UNIVERSITY OF TURKU

ABSTRACT

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Abstract

Cancer research is complex, yet extremely important field of research that contributes to the common health and wellbeing of mankind. Cancer research has developed notably over the last 20 years, but it is still very time-consuming and requires a variety of resources. Research funding is in the centre of eternal resource-conversation related to cancer research.

Networks are a significant part of all medical research as they enable knowledge transfer and thus more efficient and prolific research. Nowadays they are wide and cross national borders, which also causes some challenges. Networks have been an increasingly popular theme in academic research, but we still lack knowledge of how they are related to research funding. The aim of this study is to clarify, what is the role of networks in developing research funding in cancer research.

This study was conducted as a qualitative research with an interpretive approach. The existing literature on medical research, medical networks, and medical research funding was extensively reviewed to gain a thorough understanding about the context of the research question. Expert interviews were used to collect empirical data, which was then combined with the theoretical framework to provide theoretical and practical implications and suggestions on how cancer research funding could be developed. The data was analysed with an exploratory approach, utilising thematic analysis.

This study clarifies that networks play an important part in cancer research and also in cancer research funding. Cooperation between different actors is a necessity in this complex field of research, and wide networks enhance the chances of a researcher to get funding, which is an enabler of research. Through networks, it is possible to develop cancer research and cancer research funding, if emphasis is placed on enhancing the cooperation and communication between different parties in the networks. This study also points out several challenges regarding cancer research networks and funding, such as the decrease of public funding, increased requirements in research work and funding applications, the complexity and length of research funding process and the difficulty of cross-sectoral cooperation. It could be concluded that trust, respect, and open communication among networks are in a key position when overcoming those challenges.

Key words	Medical research, cancer research, networks, research funding

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Tiivistelmä

Syöpätutkimus on monimutkainen, mutta erittäin tärkeä tutkimusala, joka edistää ihmiskunnan terveyttä ja hyvinvointia. Syöpätutkimus on kehittynyt huomattavasti viimeisen 20 vuoden aikana, mutta se on edelleen hyvin aikaa vievää ja vaatii monenlaisia resursseja. Tutkimusrahoitus on syöpätutkimukseen liittyvän ikuisen resurssikeskustelun keskipisteessä.

Verkostot ovat merkittävä osa kaikkea lääketieteellistä tutkimusta, koska ne mahdollistavat tiedon siirron ja siten tehokkaamman ja tuottavamman tutkimuksen. Nykyään ne ovat hyvin laajoja ja ylittävät kansalliset rajat, mikä aiheuttaa myös haasteita. Verkostot ovat olleet yhä suositumpi teema akateemisessa tutkimuksessa, mutta tietoa siitä, miten ne liittyvät tutkimusrahoitukseen ei ole vielä tarpeeksi. Tämän tutkimuksen tavoitteena on selvittää, mikä on verkostojen rooli syöpätutkimuksen tutkimusrahoituksen kehittämisessä.

Tämä tutkimus suoritettiin kvalitatiivisena tutkimuksena hyödyntäen tulkitsevaa lähestymistapaa. Olemassa olevaa kirjallisuutta lääketieteellisestä tutkimuksesta, lääketieteellisistä verkostoista ja lääketieteellisen tutkimuksen rahoituksesta tarkasteltiin laajasti, jotta saatiin perusteellinen käsitys tutkimuskysymyksen kontekstista. Empiirinen data kerättiin asiantuntijahaastatteluilla, joka yhdistettiin sitten teoreettiseen viitekehykseen, jolloin saatiin teoreettisia ja käytännön johtopäätöksiä ja ehdotuksia siitä, miten syöpätutkimuksen rahoitusta voitaisiin kehittää. Datan analysoinnissa hyödynnettiin tutkivaa lähestymistapaa ja temaattista analyysiä.

Tämä tutkimus selventää, että verkostoilla on tärkeä rooli syöpätutkimuksessa ja myös syöpätutkimuksen rahoituksessa. Eri toimijoiden välinen yhteistyö on välttämätöntä tällä monimutkaisella tutkimusalalla, ja laajat verkostot lisäävät tutkijan mahdollisuuksia saada rahoitusta, joka taas mahdollistaa tutkimustyön. Verkostojen avulla on mahdollista kehittää syöpätutkimusta ja syöpätutkimuksen rahoitusta, jos keskitytään verkostojen eri toimijoiden välisen yhteistyön ja viestinnän tehostamiseen. Tämä tutkimus tuo esiin myös useita syöpätutkimuksen verkostoihin ja rahoitukseen liittyviä haasteita, kuten julkisen rahoituksen vähentyminen, lisääntyneet vaatimukset sekä tutkimustyössä että rahoitushakemuksissa, rahoitusprosessin kesto ja monimutkaisuus ja hankaluudet sektorien välisessä yhteistyössä. Tutkimuksen perusteella voidaan todeta, että luottamus, kunnioitus ja avoin viestintä verkostojen välillä ovat avainasemassa näiden haasteiden ratkaisemisessa.

Avainsanat	Lääketietellinen tutkimus, syöpätutkimus, verkostot, tutkimusrahoitus

UNIVERSITY OF TURKU
Turku School of Economics

FUNDING IN NETWORKED MEDICAL RESEARCH

A cancer research perspective

Master's Thesis
in International Business

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

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1 INTRODUCTION

This chapter introduces the topic of this study, setting the stage for the research paper. The chapter expresses motivation for the study by discussing why the topic is relevant and important from both practical and theoretical aspect. It also indicates the research question and sub-questions and finishes by presenting the general structure for the study.

1.1 Background

In Finland, every third citizen is affected by cancer at some point during their lifetime (Syöpäsäätiö 2021). The rate is even higher in some countries: According to the National Cancer Institute (2020), approximately 39.5 per cent of the US citizens will be diagnosed with cancer, and the rate of new cases is expected to increase year by year. This disease is a global burden that touches not only the sickened, but also their families. In 1891 William Coley, an American cancer researcher, injected bacteria into a man's tumours, and the treatment proved successful. Now, more than a century later, scientists are still attempting to discover, why it worked (Scientific American 2020). This illustrates how much room for improvement there remains for cancer research.

The effects of cancer extend to global health, wellbeing, and economy. It is one of the leading causes of death: In 2018 there were 9.5 million cancer-related deaths reported worldwide (International Agency for Research on Cancer, WHO 2020). Simultaneously cancer causes enormous costs for societies. Only in the US estimated yearly expenditures for cancer care are around $ 150 billion, and costs are probably going to increase as new, more expensive treatments are introduced (National Cancer Institute 2020). According to Ray and Özdemir (2016, 65), a current issue is that over the last decade, the global burden of cancer has shifted from the developed countries to the less developed ones, where medical resources are quite minor.

These statistics show that cancer is a multidimensional burden and the clearest way to defeat it is by developing cancer research and treatments. Previous research has demonstrated that such as medical research and development in general, cancer research has already come a long way. A few decades ago, young scientists and researchers were frequently advised not to focus on oncology since the disease was so complicated and clinical outcomes rather depressing. Today, oncology is often seen as one of the most interesting and popular fields in biomedicine because of the astounding advances research has produced. (Weinstein & Case 2008, 6861.)

Even though cancer research has evolved remarkably, there are still many issues and challenges related to it. As in many cases, one key issue is money. All medical research is extremely slow and expensive, a rather discouraging combination. According to Hirotaka (2018, 13), it requires a substantial investment of capital, human resources, and technical expertise and still the success rates are notably low and most of the attempts to develop a new treatment will fail. Medical research demands perseverance and time. Funding has a significant role since money can buy more time and secure the continuity of the research.

Money also brings other problems with it in cancer research, and one of the most notable ones is the conflict of preferences and goals (Ainslie 1986, 134). No one can carry out cancer research alone, which means that there are wide networks related to it. Networks enable the implementation of cancer research: with the help of networks, it is possible to divide workload, decentralize risks and intensify time management. However, different parties in these networks do not always share common goals: Even though the enhancement of new treatments should be the main priority for everyone involved, profit-seeking private companies and publicly funded research centres do not necessarily share same values and preferences, which may complicate cooperation. Research funding is in the centre of eternal resource-conversation related to cancer research. Therefore, it is important to study, how research funding is currently working, what is its association with research networks and how they are affecting each other, in order to advance productive cancer research.

1.2 Aim of the study

The baseline for this research is the researcher's interest in medical research and its development, and in that wide range of research especially cancer research has captured the attention. When it comes to a field of research that is crucial for people's health and wellbeing, it is extremely important to find new ways to make things work more fluently and effectively, which this study aims to do. The existing literature shows that cancer research has developed significantly over the decades, but there is still room for improvement and subjects that are not completely studied.

The topic of this study is important and current because it pursues to fill a research gap in cancer research networks and cancer research funding, and thus enhance the development of this important field of research. Funding is at the heart of cancer research and therefore it is possible to develop research work in general by examining cancer

research funding. The main research question of this study is to clarify, *what is the role of networks in developing research funding in cancer research.* To fulfil that purpose, it is also essential to consider research networks and research funding separately, and to study how they are currently working. The main research question is divided into the following sub-questions:

- *How research funding in cancer research has changed in the 21st century?*
- *What is the role of networks in cancer research?*
- *What kind of challenges are there related to networks and research funding in cancer research?*

The sub-questions aim to cover a complex topic in an understandable way and build a basis for understanding how networks are related to cancer research and cancer research funding. The first sub-question concentrates on current changes in cancer research funding and how it has come to today's state. The second sub-question examines the multidimensional role of networks in cancer research and the final sub-question illustrates what kind of problems should be solved to develop cancer research funding. Together, these sub-questions will serve as guidelines to read this study and enable fulfilling the main research question.

The topic of networked medical research funding is very board and must be narrowed to some extent to match the limits of a master's thesis. Therefore, this study focuses on cancer research especially and the empirical data is limited to cover only Finland. However, the theory section discusses medical research in a more general level to build comprehensive and understandable framework, since it is essential to understand medical research in general to understand cancer research. In the theory section, biobanks are used as an example under some chapters since they represent internationally networked research and are widely used in cancer research.

There is a clear research gap in cancer research networks and cancer research funding, which is another reason that the theoretical framework is built around medical research in general. Networks are a current topic and broadly studied, but not from a cancer research point of view. There is also very little literature about networks of funding in cancer research, and this study aims to contribute to that. Just as networks, also research funding in general has been studied quite widely in existing literature, but these two have not been fully studied together, especially not in cancer research. Therefore, the topic of this study is important and has novelty value, it aims to show how cancer research networks and research funding are linked together and how they affect each other.

This study is conducted as qualitative research using expert interviews as a data collection method. More precise explanation of research methodology can be found in chapter five. The study aims to produce useful insights in terms of both theoretical and managerial implications and show, what needs to be studied more in the future. The study makes knowledge contributions for medical researchers, pointing out some notable phenomena and challenges within the industry, but also for medical funders, suggesting how funding could be enhanced in cancer research.

1.3 Structure of the study

The study consists of eight main chapters, each of which has several sub-chapters. The theoretical framework of the study, which serves as the foundation for the entire research, is the emphasis of chapters two, three and four. Chapter two focuses on medical research as a concept, providing perspectives for its evolution, complexity, and infrastructure since it is necessary to understand medical research in general to understand its networks and funding. Chapter three discusses networks in medical context, describing what kind of networks there are related to medical research and why they are so significant. Chapter four adds research funding to the theoretical background, addressing changes in research funding in the 21st century and the complexity of funding in networked, international research.

The fifth chapter is devoted to discussing the study's execution as well as the chosen methods. First, the research strategy and approach are addressed, followed by the presentation of data collection and data analysis methods. The study's trustworthiness is discussed in the final sub-chapter, utilizing the trustworthiness criteria by Lincoln and Guba (1985).

After methodology, the study moves on to findings in chapter six. The findings are collected from the empirical data and presented in a sequence that is related to the theory section. To enhance the clarity of this chapter, it is divided into three sub-chapters, adapting to the research questions. The managerial and theoretical implications based on the theoretical framework are summarised in chapter seven, together with empirical findings and recommendations for future research. Finally, chapter eight summarises this study.

2 ASPECTS OF INTERNATIONAL MEDICAL RESEARCH

Medical research is carried out by scientists and doctors, and internationalisation has brought experts from all over the world closer to each other than ever before, creating wide, international research networks. The increasing longevity of humans over the last century can be credited in large part to advances in medical research. Vaccines for measles and polio, novel surgical methods such as microsurgery, and increasingly effective cancer treatments are only a few of the major benefits of medical research. (World Health Organisation 2022.) However, many challenges still occur in this important, yet complex field of research.

2.1 The characteristics of a medical research process

Medical research process to develop a new drug to the market is hindered with high failure rates and notable complexity (Romasanta et al. 2020, 1823). The first step of the process involves the identification of underlying mechanisms of a target disease. Once a protein has been observed as a fitting target for a drug, scientists start to design a compound that can affect the target. Once a promising lead is found, it is first tested in cell and animal models, before undergoing clinical testing in humans. (Paul et al. 2010.) The clinical testing contains three phases and is highly regulated by authorities. Phase I is about clinical trials in which toxicity is tested by a few healthy volunteers. In phase II patients with the disease are treated to test the drug's efficacy and safety. Finally, in phase III, the drug is tested in a large sample of patients to establish its efficacy and discover possible side effects. (Vinet & Zhedanov 2011.) Because of this complexity and slowness of the development process, innovations in practices, technologies, tools, and collaborations are extremely important.

Both public and private sectors are involved in medical research, but their key contributions differ. According to Stevens et al. (2011, 535), publicly funded research has historically provided contribution for basic research, identified therapeutic intervention approaches, and revealed illness mechanisms. The private sector has also provided insights to basic science, although these insights have been more visible during the later stages of product discovery and succeeding phases of development that are essential to bring those drugs to market. However, the industry has evolved during the past few decades and since the dawn of the biotechnology era, the boundaries between the roles of the private and public sector have blurred significantly, and the public sector is now more

directly involved in the applied-research stage of drug development. (Stevens et al. 2011, 535.)

In addition to the emergence of biotechnology companies, there were also major policy changes in the 1980s. For example, in the United States the Bayh-Dole Act allowed universities, teaching hospitals and non-profit research institutes to own intellectual property (Stevens et al. 2011, 536). After that, institutions had the ability to license their findings anywhere they chose, including private companies. According to Reichert and Milne (2002, 543), a new structure arose in which the two sectors collaborated to translate scientific discoveries into marketable products. Furthermore, because both sectors are challenged to show returns on their investments, the traditional boundaries separating the two sectors have blurred over time, resulting in a research ecosystem that is a complex sequence of interconnected events and involves a learning process that takes place over time (Gelijns et al. 1998, 693).

2.2 Innovation in medical R&D

Innovation is a key element for medical research and development (R&D) and for whole pharmaceutical industry, especially when it comes to bringing new drugs to the market (Bianchi et al. 2011, 22). According to Romasanta et al. (2020, 1802), pharmaceutical industry remains a preferred frame for innovation studies due to its many unique characteristics. Pharmaceutical industry leads in R&D investments and provides opportunities to examine the dynamics between performance and innovation. The complexity of drug development also leads to that no one has all the necessary capabilities in-house, collaboration is a necessity (Powell et al. 2005).

The need to secure treatment efficacy and safety means that the same kind of development cycle needs to be followed across the industry, despite the variety of drug types and medical targets (Scannell et al. 2012, 191). Such uniformity makes it easier to compare innovation processes between different companies and actors, which explains the contribution of pharmaceutical R&D to the innovation literature. According to Pammolli et al. (2011, 429), research on the pharmaceutical R&D is also important to help the industry to address its unique challenges. A central issue for many years has been the low return of investment and productivity in R&D. The cost of introducing a new drug to the market has risen continually and the industry is also targeted by increased scrutiny from regulators (Scannell et al. 2012, 192).

