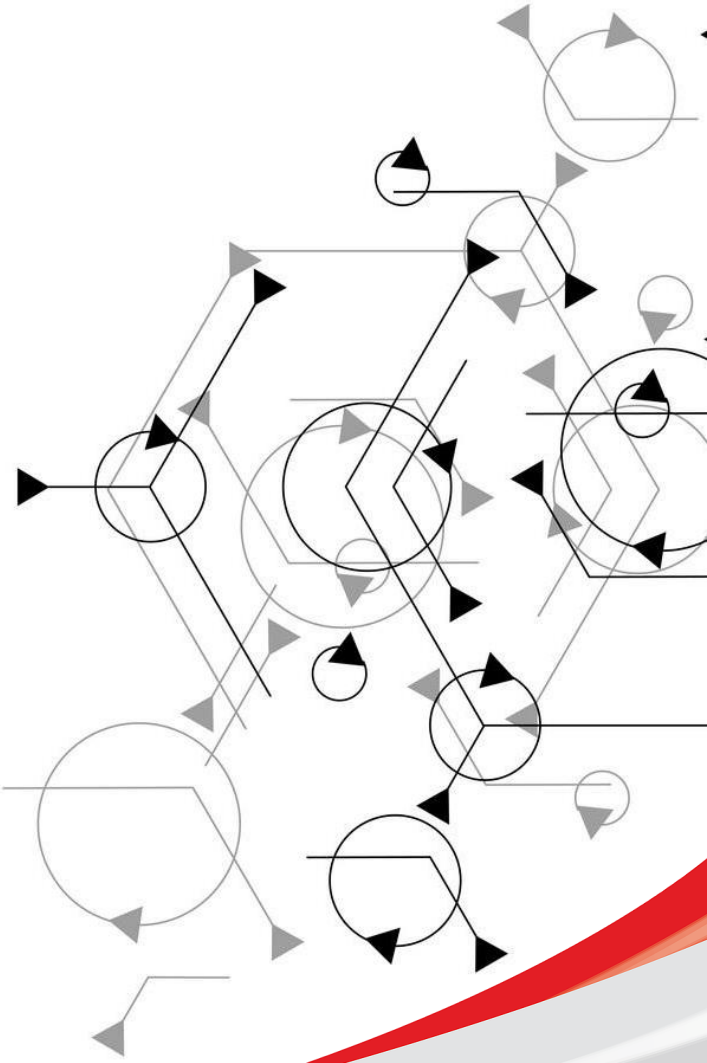
Radboud University

Researching researchers: A system dynamics view on researchers' methodological choice within the medical field



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Business Analysis and Modeling - Master's Thesis

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June 13, 2022

Abstract

Objective: As healthcare shifts toward individual oriented care, the call for a shift in thinking within evidence-based medicine has spotlighted the increasing need for novel methods in the medical research field. This study aims to model the perceived structure, feedback mechanisms, and main drivers behind medical researchers' methodological choices.

Methods: A qualitative system dynamics approach was used to analyze and connect interacting factors from eleven semi structured interviews. A causal loop diagram was constructed to identify the structure and feedback loops driving researchers' methodological choice.

Results: The resulting causal loop diagram was divided into four sections: Method exposure, method acceptance, method funding, and funding subsystem. Ten reinforcing feedback loops were identified. A system archetype called the "success to the successful" was identified in the funding subsystem. Main drivers include funding, the evidence hierarchy, exploring the topic, line of research, and the pressure to publish.

Conclusion: The reinforcing feedback loops allow for circumstances to arise where one method develops over another through its exposure, acceptance, and funding. Methodologies without funding may still develop, but in a delayed way. Healthcare institutions wanting to facilitate novel methods can implement policies which relieve the pressure to publish in high impact journals and offer funding opportunities.

Keywords: System dynamics; causal loop diagram; methodological choice; medical researchers; research funding; paradigm shift; Evidence-based medicine

Acknowledgements

I'd like to take a moment to thank all of those for their unwavering support throughout this journey. To my son Declan for giving me grace, love, warmth, and strength every day. You inspire and challenge me to be the best version of myself. To my darling husband Scott, who continues to invest in me because he feels I am worth it. I can't begin to say enough about the ways my life has been enriched through our love and partnership. To my sister Kat, without her unwavering physical support during this thesis I would still be lost in my data. She was like an "I love you, that isn't words." To Inger, who helped me structure my thoughts every time I felt lost in this journey and gave me her expert advice for only the small fee of friendship and dinner. To Bram and especially Shea, who started our study group and helped me feel less alone in this endeavor. Their emotional and peer review support was unprecedented, and a grand trio of friends has resulted from this. To Etiënne and René, who gave me the flexibility to allow myself to discover what motherhood means to me, without the pressure to spend every waking moment on this project. Their guidance, patience, extra time, and support to me as a student while I navigated a new chapter of my life, means the world to me. To all my family and friends who cheered me on from the sidelines.

If I were a statistic, I would have beat the odds, and that wouldn't be possible without all of you.

Thank you,

Jennifer Smith

Table of Contents

1. Introduction

The practice of evidence-based medicine (EBM) dominates patient care and clinical decision making in healthcare based upon its wild success over the past 20 years (Greenhalgh et al., 2014). Evidence-based medicine (EBM) can be defined by David Sackett as the "explicit and judicious use of current best evidence in making decisions about the care of individual patients" (1997, p. 3). Alongside its success is the evidence hierarchy, which orders research methods from the highest to lowest quality. The practice of EBM uses this hierarchy alongside clinical expertise to achieve and develop medical treatments and interventions for patients (Greenhalgh et al., 2014). EBM has contributed to numerous collaborations, societies, and institutes, successfully increasing the use of randomized controlled trials (RCTs) as the best method to achieve the highest quality of evidence, which is now known as the "gold standard" of EBM (Boyd et al., 2005; Greenhalgh et al., 2014). With RCTs being the "gold standard," the use and implementation of other methods can sometimes be devalued (Greenhalgh et al., 2014).

The coupling of EBM and the evidence hierarchy together has led to a paradigm, meaning the fundamentals which contribute to EBM, and the practitioners of EBM, are committed to the same rules and standards with little disagreement (Kuhn, 1962). Thus, new and novel research methods are lacking within the field of EBM (Greenhalgh et al., 2014). Complex health issues and patient needs are solved using similar methods to RCTs, which uses a straightforward, non-complex, and conservative way to develop health interventions (Vasquez, 2019). Melis et al. (2017) and Greenhalgh and Papoutsi (2018), point to the need to embrace complexity within healthcare systems, and challenge the tendency to focus on single issues which often dismiss the multitude of factors regarding an individual's health. As healthcare needs continue to shift, the need for and use of novel methods may be a pressing matter for both society and medical researchers. Many different medical specialists are calling for paradigm shifts in their field, from geriatrics (Simon & Hicks, 2018) and psychiatry (Steinert, 2020), to nutritionists (Bacon & Aphramor, 2011) and cardiologists (Rao et al., 2021). This relates to the possible need for a shift within EBM towards a new type of paradigm.

1.1 Research objective

To explore the above-mentioned topic this study uses system dynamics (SD). SD places emphasis on the whole rather than on the individual parts, and explores how a system and its dynamics, in terms of casual relationships, causes a system to behave a particular way (Vennix, 1996). By combining researchers' mental models via a causal loop diagram (CLD), the study can explore and gain insights into "what is actually happening," and how researchers perceive and experience the system in which they live or work in, and how this structure potentially drives their methodological choices. Mental models are an explanation of someone's thought processes about how something works in the real world (Manni & Cavana, 2007). It is a representation of the surrounding world they live or work in, the relationships between its various parts, and a person's intuitive perception about their own acts and consequences (Vennix, 1996). Mental databases of individuals, their mental models, are one of the most important data sources while using SD to model a complex issue (Forrester, 1994; Luna-Reyes & Andersen, 2003). A CLD is a model which shows the structure of a system by using arrows to indicate causal relationships and to capture the feedback structures between the identified factors or variables (Sterman, 2000).

The results of this study may provide practical contribution to Radboud University medical center (RadboudUMC) by providing a better understanding of why and how certain methods are, or are not, being used. This could aid in accelerating their research output towards a more flexible set of research methods. This will also provide insights into how EBM takes shape, while considering the contributions RadboudUMC makes towards the EBM paradigm. A theoretical contribution can be made by expanding the use of and practical value of SD methodologies to public health research. To this aim, the research uses SD to provide an in-depth understanding of the researchers' motivations, reasons, actions, and context behind their unfolding choices, by uncovering causal relationships and feedback mechanisms (Myers, 2013).

1.2 Research questions & conceptual model

Several research questions are proposed to achieve the goal of this research:

- *What is the perceived structure that medical researchers experience which potentially drive their methodological choices within Radboud university medical center?*

- *What feedback loops are present within the perceived structure of medical researchers' methodological choices?*
- *What are the main drivers which influence researchers' methodological choices?*

A conceptual model, depicted as a CLD consisting of two reinforcing feedback loops, is used to illustrate the potential findings of this study (figure 1). The arrows in the model, or causal links, have a negative or positive polarity connected to them which explain the relationship between the variables. If the arrow is positive, it means the variables move in the same direction, either both increasing or decreasing, creating a self-reinforcing (R) behavior. The behavior that self-reinforcing feedback loops exhibit is that of exponential growth or decline, from the initial state (Forrester, 1994). However, if the arrow is negative the variables move in the opposite direction, if one increases the other decreases and vice versa, creating a self-balancing (B) behavior. Thus, self-balancing feedback loops exhibit a counteracting behavior and are goal seeking, meaning the balancing process creates a behavior which tries to bring the system to a state of equilibrium (Sterman, 2000).

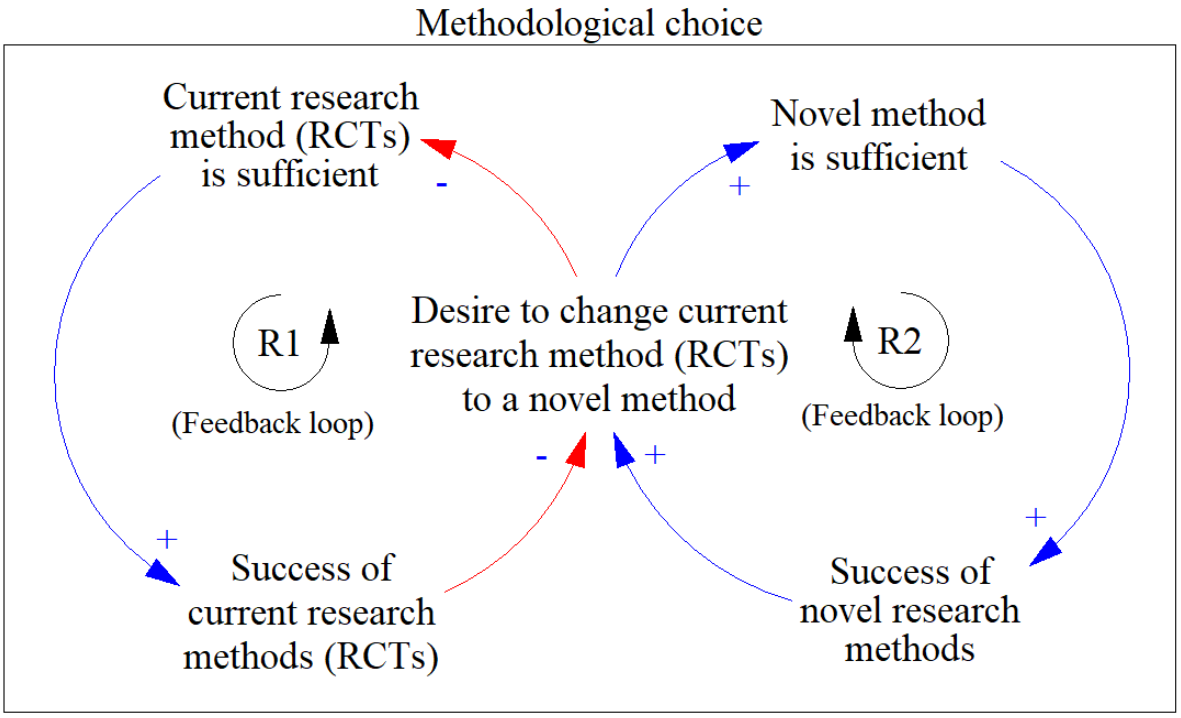

Figure 1: Conceptual causal loop diagram using the system archetype "success to the successful." Arrows represent

causal links, and the +/- represent causal link polarities. Feedback loops are indicated by the looped arrows placed in the center of each feedback loop, with the R representing reinforcing behavior.

