Mapping the Barriers to AI Implementation in Swedish Healthcare

Key Barriers: Competencies, Data Accessibility, and Demonstrating Value of AI Products

Bachelor Thesis in Technology Management and Economics

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Abstract

Artificial Intelligence (AI) has shown the potential to improve the quality of care for patients. However, barriers are preventing its adoption, and despite its potential, the integration of AI into Swedish healthcare remains limited. This thesis aims to identify the most impactful barriers to implementing AI in Swedish healthcare by identifying stakeholders, their interests, and their perceived barriers to the implementation. The data was collected through 19 semi-structured interviews. These interviewees were categorized into six stakeholders: clinicians, healthcare executives, MedTech companies, patients, policymakers, and researchers. Thematic analysis and tools from stakeholder analysis were utilized to synthesize overarching barriers in the system. The results revealed diverse perspectives on barriers for the stakeholders. The most prominent barriers identified were competencies, data accessibility, and demonstrating the value of AI products. Lack of competencies contributes to several other obstacles, and data accessibility was mentioned by all stakeholders. Demonstrating AI products' value is fundamental to integrating AI into clinical practice. The thesis calls for further research to provide solutions to the identified barriers. If solved, the large-scale implementation of AI in Swedish healthcare will be one step closer.

Keywords: artificial intelligence, barriers, healthcare, stakeholders, Sweden.

Note: The thesis is written in English.

Sammanfattning

Artificiell intelligens (AI) har visat potential att kunna förbättra kvaliteten på vården för patienter. Dock finns det barriärer som hindrar dess implementering och trots dess potential, är användningen av AI inom svensk sjukvård begränsad. Avhandlingen syftar till att identifiera de mest framträdande barriärerna för AI:s utveckling inom svensk sjukvård vilket görs genom att identifiera intressenter, dess intressen och deras upplevda hinder för implementeringen. Studiens data samlades in via 19 semi-strukturerade intervjuer. Respondenterna kategoriserades in i sex intressentgrupper: kliniker, vårdchefer, MedTech-företag, patienter, politiska tjänstemän och forskare. En tematisk analys och verktyg från intressentanalys användes för att syntetisera övergripande barriärer för implementeringen. Resultatet avslöjade intressenternas olika perspektiv på barriärerna. De mest framstående barriärerna som identifierades var bristande kompetenser, datatillgång och svårighet i att kunna bevisa värdet av AI produkter. Kompetensbrist bidrar till ett flertal andra hinder och datatillgång nämndes av alla intressentgrupper. Att kunna bevisa värdet av AI produkter är fundamentalt för att integrera AI in den kliniska vården. Avhandlingen efterfrågar forskning för att hitta lösningar på de identifierade barriärerna. Om dessa löses, kommer en storskalig implementering av AI inom svensk sjukvård att vara ett steg närmare.

Nyckelord: artificiell intelligens, barriärer, sjukvård, intressenter, Sverige.

Notera: Rapporten är skriven på engelska.

Preface

This thesis was written by six students at Chalmers University of Technology, all with an interest in AI and its recent advances in society. We would like to thank our supervisor Nicholas Surber for always encouraging us to think freely and make independent decisions. Further, thank you for your feedback and guidance as we developed a red thread within this thesis.

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1 Introduction

The following section aims to provide relevant background information for this thesis through several sub-sections. First by providing context for artificial intelligence (AI), Swedish healthcare, and relevant regulations. Then the purpose and problem analysis will be presented. This discusses the relevance of the purpose and further presents the research questions. Finally, the delimitations will be introduced to clarify the scope of this thesis.

1.1 Background

The use cases of algorithms and technologies such as Artificial Intelligence (AI) are becoming increasingly prevalent. AI has caught the attention of the public eye since the introduction of ChatGPT by OpenAI (2022) on the 30th of November 2022. However, AI has been present for decades (Davenport & Kalakota, 2019). Ongoing research into the applications of AI in the medical field is abundant (Davenport & Kalakota, 2019), but implementation in a clinical context has been slow (Petersson et al., 2022).

Sweden's healthcare system comprises national, regional, and municipal levels to ensure equal healthcare for all citizens (Anell et al., 2012). It is transitioning into a new generation of healthcare systems (Cederberg, 2023) to tackle challenges posed by an aging population and staff shortages (Regeringskansliet, 2010; Socialstyrelsen, 2022). With over a quarter of the population projected to be 65 years or older by 2050, demand for healthcare is set to increase, making it crucial to improve efficiency (Regeringskansliet, 2010). AI has the potential to streamline tasks such as diagnostics, administration, and decision-making, ultimately making medical services more accessible, affordable, and effective (Davenport & Kalakota, 2019; Meskó et al., 2018).

Due to the structure of Swedish healthcare, there are six different journal systems across the various regions (Cederberg, 2023), illustrated in figure 1. However, Cederberg (2023) expects them to consolidate into two or three systems as part of the transition toward a new generation of healthcare systems. Additionally, the Swedish healthcare system is a combination of publicly and privately owned health institutions, with a higher proportion being publicly owned (Anell et al., 2012). All publicly owned hospitals must follow public procurement laws, that is, specific laws and guidelines to ensure competition and good use of public resources (Vårdhanboken, 2021). Public procurement for medical devices has to include a requirement specification containing requirements on performance, documentation, and CE certification (Vårdhanboken, 2021). This is a landscape in which AI technology must function within.

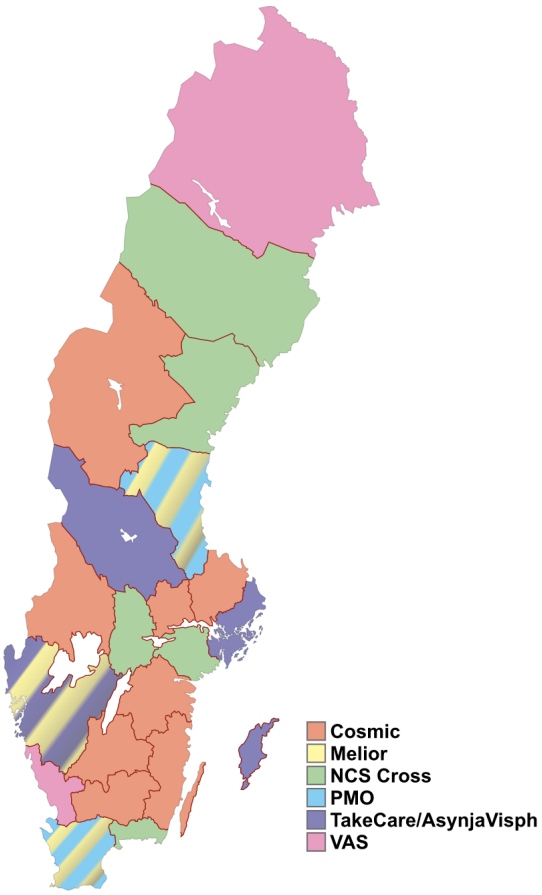

Figure 1: Swedish regions and their journal systems (eHälsa Sverige, 2023).

Before implementing AI in healthcare, several steps must be considered. In the EU, AI-based medical devices are regulated by the Medical Device Regulation (MDR) (Beckers et al., 2021). The MDR governs which products are allowed on the market, how they are placed on the market, and how they are used, requiring manufacturers to register in the European database EUDAMED (European Union, 2017). The MDR states that medical devices can be developed for commercial or in-house use (Läkemedelsverket, 2022). Commercial products must go through the process of obtaining a CE mark, indicating that the product is safe and compliant with the regulatory framework (European Union, 2017). Moreover, ethical review and approval are necessary before introducing AI into healthcare, which the Swedish Ethical Review Authority is responsible for (Etikprövningsmyndigheten, n.d-a). Furthermore, an ethical review is required for research involving sensitive personal information, law violations, physical or psychological operations, and traceable biological material. Ethics approval is also needed for clinical trials for medical devices. However, this is done by EUDAMED and not the Swedish Ethical Review Authority (Etikprövningsmyndigheten, n.d-b).

Additionally, patient privacy regulations must be considered since AI models need access to patient data. In Sweden, personal data and health records are subject to the Swedish Patientdatalagen (PDL) and the General Data Protection Regulation (GDPR) of the European Union (Socialstyrelsen, 2023). PDL governs the management of patient journals and personal information (SFS 2008:335). On the other hand, GDPR regulates how personal data must be collected, processed, and protected and is designed to give

individuals greater control over their data and strengthen data protection throughout the EU (Socialstyrelsen, 2023).

The implementation of AI in Swedish healthcare remains a pressing issue, given the coming crisis in the Swedish healthcare sector. This thesis aims to illuminate the main barriers to AI adoption. The introduction section of this thesis 1 will be followed by a methodology section detailing the data collection process of the interviews conducted. The results present the relevant information gathered from the interviews conducted, and the analysis discusses the most prominent barriers discovered. Furthermore, a section on the sustainable development of AI presents how the implementation of AI relates to the United Nation's Sustainable Development Goals, emphasizing the ethical implications of AI in healthcare. Finally, the research questions are answered and put into a larger context in the discussion and conclusion.

1.2 Purpose

This thesis aims to identify and map the barriers to the implementation of AI in Swedish healthcare. Furthermore, the purpose is to highlight the most impactful barriers to the implementation.

