't have to answer these questions, but is there anything you would basically add? What would be interesting for you to know about companies participating?

Michael Hein:
I think I would add which department. I mean. It's called innovation management in Roche information solutions. You know, I think the industries in vitro diagnostics. And the employees question, is this my crew or is it the diagnostics division?

Jörg Nink:
I'm sorry, what do you mean?

Michael Hein:
The employees question that is referring to Roche Diagnostics.

Jörg Nink:
No, this actually another good thing I will add this, uh, generally to the company. For instance, you working at Roche, how many employees does Roche have at this specific location.

Michael Hein:
Thank you.

Michael Hein:
Uh, in Rotkreuz. I think it's round about 4000. Yeah, but for innovation. I think that that this would be important. Whole Roche really has a decentralized innovation approach. In their different customer areas. It's a very heterogeneous business serving what we call now Core-Lab, Pathology Lab, Molecular lab and point of care. And these all have different, let's say centers of gravity.

Jörg Nink:
Uhm, would you add anything else to this dimension? Probably not. Then we will jump into the proper topic.

Michael Hein:
No, go to the next one.

Jörg Nink:
Yeah, so basically technology readiness level.

Michael Hein:
Yeah, and I know it by heart. Oh yeah, we applied it for a decade.

Jörg Nink:
I took this from the NASA and we're just actually concerned about the first 3 levels.

Michael Hein:
That's a good choice.

Jörg Nink:
So the 1st 3 levels or the first three stages are the ones we actually focus on. Basically conceptualizing where you actually have to have a lot of interpersonal, let's say relationships or communications. This is what we're concerned about while talking about the dimensions.

Michael Hein:
We really liked it and we added another dimension to the business readiness. NASA typically doesn't have a business viability. Just go to the moon. Yeah, cost no issue and bring them safely back and, but this goes now into the dimension two.

Jörg Nink:
Ok. Then let's continue with dimension 2. It basically deals with the general importance of

open innovation and well, what actually does contribute to it. We have three questions in this dimension. At first, how do you rate the importance of collaborating with external stakeholders for idea sourcing? If you like, you can also answer this point.

Michael Hein:
Now I can like I can start. The first of all, disclaimer Open Innovation sometimes uses different definitions. I became familiar with open novation working with companies or service providers who provide ideas or where you can place a challenge? Yeah, but maybe that's not referring to what you are meaning. The importance of collaborating with external stakeholders is super important. And I regard as the customers is our prime stakeholder there. So first of all, if you really want to change something, listen to the customer and the environment. Understand the problem. And this is little bit a potential trap of the technology readiness. Usually we or engineers and scientists tend to fall in love with this solution. And there are elements which are beyond the technology readiness, like empathizing with the customer or design thinking and co-creation. So from my perspective work for idea generation with universities and academia they tend to be a little bit too far off. However, there is a continuous stream that's a good position of Roche of prestigious institutes, including MIT, Caltech you name it. Even the venture capital space they say hey Roche, don't you think that that might be interesting for you? And usually this is dealt with our business development and Chief Technology Office. So there is a kind of a post box where all the ideas are aggregated and kind of ranked and prioritized. Active collaboration or seeking ideas at the moment or in my life. The last 10 years we were trying to understand the problems and especially in the IT space. Usually the technical feasibility is not that critical. You can find always a work around. It is more about making the solution easily deployable. Cost efficient, highly usable, save, regarding the data handling secure and things like that.

Jörg Nink:
Yeah perfect. Is there any other stakeholders where you think they are actually from very high importance?

Michael Hein:
Yeah. One continuous stream is you are working with venture capital firms. Maybe you heard about the keyword would be crea-sphere like creative sphere. Where we get our selections of

hundreds of venture companies which might be at different stages of maturity. Early stage. Late stage. Which might be interesting for our space, yeah and well with whom we can contact. And then there is typically a selection and we are continuously working with 10 to 15 of these companies at different stages of collaboration.

Jörg Nink:
So venture capitalist, also one that I should put in the selection, right?

Michael Hein:
Yes.

Jörg Nink:
Thank you. Also, do you consider collaborating with external stakeholders as more important than solely sourcing ideas within company borders? And only with the help of internal employees? So do you consider this external external stakeholder collaboration approach is more useful than innovating internally? Probably yes, you answered this as well.

Michael Hein:
If you replace external stakeholders with customers or other ecosystem players? Then it's definitely a yes. The diagnostic business is in many aspects, approaching the end of the S curve. So there is not too many dimensions, which look disruptive. From a technology point of view you can sequence a little bit more cost efficient, but also biological molecules will design the rearm of individual diagnostic, whether it's small analytes, proteins or genetic information. It's more or less there. You can improve things, but by definition. Even if you have a handheld single molecule genetic sequencing something you know where you can sequence your dog in a minute, who would care. Now, what I'm saying that technology part it's not looking for good ideas on how to do things different or better, it's more on how to shave the ecosystem. Now, that means that you are talking not only to customers and that you constantly challenge your perspective on who might be a future customer. I'll give you an example, if we talk to health care providers like a physician, you get a totally different assessment of an idea on how to improve a patient journey, for example, then talking to health care insurances. With them on the opposite of the table, which comes more and more a crucial aspect. Less technology innovation and more business model, process and eco-system

innovation and there is some disruptive potential on how to sell diagnostics in the future. Another example for technology innovation would be, if you can do all the laboratory tests in the same quality and with less cost or similar cost point of care. So at home or whatever. But that would be potentially disruptive. There were companies trying this, but with some biochemical fundamental limits. This would change the workflow or the business to some extent, but it is not in the super focus. Only the emergency parameters like cardiac markers or stroke markers and things like that to have that in a decentralized setting.

Jörg Nink:
Considering the dimension 2 would you add something? What would you like to know about? For instance about open innovation? Is there anything that you would add just considering innovation and not the virtual versus physical collaboration aspect.

Michael Hein:
Know your customer. Technology will come.