Figure 1 depicts, as RCTs are found sufficient, the success of RCTs increases, which decreases the desire to change the current method (RCTs) to a novel method. This further increases the sufficiency and success of current methods (RCTs), leading to the reinforcing feedback loop labeled R1. As the desire to change the current method (RCTs) to a novel method decreases, the sufficiency and success of novel methods also decreases, leading to the reinforcing feedback loop labeled R2. These feedback loops form a system where the circumstances for the current method (RCTs) "win" over novel methods. However, when there is a decrease in the sufficiency of RCTs, the opposite effect happens and novel methods "win" over current methods (RCTs).

The conceptual model uses a system archetype called "success to the successful." System archetypes are recurring patterns of behavior that give insights into the structure which drives the system (Meadows, 2008). The success to the successful archetype describes a relationship in which the winners eventually take all (Meadows, 2008). This is an extreme scenario, but it does represent that there is an inequitable distribution of opportunity within the system (Meadows, 2008). The inequitable distribution of opportunity in this conceptual CLD is the use of one method over the other, either RCTs or novel methods. This system depicts in a concrete way, the possible behavior which can drive a paradigm shift.

2. Literature Review

2.1 Evidence-based medicine

At its beginning more than 20 years ago, evidence-based medicine (EBM) was considered a new paradigm (Greenhalgh et al., 2014). At its conception, when practiced EBM was thought to provide superior patient care. For many years EBM has provided superior care and still does. However, there seems to be something missing as the number of persons with multiple diseases increases (Melis et al., 2017). Furthermore, healthcare is experienced as becoming increasingly fragmented, and individuals perceive a mismatch between care they need and the care they are provided with (Ernst, 2000; Royal College of Physicians, 2015). Although EBM has had a lot of success and brought many benefits to the medical field, EBM is a victim of its own success (Greenhalgh et al., 2014; Melis et al., 2017). There are many factors which influence the continuous use of the EBM

paradigm, not only due to its success in improving healthcare, but also due to industry influence, research application evaluation schemes, and the output of easy-to-follow clinical guideline practices (Greenhalgh et al., 2014). However, it is possible that EBM is reaching its limit and a new paradigm is emerging due to the complexities currently facing healthcare today. EBM may benefit from and be complementary to a paradigm where novel approaches are seen as a valuable addition to address these complexities.

2.2 Paradigm shifts

Paradigms refer to "the shared ideas and concepts that guide the members of a given scientific field" (Goldstein, 2012; Orman, 2016, p. 47). The word comes from Thomas Kuhn's pivotal book titled The Structure of Scientific Revolutions (1962). His idea is that the development of science happens in phases, it grows to a certain point and then is stable and stagnates, leading to a crisis and eventually a revolution in the field (Kuhn, 1962; Orman, 2016). This theory suggests that the breakdown of an intellectual system occurs when a particular method is no longer able to solve new problems, hence a revolution (Orman, 2016). When the change occurs, it is referred to as a paradigm shift (Hairstone, 1982; Orman, 2016). In recent years there has been research calling for a paradigm shift from evidence-based medicine to something new, which has not been readily identified. Whether it refers to statistical issues (Doi et al., 2017), patient-physician relationship issues (O'Hare, 2016), multimorbidity (Melis et al., 2017; Yarnall et al., 2017), or the sheer complexity within health services offered to the patient (Greenhalgh & Papoutsi, 2018; Royal College of Physicians, 2015), it is evident that the members within the medical and health services field are beginning to look for alternative methods to meet their needs.

2.3 Novel research methods

The word novel in its simplest definition means "new and original, not like anything seen before" (Cambridge University Press, n.d.). Using this definition towards "novel methodologies" allows for the concept to apply to a wide range of topics within the medical field. With a quick search on PubMed, from the year 2000 to 2022, a search using "novel methodologies" brings up 484,204 matches. Articles relating to novel methodologies range from meta-analyses and systematic reviews (Dorsey et al., 2015; Usui et al., 2021), clinical trial research (Ali et al., 2021), and patient centered outcomes (Kim et al., 2018). Allowing PubMed to bring up all searches regarding novel

methodologies shows that there has been an exponential increase in published articles referring to this topic. Additionally, RadboudUMC's website refers to their initiative towards "the development of new research methods, needed for research analysis of complex problems and contexts" (Radboud University Medical Center, n.d.), showing this need not only throughout the research, but also on an institutional level.

3. Methods

In this explorative qualitative study, in-depth interviews with individual researchers were conducted. These were analyzed by a SD methodology. Then, for each participant, a CLD was made that reflected their opinions and understanding of what influences them while choosing a research methodology. Lastly, the quantitative method of frequency was used to develop the final CLD, which includes all individual CLDs combined into one.

3.1 System Dynamics

SD is proposed as an appropriate method to investigate the processes which influence methodological choice, due to the complexity and dynamic nature involved with decision making. SD has been used in healthcare numerous times to address issues such as social care (Darabi & Hosseinichimeh, 2020; Wolstenholme et al., 2007), disease interventions (Hirsch et al., 2010), quality of care (Cavana et al., 1999), and healthcare improvement (Lane et al., 2000; Royston et al., 1999). Healthcare issues are known for their complexity (Greenhalgh & Papoutsi, 2018) and SD can help to model and represent this complexity. SD is an approach which uses several diverse ways to model and understand the structure which drives the behavior occurring in a system over time. One of the ways in which SD can model this behavior is via a causal loop diagram (CLD). A CLD is best suited to illustrate the process of how the factors within the situation affect each other based on internal feedback loops in the system (Vennix, 1996).

3.3 Causal Loop Diagram

A CLD is used as the tool to explore and visualize the potential dynamics of the structure as identified by the participants (Vennix, 1996). CLDs are well adapted to intuitive thinking and exploring the beliefs that individuals have concerning their situation (Schaffernicht, 2010). CLDs

use arrows to indicate causal relationships and capture feedback structures between the identified factors or variables (Sterman, 2000). Causal relationships are denoted by a negative or positive link polarity which explains the relationship between the variables. Link polarities have been explained in the previous section discussing the conceptual CLD. Feedback structures, or loops, depict a process in which actions and information in turn affect each other, thus revealing dynamic processes (Vennix, 1996, p. 31). The CLD serves the purpose of increasing the understanding of an articulated problem. In this study, the potential problem is the lack of and need for novel methods and how structure could be driving these methodological choices, as exhibited by the conceptual CLD.

3.4 Data collection

As described in the previous sections, this study follows a system dynamics approach and seeks to explore the structure influencing the behavior of RUMC researchers,' leading to their methodological choices. In this study qualitative data is gathered on researchers' methodological choices in the form of semi structured interviews. The choice for a qualitative rather than a quantitative model is driven by several reasons. First, the use of individuals' opinions allows the study to capture and model the group's thinking and understanding about the structure (De Gooyert et al., 2019). Second, the information needed to model the problem at hand resides within the mental database of the researchers themselves (Forrester 1994; Luna-reyes & Andersen, 2003). Lastly, conducting interviews will make the thinking processes of researchers explicit and descriptive, unveiling the crucial factors involved in choosing their methods.

The unit of analysis is RUMC, and the individual researchers were recruited with the help of a thesis supervisor as a gatekeeper, someone who can help gain connections through their network. Through this gatekeeper, the purposive and snowball sampling methods were used to find interested participants. Eleven participants were recruited via these sampling techniques which went as follows; Interviewees were invited purposively via email to participate in this research study based on the type of information being sought. Once participants had been interviewed, some interviewees were asked via a follow up email if they knew other researchers who may be interested in this study, allowing for snowball sampling. Lastly, to broaden the sample, minimize

biases, and dive into some insights about seniority during the interviewing process, several junior researchers were contacted.

Junior researchers were identified as researchers who had seven years or less of experience with RUMC. Previous research experience of junior researchers was not considered in this decision because this study focuses on the experiences researchers have had while at RUMC. The sampling techniques chosen allowed for a broad range of data and mental models, because participants came from a wide range of medical backgrounds and varied in years of experience. In the end, the elven interviews were enough to satisfy the need for data saturation; as no new themes, information, or codes arose from the given set of questions within the interview guide (Fusch & Ness, 2015; Guest et al., 2006).

The semi structured interview guide was set up in four themes: Initial introduction and methodological preference, potential problems faced, external factors influencing decision, and ending thoughts. The initial introduction asked about the researchers' roles, preferred methods, alternative methods to RCTs, criticism of their chosen method, and definition clarification questions. The second section asked about the implications of interdisciplinary research, complexity, and what happens in the research project when the research question is not being answered in the intended way. The third section focuses on the influence other roles have on their research such as the institution itself, funding, their environment, and project length. Lastly, the interview closes with their view of how the future of medical research might look like and how their research contributes to that view. The interview guide was developed and approved with the help of the thesis supervisors.

3.5 Data Analysis

To make sense of the data, it becomes necessary to reduce qualitative data into a manageable form which allows us to focus on the most important aspects of the data (Myers, 2013). Coding is one of the simplest and most commonly used methods for analyzing and transforming qualitative data (Myers, 2013). Coding allows for the acknowledgment of the dependency of the phenomena on the context of the situation (Myers, 2013). First, fragments of text were selected, with open codes being derived from exact wording within the fragments. Once open codes were established, axial coding began, and themes started to emerge by choosing words that linked the relationships

between certain open codes (Babbie, 2016, p. 389). Axial codes narrowed down open codes into a summation of meaning. The use of the analysis program Atlas.TI was used as a tool for ease of use and to keep track of, categorize, code, organize, and secure data.

3.6 Developing the CLDs

Written text is an excellent source to construct CLDs and for modelers to identify causal arguments within interviewees' statements (Vennix, 1996, p. 58). Following guidance from Vennix (1996), interview transcripts were read in their entirety before casual links were built. Causal links were built directly from the text, sentence by sentence. Variable names were selected in a way which allowed them to be as short of a description as possible and take on high or low values, such that they could increase or decrease (Vennix, 1996). Each resulting CLD for individual interviews was checked with the original text to correct potential mistakes, and to check if the model accurately reflected and represented the text (Vennix, 1996).

A final CLD was created by combining and comparing the individual CLDs with one another. Variables were cross referenced and categorized by the different interview codes. Categorizing the variables helped with the variable naming and defining process while building the final CLD. The final CLD uses frequency to capture the variables which were repeated at a minimum of three times throughout the individual models. Thus, an attempt was made to create a shared consensus between asynchronous interviews, following the advice of Turner et al (2014). The final CLD was built using neutral terms for describing a chosen methodology. Using neutral terms allowed the final CLD to show a researcher's methodological choice regardless of the methodology type. This process took several iterations of analyzing, variable naming, and modeling.

The final CLD strives for practical use by being built for the right audience, using relatable language and simple variable names, and allowing for an intuitive explanation (Repenning, 2003). These are suggestions by Repenning (2003) to make SD models more understandable to non-system dynamicists. Furthermore, Turner et al. (2014) suggests creating traceable links between the data and resulting map to build confidence in and validation of the final model (Kim & Anderson, 2012). Thus, in an attempt to build this confidence, the results section makes use of direct quotes to explicitly express each causal link.

3.7 Ethical statement

This study made an effort to conform with ethical practices. First, this paper has sole authorship and was not a collaboration project. Second, all interviewees were new to the student and there were no withstanding or previous relationships or overlapping roles between the student and interviewees. Third, participants' informed consent was sought through verbal confirmation. The use of informed consent forms was foregone because this study is for educational purposes, all interviewee information remains anonymous and confidential, and there is no risk to participants' employability. Fourth, information was stored confidentially on a third-party site called Atlas.Ti and all potentially identifying information was anonymized before being imported to Atlas.Ti. This study relied upon the "Rules and Procedures of the Ethics Committee" and the "five principles for research ethics" as a guide (American Psychological Association, 2018; Smith, 2003).

4. Results

This section details the results found from the analysis and answers the research questions. First, codes will be discussed along with the most mentioned codes and their definitions. Next the final CLD will be shared along with the explanation of the model and its feedback loops. Lastly, the main drivers which affect methodological choice will be discussed. These results will lead to the discussion and conclusion which will follow this chapter.

4.1 Interviews and individual models

Interviews underwent four rounds of analysis to combine and clarify codes and their meaning. The individual CLDs underwent numerous rounds of analysis, anywhere between five and nine, in an effort to create the most representative model deriving from the interviewee. Prior to the second analysis phase, there were three hundred and fifteen codes, often with single open codes describing fragments of texts. In the end, the total code count was thirty-seven, with ninety-four CLD variables being derived from them. A full codebook and all CLD variables can be found in appendix two, listed from the highest frequency to the lowest.

4.2 Underlying structure & feedback loops

The overall CLD, which contains all CLDs of the individual participants, is shown in Figure 1. The model can be divided into four sections: method exposure, method acceptance, method

funding, and funding subsystem. Each section is color coded and contains between seven and ten variables and two to three reinforcing feedback loops. The sections and their feedback loops will be explained in detail below.