1.3 Problem Analysis and Research Questions

Several reports demonstrate how AI has the potential to enhance healthcare by minimizing errors, improving diagnostic accuracy, saving time, and potentially reducing costs (Davenport & Kalakota, 2019; Meskó et al., 2018). Some research has been done in this field of the slow uptake of AI into healthcare, both internationally by Singh et al. (2020), Lee and Yoon (2021) and in Sweden by Petersson et al. (2022). These articles differ in scope and objectives. For instance, Singh et al. (2020) mainly focuses on the barriers from the perspective of healthcare providers and patients, while Lee and Yoon (2021) focuses solely on the perspective of healthcare providers. Petersson et al. (2022), on the other hand, examines the issue from the lens of Swedish healthcare leaders. These articles relate to the reasons why AI has not been implemented, mainly from the perspective of a few influential actors. There are also studies to explore stakeholders' attitudes toward using AI (Scott et al., 2021) and the views different stakeholders hold regarding AI implementation in healthcare (Terry et al., 2022). It is evident from the research conducted by (Scott et al., 2021) and (Terry et al., 2022) that different stakeholders have varying attitudes and opinions toward AI. Some are more hesitant than others, and the concerns differ among the different groups.

As stated, research has been conducted in adjacent and similar areas. Arguably, there is a current research gap regarding the barriers to transitioning from research to implementation from the perspective of different stakeholders. This is important to understand as it is evident that stakeholders have different views on the matter (Scott et al., 2021; Terry et al., 2022). The barriers have previously been identified from the perspective of healthcare providers. The research gap is interesting as the Swedish healthcare system stands in front of a major challenge, and AI can play a crucial role in solving the challenges. Using tools from stakeholder analysis, one can identify stakeholders previously not considered when mapping the barriers. By including new stakeholder perspectives, new barriers might emerge. This thesis aims to bridge this gap by addressing the following questions:

- Which are the relevant stakeholders to implementing AI in Swedish healthcare, and what are their interests?
- According to these earlier identified stakeholders, what are the barriers to implementing AI in the Swedish healthcare sector?
- What are the most impactful barriers to implementing AI? How do these barriers impact the identified stakeholders?

1.4 Delimitations

This thesis focuses on clinical applications, meaning the type of AI that would impact the direct care given to patients. AI in clinical settings focuses on improving patient outcomes (Davenport & Kalakota, 2019). There is AI impacting administrative tasks, however, this is outside the scope of this thesis. Administrative tools could, for example, improve clinician documentation, whereas a clinical tool could assist in patient diagnosis or serve as decision support.

The geographical scope of this thesis is Sweden. The country was chosen as it is in a crucial position to improve its healthcare efficiency due to the projected increase in demand for healthcare. Another reason Sweden was chosen was due to the country's high degree of trust in digital tools, which could have elements of AI in them (Sveriges kommuner och regioner, 2023), making Sweden a harbinger for AI implementation.

2 Methodology

This chapter describes how this study has been operated. This is done by providing background on why interviews were chosen as the method for data collection and how the different interviewees were found and categorized as stakeholders. This is followed by a description of how the interviews were conducted to give additional context to the data. Then, a description of how the data was analyzed is given from a stakeholder analysis perspective. Lastly, a discussion on the methodology's relevance and consequences of the methodology design. This discussion will also lift the topic of research ethics. One topic will relate to handling the interviewees' personal information.

2.1 Data Collection and Sampling

This thesis employed a qualitative research approach, utilizing semi-structured interviews to gather data. This method was chosen due to its capacity to elicit rich, detailed responses, including interviewee attitudes and experiences (Rowley, 2012), offering an in-depth understanding of the barriers to AI implementation perceived by various stakeholders.

This thesis aimed to interview professionals working with AI in healthcare who are involved in or impacted by the implementation into clinical practice. These individuals were further divided into groups representing stakeholders, consisting of actors with similar professions. A visual of this can be seen in figure 2. This thesis includes several stakeholders, and the multiple perspectives can provide a broader understanding of each group's issues and challenges and increase the validity (Reed et al., 2009).

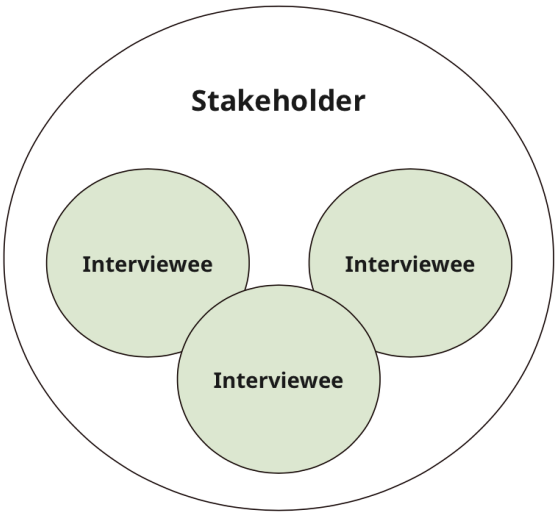

Figure 2: How interviewees represent stakeholders.

Moreover, it can also help identify any conflicting views within the group (Reed et al., 2009), which can be valuable for further analysis. The interviewees were selected based on these criteria and were found through snowball sampling and cold-calling individuals identified from brainstorming sessions within the research team. Snowball sampling

is about finding new respondents with the help of already identified and included individuals (Reed et al., 2009). This was done by the interviewees sharing their knowledge about the problem and sharing contacts. In this context, with the aim to focus on the implementation of AI in Swedish healthcare, this method is preferable as it provides new stakeholders relevant to the issue of interest. Snowball sampling can potentially increase the likelihood of the individuals agreeing to be interviewed, as they have been referred to by someone they know (Reed et al., 2009). When using snowball sampling, as described by Reed et al. (2009), there is a risk of omitting relevant stakeholders, as it could be biased based on the social connections of the initial individual. However, this limitation was kept in mind during the iterative process. Cold-calling was used to minimize the risk, as the research team's knowledge could complement the identification of the interviewees.

2.2 Interviews

The conducted interviews were semi-structured to enable flexibility, both for the interviewee and for the interviewer (Denscombe, 2017). A key feature of semi-structured interviews is that the interviewee can more freely express their thinking and develop their chain of thought. To identify the barriers to implementing AI in healthcare from the stakeholders' perspective, a semi-structured approach was desired to guide the interview toward the interviewees' perceived barriers.

The interviews were conducted by a minimum of two members from the research group. One was responsible for questions, while the other one had the task of taking notes. The interviews were conducted in person or on either Zoom or Microsoft Teams, depending on what was preferred by the interviewee. Most of the interviews were conducted in Swedish, and when the interviewee was not proficient in Swedish, English was used instead.

2.3 Data Analysis

The gathered data from the conducted interviews were analyzed using thematic analysis. Thematic analysis was used with an inductive approach, meaning themes matching pre-existing research and hypotheses were not aimed to be found, as would be attempted with a theoretical thematic analysis (Braun & Clarke, 2006). This approach was preferable as the purpose was to identify and chart the barriers rather than answering a specific hypothesis, such as if data was the greatest barrier to the implementation. Additionally, the reason for applying the thematic analysis was to facilitate the analysis of the stakeholders' perceived barriers.

The guidelines of the six-phase thematic analysis provided by Braun and Clarke (2006) were followed in the analysis. In the first phase, the gathered data was familiarized by transcribing and summarizing the transcriptions. OpenAI's transcription tool, Whisper, was used for transcribing the interviews. The text generated was compared to the recorded audio file to ensure correctness. In the second phase, the initial mapping of barriers to different themes was performed by extracting and sorting important information from the interviews. In the third phase, overarching themes were searched for by comparing, sorting, and analyzing the previously identified information. In phase four, the previously identified themes were examined and reviewed, resulting in some of the identified themes being split up and removed. In phase five, the remaining themes were named and then analyzed in phase six to identify the most impactful barriers.

Once the thematic analysis was conducted, stakeholder analysis tools were used to better understand their stakeholder roles in implementing AI in Swedish healthcare. According to Rietbergen-McCracken and Narayan-Parker (1998), a stakeholder analysis is a "vital tool for understanding the social and institutional context of a project or policy" (p. 65).

According to Rietbergen-McCracken and Narayan-Parker (1998), there are four main steps to consider when conducting a stakeholder analysis. The steps are (1) identifying important stakeholders, (2) assessing each stakeholder's interests and impact on the project, (3) assessing the influence and importance of the stakeholders, and (4) outlining a participation strategy for the stakeholders.

In this thesis, it was decided to conduct the first two steps from the approach of Rietbergen-McCracken and Narayan-Parker (1998). The first step was to identify the stakeholders involved in implementing AI in healthcare in Sweden. The nearly located Sahlgrenska University Hospital (Sahlgrenska) was contacted early as they recently opened up an AI competence center where they aim to support the implementation of AI in clinical healthcare (Sahlgrenska Universitetssjukhus, 2023). This initial interview provided some insight into the relevant stakeholders and became the starting point of the snowball sampling. However, identifying relevant stakeholders was an iterative process. As the interviews continued, adjustments were made based on a more extensive understanding of the actors involved. Next, an overview of each stakeholder's interests was created. These were revised as the interviews continued, and their interest as a group became more evident. Identifying each stakeholder's interests in the project is an integral part of the stakeholder analysis. It can provide information regarding what motivates each stakeholder and what they intend to gain or achieve from implementing AI (Rietbergen-McCracken & Narayan-Parker, 1998).