Jörg Nink:
OK good perfect. Then let's jump to dimension 3. Now we get totally into the topic I guess. Well, this dimension deals with being solely able to innovate, virtually, which we have right now during the COVID pandemic, which was actually a perfect example to test it right? So because we were unable to meet physically anymore and which is also why the two first questions are basically opposites. The first question deals with how many innovations or ideas were sourced in collaboration with external stakeholders in the year before 2020, and the same thing as soon as the virtual or remote-only time started, so this is where the first two questions relate to. I don't know if you have anything to say. Did actually realize anything during this time?

Michael Hein:
Oh yeah. So fasten your seat belt. Before COVID there were endless discussions to align with customers for a visit to get the CEO or the CFO together. Lab director to get the lab stuff on board and to run, for example a workshop. It took months, essentially. During COVID our dearest customers learned to work with Microsoft Teams, for example and started to send us videos, how the workflow is. They're super easy. It's super easy to set up virtual meetings.

Usually you have to enter a plane. So a day or two days are gone visiting a customer. I would say the collaboration is affected two or three better and also more ideas. So I mean, I love virtual meetings. Now it's much easier to set up two hour meeting then having this dining customer visit. Imagine, if techies are going to visit the customer you have a lot of let's say Roche "policeman". They are there, so that they do not overpromise. Then you have to align with global and this is much easier and much more informal in the early phase. It is also easy to quickly set up a one-hour follow up to say: "I have a couple of questions" and it's less disruptive for the customers. They can choose half an hour or one hour. When they don't have to pick you up at the airport. This is also definitely beyond Europe. So with America in general we are running a lot of flex teams with affiliates. The virtualization of our customer interaction or the push to go that route really helped. To exchange quite often or more often with our customers and the externals.

Jörg Nink:
OK, perfect thank you and then considering the next question. Of course, this is probably not the case for you, but did your company stop, reduce or continue innovating? You know during COVID and during this virtual-only time do you know any companies, especially in Pharma or MedTech that actually stopped, because of course most companies were affected by it, but I'm not sure if this is the case in the Pharma and MedTech industry. Because right now, I actually did not hear that companies stopped or reduced during this time so far.

Michael Hein:
I'm just scanning the last 18 month and maybe 80% went better and really adopted to the virtual to the new normal and in maybe 20% our collaboration decreased or was put on hold. I think I'm pretty sure you have somewhere a question concerning innovation and that there's one very important currency that is this trust thing. I will comment on this and essentially in a nutshell, I would say the organization, stakeholders or companies we have been collaborating with and had all these personal meetings rather went better. I think it's more, it's a no brainer. It's more complex to start a new collaboration from scratch with new people. So there is something like human glue between people somewhere, which is not so easy to generate in virtual meetings.

Jörg Nink:
Accurate. Yeah, this is basically what I'm coming to in dimension 4. Basically you won't see it here because it's part of my answer possibilities in the questionnaire. I told you that there's like several things on why for instance, virtual and physical should be juxtaposed as e.g. the trust.

Michael Hein:
For example we are running projects with the DFKI (Deutsches Forschungsinstitut für künstliche Intelligenz). It was set up pre-COVID and the collaboration worked perfectly than after this in a virtual environment. Also, the European Union was part of the whole thing. It's really part of an open innovation. So we really went fully virtual. It was however though, a digital project about artificial intelligence.

Jörg Nink:
Before that point you probably still had a lot of those physical meetings then, right?

Michael Hein:
Before that point. They had their headquarters in Saarbrücken and well it's a pain in the neck to get to that. However, don't get me wrong, we were treated really nice, yeah, but there's no time. The costs, because travel cost is something. And then there's an interesting one. If you decide to have a face-to-face meeting, you select people carefully. If you have a virtual meeting, it's super easy to blend people in and out. So now you can say you can have a face-to-face meeting in virtual in parallel. But that's a little bit of strange though, and it's something different then. Rather have all people virtual. Yeah, don't ask me why. That seems to be more fair than having people sitting in their room exhausted. So it's strange, so it's a lot of advantages. And especially in the software IT I think you can run this now fully virtually.

Jörg Nink:
So so actually you talked a lot about those differences between the pros and cons. Maybe at some point. I mean, you said already, the costs were at some point lower due to traveling, is that right?

Michael Hein:
Absolutely.

Jörg Nink:
But considering the process length again. Did this actually take you or did you realize any hurdles or obstacles where you say that this could have been easier resolved in a physical meeting right now.

Michael Hein:
Only in rare cases. So giving my experience pre-COVID was if you're starting a collaboration, let's say with the notorious IBM of one of the research centers. You usually feel obliged to have a face-to-face meeting with six lawyers there. In my view a super complex start up phase and there was kind of a codex to doing it face-to-face, which sometimes is wrong, it's just wrong. Let's do the first informal. Whether there's an immediate match. Let's do it not over phone over video. And after this one and you have a little bit of plan then it would maybe make sense to have a kick-off meeting or something like that. In the meantime, my team members. These guys they are sitting at their hometown, which is Barcelona, Ankona, northern Germany and now this is kind of accepted and we can keep these people at least for the project or even longer, because they are already immersed in the Roche world and there is no disadvantage, if everybody is virtual. When we are going back and this is really concerning us and I decided just to give you this. This is not a joke. We decided to have our first onsite workshop where everybody commits to be on the same side in my team about working onsite. Which is a nice twist, yeah, but maybe you can quote me. That's really changed a lot, especially in this early international faces, and especially if you're referring to open innovation it is even easier to reach out to e.g. MIT or out to our friends in Sant Cugat or something like that.

Jörg Nink:
But would you also consider if we're talking about this cultural aspect if you have, for instance, I know that we talk a lot to, for instance, Hitachi. Is that true? And they're Japan? Is this Asian culture where you?

Michael Hein:
Good point.

Jörg Nink:
Yeah, this is like basically what they're known for. I don't know you go out after your business day for instance, and then you still talk about it and actually some things actually crystallize or like get clearer even.