Open innovation, which refers to the opening of a company's borderlines to external innovation (Chesbrough 2003), has obtained strong interest in pharmaceutical industry and medical research over the last 20 years (Romasanta et al. 2020, 1816). According to Michelino et al. (2014, 11), pharmaceutical industry is actually an early pioneer in open innovation, mainly because of the importance of R&D and the distributed nature of related knowledge. Most successful medical firms have adapted their approach to innovation management to the evolving external environment, which has resulted in the internationalisation of R&D and innovation activities (Chiaroni et al. 2009, 285).

The internationality of medical research poses its own problems. According to Meijer et al. (2012, 494), international cooperation is extremely important, but the resource and knowledge transfer between external researchers causes new problems that demand specific managerial approaches. Centrally managed large repository, or network of repositories, will require more careful observation of operations, numbers of samples being spread to researchers, and the outcomes of their research (Meijer et al. 2012, 494).

2.3 Medical research infrastructures

Internationalisation, digitalisation, and evolution of knowledge transfer have been involved in the creation of research infrastructures. Research infrastructures are facilities that offer services and resources for research communities to conduct their work and stimulate innovation in their professions. These include equipment and instruments, data infrastructures, knowledge-related facilities, and communication networks. (European Commission 2022.)

2.3.1 Research infrastructures in general

Research infrastructures are an important element of science policy and critical for scientific research overall (Meijer et al. 2012, 491). Research infrastructures have become the subject of international collaboration because of their high and constantly growing costs, and the value that these facilities could create has been the issue of many impact assessments and studies (Juhlin et al. 2009). However, according to Meijer et al. (2012, 491), the governance challenges caused by these research facilities have not awoken similar interest and both decision-makers and research funding institutions tend to remain unaware of the challenges likely to be confronted as the infrastructures develop and grow.

Research infrastructures contain many challenges related to their legal status, management, and the channels for coordinating the supply and demand of research services. Some have the status of a university department, while others are agencies or research institutes, and that is why research infrastructures are very complex from a legal point of view. (RI-VIS 2020.) According to Meijer et al. (2012, 491), there has been investments in the analysis of wide centralised research facilities, but new types of organisations are emerging constantly, which poses new problems. Biobanks are a specific group of research infrastructures, which relate to governance challenges after evolving towards a networked architecture (Meijer et al. 2012, 491).

2.3.2 Biobanks as research infrastructure

According to Jeon (2014, 92) a biobank is ordinarily defined as a collection of human biological samples and associated data that has been organised in a systematic manner for research purposes. Throughout the history of medicine, samples have been collected for diagnostic purposes and clinical studies. Sample collection methods and consent practices have varied widely over time, depending on the laws and policies of each period. The new biobank concept differs from traditional sample collections in that samples gathered in a biobank can be used for a variety of possible research requirements, not just for a single study purpose. In addition to biological samples, suitable information is also collected with the donor's consent. (Finnish Biobanks 2021.) Biobanks are internationally adopted and networked research infrastructure, end therefore they are used as an example in this study.

Biobanks collect, preserve, and distribute biological materials and the data related, such as physical measures, health information, socio-economic and socio-demographic characteristics. They can operate as an interface between sample donors and medical researchers, in pharmaceutical or academic setting. Biobanks are intended to increase our understanding of the interactions between genes, lifestyles, the environment, and diseases in general, as well as to aid in the translation of this knowledge into clinical practice through improved diagnostics, therapeutics, and preventive treatment techniques. Samples can be used to validate and identify drug targets, diagnose disease mechanisms, and develop new medications based on biomarkers. Therefore, biobanks can be seen as a significant medical innovation. (Meijer et al. 2012, 492.)

The number of biobanks has grown notably during the last two decades, and they exist within a variety of organisational settings, such as pharmaceutical companies,

medical research institutes and stand-alone organisations (Meijer et al. 2012, 492). Many biobanks began as individual or small groups of researchers creating repositories to meet their own research requirements (Meijer et al. 2012, 493). According to Tutton (2007, 464), biobanking activities can be divided into three main types: First, population-based prospective biobanks that aim to study complex and common diseases over time. Second, collections of tissue samples and clinical data on specific diseases, often involved in the detection of genetic and non-genetic risk factors. And third, organ biobanks gathered by different groups working with the same problem.

According to Meijer et al. (2012, 492), the size of biobanks has also been growing during the last two decades, in addition to the total number of them. One reason for this growth could be the rapid advancement in genomic approaches to medical research shifting from the study of rare, monogenic diseases to general, multi-factorial diseases (Collins et al. 2003, 835). Researchers are demanding greater biological datasets, expecting that high-throughput technologies will permit better breakdown of complex, heterogenous diseases into more detailed diagnostic entities (Burton et al. 2009, 263). However, despite high expectations biobanks still face many methodological and operational challenges (Tutton 2007, 465).

Biobanking took off as a recognisable concept in the first decade of 21st century, driven by the tendency towards greater collections which formed for two main reasons. First, researchers desired larger collections of samples, mostly due to the need for more statistical power. Second, there is also a clear economic logic driving the development of networked collections: research funders can profit from more efficient expenditures by dividing the fixed costs of maintaining and monitoring collections across wider sample sets. (Meijer et al. 2012, 493.) Nowadays many biobanks are international, networking facilities that have evolved to offer large datasets to increasingly diverse research groups. Biobanks have brought together entities that had usually been attached to specific projects or research groups only (Meijer et al. 2012, 494).

According to Meijer et al. (2012, 492), biobanks are critical for the development of medicine. Previously, bottom-up initiatives with some national and regional networks connecting existing facilities have been the main drivers for the growth of biobanks, but recently new initiatives have been creating networks based on a top-down approach. This suggests that the network is becoming the outcome of a wide project creating a dispersed set of biobanks with a central organisation and administration structure, rather than being an initiative that brings together existing tiny biobanks. Coordination is difficult in both

cases, especially when the facilities are spread across nations with varying research management practices and regulatory. (Meijer et al. 2012, 492.)

2.4 The contemporary context of cancer research

The death rates associated with cancer have decreased during the 21st century, mostly due to improvements in early detection and treatment (Etzioni et al. 2008, 176). However, treatment failures are still an issue and can occur because of several factors, such as resistance to chemotherapies, presence of residual cells left after surgical intervention and physiological obstructions to treatments (Alexis et al. 2010, 55). In areas such as tumour microenvironment, cancer genomics, and the evolution of metastasis, more refined and in-depth studies of cancer biology have begun to lead to the recognition of new therapeutic targets and approaches to overcome treatment failure and enable even earlier detection (Hull et al. 2014, 666). This has prompted interest in utilizing developing areas such as nanotechnology to develop complementary technologies that, when combined with advances in cancer biology, can establish novel cancer treatment methods (Hull et al. 2013, 667).

Recently, there has been an increasing emphasis in targeted drugs in cancer research. The world's largest cancer research project, Pan-Cancer Atlas, published its results in February 2020, and those results are most likely going to guide cancer research around the world and help develop targeted drugs for cancer treatment. Pan-Cancer research project involved more than 1300 researchers and clinicians from 37 countries and analysed more than 2600 genomes from 38 different tumour types. The result of the research was a catalogue of changes in the cancer genome, which served as a starting point for 16 working groups, which in turn studied the development and causal links of cancer. Previous studies have focused on one percent of the genes encoding proteins while Pan-Cancer project examined the remaining 99 percent of the genome in much greater detail. Among them are the key regions that control the genes to switch on and off. (University of Tampere 2020.)

The coronavirus pandemic has been in the spotlight for two years and hundreds of millions of people worldwide have received mRNA (messenger RNA) vaccines that prevent from severe symptoms of COVID-19. Interestingly, as successful as the mRNA COVID-19 vaccines have been, researchers have long sought to use mRNA vaccines for a completely different purpose – to treat cancer. For nearly a decade, mRNA-based cancer therapy vaccines have been studied in small trials, with some promising early findings.

In fact, Both Pfizer-BioNTech and Moderna scientists used their previous experience generating mRNA cancer vaccines to create their coronavirus vaccines. Some researchers now hope that the success of the mRNA COVID-19 vaccines may speed up clinical research on mRNA vaccines for cancer treatment. (National Cancer Institute 2022.) According to Ph.D. Patrick Ott, who directs the Centre for Personal Cancer Vaccines at the Dana-Faber Cancer Institute, “There is a lot of enthusiasm around mRNA right now. The funding and resources that are flowing into mRNA vaccine research will help the cancer vaccine field.” (National Cancer Institute 2020).

3 NETWORKS IN MEDICAL CONTEXT

The topic of networks is growing and current in almost any industry or context, largely because of significant phenomena such as globalization and digitalization. Networks use a wider perspective and situate collaborations against the broad context of the other collaborations appearing across the industry, rather than looking at an alliance in isolation (Gulati 1998). Scholars use various network-analysis tools, mapping organizations or individuals as nodes linked by sets of social relationships to study these collaborations (Romasanta et al. 2020, 1816). This chapter presents how networks are related to medical research and what makes them so significant.

3.1 Characteristics of networks

Internationalisation has brought people, products, and knowledge closer to each other than ever before. The eased transfer of thoughts, experiences and information has formed global networks for all the fields of industries. Collaborative networks connect experts from all around the world and thus enhance the possibility of international cooperation (Dorogovtsev & Mendes 2001, 7). According to Kinne (2013, 768), networks require three prime factors: a set of actors, a set of relations connecting the actors and interdependencies.

Networks generally take two forms: firstly, computer-based networks that include people or organisations to achieve common goals and secondly, more commonly, people grouped together inside an organisation working to achieve creative exchange and innovation. Collaboration within networks can be either formal or informal, structured, or unstructured, but the innovation value of networks is usually apparent. However, businesses have historically contended with managing and measuring collaboration, even though it is critical to any innovation. (IMSA search, 2017.)

According to Zander (1999, 197), the enhanced knowledge exchange within multinational networks is due to the improved quality of innovation, which can be gained from the cross-fertilisation within individual technologies, or from the recombining of knowledge across affined technologies. Organisations and research groups can create synergies by building flexible linkages that allow multiple units or activities to be combined, which then again leverages innovation processes (Bartlett & Ghoshal 1990, 222).

There can be seen notable differences in the structure of innovation networks across industries, particularly in terms of overall internationalisation and diversification of advanced capabilities. Because of these differences, different approaches are suggested to the improvement of competitive advantages, as well as to the management of international R&D efforts. However, innovation processes regarding networks are likely to always involve a certain amount of knowledge transfer or exchange across different networks (Zander 1999, 204).

3.2 Aspects of international cooperation

States and organisations cooperate to achieve common goals and solve shared problems, but cooperation is not always easy (Dai & Snidal 2010). According to Stein (1982, 299), cooperative efforts may collapse under noncompliance or disagreements over division of benefits, even though different actors would share similar preferences. Organisations do not negotiate over contracts in a vacuum but are involved in a larger context of cooperative relationships, which could also be called networks. This context determines both benefits and costs of later cooperative aspirations, such that the likelihood of cooperation for any given pair of operators is endogenous to the external ties those operators have already formed. Because endogenous networks guide international cooperation, the formation of international institutions and agreements directly affects the cooperative efforts of others. (Kinne 2013, 766.)

According to international cooperation theory, states utilise international institutions to advance their objectives and establish arrangements to solve different kinds of problems (Koremenos et al. 2001, 762). Cooperation is a way to achieve common gains and solve shared problems, but the external conditions of different parties may be diverse, which tends to hinder cooperation (Kinne 2013, 767). Cooperation failures appear in many ways, but the most fundamental ones can be divided into coordination problems and collaboration problems (Fearon 1998, 269). A coordination problem occurs when actors disagree on the exact institutional form that cooperation should take, often due to discords over how to divide the resulting profits. In a collaboration problem, cooperation results in mutual efficient outcomes, but actors have incentives to defect and get profit from cheating. (Kinne 2013, 767.)

According to Fearon (1998, 270), coordination and collaboration problems do not exclude each other, but rather describe separate but linked phases – negotiation and execution. States or organisations do not usually have that much advance incentive to

organise an agreement if chances for afterwards compliance are low (Kinne 2013, 767). Researchers have presented a variety of solutions to cooperation problems and especially recent research underlines the soothing effects of institutional design, where bargaining and execution dilemmas can be alleviated by flexibility in negotiation and careful selection of membership criteria (Koremenos et al. 2001, 763).

According to Kinne (2013, 769), third-party ties enhance trust in interpersonal networks but in intergovernmental networks trust is achieved via the risk of cooperation. When different states do not have enough information about one another's preferences, gradual acts of cooperation work as costly signals (Kydd 2005). Usually signalling arguments are bilateral and thus have straight effect only to those actors directly involved in negotiations, but signals do have an impact on external observers as well. Generally speaking, network ties offer a plausible third-party assessment of a potential partner's trustworthiness and reliability (Kinne 2013, 769).

3.3 Networks in medical research

The literature shows a wide range of different interpretations of the structure, nature, and functions of networks, generating rather various predictions about the generation of collaborative relationships. However, according to Orsenigo et al. (2001, 485), most of these interpretations agree in basic assumption that networks of collaborative relationships should be considered as organizational tools for the coordination of active learning processes, especially on technology-intensive, high-growth industries such as pharmaceutical industry. This strengthens the assumption that networks are extremely important for innovative activities, such as medical research.

Most innovations require the cooperation of several different actors or organisations in today's fast changing and competitive environment. The collaborative networks in medical research leading to new products and technologies involve a lot of informal knowledge exchange, in addition to various formal contracts. (Breschi et al. 2009, 834.) Therefore, these networks are very complex and serve as *a locus for innovation* (Powell et al. 1996), because they offer current access to external resources and information while also consolidating internal expertise and learning abilities (Breschi et al. 2009, 834). According to Kinne (2013, 767), the establishment of new agreements changes the structure of a given network and also creates new network ties, which means that the microlevel actions of organisations and the macrolevel structure of networks are inseparably linked.

According to Powell et al. (1996), the emergence of a thick network of collaborative relationships among different types of firms and institutions has been a major feature of the evolution of pharmaceutical industry and medical development. When it comes to the linkages between dynamics of knowledge and structural evolution of networks, it is essential to notice the very special nature of medical research as an important, but also complex and vulnerable field of research. Networks and collaborative relations linked to them are in an important position regarding prolific medical research. (Orsenigo et al. 2001, 486.) The importance of networks applies to clinical research as well and according to Visakorpi et al. (2011), nowadays confidential understanding between the professor in charge of the research and the senior physician in charge of the clinic is crucial to success.

The emergence of new companies specialized in the production of new medical products and techniques is largely a result of a thick network of collaborative relations among medical actors. It has been stated that also settled R&D intensive firms have been able to adopt new, useful knowledge by interacting with new entrants and that the diffusion of the network has been driven by the entry of new actors expressing new techniques (Orsenigo et al. 2001, 501). According to Camarinha-Matos et al. (2017, 12), collaborative networks are drivers of value creation and essential to the future of business. Knowledge transfer has become a crucial part of R&D, especially in pharmaceutical industry. According to Christopherson et al. (2008, 168) many companies do not acquire their knowledge from a geographically narrow area. Instead, many highly innovative companies are connected to global networks and by that able to transfer complex knowledge across boundaries.