This thesis did not consider steps three and four from the approach of Rietbergen-McCracken and Narayan-Parker (1998) as the collected data did not cover these aspects. There was not enough relevant information to make this analysis. Furthermore, implementing an analysis of influence and importance would not aid the thesis question since the objective never was to understand the stakeholders' relative effect on the implementation but rather what hinders each of them. Additionally, step four was not pursued as this thesis aimed to identify barriers to implementing AI rather than providing solutions for the stakeholders' barriers.

2.4 Limitations

The reliability of the material can be discussed. Firstly, the data was collected through interviews, and each interview was tailored according to the stakeholder to which the interviewee belonged. Consequently, interviewees got specific questions about their role, which might have limited their possibilities to address other perspectives. Although, this was counteracted by keeping the interviews semi-structured, where the interviewees got opportunities to talk more about the aspects which interested them most. Additionally, some questions were the same for all the interviews to ensure that the answers provided could be compared. One example of such a question was "What are the main barriers to the implementation of AI in Swedish healthcare?".

Furthermore, using a quantitative method, such as questionnaires, would have been possible. Though, such an approach might have overlooked valuable insights from the inter-

viewees as the questions would be predetermined and could be biased toward the authors' preconceptions and beliefs (Denscombe, 2017). It was relevant to understand their main barriers and hear their insights and thoughts on the problems other stakeholders encounter. To expand on this, since interviewees were added continuously, stress groups were not chosen as methods. Further, it was interesting to hear each interviewee describe their own experience. In this way, it became evident if the stakeholder groups were more homogeneous or heterogeneous in their opinions. This insight might have become less clear during a focus group session.

Moreover, a risk with stakeholder analysis is associated with the stakeholder grouping of the interviewees (Reed et al., 2009). The grouping was mainly based on the interviewees' current professions. This type of grouping is called analytical categorization (Reed et al., 2009). The risk associated with this is that the identified stakeholders are the "usual suspects" as described by Reed et al. (2009). One strategy to avoid inaccurate information and determine barriers was to have several interviewees within each stakeholder. This strategy was successfully implemented within all stakeholders except patients, where only one interview was held. This was not ideal but may have less damage on the result than other stakeholders would have had since the interviewee was part of an advocacy group representing 4600 patients in Sweden (Melanomföreningen, n.d). However, it would still have been preferable to include several patient advocacy groups in order to represent a broader range of diseases. Different diseases might experience different barriers and concerns about how far AI should be implemented in their field.

Another limitation is that the interviewed MedTech companies were relatively large companies that already had implemented AI successfully, which might have influenced their attitude toward the issue. The process of selecting interviewees from MedTech companies did not include smaller companies or start-ups, which would have been preferable. It can be hypothesized that smaller companies face obstacles that the larger companies included in the interviews do not encounter. Thus, the barriers identified by that stakeholder may be biased.

Something else worth considering is that many interviewees belonged to several stakeholders, and therefore, all were not mutually exclusive. This is a possible limitation in how representative some interviewees and stakeholders' are. In the case of clinicians, all interviewees are physicians conducting AI research. With this in mind, it would have been desirable also to have interviewed nurses and physicians without prior experience with AI. This would have resulted in a more representative perspective from the group since it has been repeatedly mentioned that the clinicians, who are more familiar with the field, tend to regard the implementation more positively than professionals with limited or no familiarity with the field. Lastly, a limitation is that the representatives of healthcare executives are all affiliated with Sahlgrenska. As the regions in Sweden are all organized independently, healthcare executives from different regions might have different opinions and attitudes.

2.5 Research Ethics

Before the interviews, all interviewees were informed about the purpose of this thesis. They could choose how anonymous their contribution would be, which is good research ethics according to Denscombe (2017). All interviewees have consented to their role being used in this thesis, and this information has been included in the results to provide context for their perspectives.

The interviewees were also asked if the interviews could be recorded, and the recording was later deleted to ensure it would not be used for other purposes. Open AI's Whisper medium model was used for transcribing the interviewees. The software was downloaded and used locally on the author's computer, and it was run offline to ensure that no data was captured by other parties.

When conducting a stakeholder analysis, it is important not to marginalize groups and to represent other people's views to ensure good ethics (Reed et al., 2009). This was done by enabling the interviewees to talk freely and to give feedback on the parts of the report where their information was used to ensure nothing was misinterpreted. One might argue that this gives the interviewees a chance to change what has really been said to suit their interests better. This concern has been considered when processing the feedback of the interviewees, and an attempt has been made to present a fair representation of the field.

3 Result

This chapter is divided into several sections. The first section presents the identified stakeholders, their roles within the healthcare system, and the motivation for why they were selected. The section also presents the relationships among these stakeholders. The second section provides each stakeholder's interests and how they impact the implementation of AI. Subsequent sections are structured according to the different stakeholders, and the empirical results are presented from the semi-constructed interviewees belonging to the stakeholder. A full list of interviewees and belonging relevant information can be found in appendix A. Most of the interviews were conducted in Swedish, and quotes from such interviews have been translated into English. Appendix B provides a list of the original quotes.

3.1 Identifying Key Stakeholders

Implementing AI in healthcare is a complex process that requires the collaboration of multiple actors. In order to properly analyze the barriers to implementation, there must first be an understanding of the different roles that the stakeholders hold. This section aims to describe the stakeholders, their roles, and why they were chosen.

In the methodology section 2.3, it was described how the identification of relevant stakeholders was an iterative process as interviews were conducted. At the beginning of the interview process, it was evident that stakeholders such as clinicians, patients, researchers, and healthcare executives were relevant. Based on interviews with these and their perceived barriers, it became clear that other aspects, such as commercialization and legal matters, were quite prominent. Therefore, the decision was made to expand our interviews further to include these matters, resulting in MedTech companies and policymakers as additional stakeholders. This expansion of stakeholders resulted in a more extensive and varied analysis of the field. To conclude, some identified stakeholders were more naturally eminent, while others became clear through an iterative process as barriers were presented and the understanding of the field increased.

The identified stakeholders are:

- Clinicians
- Healthcare executives
- MedTech companies
- Patients
- Policymakers
- Researchers

Healthcare executives are interesting stakeholders as they make the actual decision to implement AI within their hospital by determining what technologies and tools are needed. Healthcare executives often work strategically and aim to uphold the hospital's mission. Once implemented at the hospitals, clinicians are the ones to utilize the AI technology. Due to their autonomy at work, clinicians can choose whether or not to integrate AI into their daily work. Clinicians are also the hospital's connection to the patients. Patients represented by advocacy groups generally do not have much influence over the medical

technology used to treat them. Even so, healthcare aims to care for patients, and every stakeholder can be defined as a patient to some extent. Patients are the group the technology will be used upon, and since they cannot influence development much, they are a vulnerable group.

Policymakers were included as stakeholders because of the legal aspects and the regulation's significant influence on the development and implementation of AI in healthcare. They aim to create better conditions for healthcare and research related to it. Researchers are a stakeholder exploring new areas of AI implementation in healthcare. With AI being in an early stage of its development, the research is relevant and has an essential role in implementing AI in healthcare. With this, researchers were interested in including. MedTech companies are the stakeholder that can commercialize AI inventions and introduce them to the market. They are the actors with access to the technical and legal expertise necessary for this implementation. They take the innovations from research prototypes to CE-marked medical equipment, facilitating their adoption and integration within healthcare systems.

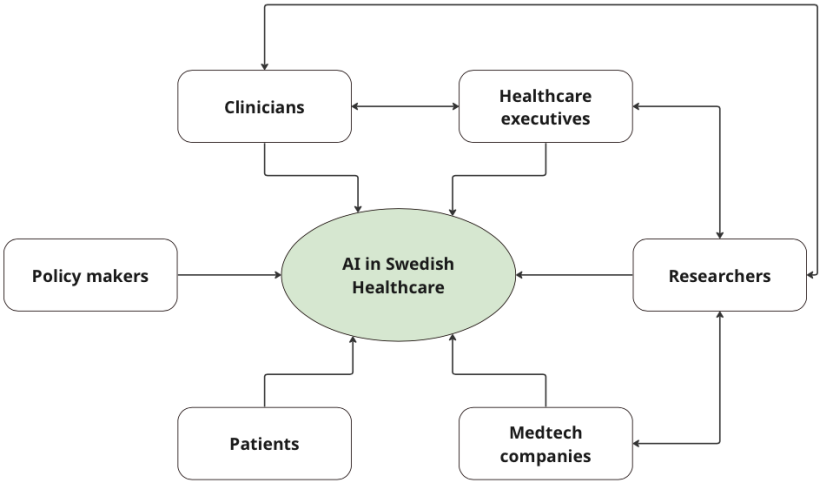

Figure 3: The stakeholder ecosystem.

Stakeholder relationships are represented in figure 3. As described in 2.4, some interviewees are not mutually exclusive regarding their stakeholder categorization. Further, clinicians are hired by healthcare executives and give care to patients. Clinicians and healthcare executives usually decide what to acquire from MedTech companies. Researchers could be hired by healthcare executives or work in collaboration with clinicians or MedTech companies. MedTech companies could also hire researchers, though this is not the case for the interviewees within this thesis. Lastly, all stakeholders have been or will be patients to some extent. This arrow is not reflected in the visual but is important to note.