Michael Hein:
No, absolutely it is. That's nowhere we showing to the trust thing. And there's some colleagues like, which really builds upon this trust. The US culture feels a little bit more pragmatic? Yeah, if there's a deal what's in for me and you align for certain couple of weeks on the project and I'm wondering whether we will continue to have these BI weekly flights to Japan. Even Hitachi on the other side or the Japanese partners think about it. Definitely you shouldn't put it to zero, but maybe 80/20. I'm looking forward to this on site Workshop about onsite work. It feels to me the face-to-face could be reduced by 60 to 80%, which is massive. Never thought this would happen.

Jörg Nink:
Yeah, perfect OK this is a good point. Then I will just ask you one last question, because you probably already have to go. Well, what did you actually prefer? I hear it out. You definitely prefer virtual meetings, I guess right?

Michael Hein:
Not with my family haha. I give you another advantage for virtual meetings you have this idea sourcing, yeah? In a virtual meeting, it's much easier for me using tools like Miro or Trello or whatsoever, that everybody has a voice and so the people tend to be more equal. While this sounds a little bit old style, but in some meetings, if there are some people sitting in the room physically they are kind of dominant. The meeting runs differently in case you have a few guys pushed against the wall, not delivering the revenues then in having equal partnership and sometimes they even don't know the people. Especially, on this equality for idea sourcing I found it very helpful to have it directly in electronic format. Yes, by the way. Also pain in the

neck if you have this sticky notes battles. So you have also rather good documentation. In general, I would say this virtual meetings are better or they're better documented than non-virtual meetings. And now I'm serious about it and there's so many team meetings around the world, about this project, this project and maybe 30% may be recorded for the people who can't participate. Great thing. And then just a secondary effect. Having the idea or discipline to contribute and to commit to the project or to the meeting also tends to be higher and more focused and attendant in some areas in the virtual meeting. You have to take care of your partners and teammates and there's many meetings where you can do emails or whatever, but not in ideation meetings, and you keep them busy and you see directly the contributions there. There it is like a little bit Big Brother is watching you, but for public. The willingness to contribute and also the discipline. I say a sentence, you say a sentence and I raise my hand. It's a lot of good things.

Jörg Nink:
Yeah, so basically considering this whole questionnaire now would you consider anything else as important for the scope of my thesis? Would you say OK he missed a crucial part in this thesis maybe to be addressed. There's a lot of research behind it already.

Michael Hein:
Yeah, I'm I'm looking forward to to see it drop. The overarching question is now this COVID helps us to push talk to virtual. Everybody now who has access to a laptop or whatever tablet and Internet could participate. So it's probably accessible to a large amount of people, you know there's no better or worse or whatever. I am wondering what are the principles to say now let's go physical an no let's keep it virtual. Well that one of the questions which is bothering me and I'm really happy that you are working on this. And help me to answer this.

Jörg Nink:
Thank you and this is basically it. If you don't have anything to add, I would just stop the recording.

Michael Hein:
I mean, it's fine, stop it.

Interview with Dr. Klaus Suwelack

Klaus Suwelack:
Definitely changed in the last few years and I think it's absolutely necessary to deal with the outer world 'cause 99% of innovation takes suppliers outside the company and not inside the company and therefore we say we have to deal with the ecosystems outside the company, in order to get access to know how from universities from startups, from a scientific organization or even patient organizations which are necessary to find out patient preferences, for example extremely important stakeholder and idea sourcing. I is vital now I would say it's not nice to have, it's vital now.

Jörg Nink:
Very good and I mean you answered already. For instance, some stakeholders that you need to consider while doing this. This would also be my next question, does your company collaborate with external stakeholders for idea sourcing? If yes, with whom? So basically who will be the main players? You don't have to list everything you know, right?

Klaus Suwelack:
No, no, but but definitely universities, scientific organizations like Fraunhofer or something like that and then biotech startups are extremely important for our business. Startups in the field of digital heads, so smaller corporations are very important for us, in order to get access to it to the newest and latest innovations from outside the company. One must say that the scientific environment has become so broad that no company can have a complete overview on what's happening outside and is able to bring in the whole knowledge and development inside the company. You have to partner with external companies, in order to be at the forefront of science. Then it is necessary to be in contact with universities, scientific organizations, and so on. As, as I already mentioned.

Jörg Nink:
Yeah perfect OK. And then there we have the last question of dimension 2. Do you consider collaborating with external stakeholders as more important than solely sourcing ideas within company borders and only with the help of own employees. So you already actually answered

this, because you gave us a lot of information. So you definitely say it is just essential nowadays.

Klaus Suwelack:
Yes, it is central, but on the other hand it's necessary to have own people inside the company who can evaluate the external landscape so. You definitely need new and different capabilities than before hand when you were looking on your own, you have to have a broader scope and people inside the company have to be able to evaluate everything that's coming from outside so.

Jörg Nink:
Of course, yeah makes totally sense true, and so thank you first for the information that will actually help me very much. Would you actually, if we just talk about how important is open innovation to you or just the topic of innovation? Is there anything you would add? I mean in the later process we will deal with the physical and virtual aspect and which impact virtual has on the company, but just considering open innovation, would you add anything else?

Klaus Suwelack:
Yeah, and maybe the question and it comes already within the 3rd bullet point. Whether you need a known R&D department or not and, and I think it's important that you have one, because you cannot rely on the external environment completely and definitely you must be able to develop something on your own, because for example, if you collaborate with a startup, they might develop a product close to the prototype and then you have to develop the whole clinical part of the product development that is something that you have to have inside this know how and nobody would partner with you if you wouldn't have an own research and development organization that is able to to develop something similar to what a startup does.

Jörg Nink:
Perfect. This is also very good information. Is there anything else you would be interested in for instance? Otherwise we can proceed with dimension 3.

Klaus Suwelack:
Yeah, yeah, I I'm not quite sure, but you could ask where does this part of the organizer in the organization sit in the organization? Is it R&D itself that is responsible for open innovation? Do you have an own organization? For example at Johnson and Johnson? We have one we have Johnson & Johnson innovation. That's the part of the organization that's responsible for scouting the outer world, so to say. So that could be of interest. How this is organized within.