Networks have become important to individual researchers as well. According to Lee and Bozeman (2005, 673), researchers who cooperate typically produce more scientific articles than researchers working alone. International collaboration increases the ability and potential to publish articles, and to publish them in international journals (Barjak & Robinson 2007, 24). Therefore, networks play an important part in the distribution of knowledge among researchers.

3.4 Networked research infrastructure in medical research

According to Meijer et al. (2012, 492), a networked research infrastructure *"is a facility based on geographically distributed facilities, instruments or datasets, e.g including collections of biological specimens"*. Individual facilities that form the networked research infrastructure may be small, but when they operate collaboratively with other

facilities, the entirety may be enormous. A current example of a networked research infrastructure is a joint action called Information for Action that includes 40 partners from EU and associated countries and is funded by the European Commission. The fundamental goal of the Information for Action is to construct an EU health information system and improve its core elements by founding a sustainable research infrastructure to support population health. (González-García et al. 2021, 2.)

On way to enhance the formation and development of networked research infrastructure is through outreach activities. Meijer et al. (2012, 496) present three main types of outreaches, first one addressed to the scientific community: Scientific papers are the primary means of increasing awareness and visibility of a specific research project or research group as a possible partner for other external researchers. The fundamental issue in this regard is that there is no common practice or established procedure for acknowledging the contributions that research group has made to the advancement of research (Meijer et al. 2012, 496). González-García et al. (2021, 2) also state that interoperability is crucial in the development of a networked research infrastructure.

The second type of outreach is addressed to industry: Medical researchers do not always consider the straight involvement of industry in their operations to be a priority, as a collaborator in the development of a common infrastructure or as a client for their services (Meijer et al. 2012, 496). The main reason for that is conflicting interests, even though cooperation with medical industry could be a significant source of funding. In general, industry is interested in profits and competitive advantages above all, while the main priority for researchers is prolific research and medical development (Ainslie 1986, 134). Still, large pharmaceutical companies have experience that can benefit medical researchers, for example regarding legal, ethical, and technical issues that international networking raises (Meijer et al. 2012, 496).

The third type of outreach is addressed to society, and especially related to medical samples, patient data and donors: Outreach to society can focus on specific groups, such as organisations, or the general public (Meijer et al. 2012, 496). The objectives are varied, and several issues must be considered when addressing the wider society. The European Commission survey (2010) shows that even though people in most countries are not worried about providing lifestyle data and samples for medical research purposes, access to genetic profiles and medical records is regarded with concern among some people. This emphasises the importance of trust, and the preoccupation over privacy and data protection (Meijer et al. 2012, 496).

3.5 Legal and social issues in medical networks

According to Meijer et al. (2012, 495), when operations become international, ethical, legal, and regulatory issues become more current and prominent. Medical networks are often very wide and extend over governmental boundaries, which may cause challenges related to different methods, practices, and regulations. National regulations on issues such as data protection, privacy and ethical frameworks vary notably across states and even apparently small differences in legal systems can become insuperable barriers that prevent the distribution of samples, resources, and knowledge within or between networks (Meijer et al. 2012, 495).

There is a need for international harmonisation in fields such as data ownership and intellectual property policies, quality control systems and confidentiality to enable international networking and integration of resources in medical research (Gottweis 2005, 192). However, according to Meijer et al. (2012, 495), harmonisation at the legal level poses diverse problems to those presented by ethical dilemmas, and ethical dilemmas are much more difficult. Legal issues are complex, but still codified and they can be solved using specific technical tools. Ethical issues in turn are multidimensional and their definition and interpretation may be contentious.

Biobanking and Biomolecular Resources Research Infrastructure (BBMRI) has spent a lot of time considering ethical issues in research networks and has come to the conclusion that the term "harmonisation" in this context should be viewed as the of uniform standards, but that that is not enough (Meijer et al. 2012, 495). Any multinational network should first agree on its ethical credentials (Chadwick & Strange 2009). Harmonisation is thus a continuous process rather than a destination and the development of common standards enables the exchange and interaction of many viewpoints (Laurie 2008, 337). However, according to Meijer et al. (2012, 495), addressing these issues is costly in terms of both time and resources, because international networks and actors will have to manage different legal restraints, ethical cultures, and de facto practices.

3.6 Networks of funding in cancer research

According to Sussex et al. (2016, 12), cancer research represents one of the largest areas of biomedical research funding, both for the private and public sector. Because resources spent for publicly and philanthropically funded medical research, including cancer research, could be utilized in other ways as well to benefit society, there is a commitment

to demonstrate why such investments are worthwhile. In the medical field, there are numerous examples of individual research breakthroughs that have resulted in significant benefits in terms of life-saving therapies or significant improvements in the quality of life of chronic disease patients. However, it is difficult to carefully define the nature and scope of the returns of a whole body of medical research, some of which may be less profitable. (Glover et al. 2014, 2.)

As funding is usually targeted to teams of researchers, instead of single researchers, collaboration is crucial (Beaudry & Allaoui 2012, 1589). According to Abudu et al. (2021, 602), collaboration between research funding organisations is also becoming more vital in order to coordinate spending in shared defined priority areas, accelerate outcomes and avoid duplication, especially at an international level. This has led to the emergence of International Cancer Research Partnership (ICRP), a network of cancer research funding organisations that share information about funded research initiatives in a central database (Abudu et al. 2021, 602). Data is openly available to help the cancer research community to avoid duplication and locate possible collaborators. ICRP was founded in 2000 and today it has 155 partners that include a wide range of governmental, public and non-profit cancer research funding organisations from the United States, Europe, Canada, Japan and Australia (ICPR 2022). Since 2000, it has totalled more than 80 billion US dollars in cancer research funding (Abudu et al. 2021, 602).

The existing literature lacks material regarding networks related to cancer research funding, and even networks related to medical research funding in general. This strengthens the assumption that there is a clear research gap in cancer research networks and research funding, which this study aims to fill.

4 MEDICAL RESEARCH FUNDING

Medical research has evolved over the past few decades, and the advancement would have not been possible without funding, grants, and subsidy. A variety of government, private and global organisations are constantly funding medical R&D throughout the world, and there are many organisations that are supporting individual researchers to help pursue and fund their research. (Conduct Science 2019.) However, there is a need for more transparency regarding who the major funders of medical research are globally, what they fund and how they determine who gets funded, as well as for the evidence base for various funding models to be improved (Viergrever & Hendriks 2016, 1).

4.1 Medical funding agencies

A funding agency is an external public or private organisation that engages in a contractual agreement to sponsor research. Funding agencies frequently mandate how their funds should be spent, what reports should be submitted and what deliverables are expected. The aim of a funding agency is generally to advance excellence or encourage interest in a particular subject, such as medical innovations. (Financial administration community training & solutions, 2022.) According to Smith (2010, 190), funding agencies are powerful institutions within the science because they can change research methods through mechanisms such as grant control and governance.

4.1.1 Public funding agencies

Public and philanthropic funding organisations fund around 40% of all medical research in high-income countries, while the rest 60% of investments come from the business sector (Rottingen et al. 2013, 1286). Public organisations are critical regarding the development of new products and knowledge, especially in less profitable fields (Viergever & Hendriks 2016, 2). For example, public and philanthropic funding organisations have played a critical role in the development of new medical products to fight neglected diseases (Rottingen et al. 2013, 1286).

According to research accomplished by Viergever and Hendriks (2016), the three biggest and financially most significant public funding organisations are The United States National Institutes of Health (NIH), European Commission (EC) and UK Medical Research Council (MRC). The NIH has been around for more than 100 years and invests approximately $41.7 billion annually in medical research. More than 80% of the funds is

allocated for extramural research, to more than 300 000 researchers at more than 2 500 universities and other research institutions. The funding model of NIF follows a rather untargeted approach and therefore does not strictly prioritize a specific area of medical research. (National Institutes of Health, Executive summary 2021, 4.)

European Commission itself is not limited to medical funding but has sub-programs that are involved with health-related research, such as the European Research Council (ERC) and EU4Health, the successor of the Health Programme. ERC grants are awarded through open competition to projects led by starting and established researchers, who are working or moving to work in Europe. The criterion for selection is scientific excellence. (ERC Annual Report 2020.) EU4Health in turn is the fourth and largest of the EU health programmes since their launch in 2003, with a budget of €5.3 billion. It provides funding to health organisations, national authorities and other bodies through grants and public procurement.

The UK Medical Research Council (MRC) is one of the oldest medical funding organisations globally: The first MRC meeting was held in June 1913. Nowadays MRC is part of the UK Research and Innovation and works closely with the UK health departments. It provides funding for every stage of research, to individual researchers, businesses, universities, and other institutions. In 2017/18 the gross research expenditure of MRC was €970.1 million. Even though it is a national funding agency for the UK, it welcomes both intramural and extramural research work. MRC is a rather dynamic organisation, supporting medical research from fundamental science to early clinical trials and preventive medicine. (UK Research and Innovation 2022.)

According to Viergever and Hendriks (2016, 7), public organisations' funding mechanisms vary considerably. Some of them fund research fully extramurally, some intramurally and some allocate funds for both. In Viergever's and Hendriks' study (2016), for six out of ten organisations that provided extramural funding the main mechanism for funding distribution was through untargeted competitive project or investor grants. Two organisations used a more targeted strategy, placing calls under prioritized areas, and the last two organisations used a mixed approach to distribute funds. Most public funders provide support in the form of project grants, and they might have some additional smaller programmes targeted to excellent individual researchers. However, some place a greater emphasis on individual excellence, and in recent years public funders have used "people grants" increasingly. (Viergever & Hendriks 2016, 7.)

There is also diversity in what kind of medical research different public organisations fund. Some funders prefer to focus on non-communicable diseases over communicable diseases, while others do the opposite (Viergever & Hendriks 2016, 7). For example, in 2015 the NIH spent more money on cancer research alone than on infectious disease research in total, whereas the Wellcome Trust allocated 14 times more on infectious disease research than on cancer research (Viergever & Hendriks 2016, 8). According to Viergever et al. (2010), there is a need for broader discussion regarding where the power to determine priorities for publicly funded medical research should lie, because resources are limited and thus priorities must be set using legitimate and fair methods. In addition, medical research funding decisions in public sector are not only made based on what kind of research is needed, but are frequently influenced by other factors, such as advocacy, political interests, and lobbying (Viergever & Hendriks 2016, 12).

4.1.2 Private funding agencies

Enhancing and enabling medical research in terms of treating and preventing illness, generating economic wealth, and advancing scientific knowledge often involves private funding as well (Breschi & Lissoni 2001, 975). According to Sussex et al. (2016, 2), the private sector builds on and interacts with public- and philanthropic-funded research and researchers. During this century, private sector collaborations with government and academia have become even more important in furthering medical research, because the public sector funding has decreased while scientific complexity and medical needs have increased (Chakravarthy et al 2016, 759).

Private funding takes a variety of forms, and some funding is distributed through philanthropic foundations, some is contributed directly (Seitz & Martens 2017, 46). Foundations are the most common private funding agencies and there are multiple types of them. Foundations can receive money from different sources, from individuals and corporations. The significance of charitable foundations has become notable in medical research, especially in Finland: The Association of Finnish Foundations supported science with 279 million euros in 2020, and the biggest share of it, 97 million, was targeted at medical and health sciences. The amount is really significant, since it represents more than a third of all research spending in the sector. The Association of Finnish Foundations is a part of the national foundation sector in Finland, but it is also a member of the Philanthropy Europe Association (Philea), which means that international

cooperation extends to foundation funding as well. (The Association of Finnish Foundations 2022).

According to Muscio et al. (2012, 63), in a climate marked by tightening public spending, universities are under growing political pressure to increase their interaction with industry and expand their own research funding choices. Traditionally, academic institutions have not been mainly concerned of bringing research discoveries to market. However, universities have been under increasing pressure to generate research that is useful for industry and to develop closer relationships with the business community in order to increase the possibilities of establishing collaborations. Therefore, the role of private funding agencies has strengthened in medical research: Institutions as well as individual researchers are seeking additional funding to meet the expectations of the industry, which cannot be fulfilled with public funding alone. (Perkmann & Walsh 2009, 1033.)

4.1.3 Public engagement in funding

A rather new trend related to medical funding agencies is public engagement (PE). Since the turn of this century, research funding agencies, researchers and universities have been encouraged to consider how they engage with communities and citizens, and public engagement has become a prominent part of many liberal government agendas around the world (van Bekkum et al. 2016, 1). According to Oliver et al. (2004, 1), researchers can improve the timeliness and relevance of their study by inviting the public to participate and thus develop actionable insights for policy and practice. Additionally, engagement with groups of people who are interested in the research topic has been noted to improve the processes of participant recruitment, research design, and communication and dissemination (Langston et al. 2005, 84).

Research funding sector in the United Kingdom has led the way internationally with efforts like the “impact agenda”, which formalised PE within the Research excellence framework as a measure for university funding (HEFCE 2009), and the Concordat for Engaging the Public with research, which demonstrates funders’ PE dedication and expectations to researchers and universities (Research Councils UK, 2010). However, there is only limited research regarding funding agencies’ own PE practices and policies. Those limited studies have found a gap between funding agencies’ science communication policies and how they are implemented in practice: Funders’ science communication and PE principles are not systematically implemented and monitored in

the research grant process – a key interface where funders can shape and influence research practices directly. (van Bekkum et al. 2016, 3.)

Van Bekkum et al. (2016) found out in their qualitative research that PE can be utilised as a problem-solving tool for improving the research grant funding process, especially in the assessment phase. While it may seem logical for funders and academics to use PE to achieve their own objectives, it is useful for those assessing and promoting PE within research to also consider the potential advantages that involving people in research could bring to individuals and society. PE can potentially improve the ecological validity of research studies, resulting in benefits for researchers, funders, and the general public. (van Bekkum et al. 2016, 9.)

4.2 Funding in networked research

4.2.1 The move to international networks

What has changed in medical research during 21st century is that whole industry has implemented a wide range of collaborations in a unique approach that connects inputs from public-private consortia, disease foundations, venture capital and industry-academic partnerships, resulting in learning from multiple disciplines (Chakravarthy et al. 2016, 760). According to Meijer et al. (2012, 495), the move to larger, international networks requires different funding structures. Funding in networked research covers a various set of activities: research costs themselves but also set up, maintenance and outreach activities, for example. The financial structure of a large, networked infrastructure differs from a small, internal team of researchers.

Funding policies and procedures differ between states. The relevance of project-based funding in the UK research system, for example, can be linked in part to the deployment of cost-recovery mechanisms and sample distribution tracking by the UK DNA banking network (UDBN). UDBN receives significant funds from a range of projects, necessitating more exact accountability. The prominence of regional governments in the management and funding of the health and research systems in Spain in turn has resulted in the formation of regionally based networks, and therefore Spain has a higher level of fragmentation. (Meijer et al. 2012, 497.) In the United Kingdom, various organisations manage non-commercial medical research funding: governmental agencies, such as Research Councils, academic associations, and medical research charities (van Bekkum et al. 2016, 2).

Even though numerous EU nations have set aside funds to promote the integration of national facilities into pan-European infrastructures, most funding mechanisms are still tied to specific research programs. This is a challenge since projects rarely receive funding for more than five years, but many research infrastructures have a much longer operational life (Meijer et al. 2012, 497).