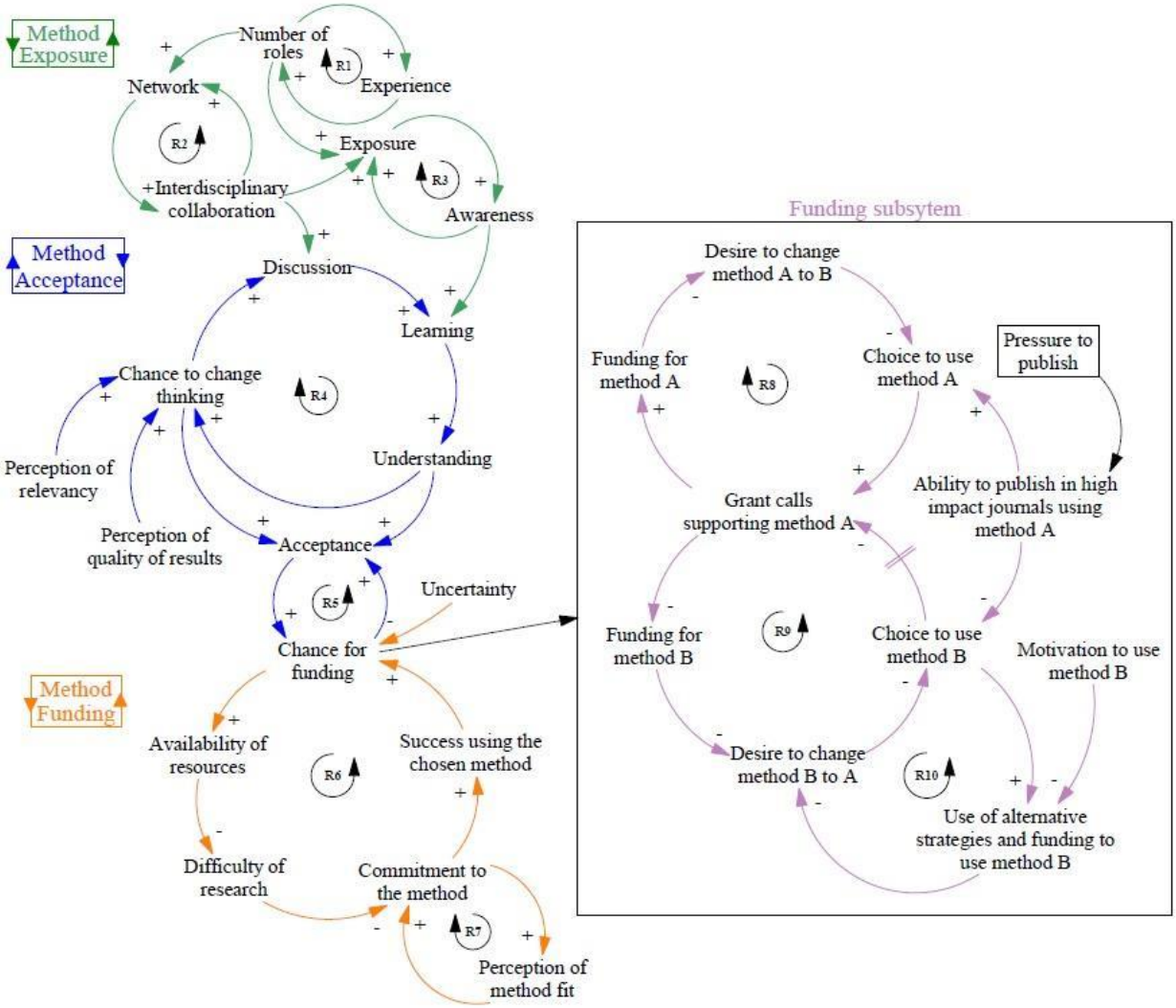

Figure 1. Final CLD with each section color coded and labeled

4.2.1 Method exposure

Method exposure includes seven variables and three feedback loops (R1, R2, R3). As a whole, this section of the model reflects discussions regarding a research project or proposal, and the overall exposure and awareness of a method. The variables, and their definition, in this section are:

Experience. Includes the total number of years in the professional and or academic field, and the previous educational background of the researcher.

Number of roles. All professional and academic roles which a researcher has taken on in their lifetime, and is currently active in. Examples of roles are principal investigator, general physician, medical specialist, and journal reviewer, to name a few.

Network. The number of relationships, connections, and or contacts a researcher has access to, like a group or system of interconnected people or things (Cambridge University Press, n.d.).

Interdisciplinary collaboration. Working with persons from different educational backgrounds, departments, research fields, institutions, universities, and the professional field. This can include international collaborations and consortia, or a stakeholder analysis to decide who and what organizations should be involved.

Discussion. The act of talking about something with others to reach a decision and exchange ideas (Cambridge University Press, n.d.). The opportunity for the researcher(s) to discuss and inform any or all interested parties about their chosen or preferred methodology.

Exposure. Each time a researcher hears or reads about a particular method, their exposure to that method increases. This applies to the exposure of methods which are new to the researcher, or to a method which has been used previously.

Awareness. The extent to which a researcher or research team has been exposed to or discussed the method before. The repeated exposure of a certain method allows for knowledge and experience of the method (Cambridge University Press, n.d.)

Learning. The acquisition of knowledge or information through study, experience, or being taught (Cambridge University Press, n.d.).

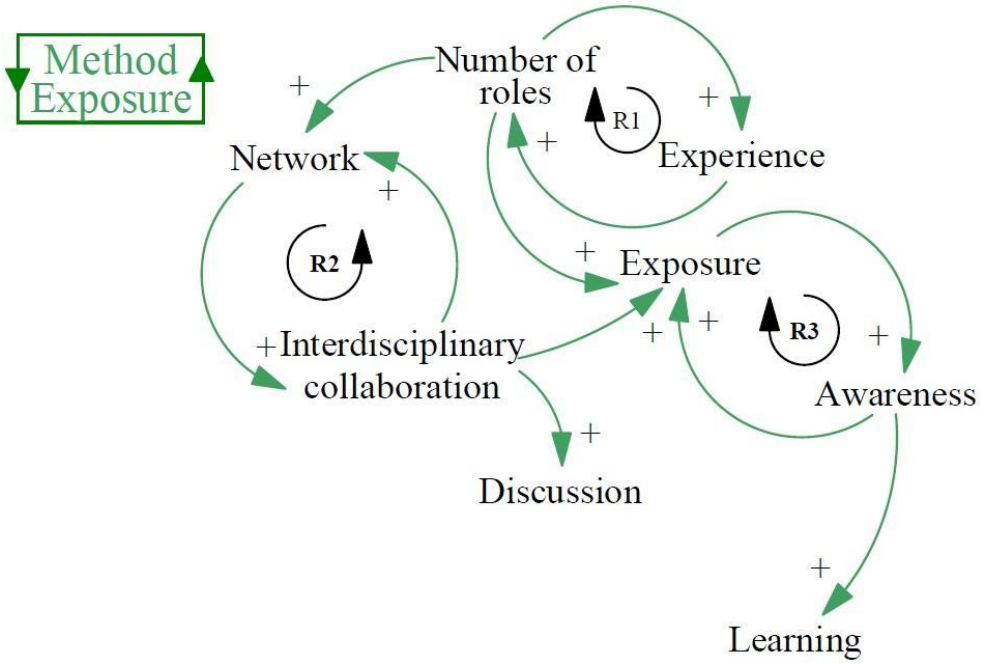

Figure 2. Close up detail of section one, Method Exposure

Figure 2 details the section named method exposure, the feedback loops in this section are:

R1. As the number of roles increases, the experience of the researcher increases, which further increases the number of roles a researcher has had in their lifetime.

> *"It's all this experience, right? The thing is, because I changed so much from roles and also topics, you get a better eye on the limited way that in some research topics, people think that there is an ideal model… [you also] see that there are different ways to explore things... and that the same problem, you can handle in different ways" (PN0654).*

The number of roles also increases the network opportunities of the researcher. For example, PN1640 is currently active in a medical professional role and *"a lot of departments who do patient care are always interested in how [medical] care looks into the problem or faces the problem… who ask me and my other colleagues to think along with them."*

R2. When a researcher's network increases, the opportunity for interdisciplinary collaborations increases, which further increases their network.

> *"A network with a lot of different expertise, and [where] you can consult with people who are having [different] expertise... is very important… because you don't have the space and*

time to become an expert on everything, whereas the problem that I'm trying to solve… it needs expertise from different approaches, so that means by definition doing it in a collaboration with different people" (PN7572).

Interdisciplinary collaborations help researchers think critically about their research, inciting discussion. *"It's really important that in these teams you have people with different expertise, so that in the end you really get to the most sensible way of doing the analysis"* (PN9810). Thus, as interdisciplinary collaborations increase, discussions also increase.

"When you work with other people, they have their own preferences and their own ideas about what's best fitting, and even more they have their own terms, their own vocabulary that you first have to identify. Sometimes you use the same words, but you mean something different, and that might be clarified only very late in a collaboration. So, there I think it is a challenge first to get some shared base and then in discussions, get further understanding" (PN3985).

With both an increase in interdisciplinary collaborations and number of roles, the exposure to methods increases. Interdisciplinary collaborations can potentially expose researchers to new methods. *"For example, this [method], I never heard of it before, and I don't know anything about artificial intelligence…"* (PN6547). Researchers also mentioned how their roles kept them up to date on methods.

"A nice thing about being an editor is that you get all these papers coming across your desk, and so you more or less automatically stay in the know with all the topics in the field and how people study them… It really keeps you up to date" (PN3275).

R3. As exposure to methods increases, the awareness of methods also increases. *"...often, I come across new methods [and] new papers in which I think, okay I have to dig into that and see if this might be a method, I can use for my question that I have"* (PN1640). In turn, awareness further increases exposure because the researcher can share their knowledge of the methods with others.

"The medical doctors that I work with, they have the same [background] like me, they're originally trained in the more traditional ways of doing things. So, for them as well it's new, and I have to explain to them… [that] there are different designs…" (PN7572).

As the awareness of methods increases, learning about these methods also increases. *"There's a lot of talk about using more machine learning, artificial intelligence type methodologies, and that's new to me and I'm learning as we go…"* (PN9810).

Overall, this section illustrates how researchers are exposed to, and become aware of, different methods. These methods could be methods which the researcher has used in the past, and are repeatedly using, or the methods could be new methods which a researcher is new to or uses seldomly. Researchers mentioned they gain exposure to methods through their roles and interdisciplinary collaborations. The experience a researcher has affects the number of roles they currently have or have had in the past. As these increase, the researcher's network and exposure to certain methods increases. A larger network can increase the opportunity for interdisciplinary collaborations, further increasing a researcher's exposure to certain methods.

4.2.2 Method acceptance

Method acceptance includes eight variables and two feedback loops (R4, R5). This section illustrates how when circumstances support a certain method, it can thrive through the acceptance of the method becoming perpetuated and propelled. The variables, and their definition, in this section are:

Discussion & *Learning.* See *method exposure* section for definitions of these variables.

Understanding. The extent to which the person, or others involved in the decision-making process, comprehends the intended use or benefit of a particular method.

Acceptance. The general agreement that something is received as adequate, valid, or satisfactory (Cambridge University Press, n.d.). In the case of this research, it refers to the acceptance and use of the methodology. Not only from the researcher who chose it, but also from others involved in the medical field.

Chance for funding. The probability that the written and submitted grant proposal will be awarded funding. The total amount of monetary value which is awarded. Funding is mainly influenced by governmental and industrial parties, grant calls and committees, and internal funding.

Chance to change thinking. The probability that the researcher can use their power to persuade and influence others thinking about a method (funders, journal reviewers, other researchers, etc.). Thus, a researcher may be able to change someone's thinking about qualitative and quantitative methods.

Perception of relevancy. The degree to which the researcher or research team believes that new knowledge, or an impact on daily practice, will be produced with the given research method.

Perception of quality of results. The extent to which the funding organization, internal organization, researcher, and or research team perceives the results produced by the method to be of high-quality evidence or knowledge.