Jörg Nink:
Cool OK, this is very good and I think I noted everything and now we can proceed to dimension 3, if that's OK for you. Also, if you want to skip back or anything if you have something in mind, just let me know. So basically the dimension 3 deals with the impact of solely being able to innovate virtually as during, for instance, the viral pandemic Corona we had just right now and therewith associated force to avoid maintaining usual habits, As for instance the physical meetings. So, if for instance you want to innovate, I've heard from several people that those physical meetings are usually very likely to conducted and well. Then we have questions as e.g. How many sourced ideas do you? Does your? Did your company usually generate in collaboration with external stakeholders in the year before 2020? So how much did they actually do before something as this viral pandemic hit and how much did this increase or maybe even decrease during the pandemic? I mean, we're talking about the medical technology and pharmaceuticals industry so.

Klaus Suwelack:
I don't have an overview on the exact number, so that's nothing I could even guess how many. How many ideas are evaluated within Johnson and Johnson or within London, but.

Jörg Nink:
So it's a. It's a very general and broad question then you would say right so I should maybe even.

Klaus Suwelack:
Yes. You only can give a rough estimate or an estimate before and after, and if I include the second bullet point, I would say that most of the corporations made with the external world

didn't go down during the pandemic because of all the instruments that we are using. For example partnering conferences where we are meeting startups or conferences or do match and mingle with other companies and all this business development stuff. That was rapidly changed into virtual meeting. So for example the biggest industry fair in this area is the BioEurope or the BioUS? Where biotech companies meet big corporate companies and it's twice a year and the most important fair I would say where these people meet and this was rapidly changed into virtual conferencing situation and it was even much easier to get access to the people via virtual tools then in real life, because it was rather easy to get someone from Washington, Singapore and London together in one room, whereas in the situation before 2020 you had to bring those people from one continent to the other, bringing them into one room and partner with startup for example. And that was often not very effective, so I would say that the virtualization in this case brought a lot of positive effects in terms of efficiency and we could even see more companies and evaluate more companies than before. But that's I would say a short term effect, because this worked, due to the fact that most people already knew each other and then it's not that difficult. So this effect may last for two or three years, but due to the fact that personal contacts and relationships are important this must change in a way so that in the future we do have these virtual meetings, but on the other hand, meetings where people can meet each other personally, due to the fact that for example people from Asia Pacific often more rely on personal relationships than others who are quite efficient and where it makes no difference whether you will sit together with the guy from Texas, because it's not that important that you have your beer afterwards? So I think in principle this will bring a positive efficiency effect. But the question is, how long does it last and the second thing is that I assume that this will lead to a way of a hybrid solution later on where people meet for a shorter period of time personally and do a lot of this matching and working together on specific projects in the virtual world. So in virtuality.

Jörg Nink:
Yeah well, one second I'm just writing. Yep perfect. So basically then we also answered the last question from dimension 3 because you said you basically didn't stop and it seems like you did make any experience. I mean usually during the pandemic you heard that a lot of companies were bankrupt at the end, right? And had to stop and had problems struggling, but this was probably not the case in the Pharma and MedTech as it sounds from your experiences right?

Klaus Suwelack:
I would say at least it didn't come to our knowledge so far. I know that a lot of startups were in trouble in terms of burning money without getting anything back, but I think the politicians were quite eager to support these companies and make it happen that for the time being, we don't see a big wave of bankruptcies based on COVID-19 at least in in the Western world, I would say I don't have a good overview on Eastern Europe or Asia Pacific, but at least in the Western world I would say there was not that big company drain due to COVID-19.

Jörg Nink:
Perfect thank you very much for this and we can proceed to actually the last question. The last dimension of my questionnaire to be honest. So we basically now have discussed all the information things and we are dealing now and the last dimension with basically the physical and virtual differences during open innovation practices you answered already a lot of them, because you have so much knowledge, you just need to let it out. That's perfect. I'm just repeating it. How did you mostly deal with external stakeholder idea sourcing before the year 2020? Virtually physically that you do a mixed approach?

Klaus Suwelack:
Yeah, I think most of the meetings we're definitely physically before the COVID-19 crisis and there was already some virtual attempt, I would say, but there was no pressure behind it and therefore these virtual congresses that already existed before COVID-19? They were not that fancy as the other conferences, because people liked to drive, to fly to Singapore to meet a few people there and people like to fly to San Francisco or San Diego for a startup conference mix up and that's natural I would say that people want to meet other people and by thus seeing the world. So, but it's not very efficient I would say, and therefore it later on during the pandemic rapidly switched to virtual communication and in partnering, because of the restrictions. So that's definitely happened very fast, because it was easy and technology was existing and people just had more time to participate in virtual conferences because it was so easy and you don't have to fly 8 hours over the Atlantic and you saved already these eight hours and you can do something else with it so. Therefore it works very efficient. I would say. And some of this will stay definitely later on.

Jörg Nink:
Well, I probably think in the next question you basically suddenly switched to virtual communication during the pandemic I think, right?

Klaus Suwelack:
Yes, I guess it's meant to be, because J&J was closed down. People had to stay in home offices, so that it wasn't even possible to go to any partnering conferences, but this has been virtualized and in principle, when you already know the people that was much easier than before, the question is whether you would get to know people you met for the first time. So that's something that was not that positive. That's not so easy to get to know people then just in the virtual space.

Jörg Nink:
OK, and then now we actually come to like questions that have basically up 20 answer possibilities at some point or even more because through my studies and through several literature reviews I well, if we're talking about virtual and physical pros and cons, for instance in meetings, I already sorted some stuff out, but during the next questions, if we're answering them, if you were answering them or if we're talking about them, you could maybe just say what would be the thing that just comes into your mind and would be also good for me to know. Of course, maybe I can add something, but also highlight some of the parts right that I have my answers. You won't see the answers now, but it's also not. You shouldn't see the answers. I guess it's my intention so that you can really think of what comes to your mind at first. So did you realize any changes when dealing with external stakeholders solely virtual during idea sourcing processes? Were there any changes where you say, OK, this was maybe even negatively, positively or just different, neutrally.