4.2.2 Networked research funding example: biobanks

The study of biobanking in the early 2000s by Hirtzin et al. (2003) states that biobanks are usually funded from the host institution's budget. However, there is a need to move towards a different financial structure, since nowadays biobanks are much larger than twenty years ago, some even operating as research infrastructures. According to BBMRI, sample collection costs for a new biobank range between €4-8 million, depending on the quantity of samples. BBMRI estimates that once a new biobank is set up, the average annual operational cost is €500 000. These significant costs are prompting requests for studies to ascertain the expenditures of running specific biobanks, but there is very little itemised information on the actual costs of establishing and running a biobank, a problem that dates to the early stages of biobank development (Meijer et al. 2012, 496).

According to Meijer et al. (2012, 496), larger biobanks demand more expensive physical infrastructures that are most likely not going to be sustainable by single research groups. Furthermore, the fixed costs that are necessary to run the facility are increasing because of the need to act as a service provider to global community of researchers, to divide the expenses of the physical infrastructure. This means that the cost structure of biobanks is becoming more complicated and requires steady, long-term funding sources and a funding model that does not concentrate on a small number of short-term research grants. Generating a flow of commercial resources, by charging user fees and collecting royalties for example, is one way to raise funds, but is not enough alone. It is necessary to have consistent sources of core funding from patient organisations, public sector, and private foundations. Developing these revenue streams requires an anticipatory procedure from biobank managers and advancement of outreach activities. (Meijer et al. 2012, 496.)

According to Meijer et al. (2012, 496), outreach activities are key factors in developing sustainable and different funding structures. In this context, outreach means a range of activities aimed at informing and enlisting the support of specific communities. As biobanks become more complex and expensive, outreach will be required to increase their prominence and obtain operational, political, and financial support (Gottweis et al.

2011, 175). Large biobanks require significant financial resources, access to a large number of individuals to construct their collections and good social awareness, especially in particular areas such as rear diseases (Meijer et al. 2012, 497). Higher publicity is also essential when seeking long-term public funding because biobanks are competing with other great scientific infrastructures for investments (Gaskell & Gottweis 2011, 159).

Despite the needs of outreach activities and significant resources linked to them, it seems that outreach activity remains quite limited. According to Meijer et al. (2012, 497), outreach is rarely a top priority for biobank managers and the initiatives that are implemented are usually restricted in scope. The presentation of new priorities and the acquisition of new skills will be required to engage with the external community. Given the general public's lack of awareness and the complexity of the issues at hand, a professional organisation should implement a fully thought outreach strategy. (Meijer et al. 2012, 497.) Currently, many biobanks fund their activities by taking a share of the revenue received by the projects that use ethe facility, which means that an infrastructure is funded as it was a group of projects. Funding is gained through national and international research grants, but there is a need for a mixed method of funding. A core long-term infrastructural funding should be combined with other types of funding, such as short-term projects and public-private collaboration. (Meijer et al. 2012, 497-498.)

4.3 Funding in medical university research

4.3.1 Topical issues in university funding

Research funding in university sector has changed in many countries during recent decades. According to Auranen and Nieminen (2010, 822), the share of external funding has increased while governmental funding has progressively decreased. Even though public funding is still the dominant source for research funding in universities, it has confronted transformations. The focus of governmental funds has been increasingly concentrated on the basis of performance while funding agencies have absorbed more mission-oriented allocation procedures (OECD 2004).

According to Auranen and Nieminen (2010, 823), there are two major arguments for the transition of public policies towards increasing use of external competitive funding: Principal-agent dilemma and the ideas of the New Public Management (NPM). The principal-agent dilemma refers to a situation where the government or a governmental agency is aiming to improve its own or broader social targets, for example through public

research funding programs (Van der Meulen 1998). As it does not have enough human resources and know-how to carry out the mission, it must utilize specialized organisations, such as universities and delegate the actual implementation of research. The challenge is to sift the best possible actors to carry out the mission and to also control the activities of those relatively independent actors. (Auranen & Nieminen 2010, 823.)

The ideas of New Public Management refer to market-like mechanisms, which create an inducement towards improved performance. The NPM has provided some answers to the challenges appeared in principal-agent dilemma by increasing the use of results as a screening method (Pollitt 1993). It has also enhanced the use of targeted external funding with related evaluation procedures as a control method. The basic idea is that if money is given to the strongest performers, it will probably present better results and therefore allocations should be based on previous results (Auranen & Nieminen 2010, 823).

According to Muscio et al. (2013, 63), universities are under increasing political pressure to strengthen their interaction with industry and expand their own research funding options, but it is unclear whether achieving such a political desired outcome is compatible with a reduction in government support, and further research is needed. There is little empirical evidence to what extent government funding impacts universities' external funding possibilities, especially those related to research and consultancy. (Muscio et al. 2013, 63.)

4.3.2 Country-specific differences

During past centuries, universities' research funding has faced some country-specific differences, for example in the allocation mechanisms of the core funds (Auranen & Nieminen 2010, 822). Result-based mechanisms are utilized extensively, but they do not fully dominate anymore. Jongbloed and Vossensteyn (2001) pointed out in their comparison of 11 OECD countries that the orientation to output is used as an allocation model to a varying extend and Geuna and Martin (2003) addressed in their research that there has emerged a great variation to the way and extent of using evaluation for resource allocation.

The research conducted by Auranen and Nieminen (2010) illustrates that university research expenditures have increase notably between 1981 and 2001 in all countries that were included (Australia, Denmark, Finland, Germany, The Netherlands, Norway, Sweden, The UK), but the share of universities in these countries' research expenditures has increased explicitly only in the UK. When comparing the proportion of expenditures

with the population of target countries, the research shows that the Nordic countries have the biggest university sector research expenditures per capita. These cross-country variations can be explained by dissimilarities in system structures. For example, in Sweden universities perform tasks which in some other countries are duties of public research institutes. (Auranen & Nieminen 2010, 827-828.)

According to Auranen and Nieminen (2010), country-specific differences can also occur in the structure of funding. In Sweden and Finland, the share of external funding is rather high, while Norway and Denmark rely mainly on governmental core funding. Additionally, the structure of external funding can vary between different countries. In Finland and the UK, research funding agencies are more remarkable financiers than in Australia or Sweden, for example. It can be argued that the differences in funding structures mirror not only variation in science and technology policies, but also wider economic and political differences. (Auranen & Nieminen 2010, 828.)

4.4 Funding in medical education research

According to Gruppen and Durning (2016, 480), medical education research (MER) suffers from a persistent and significant lack of funding. Even though it has been empirically documented by Reed et al. (2007, 1002) that adequate funding improves research quality, there are many factors that continue to limit it. MER operates in a competitive environment, which makes it essential for researchers to understand strategies for enhancing the search for funding sources (Gruppen & Durning 2016, 480).

According to Reed et al. (2007, 1007), two-thirds of published studies in MER do not get funding from outside institutions and the minority that does is still seriously underfunded. Many suggested methods for improving the quality of MER, such as sophisticated research designs and measurements and more complex studies, would as well increase the costs of the research and aggravate the funding problem (Dauphinee & Wood-Dauphinee 2004, 925). Therefore, the lack of funding creates a negative feedback loop: The quality of MER sustains from inadequate funding, but increasement in funding occurs only if the research demonstrates its value, which is not possible due to quality limitations. According to Gruppen and Durning (2016, 480), this negative feedback can be faced in criticism that MER does not illustrate straight benefits for patient outcomes, which cannot be illustrated without considerable research funding.

In addition to the field itself, also individual researchers suffer from the lack of funding since it is usually very difficult to get recognition for the value of medical

education work without receiving external funding. The lack of funding also affects capacity for work directly. External funding enables researchers to devote more care and attention to their research and it enhances the recruitment of specialized expertise in different processes and phases. The lack of funding hinders multi-institutional collaborations and decreases sample sizes and study durations. (Gruppen & Durning 2016, 480.)

According to Gruppen and Durning (2016, 480), the lack of funding in MER is a consequence of several arguments of questionable validity. Educational research is often assumed as the responsibility of individual schools, rather than the society. It is torn by arguments about whether it is public or private good, which affects the willingness to allocate resources to it (Blumenthal 2002). According to Gruppen and Durning (2016, 481), education in science, technology, engineering, and mathematics (STEM) receives notably greater federal funding than medical education, which reflects the divergent views of society about the balance between private and public good in STEM and medicine disciplines.

4.5 Medical research funding in Finland

According to Visakorpi et al. (2011, 957), medical research is conducted in a rather scattered environment in Finland. Biomedical research is mainly the responsibility of universities, while clinical research, a very significant method for cancer research, is performed especially in university hospitals. Scientific research is also conducted in other hospitals, primary health care and governmental institutes (Visakorpi et al. 2011, 957). However, university hospitals have undergone considerable structural reforms over the last 20-25 years. There has been a shift from traditional specialty clinics to domains and profit centers that combine specialties. Separate units have been transformed into business firms, and some have even been incorporated. These changes have weakened the leverage of professors in hospitals. (Visakorpi 2009, 2308.)

Finnish government has reduced funding in university hospitals significantly over the past twenty years. Public funding has fallen to less than a quarter of what it was at the beginning of the 21st century, which means that medical research is very dependent on private funding (Aarnipuro 2021). According to Keränen (2019), the amount of governmental research funding decreased even by 50 percent between 2010 and 2017. In 2010, Finnish government supported clinical research in university hospitals with 40 million euros, while in 2018 the amount was 20 million. Correspondingly, the amount of

funding offered by foundations has risen from 50 million euros to 60 million between 2010 and 2015 (Heikinheimo et al. 2020, 243).

Finnish Medical Foundation supports medical research in all fields of medicine. The foundation was founded by Finnish Medical Association Duodecim in 1960, and with the help of individual supporters and communities it has developed into a significant private foundation. Finnish Medical Foundation offers grants of more than two million euros annually to about 150 individual researchers or research groups. In 2020, the total amount was 2.9 million for 186 researchers. (The Finnish Medical Foundation, Annual report 2020.)

In 2021, Finnish cancer research received $ 5.2 million for the project of developing new treatments for advanced breast cancer. Interestingly, the funder was U.S. Ministry of Defense's cancer research program. Professor Juha Klefström stated in his speech for Pink ribbon -campaign that "Finnish Politicians do not understand the meaning of science and research funding. It tells something that we received giant grant from the United States, not from Finland. In the USA, they understand how high-class research we do here". Klefström also argued that the difficulty of gaining research funding is relatable to warfare.

According to Seppälä (2021, the Cancer Foundation), the sharp cut in governmental funding is a significant drawback. It weakens cancer research in Finland and causes a direct decline in the clinical application of research work, which is the form of research that can be applied to the treatment of patients. Funding of clinical research has been cut to minimum, and according to Seppälä (2021, the Cancer Foundation), that is the most significant problem financially. Currently, cancer research relies heavily on foundation funding in Finland, and without it, cancer research would collapse entirely. There is a need for long-term research that focuses especially on how to bring new tools and treatments for patients (Seppälä 2021, Syöpäsäätiö). In recent years, foundation funding has been filling the funding gap, but current situation is not sustainable in the long term (Keränen 2019).

5 RESEARCH DESIGN

In this chapter, the methodology of conducted study will be presented, including both the assumptions guiding the research and the chosen methods of data collection. The first sub-chapter presents the research approach for this study and discusses the assumptions influencing the research strategy and research methods. Research approach will be followed by the methods for data collection and data analysis. The chapter finishes with a critical analysis of the trustworthiness of the study, which is based on the trustworthiness criteria by Lincoln and Guba (1985).

5.1 Research approach

According to Eriksson and Kovalainen (2008, 27), the research approach should be chosen in terms of the aim of the study and research questions. The abundance of tools available to a researcher is both a liberty and a liability; there are many possibilities and options to choose from, but the chosen combination must address the research topic convincingly. According to Saunders and Lewis (2012, 104), the chosen approach points out the research's underlying assumptions, as well as the researcher's perspective on the world. According to Adams et al. (2014, 81), research design is a master plan for defining the methods for analysing and collecting the information needed, the blueprint for answering research questions. However, it is crucial that the researcher chooses the research method wisely, considering how the research will be carried out in practice.

When considering a research's philosophical perspective, Carr and Kemmis (1986) make distinction among three different forms: positivist, interpretive and critical. This study uses an interpretive approach to address the topic of the study. According to Merriam (2015, 9), interpretive approach is very typical in qualitative research and presumes that reality is socially constructed. Knowledge about reality cannot be found, but rather constructed and there can be multiple interpretations of a single event. Interpretive approach is suitable for this study because it allows to consider many different views from different areas of cancer research, and thus construct an understanding of a complex topic based on these different views.

As the philosophical perspective for the research has been formed, the actual research approach must be chosen. The literature usually utilises a division to two different research methodologies: quantitative and qualitative. Other types of research forms are mainly seen as combinations of elements from these two (Adams et al. 2014, 26).

Quantitative approaches are based on a positivist viewpoint that emphasizes the researcher's objectivity and focuses on providing quantifiable outcomes by testing hypotheses and creating statistical analyses. Qualitative methods then again take an interpretivist approach to reality, viewing it as a socially constructed entity. The aim in qualitative research is to gain a holistic view to the research problem and in that way better comprehend real life. (Eriksson & Kovalainen 2008, 193–195.) This means that qualitative methods are more suitable when the research topic is so complex that quantitative approaches are unable to grasp it.

As the aim of this study is to gain understanding and knowledge around complex issues – cancer research networks and funding – a qualitative approach was selected. According to Adams et al. (2014, 6), quantitative approach has a strict research development and planning criteria before the actual research even starts while qualitative approach aims to explore social relations and to provide explanation of the reality as experiences of respondents. As social relations and interaction are in the centre of this study, it is natural to carry it out as qualitative research. The research questions of this study are descriptive and emphasise perspectives of many different actors involved in medical research, which promotes the use of qualitative research approach (Ghauri 2004, 109). In addition, qualitative research is suitable for answering “why” and “how” questions (Doz 2011, 583), which is in line with the aim of this study.

The baseline of this study is in the theoretical framework, but analysing excising literature is not enough to fully address the research questions. Therefore, this study utilises interviews as a source of qualitative research data, to make contributions to the existing framework. According to Eriksson & Kovalainen (2008, 79), interviews consist of talk arranged into a series of questions and answers. Qualitative interviews are research vehicles, providing empirical data for the research in question. The principal purpose is to provide material that will help to answer the research questions through accurate analysis. According to Taylor et al. (2016), easy access, immediate understanding among informants, and the ability to collect data directly related to the study objectives are three components of an ideal research setting. In this study, the empirical data was collected in one-on-one expert interviews, including experts from various areas of cancer research and cancer research funding. By that, all three components are met.

According to Bogner et al. (2009, 2), expert interviews are an efficient and more concentrated method to collect data than systematic quantitative surveys or participatory observation, for example. An expert can hold a key position in the organisation and

provide an opportunity to expand the researcher's access to the field, as well as indicate additional possible interviewees, which was the case in this study. However, as all data collection methods, expert interviews too have their limitations which need to be considered. There is a risk of expert interviews endorsing an undeniable significance of expert knowledge, which can eventually be construed as non-validated confirmation. (Bogner et al. 2009, 2–3.)

This study adheres to the Finnish Advisory Board on Research Integrity's ethical integrity criteria, which apply to all scientific disciplines in Finland (TENK 2019). Researchers bare a great responsibility because of their position that allows them to call out social injustices, and therefore ethical consideration in research is crucial. According to Aluwihare-Samaranayeke (2012), critical ethical consideration is required to make sure that the research has a positive impact to its surrounding environment. Researchers and subjects should not be seen as exploiters and exploited, but rather as cooperative partners engaged in socially important projects (Rhodes 2006, 24). Researchers must prioritise the person over the research, without feeling compelled by the pressure to complete the research in a way that avoids them from putting the participant first (Aluwihare-Samaranayeke 2012).