3.2 Stakeholder Interests

This section presents and describes the interests different stakeholders experience. These interests will be motivated, and in table 1, their positive or negative effect on the implementation of AI in healthcare is presented. Depending on the circumstances, some interests can be seen as both positive and negative, and those specific cases are further explained in the following text.

Table 1: Stakeholders' interests and their effect on the implementation of AI in Swedish healthcare.

Stakeholder Group	**Interest**	**Effect on implementation of AI (+/-)**
Clinicians	Give correct diagnoses	+
	Get a second opinion on diagnoses	+
	Have explainable AI	-
Healthcare executives	Offer high quality healthcare	+
	Foster great research	+
	Attract competence	+
MedTech companies	Gain customers within the healthcare sector	+
	Create quality products	+
	Show results to investors	+/-
Patients	Feeling secure within their healthcare	+/-
	Care on time	+
	Human interaction	-
Policymakers	Sensitive personal data must be processed with care	-
	Create relevant legislation	+
Researchers	Conduct research	+
	Access health data	+

Clinicians have an interest in caring for their patients well, and therefore they must diagnose patients correctly. Within image diagnostics, according to interviewee 5, it can be complex and time-consuming to determine a diagnosis due to unclear images and many illnesses to sort through. With less time spent on analyzing images, clinicians could perform other vital tasks also required.

According to interviewee 10, clinicians also need AI to be explainable to trust the technology. By not knowing what parameters the AI considers to decide a diagnosis, the clinician will be unable to determine if the diagnosis is correct or only correctly determined by chance. Interviewee 5 also mentioned that clinicians need to make decisions based on uncertainty, and therefore they could need a second opinion on diagnoses. By either confirming the clinicians' diagnosis or correcting a wrong one, an AI could improve the treatments given by the clinicians.

The first interest for healthcare executives is to offer high-quality healthcare, and all interviewed healthcare executives believed AI could benefit from this interest. According

to interviewee 16, one upcoming challenge is the increased demand for healthcare, which cannot be solved by hiring more employees. Instead, the hospital must find innovative ways of working, for example with AI, to still offer high-quality healthcare.

University hospitals in Sweden have a mission to offer patient care but also to conduct research, innovation, and teaching. Fostering great research and thus leading the development of AI is an interest in itself. Interviewee 14 emphasized how AI research can contribute to the hospital's recruitment and, therefore, attract competencies.

An essential aspect for MedTech companies is to gain customers continuously. With the development of AI in healthcare applications, this interest is applied in the healthcare sector. Increasing the number of customers also requires them to maintain relations with existing customers by creating quality products that satisfy the customer. According to interviewee 19, many suppliers want to show their investors positive results. If the development of AI inventions is profitable for the companies, this will affect the development positively. If the development, on the other hand, is proven to be a nonprofitable market, the MedTech companies will not continue this development.

Patients wish to feel secure within their healthcare, and they need to trust their care process. Interviewee 5 emphasized the importance of trusting the clinician. Patients who trust their doctor will be more comfortable visiting the hospital. Consequently, if the clinicians themselves trust the AI, so will the patients. This explains how this interest can be seen as either positive or negative to the implementation of AI. Furthermore, interviewee 17 raised the importance of human interaction within certain functions. The patient will always need the patient-doctor relationship to feel secure in their care. Another interest is to receive care on time. With AI implemented, this interest could be accomplished to a more significant extent and more effectively.

Policymakers want to protect the rights to personal data, and all interviewees agree that sensitive data must be processed with care. The current protection laws and procedures for sensitive data have a negative impact on many actors involved in the development of AI in healthcare. Therefore there is a general interest in legislating relevant laws promoting the development of AI in healthcare.

Healthcare and AI researchers have the purpose and interest to conduct research and focus on their job and less on bureaucracy. Their findings contribute to the development, but this requires access to health data which is another interest for them. According to all interviews with researchers, large data sets are required to train an AI model. With the researchers actively working to access larger data sets, this will drive the development further. Interviewee 6 also mentioned an interest in helping patients in their healthcare as a personal reason to conduct research and contribute to implementing AI in healthcare.

3.3 Barriers According to Stakeholders

The following section presents the barriers the stakeholders consider the most critical for implementing AI in healthcare. The sections present each stakeholder's opinions and begin with a figure summarizing what barriers they mentioned. A table presenting which interviewees whose interviews are recapped within the section is also presented at the beginning of each section.

3.3.1 Clinicians

The interviewed clinicians' perceived barriers are outlined in figure 4. Ethics was a topic very much in line with the expectations of clinicians' point of view. This stakeholder is the one to meet the patient's needs and provide treatment. Consequently, ethical questions concerning the patient affect the clinicians heavily. Technology was another expected opinion since they discussed how the technology differs from their expertise. The question of data was also brought up, and they explain how clinicians use other data points than those collected in healthcare records, consequently making AI less accurate. Lastly, regulations were emphasized as a barrier. Regulations related to AI technology are not necessarily impacting the clinicians' daily work. Therefore this topic suggests the interviewees had a different range of experiences coming from their research background. Table 2 summarizes all interviewees contributing with their opinions.

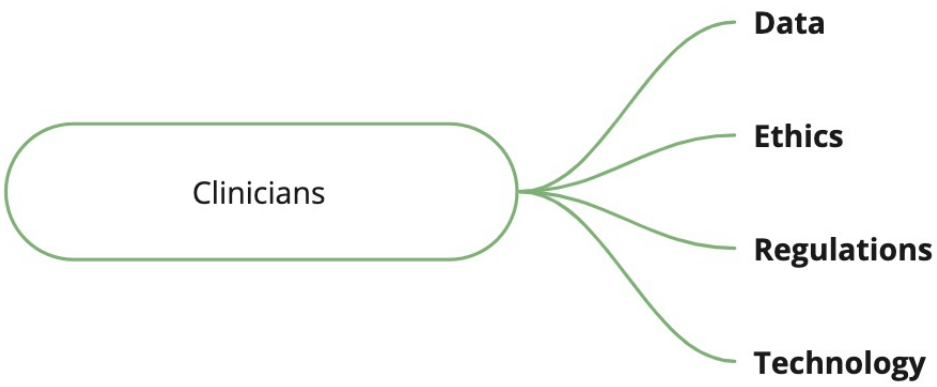

Figure 4: Barriers identified by clinicians.

Table 2: Interviewed clinicians

	Role	**Organization**
Interviewee 5	Head Physician in Radiology and Clinical Physiology	Sahlgrenska University Hospital
Interviewee 8	Specialist Physician at Section for Intensive Cara	Uppsala University Hospital

According to interviewee 8, one of the challenges in analyzing patient data is retaining data integrity while complying with GDPR. They noted that anonymized data did not work well in practice and described a situation where data transfer between different regions within Sweden is challenging. In such cases, deals with the data owner are crucial, and legal approval can be a hurdle for data transfer. The interviewee recognized the importance of caution when handling sensitive data, saying, "Though it is very hard, it probably must remain this way due to the nature of the data. If handled incorrectly, there is a great risk that something fails and leads to data leakage of sensitive information.".

However, they also noted that some professionals tend to be overly cautious with released data enhancing to be rather safe than sorry. Interviewee 8 pointed out another aspect of data, the heterogeneity among different types. They said it is easier to move forward within image diagnostics since images as data are standardized, and many types of health data are not standardized.

Regarding ethics, interviewee 8 mentioned the importance of a large population within each patient group for the different data sets. With a small patient group, the risk is that the AI would get to know one of the patients specifically, "The risk is that the machine learning model gets to know patient 623". Furthermore, interviewee 8 raised the question of responsibility. A wrong decision has to have someone responsible; that is how healthcare works. They described the COVID-19 pandemic during 2020 as one example where many patients were released too early. However, these human decisions were made based on the information they had at the time, "You have to be able to say based on what we knew, we did this and it was wrong" they said. This sort of reasoning is hard to achieve with an algorithm.

Interviewee 8 also discussed how the extensive juridical processes make it difficult for a hospital or individual to go through the entire approval process of using it in-house or CE approval. Therefore they believed that MedTech companies would play an important role here. The hospitals will be customers of a finished product. They argued that the hospitals have enough to do with their daily operations to carry through such time-consuming processes as the implementation of AI.

Interviewee 5 discussed that AI could be overconfident and cannot replicate the training of clinicians, stating, "A doctor has training that involves knowing a number of specific cases but also being able to handle things that you do not know.". In addition, interviewee 8 raised the question of the limitations of current AI technology. They said clinicians consider many types of data when they meet a patient, many of which a current AI model cannot capture. This is mainly due to the selection of data captured in today's healthcare. In other words, the captured health data contains only some data points a clinician considers. Some examples given were the smell and sight of the patient.

3.3.2 Healthcare Executives

Figure 5 summarizes barriers discussed with healthcare executives, which will be described within this section. Healthcare executives raised a wide range of problematic barriers. As their role concerns strategic decisions for the organization, they were expected to bring up questions of attitudes, competencies, and resources affected by their decisions. Regulations are also something affecting the choices they make. The more exciting barriers in this regard were data and demonstrating the value of AI products. Data is related to the technical side of AI development. Therefore, the knowledge of this barrier points to a great understanding of technical aspects. It is probable that their emphasis on the obstacle of demonstrating value is connected to their requirement to validate the products they choose. Table 3 shows all interviewees and their roles in which opinions are described.