Klaus Suwelack:
I think it did. The interaction was definitely different, but neutral . I wouldn't say that it is so negatively impacted I think. What I can say that people interacting virtually are much more focused on what's going on then people in the physical interaction, because there are so many distractors around. The physical interaction, but when you're just looking at the screen and just focusing on the content or not on the people. This has definitely a positive effect not only for efficiency, but also on people concentrating more on the topics that are on the table and

not be distracted by their iPhone or so. People are very much focused and I would say it's a bit more demanding so you have to be more present during a virtual meeting compared to others, because you have to focus and that's something that's different and might be a little bit more distressing. So after two or three hours virtual meeting it is little bit more stressful than a two or three hour meeting in the physical space where you have always interactions on the sidelines that are not focusing on the topic that you were talking about.

Jörg Nink:
Makes also total sense. Yeah, how would you rate the importance of certain aspects during idea sourcing processes? You won't see them right now, but just if you think about any aspects, for instance cost, how important are they doing? Idea sourcing processes, process length? So how long does it take? Trust in general interpersonal connectivity or relations. What would be maybe, let's say the top three aspects that you would consider during those idea sourcing processes.

Klaus Suwelack:
Yes, one is definitely the question of trust. So if you don't see the people or never met the people before and then it might be difficult. So you need some kind of an inter-relationship that you develop before you move into an open innovation interaction. I would say so the question is how to generate trust before or within a virtual meeting that a little bit tricky, so therefore it worked much better when there was already some business relationship before hand, and that's what I mean when I say there will be a mix later on, because it's absolutely necessary that sometimes people meet each other, especially for this question of trust. What's missing is sometimes the personal inter-relationship. You don't read the body language, you don't speak with. Somebody is tired or not attentive for whatever. This is something that's because people then put down their camera and that's something that's negative I would say and it's important to find of course ways on how to bring this aspect of interaction come into the new world later on.

Jörg Nink:
Also makes completely sense. I think this is also enough for this. I think, if you have anything to add there feel free, but this is totally enough I guess. I think you've answered so many aspects that are important for you as well during this time in the previous questions. So

totally perfect, have enough stuff for that. Otherwise, what do you prefer? So we actually come to the last question. If we combine it. So was there a point where you say you prefer one of those different techniques that you say physical is basically better than virtual or virtual is for you personally, better than physical?

Klaus Suwelack:
Yes, I think physical is definitely better when you start an inter relationship with the new company or a new partner. So I would always advise to go physical when it comes to building relationship and building trust and then for the sake of efficiency you can do a lot of meetings, virtual and then in between you have some physical touch points as well. So I think the hybrid model will later on be the one that will be preferred. And personally I'm somebody who wants to be in contact with people physically, so that depends a little bit on personal preferences, but I like definitely like efficiency in virtual settings where you are focusing for a short period of time and then it's done.

Jörg Nink:
Sure, well and those were basically all my questions and now we come to the last part the final question. So if we consider that the questionnaire should approximately take around 10 minutes so that nobody is bored of it after a while and just stops at some point. Is there anything else you think of, if you just consider that it should be 10 minutes not more? Is there anything you would add o anything that is interesting or could be replaced. I don't know if you know it right now, but and I mean I already made up my mind several times about how to structure these. If you know something, please let me know.

Klaus Suwelack:
No, no, I think for the time being everything is good. I would doubt about the 10 minutes. I would say mill be 15 depending on the nature of the people who are answering this, but I couldn't see now the final questions, but my guess would be rather 15 minutes.

Jörg Nink:
OK, definitely so the thing is for them it is also pretty easy. They don't have to write full text, it just that they have to click yes or no or this and that. But yeah, definitely right. I think 15 minutes also for understanding everything.

Klaus Suwelack:

Yes, that makes things easier

Jörg Nink:

Otherwise thank you very much Klaus and I would just stop the recording

Interview with Prof. Dr. Andreas Braun

Jörg Nink:

Yeah, OK, so let's start very quickly with the introduction. So welcome to my topic for the master thesis open innovation management in the European medical technology and pharmaceuticals industry and accompanied effects of physical as well as virtual innovation practices. First of all, about the agenda, we will first start with the aim of the thesis, then the end of the interview. If there's something unclear, you can of course ask questions, and we clear them in advance before we then go through the dimensions of my questionnaire. So the quantitative instrument for my master thesis, which is to be reviewed after the first dimension, which is not that into detail. We will actually go before we go into the next dimensions into the technology readiness level model. I don't know if you've heard something about it. It is basically, especially if you're innovating, it's an evaluation model on which stage and innovation process you're actually at or located. So we just have a quick look inside of it to define the scope of the questionnaire or my thesis in general, because I'm not placing the focus on further stages like after the first stage, which we will see in detail at a later state. So we can start already the aim of the thesis is basically the overall research question is described as for instance, how open innovation is conducted. Then the extent of how remote-only work affects open innovation management and juxtaposition of physical and virtual innovation practices in collaboration with external stakeholders. This is of course focused on the medical technology and pharmaceuticals industry.

The aim of the interview is of course, as I already explained earlier to gain expert knowledge on the topic addressed specially in open innovation through this interview and to use this expert knowledge to conceptualize the quantitative instrument. The questionnaire will be send to approximately 270 companies across Europe and will consist of approximately 15 questions, which are then also grouped in 4 dimensions/subtopics. Concerning the topic of my master thesis, do you have any questions so far?

Andreas Braun:

No, I think everything is quite clear on. Essentially have more questions, maybe later on we can talk about this concerning the methodology, becauses I may see some well challenges in this. But I would go to this topic when we when I have a better understanding of the questionnaire, OK.

Jörg Nink:
Of course, yeah, sure. So let's start first with the questionnaire. The dimension one this actually deals with the general facts about the company. Where is your company located? How many employees do you have? Which industry are you or in which department are you in? During my interview yesterday, I also discovered that especially in the pharma and medtech industry, it's maybe from great importance to ask if the companies are a subsidary? Otherwise would you add anything about the general facts from a company? At this point? I'm not sure this is not the deepest question here.

Andreas Braun:
Which industry? The third question may be a problem because people. Do you give them a variety of different choices or do they write something in it?

Jörg Nink:
So yes, there will be different choices, of course, it is sometimes a problem because in different companies there's different names for some departments, but I gave choice.