5.2 Data collection

According to Merriam (2015, 2), qualitative inquiry, which concentrates on meaning in context, requires a data collection method that is sensitive to underlying meaning when obtaining and interpreting data. In qualitative research, there are two types of data sources that can be utilised: primary and secondary data. According to Hirsjärvi et al. (1997), the purpose for which the data was originally produced determines whether the source is primary or secondary. In the case of a primary source, the data was created for the purpose of the research, such as data acquired via research interviews that have been prepared and executed to fit the objective of a specific study. A common way to define a secondary data source then again is as a usage of existing data that is gathered for another intention. It can help to analyse a novel research question from a point of view that differs from the one the data was originally gathered for (Smith 2008, 4–5). This study utilises both primary and secondary data sources, the main source being primary data collected from the interviews, which is supported by secondary data from previous literature and research funding agencies' webpages.

The literature shows three different interview types to choose from in general. Unstructured interviews do not have any criteria to direct the discourse; instead, the interview should flow naturally. Structured and standardized interviews on the contrary are conducted in a specific order and with a pattern of questions. Finally, between the first two types of interviews, there are guided, semi-structured, and thematic interviews. (Eriksson & Kovalainen 2008.) A semi-structured interview framework was chosen for this study because it ensures that the data is comparable for analysis as there are several interviewees included, but it still leaves room for clarifications and spontaneous follow-up questions. In addition, the interviewees in this study came from different backgrounds and areas, which means that the interviews could not be identical, even though the themes and overall structure of the interviews were similar.

Interviewing has several advantages as a data collection method. Interviews typically yield more detailed information than a text-based survey because the respondent can provide information on a wider range of topics and with greater accuracy. The researcher can also modify the questions and themes if needed, adjusting to different situations. (Daniels & Cannice 2004, 187.) However, there are some disadvantages as well. The interviewer's planning abilities and knowledge of the issue discussed, as well as the entire interview situation, may have an impact on how the interviewee answers questions. Interviews also require time and other resources, making it an arduous data collection method. (Hirsjärvi et al. 1997, 202–203.) Moreover, choosing the right interviewees is extremely important, but can be very difficult for the researcher.

Interviewees for this study were chosen based on their knowledge and experience on medical research and/or medical research funding. The aim was to find interviewees with different backgrounds from different sectors of medical research so that it would be possible to obtain a broad perspective of research networks and research funding. This aim was fulfilled, and the interviewees were able to provide insightful information and different perspectives for the research questions. The interviewees were divided into two different groups based on their background: medical/cancer researchers (group one) and company/organisation representatives (group two). Even though the interview questions were quite similar within both groups, the emphasis still differed depending on the interviewee’s expertise; with group one, emphasis was on medical research networks while group two focused more on financial matters. However, research funding was thoroughly discussed with both groups, only with a bit different perspective. Further

information about the interviewees and meeting minutes are presented in the following table.

Table 1. Interview meeting minutes

Respondent	Status	Interview group	Interview details
1	PhD candidate in international business	2	11.3.2021 34 min
2	Cancer researcher	1	18.3.2021 38 min
3	Cancer researcher	1	1.3. 2022
4	Cancer researcher	1	22.3.2022 59 min
5	Cancer researcher	1	24.3.2022 61 min
6	Research director in a hospital	2	31.3.2022 45 min
7	MD, PhD Professor, Member of the board in Repolar Pharmaceuticals	1 & 2	4.4.2022 70 min
8	PhD docent, research director in a foundation	1 & 2	4.4.2022 60 min
9	Executive director in a pharma company	2	11.5.2022 58 min

All the interviewees were informed about the reason for conducting this study and its research purpose. The overall structure and interview themes were also presented and explained in advance, which supported trust building between the interviewer and the interviewees. Most of the interviews took place in March 2022 – April 2022, except one that was conducted a year earlier in March 2021. One interview was held in English since it was the strongest common language, but the rest were held in Finnish as both the interviewer and the interviewee were native speakers. The interviews took 45-75 minutes

each. Due to the COVID-19 pandemic, all interviews, except one physical meeting, were performed via Zoom or Microsoft Teams. All the interviewees agreed that the conversations could be recorded.

Most of the interviewees in this study are experts in their fields and have considerable experience and responsibility, wide networks within medical research, international exposure and hold senior or middle management positions. Therefore, they qualify as elite interviewees (Welch et al. 2002, 613). Welch et al. (2002) identify both advantages and disadvantages related to elite interviewees in business context: The data gathered from elite interviewees is usually significant and academically important, but the openness and power of the interviewees, as well as the feedback to them may cause challenges to the validity and reliability of the study. The disadvantages of elite interviewees were considered in the data collection process of this study, and it became clear that to fully cover all the research questions, the usage of elite interviewees was reasonable. The validity and reliability of this study are discussed later in this chapter.

The interview framework was based on the academic literature reviews in chapter 2, 3 and 4, but to support structuring of the interviews, an operationalization table (table 2) was formed. According to Eskola and Suoranta (1998, 75), the purpose of the operationalization is to bring theory and practice together. In this study the operationalization table was built from the research questions, which means that the table helped to form the final interview questions that guided all interviews based on relevant theoretical framework. The operationalization of the research questions is shown in the table below.

Table 2. Operationalization of the research questions

Research question	*Sub-questions*	*Theoretical background*	*Interview themes*
What is the role of networks in developing research funding in cancer research?	How research funding in cancer research has changed in the 21st century?	Internationalisation, aspects of medical research	Research-related changes
			Funding-related changes
	What is the role of networks in cancer research?	Collaborative networks	Different actors in cancer research
			Collaboration in cancer research
			Networks of funding in cancer research
	What kind of challenges are there related to networks and research funding?	Medical research funding, medical networks	Network-related challenges
			Funding-related challenges

According to Whiting and Pritchard (2017, 562), ethics are the moral principles that lead the researcher in qualitative research, and these principles attempt to minimize any potential harm caused by the research. Therefore, data collection through interviews requires careful ethical considerations. The highest priority was given to the privacy and mutual confidentiality of the interviewees in this study. It was ensured before each interview that the interviewee participated voluntarily, understood that the collected data would be used in a master's thesis and that they could be quoted directly. Interviewees were also offered a chance to ask questions about the study in advance. To protect the privacy of the interviewees, everything is anonymized in the findings chapter.

5.3 Data analysis

The aim of data analysis is to reasonably explain the gathered data and to provide insights into the research topic. The results and data are converted into a comprehensible format, and the meaningful information within the acquired data is identified through data analysis. Even though the interpretation of collected data might be subjective, to accomplish as good analysis as possible, the researcher should be open-minded and avoid letting previous knowledge limit the findings. The researcher should also be able to justify the methods used in the analysis and discuss any limits that these methods may have. (Eskola & Suoranta 1998, 19–21.)

According to Guest et al. (2012) there are two typical approaches to data analysis: confirmatory and exploratory approaches. Confirmatory can be seen as hypothesis-driven while exploratory is content-driven and the desired outcome of the analysis affects which one to choose. The researcher usually uses confirmatory approach to evaluate their ideas and hypotheses through the data. Exploratory approach then again aims to go through the data carefully and find main themes, key words or trends that will help in the analysis, which was more fruitful in this study. Additionally, inductive social and behavioural studies are more likely to use exploratory approach since research questions are better suited to it while objectives of a confirmatory approach are better captured by hypotheses. (Guest et al. 2012, 6–7.)

In this study, data for analysis was generated through interviews, which is suitable for exploratory approach (Guest et al. 2012, 6). All the interviews were recorded, and interview notes and audio recordings were transcribed into text. In academic research, the first thing should be carefully reviewing the transcripts, and only then can formal categories and notions be created. This is an iterative process between data and notions and results in categories that can be used to organize the interview material. (Gerson & Horowitz 2002, 216–217.) Due to this, the transcribed text was first familiarized carefully by the researcher. Some secondary data sources, such as medical blogs and webpages of funding agencies and foundations, were then explored and added to the material.

There are some different ways to organize the gathered material. One is to arrange it without any pre-assumptions about the potential outcomes of the data, but this approach requires that all the previous theoretical knowledge of the subject is left aside. (Eskola & Suoranta 1998, 110.) Therefore, this study takes a different approach, using the theoretical framework and the themes that emerge from it as the foundation for arranging the data.

This is a rather reader-friendly approach because the reader is somewhat familiar with previously presented theoretical framework and thus can more effortlessly follow the analysis (Eskola & Suoranta 1998, 110). According to Eriksson and Koistinen (2014, 35), it is crucial in this approach that the researcher is very familiar with related theory. In this study, the theoretical framework was almost finished before arranging the collected data and the researcher had previously conducted two studies with relatable themes, which means that the prerequisite was met.

It is important to pick data analysis method that supports the data collection method, interviews in this case. Thematic analysis, which is based on themes found in the data, is very common method in qualitative research and useful for analysing interviews. Themes can be divided into two levels: manifest and latent, first one being directly detectable and second one implicit. The main benefit of thematic analysis is that it helps the researcher to utilize a large set of data systematically and it also enhances responsiveness and precision. (Boyatzis 1998, 4–5.) This study aims to find connections between different themes and complement theoretical framework with empirical data, and thematic analysis is a useful tool to identify the key features from the data and connect them to research questions. Furthermore, thematic analysis brings flexibility to categorisation and interpretation of collected data.

The researcher must effectively capture the meaning behind interviewees' responses in order to practice critical ethical thinking. The aim is to portray respondents' experiences as accurately as possible. This can be accomplished by adding straight quotations from the interviews, which has been done in the findings chapter of this study. Quotations enliven the text and accurately describe respondents' perspectives. In this study, emphasis is placed on the notion of true representation by presenting interviewees' perspectives in their true context and by avoiding any kind of manipulation of the data.

5.4 Trustworthiness of the study

According to Connelly (2016, 435), the utility and integrity of qualitative research findings are dependent on the trustworthiness of the study. Trustworthiness refers to methods and interpretation used to secure the quality of the study, as well as to the overall degree of confidence in data (Polit & Beck 2014, 490). One of the most common trustworthiness criteria in qualitative research is by Lincoln and Guba (1985), which serves as a baseline for a critical analysis of the trustworthiness of this study. In qualitative

research, it's rare to be able to condense a jumble of observed realities into a single, quantitatively current fact. As a result, the meaning of objectivity must be reformulated to reflect a naturalist reality in which naive realism is displaced by various constructed realities – the opinions of human beings. (Lincoln & Guba 1985.) Therefore, the criteria by Lincoln and Guba (1985) are composed of four different aspects: *credibility, transferability, dependability,* and *confirmability*.

Credibility of the research reveals how reliable the findings are and how well they correspond to reality (Lincoln & Guba 1985, 301). Some of the academic literature even state that credibility is the most important criterion because it reflects the confidence in the truth of the study (Polit & Beck 2014, 492). Credibility can be enhanced by devoting sufficient time to learning about the research topic and doing data triangulation. Possible misrepresentations affecting the acquired data should be assessed, and the data should be monitored in order to gain a deeper understanding. (Lincoln & Guba 1985, 301–304.) Data triangulation is performed by using numerous theoretical viewpoints and different research methods and sources (Lincoln & Guba 1985, 314). Connelly (2016, 435) adds that establishing credibility can include techniques such as prolonged engagement with respondents, reflective journaling, and persistent observation. *"Evidence of iterative questioning of the data, including returning to study it numerous times, should be presented and alternative explanations or negative case analysis considered"* (Connelly 2016, 435).

In this study, a sufficient time to learn about the research topic was devoted, during this research process but also in advance through bachelor's thesis and other course work, which were related to medical research and medical networks. In addition to economics, the researcher has also studied biomedicine, which brought more knowledge and perspective for this study. Credibility was increased by data triangulation and choosing research methods accurate and common in the field of research. Data triangulation was achieved by collecting data from different sources: The range of interviewees was versatile and a throughout secondary data analysis was performed. An operationalization table was used to survey the most relevant topics from the theory section and thus form the final interview questions. Prolonged engagement with respondents was also conducted since the researcher asked for clarifications and some additional questions during data analysis process and when finishing the findings chapter. To enhance credibility, respondents were chosen from different sectors of medical research, but the credibility would have been enhanced even more if there had been respondents from the

management of international medical funding agencies. However, it was not possible to reach those kinds of experts and this limitation was considered in data collection and analysis.

The second criteria, *transferability*, refers to the extent to which findings are applicable in other contexts (Connelly 2016, 435). According to Polit and Beck (2014), the nature of transferability is different from other aspects of research, because the one who decides how applicable the findings are in current context is the reader. Researcher can enhance transferability by providing a rich, complete description of the people, context and location studied, as well as being transparent about their analyses (Amankwaa 2016, 122). Lincoln and Guba (1985, 316) also highlight the importance of study description, which should include information about how the research was carried out and what criteria were employed in the decision-making process. The better the research method is described, the easier it is to assess its transferability and point out possible inaccuracies that could affect the trustworthiness of the study.

In this study, transferability was ensured by detailed description of the research process. The motivation and baseline for the study were presented in chapter 1. In chapters 5.1-5.3, the decision-making process and research-related choices were justified. This justification was based on existing literature to emphasize the advantages and disadvantages of the various options. The number of experts interviewed (8) also enhances transferability, although their full anonymity might decrease it. Still, the reader has been given enough information on transferability to allow them to evaluate it.

The third criterion is *dependability*, which describes how well the same result could be replicated in similar circumstances and how much the researcher and the circumstances influenced the findings (Lincoln & Guba 1985, 316–317). According to Polit and Beck (2014, 492), credibility cannot be achieved without dependability, such as validity in quantitative research cannot be achieved without reliability. It is notable that interviews as a data collection method are prone to a wide range of subjectivity. As a result, the research should be conducted as unbiased as possible to reach objectivity. (Lincoln & Guba 1985, 316–317.) Procedures for dependability include detailed description of the research methods and findings (Connelly 2016, 435).

Dependability was considered in this study through careful planning and structuration of interviews. Interviews were based on the operationalization table and theoretical framework, and the interview situations were described accurately. There is no reason to suppose the circumstances had a negative impact on the results. However, it

should be taken into account that one of the interviews was held a year earlier and originally it did not serve this study but a preparatory master's degree course, even though the subject was very similar. Additionally, because this was the researcher's first broad research work, inexperience may have affected the quality of data collection and analysis.

The final criterion by Lincoln and Guba (1985) is *confirmability*. It refers to objectivity, or the ability of two or more independent people to agree on the data's relevance, accuracy and meaning. Confirmability is focused with ensuring that the statistics accurately reflect the information provided by respondents and that the interpretations of data are not the result of the researcher's imagination. (Polit & Beck 2014, 492.) Confirmability can be improved by giving the reader the resources they need to conduct a confirmability audit, such as information on data collection methods and the structure of themes discovered during the analysis process (Lincoln & Guba 1985, 319).

To secure confirmability in this study, the reader was given all of the necessary instruments for a confirmability audit. All the interviewees were more or less unknown for the researcher and therefore confronted and treated as equal, which enhanced objectivity. This study also combines the viewpoints of the interviewees with theoretical framework, which means that the results should be confirmable. Additionally, there is a clear connection between the gathered data and the results derived from it. However, the confirmability could have been enhanced even more by allowing all the respondents to review and confirm the results, which would have required a longer fieldwork phase.

6 FINDINGS

In this chapter, the findings acquired in the data collection will be presented. The findings are organized into categories based on the research questions and themes derived from the theoretical framework. Citations from the interviews have been added in italics to support the stated arguments.