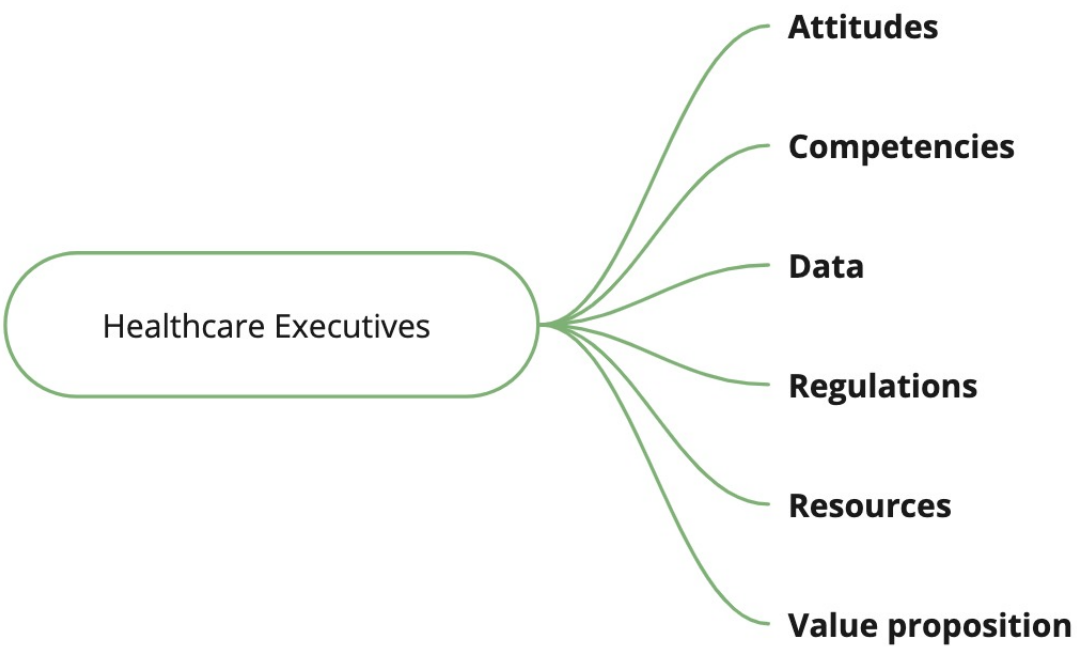

Figure 5: Barriers identified by healthcare executives.

Table 3: Interviewed healthcare executives

	Role	**Organization**
Interviewee 2	Strategist Life Science	Sahlgrenska University Hospital
Interviewee 3	Strategist Life Science	Sahlgrenska University Hospital
Interviewee 4	Director of AI Competence Center	Sahlgrenska University Hospital
Interviewee 14	Deputy Hospital Director	Sahlgrenska University Hospital
Interviewee 16	Head of Division	Sahlgrenska University Hospital

Interviewee 14 raised concerns about the fear of AI taking over, stating, "Now I go with the old cliché: will machines take over our thinking completely and utterly?". They emphasized that this fear should not be dismissed as it challenges the acceptance of AI. Furthermore, interviewee 4 said clinicians want explainable AI since it can describe why it sets a specific diagnosis for the clinician. They also added that such AI would increase trust in the technology for clinicians. Interviewee 4 continues to say that explainable AI might not be the only way; for example, current medicine is not dependent on full knowledge of how the medicine works. They say:

> After all, we use a lot of drugs, where the doctors don't know exactly how they work, etc. But they are still used. They are based on a long, clear validation process. Maybe we should think in that way when we deal with AI, i.e. a good validation process. There are no other ways to build trust in these types of systems.

Interviewee 16 believed there might be skepticism among coworkers against healthcare executives' and politicians' belief that AI development will happen fast. On the other hand, they said that though there are mixed opinions and attitudes toward AI entering healthcare, most coworkers have a positive attitude.

Interviewee 16 said the interest among researchers is to focus on their research and therefore pointed to a gap between researchers coming up with findings and the final implementation. Interviewee 2 highlighted that many different competencies are needed to get through the complex regulations to implementation. They also pointed out how challenging it is for individuals with those competencies to allocate sufficient time to participate in such a project. They, therefore, argued that it is primarily the MedTech companies who have enough momentum to drive through implementation projects.

Another prominent issue raised by the interviewees was access to data, and interviewee 3 described data as the driving force for AI development. They further underlined that there is sufficient data available and that the main concern is its accessibility.

One aspect mentioned by interviewee 16 is the importance of evaluating products, including those containing AI, before purchase to see if they perform as promised and positively affect the hospital. They argued that this is challenging, but they are working to set up structures to prove these products' effects internally.

Interviewees 2, 3, and 4 all mentioned EU regulations as a challenge for implementing AI in healthcare. Interviewee 4 noted that the regulations are not adapted to AI in healthcare and are sometimes heavier than necessary. Interviewee 3 added that the regulations are not up-to-date, possibly due to the fast pace of AI development. They also mentioned the proposed AI Act by the EU, which could classify AI systems using sensitive health data as "high-risk," subjecting them to rigorous legal requirements.

Interviewee 14 mentioned the aspect of limited time. Clinicians do not have enough time to learn about AI or to continue the development of their great ideas. Interviewee 2 also highlighted the time aspect and mentioned that if there is no time, it does not matter what attitude the clinician has toward any AI solution. The interviewee described how many clinicians' everyday practices are overfilled with everyday tasks "...already drowning in the current workload. Consequently, many might not have the time to think about AI solutions.".

3.3.3 MedTech Companies

A summary of discussed barriers can be seen in figure 6. Regulations and data were issues expected from the group since they directly impacted their product development. Companies also discussed ethics as they aim to create unbiased models. Further, attitudes affect their opportunity to sell their products to customers and are linked to their processes. Issues with proving their products' value were unexpected during the research of this thesis and created an increased understanding of the landscape in which MedTech companies work. Table 4 displays all interviewees representing this stakeholder.

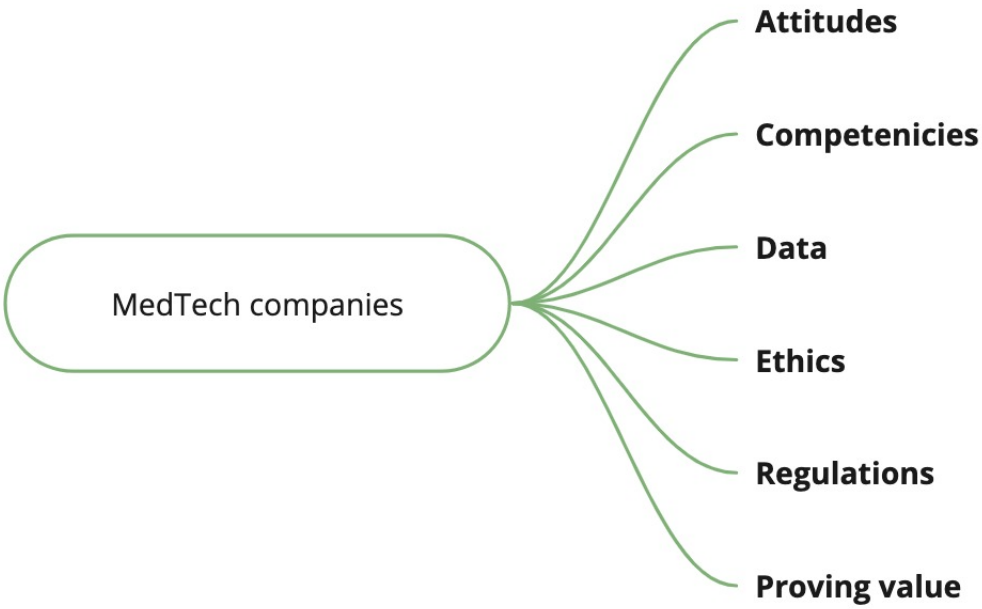

Figure 6: Barriers identified by MedTech companies.

Table 4: Interviewed MedTech companies

	Role	**Organization**
Interviewee 19	AI Lead	Sectra
Interviewee 20	Vice President of Healthcare Global	Brainomix
Interviewee 21	Healthcare Manager	Brainomix
Interviewee 22	Product Manager for AI & Clinical Decision Making	Siemens Healthineers

Concerning attitude, interviewees 20 and 21 mentioned that fear could be a barrier. Both the fear related to data and cybersecurity and the fear that AI might replace physicians, leaving them without a job. They claimed that the second fear was a common myth and referenced research they had done with the UK National Health Service and fears related to data and cybersecurity.

Interviewee 19 mentioned the unwillingness of clinicians to adapt to new ways of working as a barrier. Further, they mentioned the need for proper leadership and change management to create a smooth transition. "AI is not just a new medical device; it is an organizational transformation". According to interviewee 19, many technology projects within healthcare hit a wall. While management was enthusiastic about the product, the clinicians using the technology did not see the added value benefit and found the process of using it cumbersome.