Andreas Braun:
It's more about the industry, so you give the people choices to question #3. What industry are you in?

Jörg Nink:
Ah, yeah, it's just basically medical technology or pharmaceutical.

Andreas Braun:
Yeah, but still I mean the pharmaceutical companies. There's also some distinction, probably that can be made.

Andreas Braun:
Maybe I also would include something like, which phase of the pharmaceutical innovation process, do they mainly cover? I mean, there are big companies who definitely cover the

entire innovation process. But there are also some small and medium sized enterprises with specialized on. So this is something you may want to look in because, well, it has an immense impact on open innovation behavior, essentially. If you have the kind of full service provider or full provider, there's probably some reluctance or no necessity.

Jörg Nink:
Yeah, makes totally sense. If you are for instance, just physically manufacturer or yeah someone else.

Andreas Braun:
So this this is something you maybe want to look into.

Jörg Nink:
Yeah, that's a good idea. Thank you it is actually a really good idea.

Andreas Braun:
When it comes to the department's, I guess again, there's a selection of different departments they may want to choose, and I would go for something. I mean, this is somehow a difficult question. I assume not all companies will answer those questions, but I would at least try to ask about the revenue. For example, the annual approximately with a hint that it's not necessary to answer this question. I mean like if you want, please include the annual revenue. Something like this will be interesting as well

Jörg Nink:
Yeah, that's perfect and then, well, we can already discuss the technology readiness level. Have you heard from it?

Andreas Braun:
Yeah, I'm aware of that.

Jörg Nink:

OK, so well actually my master thesis is in the scope of probably just the research stage, so stage 1,2 3 and it is just the example from NASA. So we're actually concerned just about the very initial stages of idea sourcing basically and where there is, especially this very high interpersonal communication needed when they have to conceptualize everything. This is just to clarify, if we're talking about the dimension 2,3 and 4, just to keep in mind that we're not talking about properly bringing a product in the market at this time and just concentrate under research section. Dimension 2 basically deals with Open Innovation in the company itself. So basically just open innovation. For instance, the first question would be how do you rate the importance of collaborating with external stakeholders for idea sourcing? Of course this is a very short and superficial question, but then there is also something as e.g. does your company collaborate with external stakeholders for idea sourcing and if yes with whom? There is also great variety of answer possibilities. So it's very tailored to the industry, pharmaceuticals and MedTech. And the last question, do you consider collaborating with external stakeholders as more important than solely sourcing ideas within company borders and only with the help of own employees?

Andreas Braun:
My first question was how is the Likert scale?

Jörg Nink:
Actually, so far, just five, but I mean if there is a better example, you know, then yeah.

Andreas Braun:

This is some other questions that may lead to a bias, because I assume that there is nearly no company that would score here very low. We'll get this kind of. I'm not sure sugar effect it's called in statistics, so not well shaped curve but more like right now, politically speaking, right linear curve. I would also go with the question about you essentially asking the question how do you rate the importance of collaborating with external resources? So this is more like outside in perspective, are you only interested in an outside in perspective or are you also interested in an inside out perspective? I mean please keep this in mind.

Andreas Braun:
Because I assume that some companies are only collaborating with one way like inside out and others are collaborating outside in, and I assume there's also some coupled process again, strongly depending on your focus in the innovation process.

Jörg Nink:
You would actually basically add a question maybe concerning the outside-in and inside-out aspect, right?

Andreas Braun:
Yeah. I know from a lot of research that they're not only looking at the depth and also breath of collaboration so this is something I think you want to ask in question #2. Does your company collaborate with external stakeholders there? If yes with whom? OK, I think this is covered by so the breath is covered by question number 2 and the last question do you consider collaborating with external stakeholders as more important than sourcing ideas within the … . I wouldn't go with a yes and no answer here. Essentially, I would rephrase, rephrase the question to be also able to apply a Likert scale, because this gives you in the end more variety. Well it gives you more variants. That's one point. Second point, it will give you more variety when it comes to the statistical procedures.

Jörg Nink:
Yes, that's perfect. Thank you. So good idea as well, because it might otherwise also be too long. OK, anything else would you say? Anything else should be added, but I think at first we should go through all the dimensions and then you have something on your mind, yeah?

Andreas Braun:
Yes.

Jörg Nink:
Uh, so dimension 3 uh is basically dealing with well, solely being able to innovate virtual. So for instance, during this viral pandemic, COVID-19, for instance, everyone was strictly forced

actually to innovate or to do everything virtually so that actually some questions came up in my mind. For instance, question one, how many sourced ideas did your company usually generate in collaboration with external stakeholders in the year before 2020, and then just the opposite. After 2020 or in 2020 when COVID-19 hit Europe. In general, how did this affect you in terms of, well, the virtual aspect, and then the third question, did your company stop, reduce or continue innovating with external stakeholders during COVID-19. If they say reduce or stop, then there will be a next question too. Well, why did this happen? Basically, with several answer possibilities as well.

Andreas Braun:
OK, well I need a little more time to think about the question.

Andreas Braun:
The second question is, is again yes or no answer, isn't it?

Jörg Nink:
Basically it's not exactly yes or no, it's more like that I thought about 0-25%, 25 to 50, 50 to 75% etc. If not, if you have a better idea. Also, please let me know.

Andreas Braun:
I would give them the choice to come up with their own percentage meaning, which percentage did the amount of idea sources decrease. Yeah, maybe you find a little bit better formulation there, but then you give them, you give them some kind of space to fill in a number between one and 100. Actually, between zero and 100 and then you get a little bit more variation on this question and not like this edit queries because some are hard to work with.

Andreas Braun:
Maybe you wanna switch those two questions, first question with the third question. Now third question I think this would make more sense.

Jörg Nink:
Yeah yeah, cool, perfect and then we actually already come to our last topic which has a few more questions and this basically just deals with this physical and virtual juxtaposition. So the pros and cons as well of both practices whilst doing or innovating with external stakeholders. One of the questions how did you mostly deal with external stakeholders for idea sourcing before the year 2020 will be for the virtual physical is. Was there a mixed approach? And did you switch to solely virtual communication for idea sourcing because of physical meeting restrictions caused by COVID-19? Then did you realize any changes when dealing with external stakeholders solely virtual during ideas sourcing processes?