6.1 Notable changes in the 21st century

6.1.1 Changes in cancer research networks

Medical research has always been time-consuming and challenging, and required perseverance and patience. A common theme in most interviews was that even though science, methods and instruments have evolved, all medical research, cancer research included, is still very slow. As an example, Respondent four and their research group have been studying a new cancer treatment from 2014, clinical trials started in 2018 and they are still around five years from that treatment to be launched, if it ever will be.

However, there has been some notable changes in research networks during past 20 years. According to all respondents within an interview group one, a central part of medical researcher's daily life, in addition to practical laboratory work, is to write and publish scientific articles, and a researcher is usually ranked based on how many publications they have, in how high-level papers the publications are, and how many times they have been cited. Respondent four stated that research networks and cooperation have evolved during this century, because nowadays most of the papers demand that published articles must be available for other researchers to utilize.

> *Nowadays, researchers can utilize or produce same results that someone else has already produced. Some kind of consensus has been reached that things will be shared and general cloud services for sharing research data have got increasingly common. If you publish something, it is a fair game for everyone. This has increased the transparency of research notably.*

It was stated by most of the respondents that technological innovations have brought people from different countries closer than ever, which has developed research networks. Communication is much faster and more effortless, which means that it is easier to find

other experts and get help whenever needed. According to respondent eight, the world of a researcher was very different when the most common way to communicate was written letters, everything was slow and laborious. Now building one's network has been made quite easy and it is more up to one's own activity, not how much resources they have to acquire the newest technologies.

Apart from increased cooperation, transparency and communication, the turn of the millennium has brought some challenges as well. According to respondent four, even though the access for other researchers' publications is assured, publishing in scientific papers has been made very difficult and expensive. All texts are peer reviewed by other researchers, experts from the specific area in question, who are usually not paid for their trouble, while scientific papers charge notable sums from the researcher that is willing to publish something.

> *Publishing a single article today can cost a researcher 5000 euros. This is wrong and makes no sense, since publishing in a proper paper is almost a necessity for a researcher. A publication that is not peer reviewed is worth nothing, that is not seen as real research.*

Respondent 4 added that due to this problem, there has emerged preprint repositories, such as Bioarchive and Medarchive. Researchers can upload their texts to repositories and get comments from others while waiting for their texts to be published in actual papers, which can take a year. This shows that medical research networks are agile and adaptable, although these repositories would not be needed if the original problem was removed.

According to respondent five, the requirements for academical publications have also increased in the 21st century, which disturbs the activities of research networks. The demanded amount of concrete evidence has increased year by year in all publication series, but especially in the most high-level ones. This creates an adverse circle because the more highly ranked a researcher is, the easier it is for them to network and find collaborations. Researchers are ranked based on in how high-level series they are able to publish, but nowadays the most distinguished papers are not accessible for everyone.

> *Back in 2000, it was possible for a middle-sized research group with basic methods and basic funding to publish in the most high-level series, if they*

> *were able to find something new and unsolved. But now the papers are demanding more and more, it has totally gotten out of hand. You should cure the whole disease in one publication and today the same middle-sized research group from 2000 cannot even dream about publishing in the most high-level series.*

Respondent four was at the same wavelength, describing that publishing in the top three papers, Nature, Science and Cell, is only possible for the most well-funded and larger research groups, since one cell sequencing can cost 10 000 euros. Respondent four stated that the required amount of data in publications started to increase between 2000 and 2010, but methods and tools remained quite same. The revolutionary methodological advancements such as genome sequencing occurred between 2010 and 2020, which ultimately boosted the requirements of publications and inequality between researchers. Without the newest, extremely expensive methods, the situation was more equal for everyone. Nowadays, the older, cheaper experiments are not enough, *"you can't compete against Ferrari on Lada",* as respondent five described.

6.1.2 Changes in cancer research funding

According to Keränen (2019), the share of public funding in medical research in Finland has decreased notably in the 21st century, and this phenomenon came out in all interviews as well. Respondent six stated that some of their research projects have prolonged due to that, since individual researchers must seek additional private grants to cover the expenses, which have only increased. According to respondent five, Finnish science funding has remained stagnant while costs have risen, which might not be a sustainable situation in a long run.

> *20 years ago, Academy of Finland was the main funder in medical research. If you were able to get funding from there, your work was secured and some additional funds from private foundations were just nice to have. Now the situation is reversed: The funding of the Academy of Finland has stagnated at the level of 2005 and medical research relies on foundations, especially cancer research and biomedical research.*

Foundations are important in medical funding in other countries as well, but according to respondent five the situation is still a bit different in Finland. In the United States for example, the funders that are comparable to the Academy of Finland offer huge grants for medical research, in addition to private foundations. In Finland the proportion between public and private funding is quite distorted and the gap between public funding and increased costs rather notable. 20 years ago, researchers were extremely stressed about whether they were going to get funding from the Academy or not, it was such a big deal. But today nothing can be reckoned on Academy. However, respondent five stated that something positive might be happening since public funding has not been cut by government anymore: *"Maybe we have to hit the rock bottom to rise again."*

Another current change in research funding that emerged from most interviews was total cost model. According to the Academy of Finland (2022), total cost model affects the way in which funding applications and funding decisions are made, how funding is used, and how the use of funds is reported. The total cost model has been used from 2009 by the Academy of Finland, government research institutes and Finnish universities. Interviews revealed that researchers have adopted quite negative attitude towards total cost model. According to respondent five, in addition to the reduction of public funding, the total cost model hampers the usage of money researchers manage to get from public institutes.

> *Because of the total cost model, universities get money mainly for labour costs, which means that in university research, the manager of a research group must use all the funds from the university for salaries. Even if there would be a foreigner post doc researcher with their own funding, the manager is not able to use the money for their material costs, only for salary, which they already have. And universities won't give up this model because that would reduce their overall funding. So even universities are not on research's side on this issue, they are on funding's side.*

Respondent eight agreed on that and stated that because of the total cost model, a significant share of Academy funding goes to the organisation, not the researcher, and in many cases the organisation does not use the funds in a way that would be the most fruitful for research. The total cost model aroused strong resistance and resentment among researchers when it was introduced by Ministry of Finance, and some complaining still

arouses every year in connection with Academy's funding decisions. However, respondent eight added that private foundations or other private funding agencies have not consented to total cost model. They are still using additional cost model, which concentrates most of the funds directly on research, even though some sources, especially on university level, would prefer private agencies to adopt the full cost model since that would bring more money to the organisation.

6.2 The role of networks in cancer research

The discussions with all respondents revealed that medical research is extremely networked. These networks include a wide range of different actors, and even though most of the respondents from group one highlighted other researchers as their most important collaborators, there are other significant stakeholders as well. Respondent one mentioned that connections to the local central hospital have become crucial for their work, while respondent four stated that their research group's principal partner is a listed pharmaceutical company, which has maintained good manufacturing process and collected funds for clinical trials. *"The treatment of one cancer patient costs approximately 100 000 euros, that's not something you can do with research grants."* Respondent six added that also different kinds of associations are important stakeholders for their work.

The interviews revealed the importance of different "umbrella organisations" in medical research, since most of the researchers belong to some kind of a research organisation, such as university or hospital. These umbrella organisations can also refer to larger and higher actors than universities, or to their collaboration projects. Respondent four mentioned a joint effort of University of Turku and Åbo Akademi University called InFLAMES Flagship as an example. This joint effort connects the scientific community and biotech and pharmaceutical companies and is a good example of wide and complex networks in medical research. Respondent eight emphasised the meaning of Cancer Society of Finland as an important umbrella organisation, while respondent two added that universities and university hospitals may also collaborate closely, and their research group would have not been able to conduct their research without plastic surgeons and pathologists from the central hospital.

6.2.1 The importance of networks

As research methods and tools are evolving, there is new information appearing all the time in medical research. According to respondent one, interaction between different networks is in key position when it comes to passing that newly found information on. Even though it is quite common that organisations and even researchers are competing against one another, it is essential to expand new solutions and update knowledge worldwide. In this way, it is possible to develop better products and find more effective treatments for patients. According to respondent one, networks are extremely important, since nowadays all challenging and complex work, such as medical research, is conducted within networks. This claim is supported by the literature as well, as Varhelahti and Mikkilä-Erdmann (2016) state that changes in operational environment require collaboration between experts. Therefore, the role of research networks has lately become even more crucial.

Networks seem to act as enablers in medical research. Active interaction and possibility to ask any questions and other perspectives enhances cancer research remarkably and as respondent one stated, *"nobody can do good research alone"*. Respondent four added that it is extremely important nowadays that the members of a research group are active, that they attend scientific meetings and network also internationally, since there is good, even better research outside of Finland too. There are some organisations for young researchers, such as EMBO Young Investigator Programme, which respondent four saw as very useful ways for a young researcher to develop their knowledge via meetings and workshops, and to build their international research networks. Respondent four stated, that one's own activity, reputation and recognition among other researchers is crucial when trying to find collaborations, which is a necessity when conducting good research.

> *I was a visiting editor in a cancer paper, and I had to find two other editors to work with me. I had met a macrophage guru in one meeting and sat next to him in a dinner table, and I thought it would be magnificent to get him involved. So, I just asked if he remembered me, and luckily, he did. And so, I was able to work with a researcher as famous as Donald Trump, thanks to one dinner.*

Respondent eight also emphasised the importance of networks and one's own activity in creating them, especially in the beginning of the career. It tends to work out as a snowball effect, after finding one good contact it may open many other doors. Respondent eight stated that people are rather helpful and cooperative in scientific community, which is quite essential when advancing science and research:

> *Medicine is based on collaboration and networks, a researcher who doesn't have those is quite miserable and helpless. Networks were important already tens of years ago when I started, lonely researchers who were able to do everything alone were mostly an urban legend. Pretty much everyone cooperated with others, also internationally. And if networks were important tens of years ago, today they are a necessity.*

The discussions with all respondents from group one revealed, that the increased demands for scientific publications have strengthened the importance of networks even more. Respondent four stated, that collaborations are crucial, because the amount of data required per one publication is so enormous, that it can take several years and 10 people to finish the article. Collaborations make it possible to access the needed methods faster and reduce the overall time that must be used for one publication. According to respondent five, today no research article is done without collaboration, one article can include 30 different writers from eight different research groups. *"I think that is a good way to do science, to take the needed expertise from where it lies."*

Respondent seven brought a bit different perspective to networks and research collaboration. As other respondents from group 1 spoke from the perspective of a research group, respondent seven has done research mainly alone, although "alone" does not mean isolating completely. They stated that they have been able to do successful research while working as a doctor by networking with similar people. Even though the concrete laboratory work might have happened alone, respondent seven has been internationally networked with other researchers, as well as with company representatives. Networks have made it possible for them to do successful research without the support of a research group. Respondent seven emphasised the meaning of networks in medical research as follows:

> *Everything is based on a good idea and on implementing that idea in a right way. But this may take many people from many different areas. Expertise must be put together in a prolific way because no one is an expert of everything. This stands out in medical research, since a good researcher usually is not a good businessman, but economical understanding is also needed in a modern, capitalistic world.*

6.2.2 Network-related challenges

According to respondent eight, cooperation is close in medical research, but competition is still extremely hard, between companies as well as between individual researchers. Respondent four was on the same wavelength, stating that some people can be a bit sceptic and even paranoid, fearing that others are only trying to steal their research results even when the intensions are good. Prejudices and scepticism hinder prolific cooperation and thus slow down innovations. The importance of networks appeared in this also, since it is easier to earn other's trust if they are not total strangers or if one's reputation is good. However, in the research world a good reputation does not always mean one's friendliness and trustworthiness, as respondent eight described.

> *It is all about your credits and acknowledgement. It is a common joke that you don't have to be psychopathic in this occupation, but it sure helps. It helps to be somehow unconcerned; the top researchers may be quite difficult personalities, usually they are not the nicest guys.*

Respondents one and two stated that when it comes to collaboration between different actors in an environment, where not all actors share common goals, challenges may occur. Commercial actors, such as pharma companies, are sometimes seen in a rather negative light by research-oriented actors and prejudices tend to weaken collaboration between different parties. Due to respondent 1s own experiences, universities are usually eager to work with private companies, while clinicians can be extremely reserved towards such cooperations: *"Clinicians do medical research together with medical companies and usually these researchers are started by companies. Apparently, clinicians sometimes feel like companies try to deprive them, but I don't know where this comes from."* However, it is notable that these kinds of challenges do not always occur and there are collaborations

between commercial and non-commercial actors that are extremely fruitful. Respondent six for example stated that their collaboration with large pharma company was a success and they would not have been able to do that project without them. In that case, the key to success was that everyone knew their own role and respected others.

It was also stated by most of the respondents that when dealing with people, no matter if they are researchers or company representatives, there are always some conflicts and some individuals that are more difficult to work with. Personal chemistries do not always agree, which is perfectly normal, but the problem occurs when the competition between individuals intensifies so much that researchers are not willing to share their knowledge and cooperate with others at all. The situation has not gone that far yet, but this phenomenon could be something that should be kept an eye on in the future as globalization and advances in research methods have strengthened the competition more than ever before. Respondent three emphasised that in a competitive environment, where some of the researchers might be a bit paranoid, the meaning of networks is highlighted and building them must be started in some other way than straight asking for help. The trust and respect of others must be earned.

According to respondent eight, the intense competition between researchers is not only a bad thing. When an innovation or phenomenon appears, researchers seize a chance eagerly and try to take it forward.

> *It's very important for evolution that people compete and try different things. It advances science, but of course it is also very predatory since there are so few winners in that game. It depends a bit on luck who wins and who loses, but also on one's abilities and networks, maybe even unscrupulousness. It is an interesting set-up, that cooperation is the lifeblood of research but at the same time we are fighting brutally over who gets publicity, funding, and great students. The spiral can take you up or down, depending on whether you happen to hit the goldmine or be in the right place at the right time.*

Respondent seven brought a bit different perspective for network-related challenges, stating that even though cooperation is essential, the collaboration between different sectors is not always fluent and successful. Today, market power plays a big part in all medical research and large pharmaceutical companies are very important actors in the

field of research and drug development. According to respondent seven, universities focus mainly on basic research, education and maintaining expertise, while most of the drug development actually occurs inside pharmaceutical companies. Respondent seven stated that, according to their experience, university researchers are not that eager to help in external projects, citing their "free research". In Sweden, collaboration between universities and pharmaceutical companies is more popular than in Finland. It is a common practice that companies buy research from universities and in that way, universities get funding and companies knowledge. However, it is notable that these kinds of collaborations occur also in Finland, just not on such a large scale and some prejudices still exist.

6.3 Funding in cancer research

It came out in all discussions with respondent group one that a great amount of time in cancer researcher's daily life is allocated to gaining funds. The Cancer Foundation, for example, funds researchers for one year at a time, the older and more experienced researchers might get two or three years, but basically the funding must be applied again every year. Respondent three described this as follows:

> *It feels like you must gain money all the time. About 20 per cent of my time goes to applying for grants. That is quite much time taken away from the actual research work, how much more I could do with an ongoing funding.*

Additionally, one research grant or single foundation usually is not enough to cover the costs of one research project, which means that additional funding must be searched throughout the project.

6.3.1 The complexity of research funding

The process of gaining funding in cancer research is not a simple one. It may take weeks, even months of work in some cases, and includes a great amount of jargon and bureaucracy. The requirements have also increased and when a researcher applies for a grant, just an idea is far from enough. According to respondent four, there should be hypotheses and the more experiments the researcher has already done, the greater the chances are to get funding. This can be a bit tricky, that a researcher is trying to get

funding for a future project, but in in practice, the project should be already started at some level before it can get funding. *"Usually, when I write down to an application my hypotheses and what I'm going to do, I have already done some of that".*

Respondent five too stated that requirements for funding applications have increased, but in Finland the situation is not as bad as in some other countries. In the United States for example, the project must be already very advanced when applying for funding. In practice, money is sought for work already done.