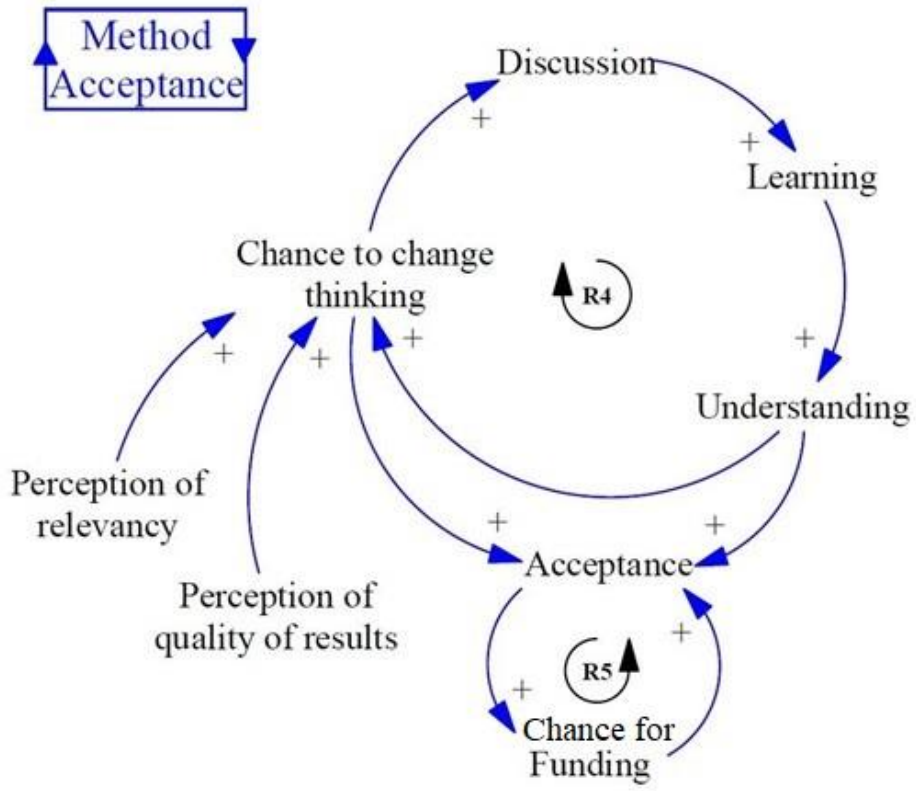

Figure 3. Close up detail of section two, Method Acceptance

Figure 3 details method acceptance, the feedback loops in this section are:

R4. An increase in discussions leads to an increase in learning, understanding, and the chance to change thinking, which further increases discussions. Discussions and learning are two variables

elicited from an interview question which specifically asked about criticism towards novel methods. Criticism, in the form of discussion, helped researchers learn more about methods. Thus, an increase in discussions increases learning.

> *"...you can use the criticism from all kinds of fields on what you're doing. For example, I went into [a] discussion… and I learned a lot from them, and when I brought [those ideas] into our research group… there was criticism from my own group… but there came discussions out of that that were very fruitful to all of us" (PN4285).*

As learning increases, understanding about a method also increases. Researchers mentioned the need for understanding by other researchers, medical professionals, and funders. Overall understanding about a research method, how to apply it and design the study, how it is relevant, and when it best fits, increases through the process of learning more about it.

> *"[When working with new methods] I first try to explain to people that there are perhaps different ways of looking at things… I try to challenge them, and I try to learn from it, I try to connect people amongst each other, I try to understand, but it's also new for me…" (PN0654)*

When researchers can help others understand more about a method and why they chose it, other researchers and persons involved may change how they think about that method. Thus, when understanding of a method increases, the chance to change thinking also increases.

> *"...when we are writing our results, for example of qualitative research, [knowing how medical professionals] view, and their way of thinking about qualitative research, helps me to write it down in a way that they understand it; and that way I can show them that, for this research question, we really needed this methodology… when you communicate that kind of findings with the doctors who are very focused on quantitative research methods, they also have a kind of "wow" feeling. So that's very nice to see that you can help them think in another way" (PN6547).*

Perception of relevancy and *Perception of quality of results.* An increase in the perception of relevancy and quality of results of a method can help increase the chance to change thinking about

that method. For example, PN9810 mentions needing to extend the chosen method to other topics so that others understand the relevancy of the method better.

> *"Sometimes I get the feeling here that [the hospital does not] really see the point of what I'm doing… As a consequence of that I have gotten more involved in [other topics] ... then I know that the head of department will understand better what I'm doing…"*

The quality of results can play a role in a researcher's mind about which methods produce a high quality of results. Thus, an increase in the perception of the quality of results can also increase the chance to change thinking.

> *"The traditional pyramid of evidence, starting with the qualitative and the case studies, and then the pilot work, and then, well in the end you have of course the RCTs, and the meta-analysis… The different types of study creates different levels of evidence and in medicine of course people tend to trust RCTs better than pilot studies. Which is logical because they have more power" (PN6840).*

PN3275 concretely states how the quality of results and perception of relevancy can tie together.

> *"I try to be very relevant from a societal perspective and that of course fits with complex questions, and nobody really knows what to do, but everybody holds an opinion… because these are questions that we've tried many times before, and we failed…"*

As the chance to change thinking increases, the opportunity for discussion also increases. Those who have changed their opinion about certain methods seemed to share why they changed their thinking with others, eliciting discussion and thus creating this reinforcing feedback loop (R4).

> *"I was in the committee of [funding institution]... and these people were completely trial fetishists… and there I really sometimes had to debate that it's useless to do a trial about the topic that they offered there, and then they started to embrace the different phases of evaluation, of complex interventions, and now they changed towards that… It is nice that I have a background in clinical epidemiology and evidence-based medicine. So, people know that if I shift another way, there must be a reason…" (PN0654).*

This feedback loop (R4) elicits the overall acceptance of a method through the chance to change thinking and understanding of the method. When there has been an increase in the chance to change in thinking or understanding or both, there is an increase in acceptance. For example, PN7572 mentioned,

> *"[When] you've been trained in doing RCTs [and when] you've been trained in doing epidemiological work… familiarizing yourself with different methods… really asks you to step out of your comfort zone, but for a good cause because then I see how it brings important new insights that I would never have received when I would have stayed to the more traditional ways of doing research."*

R5. This smaller feedback loop shows the direct effect that acceptance of a method has on the chance for funding. As illustrated earlier, the chances of a method's acceptance rely on the way others think about and understand the method. When acceptance of the method increases, the chance for funding also increases, which can further increase the method's acceptance. This idea emulates the idea that *"...Money breeds money"* (PN3275).

> *"In general, the field is gaining more and more acceptance… and [we have] gathered more and more evidence that these methods are the best we can do for the type of questions we try to address… [but] funding is a huge determinant of what you can do and how much you can do…" (PN9810).*

Overall, this section illustrates how a method becomes more or less accepted in the field, and how the chance for funding can further fuel its acceptance. How those involved in the medical field, both the researchers and those in professional roles, think about the method can affect the acceptance of the method. As all involved in the process begin to increase their understanding when and why a particular method fits best, overall acceptance increases which increases the chance for funding institutions to award funds for the research project and its chosen method.

4.2.3 Method funding

Section three includes eight variables and two feedback loops (R6, R7). This section entails how the chance for funding affects the availability of resources and the commitment to a methodology,

which in turn affects its overall chance for future funding opportunities. The variables, and their definition, in this section are:

Chance for funding. See variable definition from section three, method acceptance.

Uncertainty. The extent to which the grant committee doubts the ability of the method to apply practically to the research question, issue, or topic based on the method's previous performance.

Availability of resources. This consists of funding, the time of researchers and participants, access to data sources, such as databases, patients, populations, etc., and the availability of facilities or software, such as state of the art measuring or analysis tools.

Difficulty of research. The amount of effort it takes the researcher or research team to accomplish their goals. This includes the influencing external factors which can cause delay in research such as a drop out of participants, researchers, burnout, etc.

Commitment to the method. The extent to which the researcher or research team is sure of, dedicated to, and chooses to continue the research project using the chosen methodology.

Success using the chosen method. The number of proposals which are successful, meaning the resulting research is conducted to completion and possibly published. It also encompasses the number of times that the chosen method was awarded funding, answered the research question, and was adequate in the past.

Perception of method fit. The perceived fit between the research question and the method of choice, expected to yield the best quality of results for the question. The method which best fits the research question is based on the question itself, the goal of the knowledge, such as generalizability or specific knowledge, and the research topic. Its fit also depends on the terms of funding grant calls and the availability of resources.

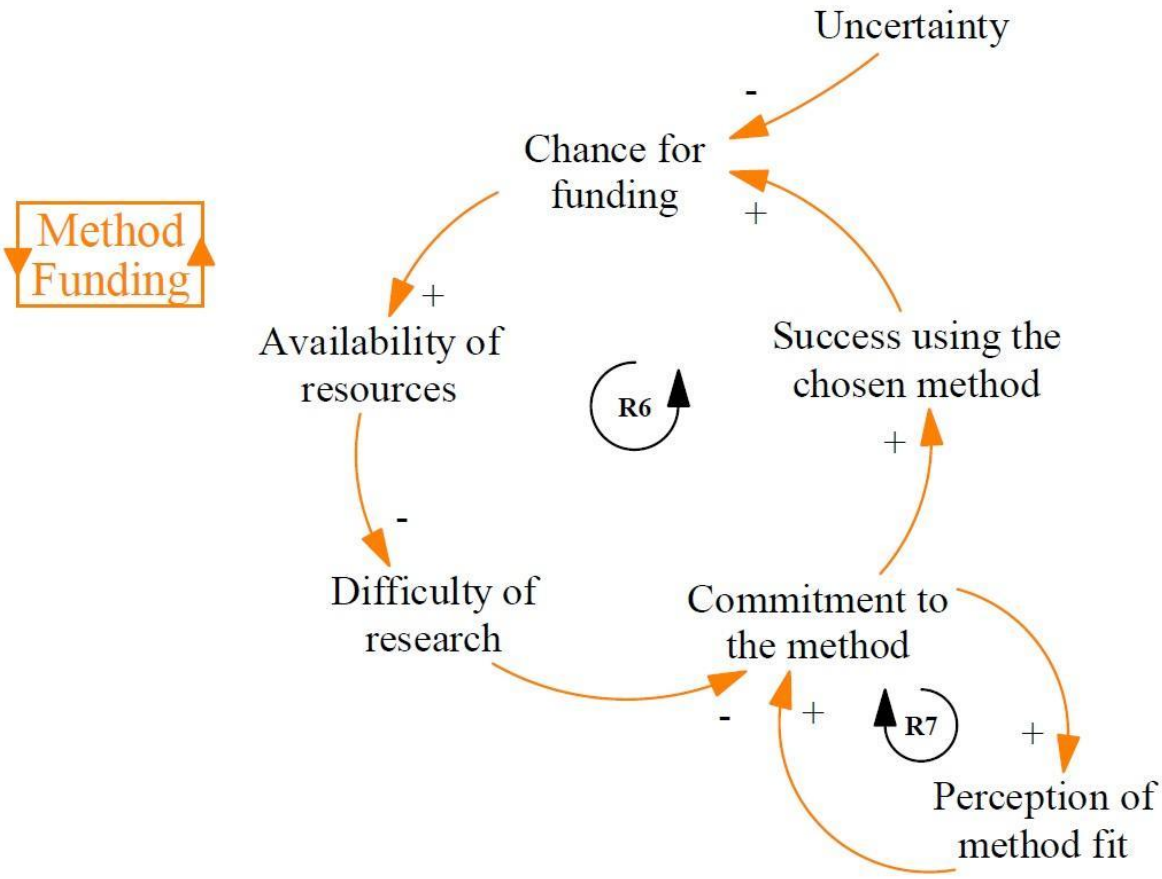

Figure 4. Close up detail of section three, Method Funding

Figure 4 depicts section three, the feedback loops in this section are:

R6. As the chance for funding increases, the availability of resources increases. As availability of resources increases, the difficulty of research decreases. As the difficulty of research decreases, commitment to the method and success using the chosen method also increases. As the success using the chosen method increases, the chance for funding for the method also increases, creating the reinforcing feedback loop labeled R6.

As the chance for funding increases, it helps propel and increase the availability of resources. With more funds researchers can hire more students or workers and pay for services, measuring tools, or spaces to conduct participatory research. This relationship also directly impacts the length of time of the research as *"typical grants you get are three or four years"* (PN3985).

> *"...If I want to do these very fancy scans of patient lungs, etc. I can only do that if I have an enormous amount of money, so I actually think the funding affects a lot… [Also] if I have good funding, I can employ PhD students and we can do a lot more projects, both in terms of the topic and the quantity" (PN9810).*

Thus, an increase in the availability of resources decreases the difficulty of the research. This is because there are more resources to conduct the research. The model assumes that there are no other factors which influence these two variables. In reality, there are many unforeseen events which can affect both the availability of resources and difficulty of the research. This also supposes that the money funded to a research project is in competition between priorities and causes the researcher or research team to prioritize where funds go, and which resources are needed most. However, these external factors are outside of the scope of the model. PN4285 summarizes this by saying,

> *"We underestimate the effort enormously… [and] you probably do not realize exactly what you are doing [to other people] when you are doing something that is too complex or too complicated... so, that's a very difficult thing. So, I stopped doing projects [with one institutional funder] and I started to do international projects. They are much better funded, so I had extra possibilities to have two or three PhD students doing one project with two or three research assistants, a statistician, a data person, etc."*

Researchers mentioned when the research is not going as planned, due to the above-mentioned unforeseen events, adjustments may need to be made. Unforeseen events can increase difficulty and decrease the commitment to the method because it can cause adaptations to the research project. *"Often when you are performing a study all kinds of things happen that you didn't take into account… That means that you can always try to go back to the funder… and hope that you get a chance to make that adaptation"* (PN6547). Thus, as the difficulty of research decreases, commitment to the method increases, as there is less of a chance for adaptations.