Andreas Braun:
I would rephrase the first question to simply give them the same choices. You will see that what changed and how it changed and you know again in this dichotomic world where it's hard to do data processing.

Jörg Nink:
Here, OK, if you go on from this question. Every of those questions has like up to 20 answer possibilities, so it's about trust, costs, process length etc.

Andreas Braun:
I would be I would be curious about a question #3 and multiple choices, but you mentioned already some. I mean trust and what else did you did you include?

Jörg Nink:
So there was for instance for each aspect two possibilities. Of course you gain trust or you decrease in trust. For instance, trust there was also cost efficiency, process length in general, communication problems, language barriers.

Andreas Braun:
Open up this question and I would really, but you mentioned they have multiple choices around 10 to 15. Whatever, yeah?

Jörg Nink:
Yeah.

Andreas Braun:
And if you somehow narrow it down to a set of I don't know, maybe five or six, yeah then I would go as following and then with all the other multiple choice equally. Yeah, and then and then you would. You would go with a Likert scale from 1 to 7 or 1 to 5. Stick with the Likert scale you already using, so either everything one to five or one to seven and then you ask them to rate those statements. Don't ask a question in this case, but give them statements and they rate those statements from one tool. I appreciate normally 1 to 7 Likert scale.

Jörg Nink:
Yeah, makes sense. Noted. And then, well, how would you rate the importance of certain aspects during idea sourcing processes? This is basically all the things that I came up with in the question before.

Andreas Braun:
How would you rate the importance of certain aspects during? I don't get that question. Which aspects?

Jörg Nink:
So there's for instance, let's say cost efficiency. Trust. How important do you rate them?

Andreas Braun:
So that's not actually one question. How would you rate the importance?

Jörg Nink:
Yeah, it's basically all those aspects included with the like all of aspects as trust, etc. on a Likert scale from 1 to 7. Then beneath that costs etc.

Andreas Braun:
OK that's a metrics question. In other words, OK, yeah it's called metrics question so well you would do this in a metrical form. Yeah, you can go with that, I mean.

Andreas Braun:
How would you know what do you prefer in terms of sourcing ideas with external stakeholders in order to increase innovation power? Why do you prefer? I mean it takes me at least one way to think through the idea. Maybe you can rephrase this question first of all, because it's hard to figure out what you're actually asking for and innovation power is. A difficult term I mean. What do you mean by power? Is power like power struggle? So let's say some kind of cultural effect. Or do you mean innovation capability?

Jörg Nink:
Innovation capability exactly.

Andreas Braun:
OK, then I would go for innovation capability.

Jörg Nink:
What would you add or change? Would you change something? Probably you said that I should rephrase some of the questions because they also take a long time to think about.

Andreas Braun:
One of the problems or one of the challenges I see with your question catalog is you're developing a couple of different dimensions? OK, that makes sense, but in statistics very important that those various different dimensions shows some kind of interaction and that they are somehow linked. Other words. Well, from a statistical point of view how knowledged you are in statistics. Have a look into Krombach Alpha yeah well that's reflecting the validity or the reliability. Essentially it's called reliability test. I would suggest that you should maybe rely on a questionnaire that has already been used, because when you develop your own question you always have the problem to do the various different item load on one dimension. That's question one problem number one and now there is problem number 2. So what to do

when it doesn't work? I mean, how can you proceed from there? If I look up some hypothesis then it gets really tricky and then it gets really annoying for you, so this could be something as a general feedback from my side, this could really destroy your work essentially.

Jörg Nink:
And I have one question, because I actually thought about it as well. I remember you offering me a questionnaire as well, but just for this topic, I wasn't sure if there is something very similar because I also did some literature research on some online database literature databases and there was basically nothing about this topic, because it was so recent, especially in the Pharma and MedTech industry. This comparison between those two. Do you think there will be something very similar to it or?

Andreas Braun:
I know probably no, but let's go through your dimensions so the dimension is. Essentially you're asking for Open Innovation. There are definitely a couple of different questionnaires that tackle the problem of Open Innovation. Going back to certain articles on open innovation, you will find tons of the questionnaires and I would suggest to take alook at a couple of different papers where they try to identify certain dimensions on open innovation and then I would look at them. Maybe you can use Krombach Alpha to say the dimension on open innovation is essentially based on the work of those two authors, or three authors and the questionnaire was used from other specific works and that this question already showed a very good fit. Something like this so.

Jörg Nink:
So you would probably get some more questions from a different article for dimension two. Would you also do that with dimension three and four.

Andreas Braun:
Let's go to dimension 3, please. I mean that that's a little bit more tricky, because it is hard to find something I guess. There's some literature already. I assume there's already some literature on the differences between physical versus virtual meetings. For example, maybe you want to draw on this, and maybe you're going to find something just by typing in meeting and COVID-19 or something or virtual or I don't know, you know. I mean like you may find

something, but this is pretty much something you can work on? Yeah, so that's fine. And going back to dimension 4, which is essentially. I mean, when it comes to your theoretical foundation in the thesis. What kind of theoretical approaches do you discuss when it comes to ideas sourcing with external stakeholders?

Jörg Nink:

I'm studying in Estonia. It's not quite the same as in Germany. I guess we should not have as much theoretical foundation as in Germany and are basically just limited to 50 pages.

Andreas Braun:
OK so so let it be like this. Nevertheless, I would strongly suggest to look more in depth in the literature on absorptive capacity.

Jörg Nink:
Yeah OK, I covered this idea. I have this aspect in there.

Andreas Braun:
That was the reason why that was one of the basic questions asked in the beginning. Where you looking at it from the inside-out or outside-in perspective or inbound outbound perspective. The more I understand your questionnaire the more I assume it's more like a an outside in perspective you're interested in, which is totally fine by the way. But when it's only this when you're going for this outside-in perspective, I would concentrate essentially on absorptive capacity, because absorptive capacity again has these two different processes. Exploration, exploitation phase. This is definitely the exploration phase of open innovation capacities. So maybe you want to go for the fourth dimension. Maybe you want to at least include some aspects of absorptive capacity. Once again it helps a lot, if you have already tested or somehow at least tested questionnaires.