> *In Finland, we are not there yet but still, if you have no data when applying for funding, the situation is not that good for you. If all you got is a hypothesis or an idea, the application must be exceptionally written, you must somehow convince the funder that even though some step failed, the whole research would not fall because of that.*

Regardless of whether the funder is a foundation or a public funder, the funding process starts with the funding organisation opening their application form. Usually, the application period is once a year, but some foundations prefer an on-going alternative. The funding organisation gathers a group of experts to evaluate all applications. According to respondent eight, the Academy of Finland uses foreign evaluators, paying them to come to Finland for a couple of days to evaluate the applications in panels, but the Cancer Foundation, and pretty much all the other foundations as well do not have that kind of resources. The Cancer Foundation has two committees, filled with local cancer research professors, who read and evaluate the applications for a nominal compensation.

The application period itself may take one to three months, and within one funding organisation, there may be several rounds, especially in international funding agencies. After the application period, the evaluation period starts, which in turn takes several months. The length and complexity of funding process was criticized by most of the respondents because first the researchers must spend weeks or months writing the application, and after that it may take six months before they know if they are accepted or not. The length of the process also varies greatly among the funders. According to respondent 5, different cancer institutes are very efficient, if you leave an application in September, the money is yours in December, if you are accepted. The Academy of Finland in turn is extremely slow, if the application period is in September, the money will be delivered in August, almost a year later. That is a very long time to wait, especially

in cancer research because it is possible that in one year, a good idea has already passed by. Respondent seven stated as well that when applying for public funding, it can easily be a one year -process, which is too much.

If funding process is long and complex in Finnish organisations, it is even more so in large, international agencies and especially in consortium grants. Respondents four and five both stated, that it is almost impossible for Finnish researcher or research group to get funding from the United States if they do not have a straight link to there. The system is so complicated and bureaucratic that it takes time to learn the process, even with local help. Smaller, European foundations concentrated on cancer especially then again are quite like Finnish ones, funding process may be even more structured in those. However, according to respondent five, European Research Council can be the despair of researchers:

> *"I have once applied for ERC funding, which means a great amount of money, and didn't even get close. Basically, I spent one summer in library, just writing the application. It is extremely demanding process and that's why I haven't applied again. You really should have the nerve to stick your neck out and that applies to EU Horizon and others as well."*

Respondent four described that they had just applied for ERC funding, two million for five years, and agreed with respondent five that it was a heavy process. In the first round, the Council reads a five-page grant application and if managed to get to the second round, the application must be 15 pages long. And it takes one year that the final results about who gets funding arrive. Respondent four stated that these both applications must be submitted at the same time, and if the applicant is not selected to the second round, they will get a qualifying period of two years. All the respondents from group 1 also stated that the workload does not end when the funding is granted, they must report regularly to the funder how the research is proceeding.

6.3.2 Research funding and networks

In a research funding process, the main actors are the funder and the one that is to be funded, but also other, more invisible parties may be involved. According to respondent four, universities have their own research funding units, which can be a great help for researchers in the funding process. Especially when it comes to The Academy funding,

where also the dean is involved. Respondent four stated that nowadays, as their research group operates under the university, all their research grants go through university systems, and therefore close cooperation and good relations with research funding unit and finance unit are important. And in bigger EU-applications the role of university units is even more significant.

Respondent five also stated that university has some employees, whose main duty is to help researchers get funding, by identifying new, possible financial sources and by translating and explaining bureaucratic rules and regulations. According to respondent five, their research group has an own manager or coordinator for financial issues, a personal funding officer, who has been a remarkable investment. This funding officer has been an enormous help for the whole research group, especially when the grant applications have become more and more complicated and demanding. Respondent 8 emphasised the role of whole research organisation in research funding, university or university hospital for example. *"The fact that organisation provides a research group with a dry, warm interior is already an investment in that research."*

According to respondent four, networks are essential in cancer research, but they are also important in cancer research funding. According to respondent 8, different funders may collaborate with each other, to go deeper into some specific problem. The Academy of Finland, for example, has a lot of international cooperation, especially within the EU. Respondent eight stated that international dimension and cooperation is quite typical for public research funders, and they can sometimes arrange very large-scale projects, the EU Joint Programme for example. However, it is not unusual that private foundations organise cooperative projects as well.

Funding-related collaboration within a research group can also be important, since even though the definite responsibility of funding belongs to the leader of the research group, the workload can be divided. Respondent four stated that usually collaborators are asked in funding applications, which emphasises the meaning of external research networks. They stated that it can matter a lot in research funding process, how internationally one is networked. It is easier to get funding, if the researcher has wide connections and is known and trusted by others, because that strengthens the impression of the funder that their money will not be wasted. Respondent five was on a same wavelength, stating that a researchers collaborative networks matter a lot when searching and applying for research funding.

> *It is quite unlikely that one researcher would have done everything necessary for a funding application or would alone have all the necessary expertise and knowledge, but networks can save you here. It is skilful application writing and project management to state that you can do this by yourself and then you have these kinds of collaborations to help you in that and so on. It's about the big picture.*

According to respondent nine, networks are extremely important when it comes to funding private medical companies as well. They stated that building wide networks naturally advances one's own career but can also play a big part when applying for funding, especially when it comes to venture capitalists. They want to check the background of the applier carefully, who they work with, who else has funded them, are they trusted by others and so forth. According to respondent nine, when they have negotiated with venture capitalists, usually they have wanted to contact other parties from their networks as well, to make sure that the investment could be prolific.

6.3.3 Funding-related challenges

One notable challenge in cancer research funding that emerged from several conversations is the decrease of governmental funding. In general level, cancer research is well-funded field of research, but the funding sources have changed. According to respondent seven, *"when we are talking about medical research funding in Finland, cancer research included the money that comes from our society is comparable to peanuts."* Respondent five sees this as a problem, since society does not offer any common basic funding or ground funding, researchers must always start from scratch:

> *In many countries, the university professorship is accompanied by two researchers, for example, but not in Finland. We must always steal a little from some previous funds for the next project, to get the preliminary data we need for the next funding application. If we had those two extra researchers, they could focus on preliminary experiments with their grants, and we would be able to gather the applications much more efficiently. But we don't have them, and it is a significant defect.*

According to respondent five, in many other countries the funding system resembles the one Finland got 20 years ago. In the United States for example the funding agencies comparable to the Academy of Finland offer very large grants that form the basis for research. This used to happen in Finland also, and foundation funding was used only to complement Academy funding, but today the relation has turned the other way round. Respondent five described their feelings as follows: *"Of course, foundations play a big role in other countries as well and maybe it's not a bad thing. But it's a matter of prestige, are we a country where the state doesn't care about the funding of science?*

According to respondent seven, the decrease of public funding itself is not a challenge, because private funding has been able to stand in, but it does create some negative side effects. Capitalistic system has speeded up medical development, but it has also moved drug development to pharmaceutical companies. The amount of money and resources within large companies, such as AstraZeneca or Pfizer, is something enormous and enables rapid development, as COVID-19 vaccines have showed. However, companies want to protect their innovations with patents and new drugs tend to be very expensive.

> *Now that new drugs and vaccines come from pharmaceutical companies, they are sold at high prices. These companies invest billions in drug development, and of course they want to get their investments back at some point, that's how companies work. But this means that poor countries cannot afford the newest drugs and that is a problem.*

Respondent eight added that one eternal question in cancer research is that there is too little money, referring to the decrease of public funding. Money is too little in relation to the past and in relation to other countries. According to respondent eight, previously Finland was comparable to other Nordic countries, Switzerland, and the Netherlands in clinical medical research, but today the category is same with the former Eastern bloc. Organisations can no longer rely on the state's funding: The Ministry of social affairs and health funded medical research with 90 million euros at the turn of the millennium, today the amount is just over 20 million.

> *If we talk about national investment in research, what percentage of GDP goes to research funding, in Finland it's one tenth compared to Sweden, not*

> *to mention the super countries of research such as the Netherlands, Switzerland, and the United States. The decrease of public research funding is a big problem in this sector, foundations will not be able to compensate it forever.*

Also, the length and complexity of funding process in cancer research and the amount of work that researchers must put on it to get funding were seen as a challenge by many respondents. Applications can be extremely laborious, and the time consumed to them reduces resources from the actual research work, not to mention the time it may take for the funders to make final decisions. According to respondent four, it is quite frustrating that applying for grants is laborious, the decision must be waited for a long time, sometimes so long that the original idea is already outdated, and to crown it all, everything must be done repeatedly. Respondent four stated that funding should be more long-lasting, now most of the university researchers must go through the process every year and constantly worry if they will be able to continue their work. Respondent five was on the same wavelength, stating that the two biggest structural problems in cancer research funding are the amount of funding and the length of the funding process.

> *Nowadays, the research projects should be revolutionary, they should reform science and serve equality, and then the sums that most funders offer barely hire one researcher, nothing is left for material costs. Funders should offer such sums that researchers would be able to do the required work. And then there shouldn't be an unreasonable length of time between applying for money and receiving money, as it is now in the case of Business Finland and the Academy of Finland.*

As many of the problems in cancer research funding were especially related to public funders, respondents four and five pointed out one problem that applies to private foundations. According to them, the Academy of Finland gives an opinion on their decisions but most of the foundations do not give any feedback from the applications they receive. They do not explain, why someone got funding and someone not, which is mainly a question of workforce. Still, it is impossible for those who are not accepted to know if they were even close and what they should have done better. Researchers know nothing about the criteria, not even a score limit. According to respondent five, *"applications are*

almost always rated somehow, so I don't think it would be too much to ask that applicants were informed of their own score and the score limit of that year."

Respondent seven brought a slightly different perspective for funding-related challenges, stating that they have been able to do good research without any grants or external funding. They admitted that in some cases grants are a necessity, for example when purchasing a new machine, but they have managed on their own. This is a bit at odds with the statement of respondent eight: *"The equipment and facilities must be in order, otherwise it won't be world-class research but fiddling and the problem is that in Finland we don't always have enough money and resources for world-class research."* However, respondent seven stated that their success without external funding has been possible only because of wide networks, they have actively networked with similar people all over the world. Also, respondent eight emphasised that the solution for limited funding and resources could be international networks, to collaborate with those who have resources. Respondent seven however does not see the lack of resources as the actual problem:

> *To have better research in Finland, we need bold thinking and better innovation. And above all, better cooperation with different sectors and abilities. Usually, one person cannot complete an innovation by themselves, we need different abilities and skills to be put together and all the necessary skills might not be found among researchers.*

Even though there were some different perspectives about funding-related challenges among respondents, it emerged from all conversations that currently funding in cancer research does not work as efficient as it could, and it is a notable burden for most researchers. Moreover, the size of the grants has remained quite the same while the requirements for researchers have increased significantly, which can be seen as a grievance.

7 CONCLUSIONS

The conclusions of this study are discussed in this chapter. The chapter aims to provide answers to the research questions by merging the presented findings and theoretical framework. The chapter goes through theoretical and practical implications separately and ends with limitations of the study and suggestions for future research.

7.1 Theoretical implications

Research funding is complex and multidimensional field and in key position when it comes to developing any kind of research: There is no research without money. The significance of research development is emphasised in the field of medical research, where innovations and improvements contribute to people's health and wellbeing. Cancer research is nowadays a popular and well-funded sector of medical research due to recent advances (Weinstein & Case 2008, 6861). However, some challenges and targets for development still occur, as in all medical research.

This study aims to clarify, what is the role of networks in developing research funding in cancer research, and this main research question was complemented with three sub-questions: How research funding has changed in the 21st century in cancer research, what is the role of networks in cancer research and what kind of challenges there are related to networks and research funding. In this sub-chapter, the theoretical framework and findings are discussed by analysing what was discovered on each sub-question.

The existing literature shows that networks have affected medical research in many ways over the last 20 years. According to Dorogovtsev and Mendes (2001, 7), collaborative networks connect experts from all around the world and thus enhance the possibility of international cooperation. This has expedited the innovations and development in medical research in the 21st century, because both tangible and intangible resources can move more easily and efficiently than before. Recourses are spread nationally but also across national borders: External innovations have obtained strong interest in medical research over the last 20 years (Romasanta et al. 2020, 1816). In cancer research especially, the 21st century has brought improvements in early detection and treatment, and the death rates associated with cancer have decreased (Etzioni et al. 2008, 176).

The empirical findings in this study also emphasise the pronounced role of networks in medical research over the last 20 years. The technological innovations have brought

people from different countries closer than ever, which has strengthened research networks: Communication is much faster and more effortless nowadays, which means that it is easier to find other experts and share resources more efficiently. This can be seen also in the emergence of networked research infrastructures, which distribute facilities, instruments, data sets and other resources globally (Meijer et al. 2012, 492). Transparency has also increased: During this century, most of the medical papers have started to demand that published articles must be available for other researchers to utilize, which eases knowledge transfer. However, new innovations, international cooperation, and advancements in medical research in the 21st century have also increased competition and researchers are required more than ever before, by scientific papers and by funders.

Networks and networking have affected medical research funding as well. According to Chakravarthy et al. (2016, 760), the whole medical industry has implemented a wide range of collaborations in a unique approach that connects inputs from public-private consortia, disease foundations, venture capital and industry-academic partnerships, resulting in learning from multiple disciplines but also making medical research funding quite multidimensional and complex. The improvements in medical research in the 21st century also mean that more money is required; advanced research methods and tools are extremely expensive. The empirical findings show that this can complicate the work of cancer researchers, as they must put a lot of time and effort to grant applications since funders are demanding more and more.

While the financial needs have increased, governmental funding has decreased significantly in Finland, which is the most notable change in Finnish cancer research funding in the 21st century. Public funding has fallen to less than a quarter of what it was at the beginning of the century, which means that cancer research is very dependent on private funding (Aarnipuro 2021). According to Heikinheimo et al. (2020, 243), Finnish government supported clinical research in university hospitals with 40 million euros in 2010, while in 2018 the amount was 20 million. The notable decrease of public funding was also emphasised in the empirical findings. Today, the funding of research projects in Finland consists of patches, it is very scattered. Private foundations play a considerable role in cancer research funding, but usually one grant from one foundation is not enough to cover the costs of a whole research project, which means that researchers must seek funding constantly.

Another significant change regarding cancer research funding in the 21st century that did not appear in existing literature but was found from empirical data is the

implementation of total cost model. The total cost model has been used from 2009 by the Academy of Finland, government research institutes and Finnish universities and empirical findings revealed that researchers have adopted quite negative attitude towards it. The total cost model restricts the final use of funds, directing them mainly on labour costs. This is problematic for researchers since when the money comes from funders that have adopted the total cost model, researchers are not able to decide how to use it. This may not be the best for research itself.

The role of networks in all medical research, including cancer research, has grown to be very notable and both existing literature and the findings of this study underline the fact. According to Breschi et al. (2009, 834) networks offer current access to external resources and information while also consolidating internal expertise and learning abilities. This enables more effective and productive research work: Researchers are not tied to one place and one research group, knowledge can be transferred easily, and results can be shared and compared globally. Interviews showed that nobody can do good research alone in a field as challenging and complex as cancer research, cooperation is a necessity as no researcher can possess all the necessary knowledge and recourses. This also means that one's own activity, reputation and recognition among other researchers becomes more crucial.