As commitment to the method increases, there is an increase in the success using the chosen method, further increasing the chance for funding of the method in the future. When more research using a method is produced, it can give a chance for funding institutions to have an idea of how a research method applies to certain topics. For example, PN1640 *"was one of the first in [their]*

department to do qualitative research" and because of the success of this method, the study was repeated.

> *"...that was, I think, my most brilliant research… we already published twenty papers on that method or not on the method but on the results of that method" (PN1640).*

Uncertainty. An external variable which affects feedback loop R6 is uncertainty. As uncertainty revolving around a method increases, the chance for funding for that method decreases. Researchers realize that *"...funding agencies want robust work, they want to actually know… what they will get when they pay for it…"* (PN6840). PN1640 explains a similar idea saying, *"I wrote a research grant [proposal]… and you have to have two rounds, I get to the final round and… the committee asked, yeah but what's qualitative research? ...I had to explain to the committee what qualitative research is. So, then you know already that I didn't get that grant."* PN7572 also alluded to the implications uncertainty of the chosen method can have on the chance for funding.

> *"The big challenge… there is uncertainty of how to begin, which makes it difficult to persuade others to develop a new method, or use a method many are unfamiliar with… and that's also difficult because when you write a grant application… there's still a huge gap in what people expect and what you can offer beforehand."*

R7. An increased commitment to the method increases the perception of method-fit which further increases commitment to the method. The research topic, question, and type of results the research aims to produce, can also determine the perception of the method fit. *"I always try to [choose a method and] start discussion from the content. So, what is the research question that we want to answer and what fits the answer best, uh what methodology…"* (PN9844).

> *"When you want to answer which methods to choose it depends on the research question and sometimes you first need qualitative research to define the research question, and sometimes you need quantitative research, it depends" (PN6547).*

This section, method funding, gives a general overview how, when circumstances are supporting a method, a method's success can secure future funding opportunities and increase the perception that the method chosen, fits the research project. However, the implications that funding can have

on research lead to a deeper look into how the chance for funding itself is structured, and how this can affect the choice to use a certain method.

4.2.4 Funding subsystem

Funding subsystem includes ten variables and three feedback loops (R8, R9, R10). This section of the model is a subsystem of the chance for funding that reflects how grant calls and the pressure to publish can affect method choice. The variables, and their definition, in this section are:

Grant calls supporting method A. The number of grant calls which are available for researchers to apply to, and which support the use of the particular method the researcher or research team has chosen, labeled as method A.

Funding for method A and *funding for method B.* The amount of monetary value which is awarded to a grant proposal using the chosen method.

Desire to change method A to B and *desire to change method B to A.* The extent to which a researcher or research team wants to or wishes to change their method choice to an alternative or similar method.

Choice to use method A and *choice to use method B.* The act of choosing a particular method(s) between two or more possibilities (Cambridge University Press, n.d.).

Use of alternative strategies and funding to use method B. The use of strategies and alternative funding possibilities, as described by the team or researcher, which enables them to use their method of choice.

Ability to publish in high impact journals using method A. The perceived ability and likelihood that the research method A will be applicable for high impact journals. RadboudUMC considers an article high impact when it is published in a journal with an impact factor of eight or higher.

Motivation to use method B. The desire that an individual researcher or research team has to use a particular method, labeled method B, based on their reason or reasons for choosing the method. This is based partly on the perceived need for method B, meaning its use is considered essential or necessary (Cambridge University Press, n.d.).

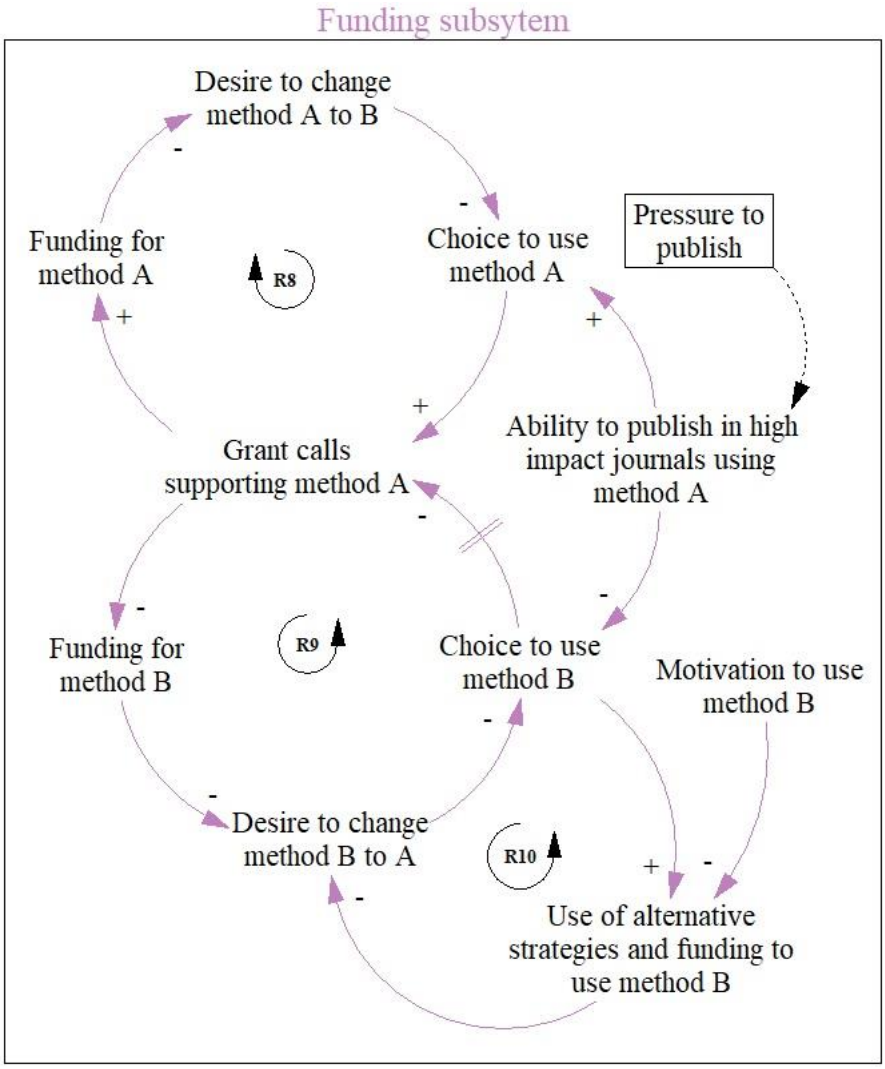

Figure 5. Close up detail of section four, Funding Subsystem

The chance for funding relies on the grants which are available. Which led this model to take a deeper look into the chance for funding.

> *"There's only very little bottom-up possibilities nowadays. You have this veni vidi vici, but yeah, that's only for a few people and for the other ones… you have an idea, and you see a grant possibility and then you look if your idea still fits in what they ask you, but that's a very complex procedure actually…" (PN0654).*

Furthermore, the distinction between method A and B throughout these variables presupposes those methods are in competition with each other when that is not always the case. There are instances when methods are complementary and where mixed methods are even preferred, "*[my]*

preferred methods are mixed methods, action research, [both] quantitative and qualitative" (PN7217). However, if the complementary methods are funded together, the desire to change methods decreases, because they receive funding. If one of the methods is not supported by the funding institution, even if the methods are complementary, this model still supposes that funding will not support one of those methods, leading to an increase in the desire to change at least one of the methods. Thus, the structure of the funding subsystem is still applicable to the use of mixed methods.

Figure 5 depicts the section named funding subsystem, the feedback loops in this section are:

R8. As grant calls supporting method A increase, funding for method A increases. As funding for method, A increases, the desire to change method A to B decreases. As the desire to change method A to B decreases, the choice to use method A increases, which further increases grant calls using method A.

As grant calls supporting method A increase, funding for method A also increases. Researchers mentioned that *"your research subject and design has to fit the call of the grant. So that already narrows down what you can do"* (PN6840). The method chosen should be supported by the grant call before funding can be awarded.

> *"…you need to have projects granted and that means that you have to take into account whether a proposed method or a proposed whatever will be accepted" (PN6547).*

As funding for method, A increases, the desire to change method A to B decreases. For example, PN7217 mentioned *"Grant committees give more grants to action research,"* and PN0654 mentioned *"more and more [grant calls] ask very much things in advance... So [grant calls] don't give much choice."* Therefore, if the method chosen fits the requirements of the grant call, such as the grant call supports method A, then the researcher should have no desire to change their methodology to a different one, such as method B.

> *"... [at the time] there were a lot of grant proposals for [research topic] and I was quite successful then, so within a few years I had my own research line…" (PN6547).*

As the desire to change method A to B decreases, the choice to use method A increases. When a grant call supports the method, and funding can be more easily secured, researchers can choose to

use method A and apply for the grant call supporting method A. Thus, as the choice to use method A increases, the number of grants supporting method A also increases. This subsystem follows a similar logic to the previous sections in the model, which is, the use of a particular method leads to further chances of funding for that method.

> *"...sometimes you go with the flow… this is what's being accepted, and this is what is being proposed, and then you follow the flow of the current thinking…" (PN8944).*

R9. As grant calls supporting method A increases, funding for method B decreases, which increases the desire to change method B to A. As the desire to change method B to A increases, the choice to use method B decreases, increasing the amount of grant calls supporting method A. This feedback loop tries to capture how researchers may change their original method choice to a method that fits within the grant call requirements.

> *"...If I have a certain research question, I would then look at the best method that fits that question… If the grant application does not allow for that methodology, I would look at a methodology that would be close to that, that would fit it best, but would still be eligible for the application. Because if I know that a certain design won't be eligible then there's no use for submitting a grant proposal" (PN9844).*

Feedback loops R9 and R10 together create the "success to the successful" system archetype. This is a system in which resource allocation will continue to flow to the option which has the most success, further increasing the success of that option. A few variables mentioned by interviewees that can break this system are the motivation to use method B and the use of alternative strategies and funding. This leads to a delayed decrease in grant calls supporting method A and the feedback loop labeled R10.

R10. As the choice to use method B decreases, there is a decrease in the use of alternative strategies and funding to use method B, leading to an increase in the desire to change method B to A, further decreasing the choice to use method B.

However, if the motivation to use method B is strong enough, an increase in motivation to use method B increases the use of alternative strategies and funding to use method B, decreasing the desire to change method B to A, increasing the choice to use method B. There were varied reasons

why researchers were motivated to use methods where grant calls, and therefore funding, was not easily gained.

> *"I'm always searching for new ways… so yeah looking for more innovation and… there is a lot of pressure on you to get the research grants to get the money and then you are going to become, I think, opportunistic and you are going to write the research grants they want to hear. I resist that… I'm only doing research that I believe in" (PN1640).*

Without grant calls to support method B, researchers will likely postpone or change the project, break their research question into smaller pieces, or delegate the research to other positions which require no funding. Researchers may employ many different strategies to be able to use a particular method (B). As the use of alternative strategies and funding to use method B increases, there is a decrease in the desire to change method B to A. Thus, as the desire to change method B to A decreases, there is an increase in the choice to use method B.

> *"If I have research questions that I feel need to be answered I will still answer them, but then I have to downscale them and then I have to see, okay does it fit a master student's project…? ...you try to look broader than your general avenues of getting grants because the way that science is designed, you need to bring in your own money… That doesn't mean that you don't try to do new things… For example, you write a grant about something that's more traditional, and then as a work package you might have a small study [added on] … then you can make the leap to a new study. Then you can at least say… It's based on something that I've already explored. but it's difficult" (PN7572).*

This feedback loop can affect R9 such that, as the choice to use method B increases, there is a decrease in grant calls supporting method A. Thus, slowly shifting the funding opportunities from one method (A) to another method (B).

Pressure to publish. The pressure to publish in high impact journals can affect which method choice the researcher makes. As the ability to publish in high impact journals using method A increases, it increases the choice for method A and decreases the choice for method B. This can even override motivation to use method B because, *"if we do other types of research, we won't get it highly published, and that is one of my management tasks"* (PN4285). In this instance 'other types of research' can be labeled as method B.

Publishing in high impact journals was mentioned several times by researchers in order "*to survive"* and as part of a *"rat race"* (PN7572; PN6547). The quotes below illustrate how the environment researchers work in contributes to this pressure to publish in high impact journals.