The integration of AI applications into existing systems and clinicians' workflow was described as a barrier by interviewee 19. They emphasized physicians' unwillingness to learn new tools that require manual integration on top of all the other tools and monitors. The workflow integration barrier was reiterated by interviewees 20 and 21. They also

emphasized the importance of expectation setting, and close and early collaboration with hospital staff, ensuring clinicians understand their product.

Interviewee 20 further underscored the importance of collaboration and making the physicians feel involved in the training process. They explained that AI models for stroke diagnostics typically have an accuracy of around 90%, but that this was not enough:

> There's no point going in saying we have 90% sensitivity and specificity which most products should do, but you still have in every case, you know, five in every 100 You're going to miss with the software. So what does the physician do? How do they manage that?

Interviewee 20 further emphasized that medical professionals must understand and feel comfortable using the product.

> Obviously, any commercial company keeps the IP (intellectual property) for the AI separate. But if you don't allow the clinician to understand how the software is working, and what it is actually saying, then you have to have very, very accurate algorithms that people can see. Yeah, it's a binary output. I get it. I agree with it, and I move forward. In health care, it's much more nuanced.

Interviewee 22 emphasized the exceptional quality of patient data in the Swedish healthcare sector, "the best data in the world". It is further described as an underutilized opportunity for developing more advanced AI models and decision support systems. It was noted that access to data could be difficult, but it was not identified as a primary concern.

Interviewee 19 was hesitant regarding the concept of Explainable AI, stating that "its relevance for clinical professionals is up for discussion". Transparent AI was deemed more important. They declared that clinicians need to understand what type of data the model was trained on to be wary of potential biases endemic to the model.

The challenge of getting regulatory approval and a CE mark for a medical device was described by interviewee 19 as "a question of time and money" rather than as a primary barrier. Moreover, interviewee 19 pointed out that numerous MDR-approved AI applications remain unused in healthcare. This lack of commercialization is primarily due to companies' inability to demonstrate their products' value to hospitals. Interviewee 19 declared that the primary barrier is going from a regulatory-approved research prototype, integrating it into the clinical reality, and delivering real value to hospitals. Additionally, they said that for most applications, companies struggle to demonstrate how their product will save time or use "improved quality" as a tangible argument to sway healthcare executives. This problem was further compounded by the insufficient digitalization of healthcare processes when interviewee 19 said: "How can companies prove that their technology makes a certain process quicker when the hospitals themselves do not know how long the process takes?". Interviewees 20 and 21 also mentioned the need to show value upfront but claimed that they had been able to do so effectively by choosing a field where time is critical, as in stroke diagnostics.

3.3.4 Patients

Figure 7 shows barriers described by the patient advocacy group on behalf of its members. The included patient advocacy group, Melanomföreningen, is an association for melanoma patients. Attitude as a barrier was expected since patients have ranging opinions on AI involvement in healthcare. The issue of data was brought up from a patient's perspective, underscoring that patients are willing but unable to contribute with their information. The interviewee is specified in table 5.

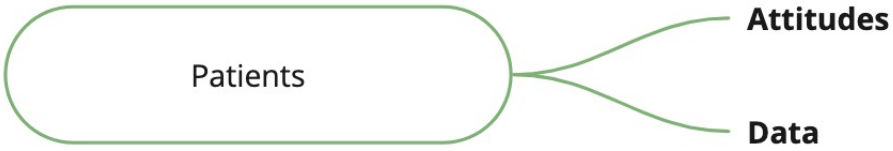

Figure 7: Barriers identified by patients.

Table 5: Interviewed patients

	Role	**Organization**
Interviewee 17	Chairperson	Melanoma Association (Melanomföreningen)

Regarding attitudes, interviewee 17 mentioned how patients have concerns about how AI technologies are validated. Patients are doubtful if AI models are trained on data that represents the person being treated. Interviewee 17 said, "It is very difficult because the AI is no better than what it has been trained on.". If AI is not trained on data similar to the treated person, the AI cannot give an accurate analysis. The interviewee further believed patients must witness AI functioning in a clinical environment before they can trust it. However, they underlined that they do not see AI as a replacement but as a clinician-supporting tool. The interviewee meant it is crucial to maintain human interaction and to know that it is not an AI that makes the final decisions.

Another hinder, according to Interviewee 17, is that many patients are willing to share their data with researchers, depending on the purpose and context. However, in Sweden, the interviewee said there is no such system for patients to approve what data they wish to share. However, the interviewee emphasized that the data shared must be kept private. The interviewee mentioned the EU law for data protection and privacy, GDPR, to be good in principle, despite the bureaucracy that comes with it:

> I actually think GDPR has its advantages despite the problems it has. The problem is that it is sometimes bureaucratic, but forces you to think of privacy by design. But you might think that things should go a little easier.

Interviewee 17 said there ought to be a way to own your data and, at the same time, share it easily. The interview added: "We hope that the European Health Data Space will solve some of the problems that GDPR has but still protect the patient.".

3.3.5 Policymakers

Figure 8 shows barriers brought up during interviews with policymakers. Data and regulations were expected barriers from the stakeholder since their investigations were closely linked to data and regulations. Policymakers also raised the question of technical competency within the Swedish government office as a potential barrier to effective legislation. The list of interviewees can be seen in table 6.

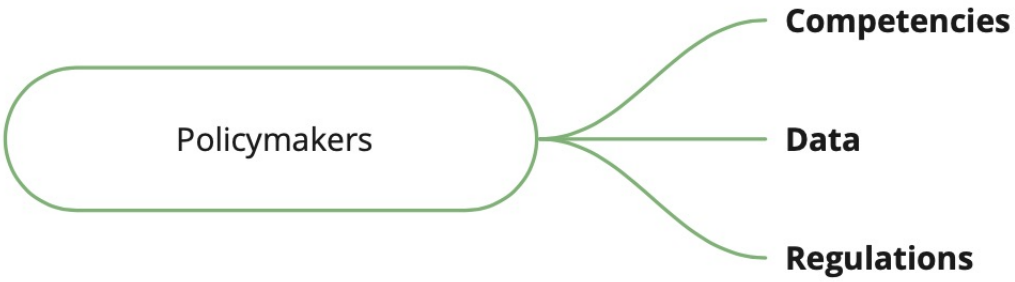

Figure 8: Barriers identified by policymakers.

Table 6: Interviewed policymakers

	Role	**Organization**
Interviewee 12	Investigator	Swedish Government Inquiries
Interviewee 13	Investigator	Swedish Ministry of Health and Social Affairs

Both interviewees, 12 and 13, mentioned a knowledge gap in the Swedish government office. Interviewee 12 explained, "These questions and problems are very technical; they sound easy, but in reality, they are very hard, kinda like the tunnel through Hallandsåsen" (the tunnel, in this context, refers to an infamous building project in Sweden). Interviewees 12 and 13 described that not enough people with a technical background are working on these questions, resulting in policymakers and elected officials not feeling confident in making fast and effective policies. The interviewees believed this is one of the reasons why the legal framework does not keep pace with technological development.

According to interviewees 12 and 13, the different regions, counties, and hospitals in Sweden use different systems to store patient data, which is a barrier to efforts to digitalization and AI implementation, caused by the absence of national guidelines and the self-governance of regions and counties. Interviewees 12 and 13 believed this hinders developers and researchers from gathering enough data to train their models. To create models that work nationwide, the data needs to be structured and standardized manually, which is time-consuming and sometimes not possible. Interviewee 12 mentioned there has previously been a pattern of different parts of the healthcare system implementing new

technology without analyzing and settling on a future-proof standard. This contributes to the chaos that constitutes healthcare systems everywhere, not just in Sweden.

Interviewee 12 said, "We have seen that the conceptualization is not great, some were written in the 1970s, but it feels like it was written in the 700s". It is a problem that some of the legislation is now outdated, as concepts and meanings have changed. This makes it complicated for lawyers to interpret and apply the law, which hinders the development and implementation of AI in healthcare since lawyers choose to interpret with precaution. Furthermore, concepts such as AI and large-scale data analysis were much less prevalent before, and therefore, such concepts lack clear guidelines, complicating lawyers' work.

3.3.6 Researchers

Figure 9 represents the barriers researchers raised during their interviews. Data, ethics, and regulations were expected barriers due to their interest in conducting research and developing non-biased AI models. All researchers contributing with their opinions can be seen in table 7.

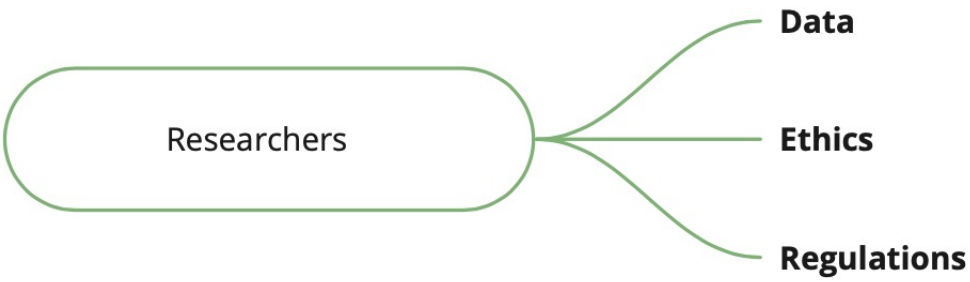

Figure 9: Barriers identified by researchers.