Jörg Nink:
OK, so you mean I should also definitely include the absorptive capacity capacity aspect. And this is what I was askin myselfg. I thought about this as well, if I even put it in the questionnaire at some point, even the word. But then I was thinking like.

Andreas Braun:
No. Nobody would understand. Taking into consideration that some of them are biologists I don't know. They are more like natural scientists, they have a totally different understanding of absorption e.g. some element in the body, for example something like this, so totally different meaning. So I would definitely not use the word absorptive capacity, but I would try to get a little bit more questionnaire that tackle the concept of absorptive capacity. By the way, well, this is everything we wanted to discuss about the questionnaire because I would be interested in getting a better understanding of your hypothesis, because I assume when you're dealing with a questionnaire. In the end, you want to come up with hypotheses and want to proof those hypotheses? Or is this not something you're in?

Jörg Nink:
I mean I have and it is very precise to be honest and I also have research questions. So the thing is now I have to decide what I will basically take and I thought actually I will consider just on stating research questions because we have to choose between these two.

Andreas Braun:
Yeah OK, here is. Here is the point I would like to make. This is now my interpretation. In a nutshell, you want to figure out if the absorptive capacity of pharmaceutical and medical device companies has somehow changed during COVID and what impact have a physical versus virtual idea sourcing with different stakeholders on the absorptive capacity.

Jörg Nink:
Yeah, so basically just to correct one thing. I'm actually not gonna lie. I would not like to go too much into this COVID-19 thing and rather more about in general virtual times because in the Pharma and MedTech industry not that much has changed during during COVID except the digital aspect, so I just want to keep this in the virtual part actually.

Andreas Braun:
Ok. I would narrow it down to absorptive capacity.

Jörg Nink:

I actually thought it is too fancy. I actually wanted to include it.

Andreas Braun:

No. It has a better theoretical framework based on Cohen and Levinthals research. It is a concept of the 1990s I think. It has definitely more theoretical basis than open innovation and you want to see how well but well, virtual and physical influence absorptive capacity.

Jörg Nink:

Makes sense, yeah, I noted everything.

Andreas Braun:

Anything else I can? I can help you with?

Jörg Nink:

No, actually you have helped a lot and I thank you very much for it. Wait as I will stop the recording if that's OK?

Andreas Braun:

Obviously.

Open Innovation Management in the European Medical Technology and Pharmaceuticals Industry and accompanied effects of physical as well as virtual innovation practices

Name of the presenter: Jörg Nink

Health Care Technology (MSc)

School of Information Technologies

Tallinn University of Technology

Agenda

- Aim of the thesis
- Aim of the interview
- Questions?
- Dimension 1
- Technology Readiness Level
- Dimension 2
- Dimension 3
- Dimension 4
- Final question for the expert

Aim of the thesis

The overall research question focuses on…

- … how Open Innovation is conducted …
- … the extend of how remote-only work affects innovation management …
- … the juxtaposition of physical and virtual innovation practices in collaboration with external stakeholders ...

… in the medical technology and pharmaceuticals industry.

TAL TECH

Aim of the interview

- Gain expert knowledge on the topic addressed
- Use expert knowledge to conceptualize quantitative instrument (questionnaire)
    - Questionnaire with approx. 15 questions
    - Questions are grouped in 4 dimensions (sub-topics)
    - Will be send to 270 companies across Europe

Dimension 1

Deals with general facts about the company:

- Where is your company located? (Single choice)
- How many employees do you have? (Single choice)
- Which industry are you in? (Single choice)
- Which department are you in? (Single Choice)

TECHNOLOGY READINESS LEVEL (TRL)

Idea Sourcing

TAL TECH

Dimension 2

Deals with the general importance of Open Innovation, to show the importance of the topic addressed and what/who specifically contributes to it:

- How do you rate the importance of collaborating with external stakeholders for idea sourcing? (Likert Scale)
- Does your company collaborate with external stakeholders for idea sourcing? If yes, with whom? (Multiple choice)
- Do you consider collaborating with external stakeholders as more important than solely sourcing ideas within company borders and only with the help of own employees? (Dichotomous)
    - If yes, why?
    - If no, why?

TAL TECH

Dimension 3

Deals with the impact of solely being able to innovate virtually as during a viral pandemic and the therewith associated force to avoid maintaining usual habits as e.g. physical meetings:

- How many sourced ideas did your company usually generate in collaboration with external stakeholders in a year before 2020 (before COVID19 hit Europe)? (Single choice)
- Did the amount of sources ideas in collaboration with external stakeholders decrease since physical restrictions through the COVID-19 pandemic affected Europe in 2020? (Single Choice)
- Did your company stop, reduce or continue innovating with external stakeholders during COVID-19? (Single Choice or Dichotomous)
    - If stopped or reduced, why did you stop or reduce collaborating with external stakeholders for innovating? (Multiple Choice)

TAL TECH

Dimension 4

Deals with the comparison of physical and virtual Open Innovation practices:

- How did you MOSTLY deal with external stakeholders for idea sourcing before the year 2020? (Single Choice)
- Did you switch to solely virtual communication for idea sourcing, because of physical meeting restrictions caused by COVID-19? (Single Choice or Dichotomous)
- Did you realize any changes when dealing with external stakeholders solely VIRTUAL during idea sourcing processes? (Multiple Choice)
- How would you rate the importance of certain aspects during idea sourcing processes? (Likert Scale)
- What do you prefer in terms of sourcing ideas with external stakeholders in order to increase innovation power? (Single Choice)
- Why did you prefer virtual / physical?

TAL TECH

Final question for the expert

For further improvements of the questionnaire (Consider: Questionnaire should approximately be at a 10-minute conduct length):

- Are the questions and their separation into different dimensions appropriate in order to address the topic accordingly and is there anything you would add as a remark or question?

Thank you very much!