> *"People are stimulated to publish their work… in general there's pressure from, especially from the organization, to publish your articles… it's not per se about the quantity of the publication but it's also about the impact that a publication has, you know? The impact factors of journals are important, even though we say that it shouldn't be the priority or shouldn't be the first criterion to look at. In practice it still is an important factor… you want it to be in a high impact journal" (PN9844).*

> *"…[the hospital has] this kind of, I would say not very modern criteria on how you are evaluated as a researcher, which is very much based on journals and impact factors etc. and there's a lot of counting, oh I need at least one more paper with above eight impact factor, otherwise I will not be eligible to apply for a [particular] grant etc.… It really comes down to hunting for high enough points so that you are counted in the hospital evaluation system" (PN9810).*

Overall, this section illustrates how grant calls can accelerate the use of certain methods. When no grant calls are available for a certain method, researchers may be motivated to seek out alternative strategies and funding. The main external influencer of researcher choice for either method A or B, is the pressure to publish in high impact journals. Researchers also mentioned that the environment they work in contributes to the pressure to publish in high impact journals.

The final CLD and the four sections assume that a preliminary choice may change over time due to several external factors. Researchers within the team are in consensus that the method chosen is the best choice, before the method is truly chosen for the research project. The reinforcing feedback loops help us understand how the understanding of and the thinking about the method brings about more acceptance and chance for funding of a particular method.

However, even if the research team or researcher believes the method is the best fit for the research question and topic, funding can halt the use of the method chosen. The method can still be used, but researchers need motivation to seek out alternative ways to use the method. Furthermore, the pressure to publish can impact the method choice of the researcher or research team. This leads us

to research question three which investigates the main drivers' researchers consider when deciding upon the best method.

4.3 Main drivers

The main drivers which researchers mentioned influence their methodological choice are Funding, the evidence hierarchy, exploring the topic, pressure to publish, and the line of research. Each driver will be detailed below.

Funding. This includes available resources and grant calls as a dimension of funding. Funding institutions can request specific methods and can reject proposals for many reasons. Researchers will not always accept changing the method to the committee's choice. They may appeal their decision or wait for the right opportunities to use the methods they think best fits the research question.

> *"…we were disappointed by a rejection from a grant proposal we did… we thought that a randomized trial would not be the best design for this and we argued with the committee… then they said, but we want you to do this design, so we're not going to give you the money… but we are going to object against the decision…" (PN9844).*

Based on the grant calls, researchers try to anticipate the grant committee's wants and needs or may even change their method to the grant call requirements.

> *"The way you conduct research is very much dependent on available sources and that's what you sometimes see now… For example, if I'm a referee or a committee member, you see that the available time and available money is actually an obstacle for ideal research… and you see researchers react [to] it by promising all kinds of things, right? but you already read that they're not able to do it, or that they themselves also feel that they're just applying to the criteria of the funding… but their heart is not there… It's challenging to write the proposals and try to anticipate how the [reviewers] are going to receive your proposal" (PN0654).*

Grant calls often ask researchers to comply with many rules, even when it does not make sense for the research question or design of the project. The grant committees, and even persons beyond

those roles who are involved with the funding institution, have the power to stimulate which research methods or designs are used.

> *"For example we had… this top civil servant in the [institution]... and [they] had very strong feelings about participative research or action-based research, and you see that the institutes [are] trying to set up programs in that area… this happens all the time [and] you somehow have to comply" (PN3275).*

Thus, funding influences the methodological choice depending on what grant calls are available and which methods, designs, or topics the grant calls support.

> *"[Funding] has in one way, an accelerating effect. So when you have ideas and you see that there's for instance an [applicable] grant option, it can accelerate [your research]... but when there are no grants for these type of questions than it can give delay because it's not simple to have these kind of questions rewarded…[which are] focused on these kind of methods…" (PN3985).*

Figure 6. "Hierarchy of evidence pyramid" Note. This model is reproduced from "Options for basing Dietary Reference Intakes (DRIs) on chronic disease endpoints: report from a joint US-/Canadian-sponsored working group" by E.A. Yetley et al., 2016, *American Journal of clinical nutrition, 105*(1), 11S (http://dx.doi.org/10.3945/ajcn.116.139097). Copyright 2016 by ResearchGate.

The evidence hierarchy. The evidence hierarchy (figure 6) is a pyramid that informs doctors, students, professors, etc., about which methodologies produce the highest quality of results. The top of the pyramid starts with research designs and methods of the highest quality of evidence and works its way down to the lowest quality. Researchers mentioned that this pyramid and the idea of 'good evidence' can influence perceptions and decisions regarding methodological choices.

> *"Healthcare often uses this "evidence paradigm" to judge the methodology of a proposal, when you don't fit the expectations of the medical field you receive more criticism, it makes it more difficult to use different methods" (PN3275).*

> *"I've seen how randomized control trials are weighted against [other] ideas or other types of research…" (PN4285).*

Thus, the evidence hierarchy contributes to the *perception of quality of results* in the minds of medical professionals and researchers alike. This can facilitate the use of research methods and types near the top of the pyramid.

> *"...in medical research it is still asked of you to do large clinical trials to get the highest level of evidence" (PN6840).*

Exploring the topic. The need to explore a topic further influences the type of methodologies which fit an explorative design best. As an example, pilot studies, which explore a research topic more in depth, use many different research methods. In turn, these pilot studies help researchers gain the necessary knowledge to properly conduct RCTs.

> *"…[choosing the right method] depends on what you already know about, because if you know very much about something, you can randomize it, but if you know very little about a problem, you first have to explore it more qualitatively or in a database study… sometimes people start too early with the trial and then you read in the discussion paragraph… that they actually didn't know anything about the problem and that they should have done the study differently. The randomized trial is the final product, but a lot of people do a trial as a sort of first step. And then you get a lot of negative trials because it's a very inefficient way of exploring an unknown problem. It takes a lot of time, and it takes a lot of money… (PN0654).*

> *"[it is] always a balance to decide what stage you are in the intervention, [whether] you can decide to do an RCT or not… [but] RCTs are of course still, highly used [and is] one of the preferred options… [we] also do of course some pilot work, where we try to explore some new options… [but] In the end we always build towards the large RCTs" (PN6840).*

Pressure to publish. The pressure to publish in high impact journals influences researchers towards methodologies which they know can become published in high impact journals. According to Joannah (2022) from scijournal, only around 7.44% of journals have an impact factor over eight, and this percentage is from around thirteen thousand journals across twenty-seven research fields. When there is a need to publish in high impact journals, researchers may be dismayed to conduct qualitative or novel research, which can push new methods to the wayside. As researchers are *"unable to publish in high-ranking journals when [they] write qualitative research"* (PN1640). This pressure can influence the researcher's methodological choice towards the use of controlled trials. This is also detailed in the explanation of the model labeled 'funding subsystem.'

> *"Unknown methods are not often accepted in larger journals, [you then] need to publish in smaller journals, which can have implications on where you want to position yourself in the research field" (PN4285).*

Line of research. The line of research, or topic, that a researcher is working on influences the use of the methods which are most appropriate for the research questions within the researcher's topic. All interviewees mentioned their topic affecting the type of methods and designs they use and are interested in. To give some examples of how the research topic facilitates the use of particular methods, several quotes are below.

> *"In [my topic], randomized control trials are impossible. you can't randomize individuals in the way that I used to do that with drugs" (PN4285).*

> *"I'm a professor at [topic] so yes, I work on research which basically centers around… the healthcare system… and I basically tend to do mixed methods of research so quantitative and qualitative" (PN3275).*

> *"Especially in my field of research, we don't have good options for randomized trials because of the practice of [department], we work with a lot of factors…" (PN9844).*

"If you had asked me ten years ago, I would have said that I prefer randomized controlled trials because I've done quite some. Partly it has to do with the research field I'm working in [now] which is often about [subject], a more soft medical field…" (PN6547).

5. Discussion and Conclusion

This study aimed to gain insights into the perceived structure which potentially drive medical researchers' methodological choices within RadboudUMC, identify feedback loops present in the structure, and explore the main drivers influencing their choice. This study specifically revolved around the use of and need for novel methods, with the conceptual CLD depicting a choice between novel methods and RCTs. In practice, what constitutes "novel methods" changes from researcher to researcher based on their previous knowledge, expertise, and line of research. This led to a final CLD which did not make the distinction between RCTs and novel methods, and instead focused on the choice between method A or B. The resulting final CLD and analysis of the interviews revealed that researchers' perception of the structure, in which they work and make choices in, is one with multiple reinforcing feedback loops.

Overall, the final CLD revealed that researchers' methodological choice is driven by the methods they are exposed to, the methods accepted by them and others, and by the availability of funds for their chosen method. The structure depicts how researchers may be reinforced in their ideas, as the identified feedback loops increase or decrease the use of a particular method, such as method A or B. Thus, showing how the system can reinforce preferences for some methods over others. Whether the researcher chooses a novel method or an RCT, the reinforcing behavior of the CLD give insights into how a method's success increases the chance that, with a similar research question, the researcher is more likely to suggest and use the same research method. Thus, the results presented support the assumption that one method's success drives its success further and decreases the success of another.

However, researchers often mentioned that funding and the pressure to publish was a large component when deciding upon which methodology to choose. A total of ten reinforcing feedback loops were identified with five out of ten feedback loops being linked to the term "funding." A further look into the structure of "chance for funding" revealed a subsystem with the same success to the successful behavior as the conceptual CLD. Unlike the conceptual CLD, funding, rather than

the (in)sufficiency of the method, was the main driver of this archetype. Other main drivers of this choice include the ideas of the evidence hierarchy, whether researchers are exploring the topic, and which line of research they work in. This section aims to discuss how the final CLD can be interpreted, what the CLDs contributions and limitations are, and where future research may benefit.

First, the model verifies other studies by explicitly stating the relationship between one's network and interdisciplinary teams. Several studies have found that knowledge production is increasingly a product of networked and interdisciplinary design (Aardgaard, 2021). While Reid and Mooney (2016) have found that questions being asked by decision makers are also increasingly of interdisciplinary design. This follows the idea that this study found, where researchers need to comply with grant calls, which often calls for interdisciplinary teams. This could imply a rise in the development of novel research methods, as different methods are potentially being proposed and the melding of methods could increase new method development.

Second, the model makes us conscious of the success to the successful archetype, part of the funding subsystem, which demonstrates the relationship between funding and methodological choice. The section labeled method acceptance reinforces the idea that choosing a method that is both well known in the field and by the researcher, would be the best method fit. This challenges the idea that researchers are objectively choosing a method based on the perception of method fit to the research question. In reality, acceptance, granting opportunities, and other influencers drive the success of and choice for certain methods.

This reveals how medical researchers perceive how the system drives the way medical research develops, steering methodological choices in a certain direction, and effectively driving the development of medicine and health interventions. The perception is that the system perpetuates the use of well-known methods, further increasing knowledge and information about those methods. This creates an environment where the choice to use and availability of funding for those methods is generally higher. Similar ideas about how funding can shape research output and research groups can be observed in several other studies (Aagaard et al., 2021; Homer & Hirsch, 2006; Viner et al., 2004).

Aagaard et al. (2021) states that “individual researchers and research organizations navigate an increasingly complex globalized science funding system” (p. 20). This study further suggests that the conditions and culture surrounding these topics, which allow these perceptions and potential paradigms to form, are also complex. Additionally, powerful actors and biases can potentially be dominating the reality of the socially constructed model in this study (Allison & Stewart, 1974; De Gooyert et al., 2019; Hammond et al., 2021; Viner et al., 2004).

Third, when there is a need to publish in high impact journals, the publish ability of one method over another can override the motivation and perceived need to use a novel method. This is due to the need to fulfill a quota set out by the university. This study confirms the feeling that researchers throughout the medical field have, which expresses the need and pressure to publish to survive as a researcher, or to maintain one's position (Becker & Lukka, 2022; Rawat & Meena, 2014; Yeo et al., 2021). A book called “The publish or perish book,” a guide for researchers on publishing their work, signals to how important publishing is within the research realm (Harzing, 2010).

Finally, the results resemble the idea of Kuhn (1962) who evokes the idea that researchers learn from a basis of their field on shared paradigms and commit to the same rules and standards of research, without disagreeing over the fundamentals. The structure contributes to a “genesis and continuation of a particular research tradition” (Kuhn, 1962, p. 11). This seems to be true for a particular type of knowledge, such as the effectiveness of an intervention, or for a topic or line of research, such as the quality of life or outcome measures. The reinforcing behavior of the model confirms Kuhn's idea about paradigms by revealing that certain conditions or circumstances may happen where either method A or method B develops. Such as one method has higher acceptance and thus easier access to funding over another method.

However, this does not mean that when circumstances are not supporting the other method that it does not develop, it only means that the other method develops more slowly, leading to different stable states of the system depending on the circumstances. It could just mean a matter of time and extra effort to use a method without support. Thus, there is a delay when choosing methods which either are not accepted in the environment, or which are accepted but are not funded. This reasoning, and what the CLD exhibits, relates more closely with an idea called “accumulative advantage.”