Table 7: Interviewed researchers

	Role	**Organization**
Interviewee 1	Assistant Professor at Data Science and AI	Chalmers University of Technology
Interviewee 6	Postdoctoral Researcher in Computer Vision	Chalmers University of Technology
Interviewee 7	Associate Professor at Computer Vision and Medical Image Analysis	Chalmers University of Technology
Interviewee 9	Specialist physician in Dermatology and Venereology, Associate Professor, Adjunct Senior Lecturer	Sahlgrenska University Hospital
Interviewee 10	Associate Professor in Machine Learning	Halmstad University
Interviewee 11	Professor Emeritus	N/A
Interviewee 15	Doctoral Student at Department of Computing Science	Umeå University
Interviewee 18	Senior Lecturer at Science	Chalmers University of Technology

Interviewee 6 discussed the issue of data. They pointed out that the main barrier, as a researcher in computer vision, is to provide models with sufficient amounts of diversified data while preserving patient confidentiality and safety. They mentioned that AI models developed for healthcare applications tend not to reach the desired performance due to insufficient accessible data. Interviewee 7 reiterated the data accessibility limitation and accentuated the ensuing generalization problem. They noted that several high-performing machine learning models had been trained on narrow data sets, raising concerns about their performance in broader clinical settings on new patient cohorts.

Interviewee 6 noted that systems for accessing medical data are designed for medical researchers, creating challenges for technical researchers with different requirements. Interviewee 7 also identified medical data systems as barriers and emphasized that unorganized medical data requires the time-consuming manual assembly of cohorts. A related issue raised by interviewee 11 is regarding who has access to the data, and they say many companies lack access to data today and cannot move forward. They also discussed the extensive regulations within Europe and mentioned GDPR, MDR, and the upcoming AI Act.

Both interviewees, 6 and 7, highlighted another contributing factor to the problem of medical data. Interviewee 6 explained that there are methods to develop models of non-labeled data, but these methods still need to be mature. This requires the data sets to be annotated. This can be done for general images without expertise, but medical images require medical annotation proficiency. This implies a significant investment in both money and time designated by hospitals and clinicians. Not only does the manual annotation require medical expertise, interviewee 7 mentioned that this is needed for the process of curation as well to be able to draw necessary conclusions.

As highlighted by interviewee 15, trust is a critical challenge in the implementation of AI in healthcare, and they expressed that the extent of trust in systems will influence their adoption. If clinicians do not trust the system or its outputs, they will unlikely integrate it into their workflow. Moreover, a lack of understanding of the system will also affect willingness to adopt. Interviewee 10 suggested transparency and "explainability" are vital factors in building trust in AI systems. However, interviewee 18 raised concerns about "explainability", arguing that it might be the biggest threat to the adoption of AI. Using algorithms that align only with clinicians' views can reinforce biases and result in worse outcomes, even if the AI algorithm functions well.

Further, interviewee 10 believed that academic researchers must collaborate with industry and technology companies to create a platform where the industry can help with all practical aspects, including paperwork. Interviewee 1 also explained that the legal processes of developing medical devices are unknown and time-consuming for many researchers and, for some, even perceived as entirely insurmountable. Interviewee 1 believed that, as a consequence, researchers tend to shut down many projects before these steps, leading to less exploring and testing in actual prototypes.

Interviewee 9 noted the legal processes as the main barrier to implementing AI in healthcare. With a required CE classification, a clinical investigation plan, an investigator's brochure, risk classifications, and rigorous paperwork, there is a risk, according to them, drowning in paperwork. Interviewee 9 mentioned this process's necessity and that it must be done. Interviewee 9 said "I am not a paper specialist. I am a specialist in dermatology.

All the paperwork makes me nervous, so therefore, I move on to the next project, my curiosity is driving me to the next project."

The extensive ethics review procedures are described as crucial to addressing ethical considerations of AI development. The researchers noted that they tend to be unnecessarily complex and slow. Interviewee 10 stated that the ethics approval process takes around 60 days, and the overall process from idea to project takes approximately six months. There is a desire among interviewed researchers for a more standardized procedure and emphasized the need to streamline the process.

4 Analysis

This section analyzes the results obtained from interviews to identify the most impactful barriers to implementing AI in Swedish healthcare. The analysis focuses on motivating why these barriers are deemed most prominent to the issue and how stakeholders may be impacted by them. Furthermore, the analysis aims to connect the stakeholder interests to the barriers in order to gain a better understanding of their implications. The barriers in focus are competencies, data accessibility, and demonstrating the value of AI products. The identified main barriers can be seen in figure 10. The three barriers exhibit distinct properties. Data accessibility has many sub-barriers that collectively decrease access to data. Competencies impact the amplitude of multiple other barriers. Lastly, demonstrating the value of AI products is a direct hindrance to implementing AI in healthcare. Independent of barrier structure, all three are essential contributors to hindering the implementation of AI in Swedish healthcare.

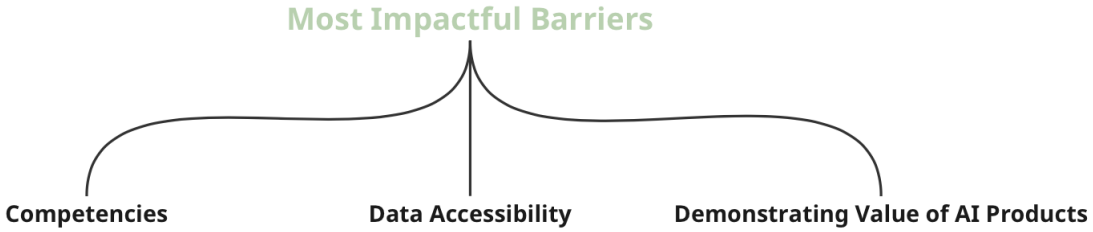

Figure 10: Most impactful barriers to AI implementation in Swedish healthcare.

The results presented several important barriers. There are reasons why some barriers were deemed less impactful. The ethical concerns surrounding the usage of AI were lifted by clinicians, healthcare executives, MedTech companies, and researchers. However, large, diverse data sets and competencies can solve many of these concerns. The ethical concerns can be seen as consequences of multiple shortcomings. Furthermore, the healthcare executives argued that limited resources, more precisely clinicians' time, are barriers to implementing AI in Swedish healthcare. However, the clinicians did not mention this problem, indicating that it might not be that important to the implementation. Additionally, as argued by the clinicians, there are technological limitations to AI, such as being unable to consider some types of data, such as the smell and sight of patients. However, this might only be a barrier for specific use cases and only affect some parts of AI implementation in Swedish healthcare.

4.1 Competencies

The lack of competencies is an impactful hinder as it enhances several other barriers. The issue is widespread within hospitals, research institutions, and the government office, emphasizing its significance. Sometimes the lack of competence might be solved by adding a new actor, and other times it demands collaboration between the right mix of competencies or for new competencies to be learned.

MedTech companies and clinicians both mean there needs to be close collaboration between the two parties. It is argued that clinicians need to be educated to understand and interpret the functions of AI. MedTech companies mean that the new competencies are crucial for the clinicians and their trust and attitude toward the technology. Due to

clinicians' autonomy, they might choose not to use AI if they do not trust the tool. This is one barrier that a lack of competencies reinforces. This and other barriers enhanced by the lack of competencies are displayed in figure 11. However, it is interesting that clinicians themselves did not raise these concerns. This might be because the interviewed clinicians were also AI researchers and, therefore, familiar with AI and did not reflect on the need for competencies regarding AI tools and the attitude toward AI. Another question is if patients would trust AI. As concluded in this thesis. If clinicians do not have the trust, then patients will not either.

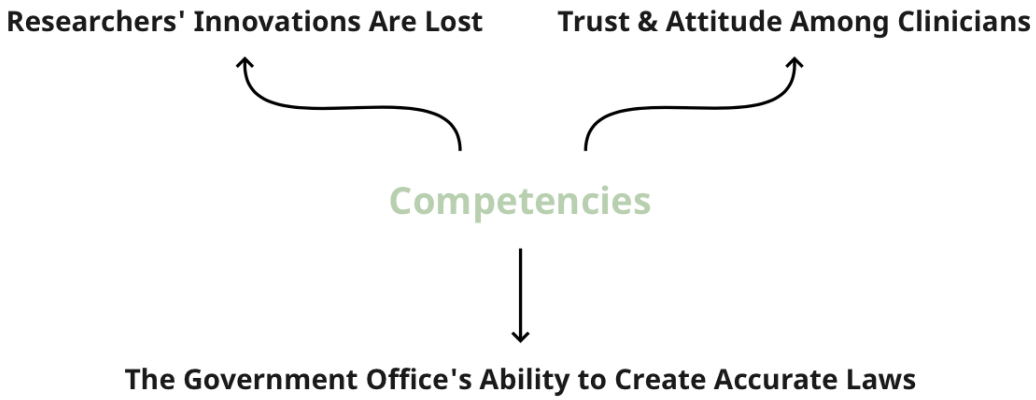

Figure 11: How competencies affect other barriers.

Furthermore, healthcare executives argued that there is a gap between research and implementation and that the root of this problem is the need for diverse competencies to drive this process. According to policymakers, there is currently a knowledge gap in the Swedish government office. AI is a relatively new technical field, and they state that there need to be more lawyers that have the technical knowledge. One of their primary interest is to create relevant legislation, but this is aggravated due to the competence gap. This, in turn, creates a barrier for researchers, making the legislation and bureaucracy too complicated.