The importance of networks has even increased during the 21st century. The literature shows that medical research has leaped forward, methods and tools have improved notably. According to World Health Organization (2022), the longevity of humans has increased over the last century largely because of the advances in medical research. The empirical findings in turn indicate how advancements have affected the life of researchers: requirements have increased in everything, from scientific articles to research work itself. Cooperation has become more important than ever and as literature shows, it transcends national borders. According to empirical findings, cooperation should also extend to different sectors as in cancer research the cooperation between researchers is not always enough. Sometimes the necessary expertise can be found in factories, businessmen or engineers, for example. It also appeared in the empirical findings that networks create an endless cycle around cancer research, and they are needed in many ways: Researchers need networks and especially collaboration within them to carry out their work, but to find collaborations, they must be networked and trusted by others.

The existing literature does not show how networks are connected to research funding, but this question was addressed in the empirical findings. There may be many parties involved in the research funding process, for example assisting experts and umbrella organisations, and open communication and cooperation between them is important in terms of positive outcome. Different funders in turn may collaborate with each other to go deeper into some specific problem and this kind of collaboration occurs between national foundations, but especially among public, international funders. The empirical findings also emphasised the role of individual researcher's networks and funding-related collaboration within a research group. Naturally, funders want to target their resources on prolific, successful research projects, no matter if they were public institutions, private foundations, or capital ventures. If a researcher or research group has wide networks and is known and trusted by others, it is much more likely that they will get funding because that strengthens the impression of the funder that their money will not be wasted.

It was illustrated by both literature and empirical findings that medical research funding is complicated and there are several challenges related to it and its networks. Different actors cooperate to achieve common goals and solve shared problems, but cooperative efforts may collapse under noncompliance or disagreements over division of benefits, even though different actors would share similar preferences (Stein 1982, 299). According to Kinne 2013, 767, cooperation is a way to achieve common gains and solve shared problems, but the external conditions of different parties may be diverse, which tends to hinder cooperation within networks. The empirical findings confirmed these challenges and added some other phenomena as well. Some old prejudices between different sectors may hinder cooperation in cancer research, while intensified competition may disturb the cooperation between individual researchers. The prejudices may have caused that In Finland collaborations between universities and pharmaceutical companies are not as usual as in Sweden for example, where these collaborations have proved to be extremely prolific. It could be interpreted that mutual trust and respect and that everyone understands their own position in the research project are key factors to fruitful cooperation within networks.

The literature also pointed out that as medical research is very international, there are legal and social issues related to it. According to Meijer et al. (2012, 495), ethical, legal, and regulatory issues become more current and prominent when operations become international. Medical networks are often very wide and extend over governmental

boundaries, which may cause challenges related to different methods, practices, and regulations. The literature showed that internationalisation has shaped medical research funding as well: According to Meijer et al. (2012, 495), the move to larger, international networks requires different funding structures. Funding in networked research covers a various set of activities: research costs themselves but also set up, maintenance and outreach activities, for example. However, the existing literature does not fully explain what kind of challenges there are related to cancer research funding, or even medical research funding in general, but this question was gone through broadly in the empirical findings.

The only research funding-related challenge that emerged from both literature and interviews was the decrease of public funding, although its real effects on cancer research were pointed out only in interviews. According to Aarnipuro (2021), Finnish government has reduced funding in university hospitals significantly over the past twenty years, which means that medical research is nowadays very dependent on private funding. The empirical findings showed that the Academy of Finland used to offer very large grants that formed the basis for research and foundation funding was used only to complement it, but today the relation has turned the other way round. Since society does not offer any common basic funding or ground funding, researchers must always start from scratch. The empirical findings also showed that the decrease of public funding has created some negative side effects. Since large pharmaceutical companies have much more resources than university researchers for example, the drug development takes place mainly within companies. Naturally, these companies want to get their investments back which means that new drugs tend to be very expensive and poor countries cannot afford them. It could be considered if this is ethically correct, especially when literature states that the global cancer burden has moved from the developed countries to less developed, poorer countries (Ray & Özdemir 2016, 65).

The empirical findings showed that the complexity of funding process in cancer research causes notable challenges to researchers. A great amount of time in cancer researcher's daily life is allocated to gaining funds, which reduces resources from the actual research work. The requirements for funding applications have even increased lately, but the grants have not which causes a notable challenge. The research projects should be almost revolutionary to secure funding but the sums that most funders offer do not cover the costs that kind of research work requires. The length of funding process was also emphasised as a problem that disturbs fruitful research since first the researchers

must spend weeks or months writing the application, and in worst cases it may take almost a year to actually receive the money, if they are accepted. That is too long time to wait, especially in cancer research because it is possible that in one year, a good idea has already passed by.

There were slightly differing views on the adequacy of cancer research funding in the empirical findings. Based on the empirical data it could be concluded that in private companies where main funders are venture capitals, the money really is not a problem if the company has invented something useful. However, the situation is not as good for academy or university researchers, in that sector some projects are not carried out due to insufficient funding and that phenomenon is largely based on the decrease of public funding. Because of the lack of money, Finnish cancer research is not comparable to the super countries of research anymore. Even though there is good research in Finland, according to empirical findings its grade has fallen when measured internationally.

The empirical findings of this study are aligned with the existing literature on medical research funding and medical networks, but they also bring new insights into the topic and deepen the knowledge especially from the perspective of cancer research. The following table (Table 3) outlines the theoretical implications of this study, adding the empirical findings to the theoretical framework.

Table 3. Framework of theoretical implications

Research question	*Sub-questions*	*Theoretical findings*	*Empirical findings*
	How research funding in cancer research has changed in the 21st century?	Increasement of international cooperation	Increased competition regarding research work and research funding
		Decrease of public funding	Increased demands of scientific publications and funding applications

What is the role of networks in developing research funding in cancer research?		Significance of private foundations has grown	Implementation of total cost model
	What is the role of networks in cancer research?	Significance of networks has increased in the 21st century	There is no cancer research without networks
		Networks enable the development of research	Networks extend across national and sectoral boundaries in cancer research
			Wide networks enhance researcher's chances to get funding
	What kind of challenges are there related to networks and research funding?	Differing conditions and preferences may hinder cooperation within networks	Old prejudices may hinder cooperation between different sectors in cancer research
		Legal and social issues occur due to internationalisation	Complexity and length of funding process is a notable challenge
		Decreased public funding causes challenges for research	Decreased public funding has caused negative said effects in cancer research

Overall, there were no conflicts between this study's theoretical and empirical findings or contradictions between the framework and the statements of the interviewees.

The collected data rather complemented theoretical framework, offering more precise knowledge on cancer research funding and networks. By combining theoretical and empirical findings, it was possible to form a coherent and comprehensive understanding about how cancer research funding is currently working and how networks are related to it.

7.2 Practical implications

This study shows that networks are crucial for prolific cancer research and there is also a clear link between networks and cancer research funding. No one can conduct good research alone and this seems to apply to research funding as well, many different parties and connections are needed in the process. The importance of networks extends to every sector of research and a lot of different expertise is needed in a field as complex as cancer research. It requires cooperation over national and industrial borders.

As the role of networks is so significant in cancer research, young researchers should be encouraged to build their networks and connect with people all over the world. As this study shows, sometimes the needed expertise can be found only outside of Finland, and therefore international contacts are extremely important. More experienced researcher should help their younger colleagues and open their own networks for them. Even though the competition among researchers is rough these days, the advancement of research should be the priority for everyone. Researchers should be careful that the competition between individuals does not intensify so much that they are not willing to share their knowledge and skills anymore. Eventually, the skills of an individual researcher are not enough in cancer research, it requires more than any individual can do alone.

Networks can be extremely wide and international in cancer research, and it is understandable that problems and challenges may occur when parties with different backgrounds, goals, and opinions cooperate. In this study we find that cancer research requires knowledge and expertise also outside the scientific research itself and to advance cancer research, cooperation between different sectors should be enhanced. Mutual trust and respect are in key position in this, old prejudices should be left aside, and different parties should value each other's different knowledge and contributions. Even different interests can be included in a successful collaboration if everyone knows their own role and respect other roles as well.

This study shows that funding in cancer research is complex and requires a lot of time and resources from the researchers' perspective. Currently, the laboriousness of

funding process for researchers is notable but the amount of money the funders are offering per one grant is not, and this relation should be improved. If the funding applications require as much as they do currently, it should correlate with the amount of funding, so that researchers would not need to apply constantly. Overall, funding should be more long-lasting in cancer research. It would be a bigger risk for the funder if the project eventually fails and they have funded it for several years than to commit only for one year at a time, but in a long term this could advance cancer research since researchers could focus on more the research work itself, not on writing funding applications.

The funding process in cancer research is currently too long when it comes to public funders. The process may take even a year and during this time the researchers must worry if they will be able to continue their research or not unless they have funds from somewhere else. The empirical findings showed that private foundations manage to keep the process much shorter, it may take only four months from the beginning of the application period to the point where researcher or research organisation receives the money. Therefore, it should not be impossible for public funders, such as the Academy of Finland to compact their funding process, it would enhance the work of cancer researchers.

Private foundations also have room for improvement in cancer research funding. Most of the foundations do not give any feedback from the applications they receive. They do not explain, why someone got funding and someone not, there is no public evaluation criteria that researchers could follow. This is problematic since researchers cannot know if they were close to approval or should they do everything differently in their next application. It is quite difficult to improve without any feedback and if foundations do not have enough recourses for detailed analysis of applications, they could still present the scores and overall score limit. Applications are almost always rated somehow, and the applicants should be informed how they rated compared to others, that would give guidelines for those who are not accepted for funding.

The aim of this study was to clarify, what is the role of networks in developing research funding in cancer research. The findings show that networks are crucial in both research work and research funding, and these two can be developed by enhancing the operations of networks. Cooperation is needed in cancer research funding, and wide networks also improve the chances of a researcher to get funding. The importance of wide networks and cooperation between different sectors is emphasised in cancer research since it is extremely complicated and important field of research that requires versatile

expertise. In addition to the role of networks in cancer research funding, this study also presented some additional findings about challenges related to cancer research funding and networks. By identifying and seizing these challenges it is possible to develop cancer research; enhancement of the funding process and cooperation within networks are in a key position.

7.3 Limitations and suggestions for future research

This study was carried out in accordance with recommendations and conventions found in qualitative research literature. As a result, the overall trustworthiness of the study is acceptable. However, there are some limitations regarding empirical data. Firstly, the study is limited to focus on cancer research funding only in Finland. All the respondents were Finnish and there was no remarkable comparison between countries, even though funding systems and policies do vary. The emphasis was placed on Finnish research and research funding to keep the scope of this study manageable for a master's thesis.

Secondly, the data was collected quite widely, but no international funding organisations or public funder representatives were reached. There were researchers, pharmaceutical company representatives and foundation representatives among respondents, which ensured that a wide perspective about cancer research funding was gained, but the perspective would have been more complete if also international funding organisations and/or public funders from Finland would have been interviewed. However, this limitation was considered when analysing the data and it was possible to answer comprehensively to the research questions also without international and public funding organisation representatives.

This study showed that there is room for improvement in the functioning of cancer research networks, and those networks should be investigated more in the future to enhance cancer research. An interesting research topic for future research could be to study how collaboration between different sectors included in cancer research could be enhanced. Several challenges regarding cancer research funding were also pointed out in this study, and it could be useful to investigate those problems more precisely and to compare them to other countries and their challenges, as this comparison was left out in this study.

There is a clear research gap in how networks are related to cancer research funding, but also in the networks of cancer research in general and this study is not enough to fill that gap completely. This study produced useful findings regarding cancer research

funding and cancer research networks but there is still room and need for more research on how to develop cancer research through networks, not only cancer research funding. Additionally, this study pointed out that since nowadays drug development takes place mainly within pharmaceutical companies, the newest drugs and treatments are too expensive for poor countries. At the same time, the global burden of cancer is shifting from developed countries to those poorer, less developed ones and this issue should be taken into consideration in the future more emphatically.

8 SUMMARY

Cancer research is constantly developing and important field of research, since the effects of cancer extend to global health, wellbeing, and economy. Even though methods and tools have improved notably over the past 20 years, there are still several challenges related to cancer research. It is extremely time-consuming and requires a lot of different recourses, that no individual researcher can hold. Therefore, there has evolved wide networks in cancer research, which are crucial for prolific research but also have their own challenges. Some of these challenges are linked to research funding, but the connection between cancer research networks and cancer research funding has not been fully studied before. Therefore, this study has analysed, via the main research question *what is the role of networks in developing research funding in cancer research,* how cancer research funding could be enhanced through networks. The main research question was covered by clarifying how research funding has changed in the 21st century, what is the role of networks in cancer research and what kind of challenges may occur related to networks and research funding.

The study was carried out as qualitative research, where experts from different areas of cancer research and cancer research funding were interviewed to attain a wide perspective over the studied issues. An extensive literature review, presented in chapters 2, 3 and 4, was also conducted to form a coherent baseline for this study. The empirical data from interviews was analysed with thematic analysis and the methodology was thoroughly presented in chapter 5. The empirical findings were grouped based on the research questions and gone through in chapter 6. The theoretical framework and empirical findings were eventually combined to provide comprehensive implications in chapter 7.

This study has found that networks are extremely important for cancer research and cancer research funding, and both can be developed through them. Networks enable cooperation between different actors and enhance the distribution of different types of recourses. The changes in cancer research funding in the 21st century have even strengthened the importance of networks since the requirements of research and research funding applications have increased notably. It is indisputable that no one can carry out alone research work as demanding as cancer research, networks are crucial in it. Nowadays networks play an important part in research funding as well, since both funding agencies and researchers that seek funding have started to cooperate in their quarters to

achieve better results. The chances of a researcher to get funding also increase notably if they have wide networks behind them and are trusted and known by other actors in the field.

This study also pointed out several challenges related to networks and funding in cancer research. The cooperation within networks is not always unproblematic, since in cancer research networks include a variety of actors from different sectors, and different opinions, preferences and goals may appear, as well as some prejudices. The competition has also increased between companies but also between individual researchers, which may hinder cooperation. In research funding in turn the decrease of governmental funding, adaptation of full-cost model and the complexity and length of funding process are the most notable challenges that hinder the work of cancer researchers. The results of this study conclude that cooperation between different sectors in Finnish cancer research should be improved, because it correlates to the fluency of cancer research and cancer research funding. Trust and respect between different parties is central for improving cooperation, everyone should be aware of their own position in the project and trust that fruitful cooperation is possible even with different backgrounds when everyone invest in it.

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APPENDIX

Interview questions

Q1: Please introduce yourself, your background, and current role(s)
Q2: What kind of networks are related to your work?
Q3: How do you communicate within your networks?
Q4: How your (research) networks function currently?
Q5: How would you develop your networks and their functioning?

Q6: Have there been significant changes in cancer research in the 21st century?
Q7: Have there been significant changes in cancer research funding in the 21st century?
Q8: How funding in cancer research works currently?
Q9: What is your role in funding?
Q10: Are there some overall practices and conditions in cancer research funding?
Q11: Who are involved in a research funding process?
Q12: Where do you usually seek funding?
Q13: What must be ready when applying for funding?
Q14: What is critical to getting funding according to your own experience?
Q15: What kind of challenges do you see in cancer research funding?
Q16: On what and from whom does the funding depend?

Q17: What kind of role do the funders have in research?
Q18: What kind of networks are related to research funding? Who are involved?
Q19: Are there any conflicts of interest within these networks?
Q20: Are there any other challenges in research funding networks?
Q21: What would you change in the funding process?
Q22: What would you change in your own work?