Accumulative advantage is the idea that scientific contributions accrue at greater increments for certain scientists over others (Allison & Stewart, 1974). Alison & Stewart (1974) and Viner et al. (2004) draw upon this idea to validate and point out that resources flow disproportionately within academic research and give certain members within the field a competitive advantage. Those studies support the idea in this study that researchers need to work harder when the circumstances do not support their chosen method. Thus, creating a scenario where scientific contributions accrue at greater increments for certain methods over others.

To that end, this study does not answer the need for a paradigm shift, it signals the emergence and development of a paradigm shift. Interviewees in this study mentioned that some of these methods they started using ten to fifteen years ago, and yet many still struggle to secure funding and acceptance for their method. While medical researchers seem to agree on the use of multiple methods, the research also reveals that funding institutions may not yet strongly support a diverse range of methods. Medical researchers have been signaling the need to look at patients from a multifactorial view, rather than a single-issue view. 'Traditional' methods may not be able to answer 'new problems' such as those which are complex, wicked, and nonlinear, but these methods are still needed for gaining a certain type of knowledge. Thus, methods need to be developed side by side with resources being allocated to a diverse range of methods to avoid competitive advantage of methods and to help the medical field tackle new problems. Thus, a slow and cautious paradigm shift which includes these other methods as part of its fundamental basis, may be a suitable way to describe the state of the system of the medical research field.

5.1 Contribution to knowledge

This study is the first to explore and create a causal loop diagram of research funding and methodological choice through the perspective of individual medical researchers. Consequently, this bottom-up approach compliments the previous top-down studies on academic funding. This study supports the numerous articles within the medical field which are signaling for and towards a paradigm shift. Discovering the "success to the successful" system archetype extends the examples of such an archetype, and what can break such a system, to the field of research funding. This multidisciplinary study and the use of system dynamics further contributes to the pool of complexity science papers, creating synthesis between the ideas in medicine and business analysis.

Lastly, the coding process used in this study can be useful in contributing to further examples of modeling asynchronous data in system dynamics.

5.2 Contribution to practice

The results of this study can inform RadboudUMC how to facilitate the use of certain methods and help to identify where policies can be implemented to change the behavior of the system. Policies regarding chance for funding, exposure, interdisciplinary collaborations, motivation to use method B, and pressure to publish could be both feasibly implementable and impactful to the current perception of the structure. The study's results increase insights into the need for funding and supportive tools for new methods in development. Through a bottom-up approach meaningful findings were derived which can help inform and potentially enable funders, and other supporting actors, towards understanding how they co-influence the scientific system. Thus, the findings of this study are potentially relevant for RadboudUMC management and researchers in the creation of policies which can further facilitate the use of certain methods, as the mission vision and strategy of RadboudUMC strives for "person centered and innovative" healthcare (Radboud University Medical Center, n.d.).

5.3 Limitations & future research

This study has several limitations. First, interviewees were selected from a network of researchers which focuses on complexity sciences. The interviewed researchers may have more interest in using methods which are not widely used in the medical field. Only one interviewed researcher had positive sentiment towards RCTs, whereas all other researchers spoke to the disadvantages of RCTs and advocated for other methods. Second, the interview guide inquired about criticism, complexity, and interdisciplinary research. Having researchers reflect upon these topics could have influenced the sentiment towards certain methods. Third, the individual CLDs and final CLD did not go through member checks, whereby the participants' opinions are fed back into the model. Member checks could have been conducted to further increase the validity, ownership, and consensus of the final model. Thus, the model is only a simplified view of what the data revealed.

However, based on reactions and feedback received by medical researchers while discussing this study's topic, and the final CLD, this study may well reflect the views about the perceived structure guiding methodological choice. Previous discussion points signal to and support areas within the

CLD, and the identified main drivers, as being of interest within academia. Thus, the results and implications of this study could be generalized in a representational and internal way, meaning that the perceived structure has a potential to be found again within the parent population (Ritchie et al., 2021).

Previous studies have often focused on institutional funding and grant opportunities, without considering the researcher or individual perspectives which the system of funding effects. Future research expanding upon this study in the form of group model building and other quantitative methods to analyze or build a simulation model, may be beneficial and insightful for the medical research field and beyond. Discovering where the initiative for funding opportunities comes from and how these decision makers drive the behavior of the actors in the system, can be complementary to the available knowledge on research funding. Exploring funding and topics related to this study in these directions, could help increase the potential formulation of policies towards more equitable means of funding opportunities. There could also be explorations on questions relating to what types of power are playing a role, and how niche fields grow in such a research environment. The model presented in this study has been an initial exploration of the mentioned topics and is a means to other analytical endeavors.

7. References

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8. Appendices

Appendix 1 - Interview guide

Introduction:

Thank you for participating in today's interview! Just to recap, the research you are contributing to is trying to uncover how researchers make the decisions they do with regard to their research, particularly in the medical field. As hospital care becomes increasingly patient centered and patient care is becoming more complex, especially as they age, the medical field may face the need to change how they approach patient care. Currently, RCTs in EBM reigns supreme in medical decision making. RCTs are very successful and effective, however this research method typically looks at issues as a linear problem, which ignores the complexity of individual patients. Therefore, this research is trying to find out how researchers choose their research method in this increasingly complex environment. This interview should take approximately 45 minutes. With your permission I would like to record our conversation so that the interview can be properly transcribed for analysis. Your interview data will be anonymous and confidential. The research paper will be available to you once it is completed, upon request. Do you have any questions regarding what I just mentioned? And is it possible to record our conversation with your approval? Before we start do you have any additional questions? Thank you! The recording has started and we may begin!

<u>PART 1: Introduction/Methodological choice</u>

1. *Would you please introduce yourself?*
    a. *What is your role within the research field?*
        i. *(follow up) Do you sometimes take on other roles? For example, co writer, editor, grant approvals*
2. *How would you define evidence-based medicine? (Clarify definition)*
    a. *(follow up) What kind of research designs do you consider a good way to gather evidence for evidence based medicine?*
        i. *(Follow up) Why?*
3. *What research method is your preferred type to use?*
    a. *(follow up) Why is that your preferred method?*
4. *How does your role(s) affect the way you conduct research?*

    a. *Would taking on additional roles change the way you conduct research?*
5. *In this research complexity is seen as (give idea about complexity)…*
    a. *How would you define complexity in your field or research? (Clarify definition/idea about complexity)*
    b. *What makes a case/patient complex? (elicit specific reasons for complexity)*
6. *Are there other research designs other than RCTs that you have used or would consider using?*
    a. *(follow up) Why? (Or why not?)*
        i. *(If yes) How often are you met with criticism when you choose research designs other than a RCT?*
            1. *(If yes, follow up) Does this criticism make it more difficult to continue to use research designs other than RCTs?*
7. *How does the medical field industry in general influence your behavior as a researcher? (external factors) (Clarifying point if needed) For example, trends in research and medicine*

<u>PART 2: Potential problems faced</u>

1. *How do you engage with different research methods to help you answer complex questions?*
2. *What do you do when it feels like your research question is not being answered accurately?*
    a. *(If yes) What is the follow up process when this happens?*
3. *Does your department collaborate with other departments within RadboudUMC?*
4. *Do you ever engage in interdisciplinary research? For example, involving others outside of the medical field*
    a. *(follow up) How often has or does this happen?*
    b. *(follow up) How does this affect your research design? (Seeing if interdisciplinary research affects choice)*
5. *Who are your collaborators in research?*

<u>PART 3: External factors influencing decision</u>

1. *How does the hospital play a role in the research which is produced by RadboudUMC? (external factors)*
2. *Which roles influence the type of research designs you use?*
    a. *How much influence do these roles have on your research design?*
    b. *How much influence do you have on your research design?*
        i. *(possible follow up) Is there a formal process you can follow to change the research design to your vision?*
3. *How long does your typical research project last?*
    a. *(follow up) Is the proposed length of your research chosen by you or is it influenced by outside factors?*
4. *How much does funding affect the type of research you conduct?*
    a. *(Follow up) How much leverage does the funder role have on your research?*
5. *Who plays the most important role with regard to research funding?*
    a. *How do they influence the research which is conducted?*
6. *How does your environment influence the decisions you make?*
7. *What factors influence which research design is chosen?*

PART 4: Ending thoughts

1. *How do you view the future of medical research in terms of research design?*
    a. *In what ways is your research contributing to this future?*

Appendix 2 - Code book and CLD variables

Variables originated from the below codes, with most variables taking on the same name. The table following the codebook represents all variables which were used in the individual and final CLD. They are listed from most frequent to least frequent.

Acceptance	Explore topic	Method fit	Pressure
Available resources	Exposure to methods	Motivation	Problem faced

Awareness of methods	Funding	Multifactorial	Process
Change in thinking overtime	Grant fit	Multiple perspectives needed	Relevance of research
Critical	Integrating research into society	Network	Roles
Difficulty of research	Interdisciplinary collaboration	Openness	Uncertainty
Discussion	Journal	Persuasion	Understanding
EBM	Learning about methods	Policy point	
Evidence Hierarchy (quality of evidence)	Line of research	Power	
Experience	Medical culture	Preference	

Variables	**Meaning**
Awareness of novel/other/alternative/different/the method(s)	Awareness of other methods which are "new" to the researcher/participant; awareness of a method which the participant is not an expert in; Having basic knowledge about a method, but not yet an expert in the method; Ex. "I know that method, and read up a bit about it." Researchers are aware of the method but may not yet be an expert in the method, or have yet to begin learning about or using the method.
Exposure to novel/alternative/different/the method(s)	Being introduced to methods which are "new to me," or otherwise unknown by the researcher; Ex."I have never heard of that before, interesting! I will have to look into it." Introduced to a particular method. The repeated use of a certain method.
Interdisciplinary collaboration	Includes working with persons from different: Educational backgrounds, departments, research fields, institutions, universities. Includes working with persons in the professional field; Can also include a stakeholder analysis to decide and come

	to a consensus on best method for research project; Includes international collaborations/consortia
Learning	The acquisition of knowledge through experience; For example, exposure to a method unknown by the researcher increasing learning by first exposing others to methods new to them, therefore gaining new knowledge; chance to learn
Number of roles	Academic and professional roles; Includes amount of times participant has changed roles; Head of department; Physician; Clinician; Grant reviewer; Chair on grant committee; Journal editor; Journal reviewer; Co-author; Project leader; Drug developer; Guideline developer; Supervisor; Professor; Researcher; Teacher; Guideline reviewer; Nurse; GP; Psychologist; Physiotherapist
Pressure to publish	The amount of perceived pressure that a researcher feels by the need to fulfill the quota and expectation to publish in high impact journals; Funding received for publishing in high impact journals; Desire to have a high position; (pressure to publish) The perceived amount of pressure a researcher feels to publish their work; to perform to a set of expectations
Chance to change thinking	The probability that the researcher changes their thinking about what methods are "useful" for their research topic or research question; Change of view over time on what methods are seen as valid, accepted, or of producing quality results; change of view overtime of what the best research question is to produce knowledge
Experience	Number of years in the academic/professional field and/or in role/position; Number of years in the field; as a researcher; number of roles the participant has/had;
Understanding	The extent to which the researcher; journal reviewer; grant reviewer; can grasp the intended use or benefit of the method; possibility of consensus about the use of the (novel) method(s)
Availability of resources	The available time of researchers, participants, students, etc.; The available data sources, such as access to databases, patients, populations, etc.; Availability of facilities, such as state of the art measuring tools, etc.; Time/money/resources for novel research;
Discussion	The process of talking about something in order to reach a decision or to exchange ideas; includes feedback rounds; The

	chance or opportunity for the researcher to discuss and inform others about their chosen method
Chance of funding	The probability that the proposal with the chosen method will be awarded funding by the grant committee of the funding institution; The probability that the written and submitted grant proposal will be awarded funding
Chance to persuade	Possibility that the researcher can persuade funding institution of the benefits of a different method than the originally agreed method; The probability that the researcher can use their knowledge or expertise to influence others
Commitment to methodological choice	The extent to which the researcher is sure of, dedicated to, and chooses to conduct the research using the chosen methodology
Desire to use the method	The extent to which the participant wants or wishes to use the method of choice
Funding	The amount of monetary value which is given to a proposal; Influenced by governmental parties, industrial parties, grant calls, institutional funding; The amount of money which is available for the method chosen
Grant fit	The extent to which the methodology proposed fits or fulfills the requirements specified in the grant call; The perception that the method fits the needs and requirements stated by the grant call; Method matches the needs of the grant call
Network	Amount of relationships, connections, and/or contacts a participant has access to.
Number of proposals using novel/alternative methods	The number of proposals written and submitted to a grant call which use a "new to me" method; The amount of written and submitted proposals which use methods specifically focused on complexity science/issues; The amount of written and submitted proposals which use methods specifically focused on complexity science/issues
Perception of method fit	The perceived fit between the research question and the method of choice to give the best results for the question; Method fits best with research question; most feasible method in terms of time and financial constraints and considerations; feasibility of using the method in terms of available resources and data
Perception of relevancy	The degree to which the research topic, question, and or method is seen as being necessary and appropriate; The research produces

	new knowledge or insights
Persuasion power	The extent to which the researcher or participant can use their expert (use of extensive knowledge/experience); referent (charisma, trust, respect); or legitimate(use of position/authority based on position) power to influence others; Possibility to make arguments
Use of RCT	The decision to use RCT as the methodological choice for the researchers grant proposal/research; The extent to which RCTs are used in evidence based medicine; RCTs are just under systematic reviews on the evidence pyramid
Acceptance of novel/other/the method(s)	The researchers ability to see the method type as valid, adequate, or suitable
Criticism	The extent to which the researcher experiences disapproval of the chosen method by others and/or the grant committee
Demand to publish in high impact journals	Influencers: Desire to have a "high position;" Funding which is received for publishing in high impact journals; Outcomes: Difficulty to stay transparent; Exclusion of data to come to "nice" results; barrier to research field as a young person(s); The need to fulfill a criterion to publish in journals with an impact factor of 8 or above; Seen as very difficult to publish qualitative studies in high impact journals; RCTs are well known for being accepted in high impact journals
Difficulty of research	The amount of effort needed to secure tangible and intangible resources; the amount of effort it takes the researcher/team to accomplish their goals; The influencing factors which can cause delay in research such as a drop out of participants, researchers, burnout, etc.; unexpected events in funding such as when a grant is awarded, there are at times events which happen (such as the dropout of participants, the inability to access data/population sources; etc.) Which can adapt the amount of funding/ terms of the grant (extend the time; extend the funding; drop the funding; etc.)
Feasibility	The state or degree of being easily or conveniently done
Industry influence towards EBM paradigm	The influencers which allow the medical field to perpetuate the evidence hierarchy
Influence on methodological	The extent that the methodological choice can change based on

choice	the inputs a researcher receives
Need for more perspectives	The importance and need for multiple methods and perspectives on a research project; Partially defined by interdisciplinary collaborations- The need for multiple academic and professional disciplines (as well as participants, patients, common society, politicians, etc.) working together towards a common goal; The importance and need for multiple methods and perspectives on a research project
Need to explore topic	The need to gain more/new/in depth insights into the research topic/problem; The need to understand a topic in depth; exploratory/explanatory knowledge
Need to know effectiveness	The need for the researcher to find out the effectiveness of an intervention; The extent to which the patients the clinician sees in daily practice apply to the RCTs of the interventions recommended
Number of grant proposals awarded funding	The number of grant proposals which are awarded funding to conduct the research
Number of proposals using "traditional" methods	The amount of proposals which are written and submitted to grants which use well known and common methods in the medical field; such as RCTs, and other controlled trials; mainly of quantitative and classical statistical nature; The amount of grant proposals written and submitted which use RCT as the method of choice
Number of research topics dealing with multifactorial interrelations	The amount of research questions and or topics which require a look into interrelated factors
Perception of acceptance	The perceived acceptance of the method chosen
Perception of problems faced	The perceived problems or limitations or barriers which arise when the researcher chooses a currently known methodology to answer the research question; These could be: Amount of patients needed; amount of time need; amount of costs needed; the need for heterogeneity/homogeneity; the need for small/large patient population; Causing the researcher to think critically about the commitment to that method choice
Perception of RCT as best evidence	The perception to which RCTs are the highest level of evidence and of highest quality within the medical research field; Perception and thinking that RCTs are gold standard on the basis

	of the evidence hierarchy; Most researchers are looking to build up to the "final" research output which is an RCT; The extent to which an RCT is seen as the best method to gather evidence within the medical research field
Perception of resistance	The perception of which methods are likely to receive funding; perception of which methods are likely accepted by certain funding institutions; perception of resistance towards novel methods; Medical sciences feel rusted in their tracks (Interviewee quote); The perception of the resistance to or refusal to accept the method chosen by the researcher in the general idea of the medical field; based on experiences of rejection of the method
Perception of success of methodological choice	Based on method fit, the researcher has a perception of the method being successful in giving the best results for the RQ
Problems experienced in daily practice	Number of times doctors cannot find literature of patient symptoms; The perceived problems or limitations or barriers which arise when the researcher chooses a currently known methodology to answer the research question; These could be: Amount of patients needed; amount of time need; amount of costs needed; the need for heterogeneity/homogeneity; the need for small/large patient population; Causing the researcher to think critically about the commitment to that method choice
Seniority	The possession of having a privileged position earned through longer service or higher rank; partially earned through years of experience and experience in the field; Being of higher status than persons who have been in the same research field for a shorter amount of time; Having the ability to acquire a higher position; The means to acquire a position the researcher desires, which is seen as having more authority than their current position, through skills, knowledge and experience
Uncertainty	The extent to which the researcher/grant committee doubts the ability of the method to apply practically to the research question/issue/topic; The extent to which the grant committee perceives the method choice as a risky method to fund
Use of evidence hierarchy	The use of an evidence hierarchy scheme to inform the participant about qualities of evidence from research methods; such as GRADE; Evidence pyramid; new evidence pyramid;

Ability to expect certain results and funding institution behavior	The extent to which the researcher has enough knowledge about the method to be able to expect and anticipate what the results may look like and how the method will be perceived by grant committees; Anticipating how the grant committee will react on the grant proposal by using the participants previous experience with, and other persons experience with, grant committees as a basis for their possible reactions
Actual funding received	The actual amount of funding received/awarded based on the proposal being accepted/awarded
Actual number of research papers using novel methods	The number of proposals which are granted funding and contract terms and are conducted successfully with the resources given and available
Anchoring bias	The extent to which the researcher relies heavily on their previous knowledge and background regarding a method; this can change based on what factor is being considered with this bias. For example; if a method has been rejected in the past, this may cause anchoring bias for future proposals using the same method, or against the same institution/journal which rejected the method; Or for example the success of the method previously may cause the anchoring bias for future proposals using the same methods, and towards the same institution/journal which accepted the method; Ideas about the limitations/benefits of researchers preferred methods
Anticipation of how grant committee will react	Anticipating how the grant committee will react on the grant proposal by using the participants previous experience with, and other persons experience with, grant committees as a basis for their possible reactions; The extent to which the researcher has enough knowledge about the method to be able to expect and anticipate what the results may look like and how the method will be perceived by grant committees;
Chance of using novel methods	The probability the researcher/participant will choose a "new to me “or new to their research field method as the methodological choice
Chance of using RCT	The probability the researcher/participant will choose RCT as the methodological choice
Consensus	The general agreement of persons on what the research problem is and what the best method is to answer that question

Decision to apply alternative methods	The decision by the researcher to choose a method which is "new to me" or to the field of research
Desire to explain the limitations/benefits of different methods	The willingness and enthusiasm of a participant to explain and educate others about the methods they have knowledge about, learned about, or know about
Desire to persuade the committee	The desire to take an active role in influencing/persuading the committee about the benefits or the reason why the method chosen is the best method for the research question and project/grant
Early phase of the study	The early phase of the study is when the topic is still in need of exploration before ending or starting a RCT, if applicable
Experience with RCTs as the main research method	The amount of experience a researcher/participant has with RCTs; in terms of education, previous and current background, previous and current knowledge, experiences regarding others perceptions of RCTs, using the RCT as a method, successful use of the method, etc.
Fear of losing researcher position	The level of concern or fear the researcher has if their researcher position were revoked
Grant calls which support novel methods	the amount of grant calls which are currently available and which support the use of "novel methods" (new to the researcher/participant) in the medical field
Grant committees and institutions which push RCTs	The choice of the funding institution and/or grant committee to ask for RCT as the method, and reject any other method, even when there are great reasons to use a different method other than RCTs
Independence	The extent to which the researcher can act independently, within reason, such as within the boundaries of the grant institutions/university; Researcher does not rely on the researcher position as only source of income; researcher works professionally in another role outside of research;
Institutional aims towards "Innovation" in medical research	The extent to which the institutional (RUMC) mission, strategy, and vision, affect the type of research which is produced by researchers at RUMC, thus helping or inhibiting the use of the researchers chosen method/the use of "new to me" or "new to the field" methods
Limitations	The amount of limitations a method has; found by the researcher and/or grant committee; expressed in amount to which something

	is not possible;
Motivation to use alternative/other methods	The extent to which the researcher is willing to use other, or "new to me" methods; Willingness to use methods which are unfamiliar or new to researcher/research field
Need for a strong network	The need to have a strong support system through the networks available to the researcher; The need to have availability to multiple connections and relationships to have a sense of support from others and/or institutions
Need for alternative methods	The demand for methods which differ from the methods which are currently used by the researcher, these can be new to me "novel" methods, or methods which are rarely used by the researcher themselves.
Need for funding	Need for participants; time; funds; data; facilities;
Need to fulfill expectations	Need to publish; need to secure funding; The amount of perceived pressure a researcher feels to write a grant proposal which they feel will receive funding from the grant committee; Anticipation of how the grant committee will react.
Need to innovate	The need for innovative methods in the medical field
Need to search for new designs and methods	The need to develop and seek out designs and methods which can achieve the results or outcomes the researcher desires
Number of articles published using novel methods	The amount in quantity of research proposals which become published articles in journals
Number of factors influencing the research topic	The number of factors which are interrelated regarding the research topic or question; The research being conducted is multifactorial and considers multiple casualties to answer the research question
Number of grant proposals submitted	The amount of grant proposals which are written and submitted to grant calls/committees
Number of proposals using RCTs	The amount of grant proposals written and submitted which use RCT as the method of choice
Number of rejected proposals	The amount of proposals submitted that are rejected by the grant committee
Number of rejections	The amount of submitted proposals which are rejected due to a inadequate method/unknown method/need for a different method; or due to the proposal not fitting the grant needs

Overpromising	The amount of proposals which are transparent and realistic about their deliverables; many proposals tend to over promise on their deliverables of the project, access to data and resources, suggested timeline, etc.; Amount of proposals overpromising all kinds of things
Perceived need to fund novel methods	The perceived need to fund novel methods; The perception that novel methods in medical field need to and should be funded
Perception of quality of RCT	The extent to which the participant perceives/regards RCTs to be of high quality evidence/information; The extent to which the funding organization/internal organization and/or participant perceives/regards novel methods to be of high quality evidence/information
Perception of quality of results	The extent to which the funding organization/internal organization and/or participant perceives/regards novel methods to be of high quality evidence/information
Perceived value of research	The degree to which the participant believes their research is of value or is important to society; patients; The degree to which the participant/others acknowledge the value of the knowledge being produced; ability to use the research practically
Research base of complexity sciences	The amount of research articles which have been published and contribute to complexity sciences and methods
Risk of changing the research method once granted funding	The extent to which the researcher may change the method to a different method once the grant has been approved.
Specialization	The extent to which the researchers role requires them to have detailed specific knowledge about a subject/method/or research field
The research objective following current trends in the medical field	The extent to which the research proposal and its objectives are following the current trends in medical research; Trends are influenced by the context such as: current events; societal topics; politics; Funding programs; etc. A few examples; research in cancer is often trending due to society's perception of the importance of tackling this disease; Research for COVID has been heavily funded due to current widespread global events around the virus

Use of methods researcher is an expert in	The use of methods which the researcher most currently uses, has used, and has the most experience in and knowledge about; Sort of the "go to" methods of the researcher; based on area of expertise and research field/topic; Ideas about the limitations/benefits of researchers preferred methods
Vulnerability	The possibility/vulnerability for the proposal to be open for criticism and more likely to be rejected for funding
Wicked problems	Problems which are unable to be solved through one solution, multifactorial and inherently complex, full of uncertainty; Context of the environment; Mismatches between practice and research- When current research is not found sufficient to answer questions which the medical field is facing
Length of research	The amount of time a research project takes (perceived/actual)
Question unable to be answered using current methods	A problem faced; the extent to which the researcher is unable to answer the research question using methods which are currently used by the researcher or known by the researcher
Rejection of proposal	The rejection, disapproval, unacceptability of the proposal; proposal seen as inadequate
Research on problems experienced in the real world	Research reflects the needs within healthcare; reflects the needs of the professionals researchers work with; research topic and question reflects the needs within the healthcare field; relevancy/value of research
Successful proposals using novel methods	The number of proposals which use novel methods and are successful; meaning they are carried out in their entirety, finished, completed, and possibly published in a journal/several journals; The amount of times in terms of quantity, that the chosen method has been awarded funded; answered the research question; and has been found adequate in the past;