It appears that many researchers lack interest or do not have the regulatory competencies needed to go from initial research to CE approval. It is a long process with many steps, meaning there is a risk for researchers to be inhibited by the extensive paperwork. After all, researchers' main interest is to conduct research, and they want to focus their time on that. Therefore, many researchers do not know the legal processes at all, and thus, many good ideas might not reach the implementation stage. As such, knowledge about these complex regulations must be shared between stakeholders for AI to be implemented. This is further supported by the MedTech companies since they know these complex regulations and do not see them as a main barrier.

To these points, acquiring additional competencies could decrease the impact of other barriers. The lack of competencies could be seen as the root of several other hindrances. Therefore solving the question of competence accelerates the implementation of AI in the Swedish healthcare system.

4.2 Data Accessibility

It has become evident that having access to vast amounts of data is integral to developing high-performing AI models. In the case of healthcare applications, 'data' involves sensitive and highly regulated patient data. Through conducted interviews, it becomes clear that accessibility is a prominent barrier to the implementation of AI in Swedish healthcare. All stakeholders independently expressed this barrier to various extents, indicating that this issue affects the entire system. It is important to note that the issue of data is not due to a limited amount of health data in Swedish registers and records, instead, it is a question of accessibility. MedTech companies described that the data in Swedish healthcare is an underutilized opportunity. Furthermore, healthcare executives explained that data is the fuel to AI development and underlined that there is no shortage of data, it is access that is the main issue. Data accessibility is a fundamental prerequisite that needs to be accomplished for the implementation to be feasible.

The breadth and complexity of this barrier make it challenging to address, and therefore it is considered a significant obstacle to the implementation of AI in Swedish healthcare. This is demonstrated by the many components contributing to the issue, illustrated in figure 12. They all serve as essential aspects affecting stakeholders to various degrees. One of the components is the regulations for sensitive data. Regulations, such as required ethics approval and international laws, have a direct impact on the amount of data that is accessible. Policymakers are the stakeholder with the greatest opportunity to impact AI regulations. However, almost all interviewees, independent of which stakeholder they belong to, emphasized the importance of preserving the patient's privacy and confidentiality. Thus, ethical implications add complexity to the change of regulations. Consequently, ethical implications drive the lack of data access.

Data storage systems are another component that challenges access to data for researchers and others requiring it for the development of AI models. The systems are adapted for clinicians rather than researchers. Further, many types of data are currently non-standardized in Sweden. The field where AI has made the most progress is medical images, which have a standardized format. This highlights how data accessibility influences the choice of which AI models can be implemented. This is where policymakers have an impact as they investigate how to create a more unified data landscape in Swedish healthcare. Medical journals are currently diverse within Sweden, which limits researchers' ability to collect vast amounts of data and efficiently train their models. Another problematic fact was raised by the clinicians who said they do not only make decisions based on recorded data but also on other information that is not put into any journals. This is a challenge for AI technology in healthcare, as it will not be able to learn from these important data points. The need for expert annotation also contributes to the limited accessibility of data. However, this primarily slows down the process rather than being a difficult component to address, as the main issue is the lack of resource time among clinicians.

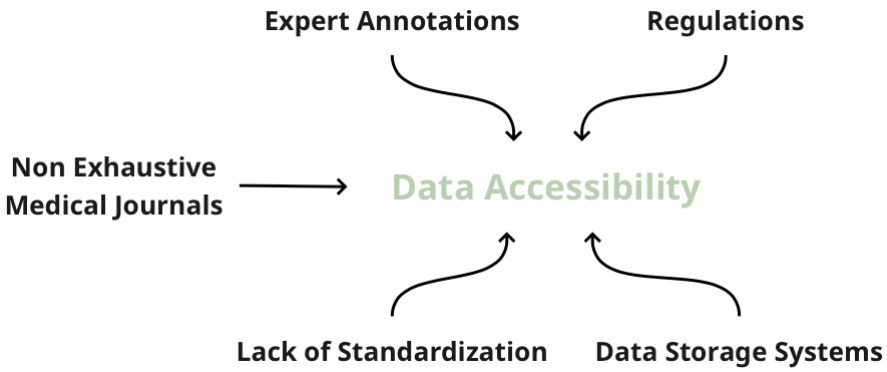

Figure 12: Data accessibility depends on several components.

As a result of this thesis, stakeholder interest was identified to understand who is affected by the barriers. Several stakeholders are affected by the lack of data access, but the researchers are the most directly affected, as their primary interest is to conduct research. This work is directly impacted and inhibited by this barrier. During interviews, it became clear that several researchers had encountered problems with data accessibility on their AI projects. Sometimes the access was inhabited, and other times highly time-consuming and thus postponing the entire project. Furthermore, clinicians' interest in giving the correct diagnosis is negatively implicated by the data accessibility barrier if not solved. When AI is used as a tool for clinicians to get a second opinion on a diagnosis, they need their models to be high-performing. Therefore they must have been developed with sufficient, population-based, and diversified data. In addition, the interests of healthcare executives to offer high-quality healthcare are also negatively implicated by the data accessibility barrier if not solved. As previously mentioned, the lack of data can potentially lead to biased models. Hence the interest of healthcare executives to provide high-quality care to all citizens gets affected if the data accessibility barriers are not resolved for the implementation of AI. Additionally, the interest of patients to feel secure in their healthcare may also be secondly affected by this issue if the data is biased and, consequently, not receiving equal care.

It is interesting to notice that MedTech companies were the one stakeholder group that did not put much emphasis on this barrier. During interviewees, it was noted that access to data could be difficult but not a primary concern. There may be some different explanations as to why this stakeholder does not share the perception of data accessibility with the other. Firstly, some of the included companies explained how they are not involved with the actual development of the products but rather later in the process by implementing the finished and approved products. Therefore, they might not need to consider this aspect. Secondly, the MedTech companies within this thesis were established and might face different barriers than other actors.

4.3 Demonstrating Value of AI Products

Demonstrating the value of AI products has, through an extensive analysis of the results, been deemed as one of the most prominent barriers to the implementation of AI in Swedish healthcare. Healthcare executives and MedTech companies were the only stakeholders to mention this issue. At first glance, this barrier, therefore, seemed inconspicuous. The analysis later demonstrated how fundamental this barrier is for the actual implementation of AI in healthcare. Leaving this barrier unsolved will result in a bottleneck for the whole machinery required for the implementation. If the product's value cannot be proven, responsible healthcare executives cannot motivate the purchase of it. Therefore it is a crucial barrier to overcome for AI implementation in healthcare to move forward.

MedTech companies exclaimed that the most important thing to prove to hospitals is how their products save time in their processes. The interviewees also emphasized that companies are struggling to prove the time saved. A reason for this is that the hospitals themselves generally do not know the amount of time their processes demand. This is often due to the inherent variability in the time required for each patient's unique circumstances. Another reason is the inherent qualities of many AI tools. It might take some work to demonstrate the amount of time saved. An example of this could be if AI would lower the degree of revisits. It does not save immediate time but rather over a more extended period. If companies are struggling to prove the value of their products, why would healthcare executives choose to invest in AI when it is associated with significant investments? This is increasingly a problem as most Swedish healthcare units are publicly run and have to follow the laws surrounding public procurement. It would be impossible and illegal for healthcare executives to procure medical devices that have yet to be proven to follow the requirements of the procurement contract.

For healthcare executives, procuring AI solutions is in their interest as it might attract competencies and improve the quality of care. Demonstrating the product's value successfully would help clinicians embrace new AI technology in their workflow. If they can get concrete data on how AI improves their work, overcoming their hesitancy regarding the change would be easier. If companies cannot prove the value of their products, they are unlikely to gain customers and satisfy investors. As a result, companies may be forced to seek profits in other industries, making AI implementation in healthcare nonexistent.

5 Sustainable Development of AI

In 2015 the United Nations (UN) and its member states committed to 17 development goals for a more sustainable future by the year 2030 (United Nations, 2015). As of 2023, there are less than seven years until 2030, and according to the UN, "action to meet the Goals is not yet advancing at the speed or scale required" (United Nations, 2020). In September 2019, the UN Secretary-General met with world leaders and called on all sectors of society to mobilize for a "decade of action and delivery for sustainable development" (United Nations, 2020). Implementing AI in healthcare may potentially impact these objectives in several ways; this chapter aims to outline its main effects, with a particular focus on the five most relevant goals, presented in figure 13.

Figure 13: United Nations Sustainability Goals (United Nations, n.d)

5.1 Good Health and Well-being

Many analysts extol the benefits of implementing AI in healthcare. According to Sunarti et al. (2021), who conducted a comprehensive literature search over articles studying the implementation of AI in health services, "AI offers the potential for a huge improvement in patient care and a reduction in healthcare costs.". This claim is further supported by Spatharou et al. (n.d), which states that AI will assist clinicians in being more efficient and improving their productivity in care delivery. Moreover, AI could ease clinicians' burden, allowing them to focus on patient care. It is surmised that AI will raise morale among clinicians and improve staff retention. Furthermore, Lee and Yoon (2021) mentions numerous advantages of AI solutions in healthcare, improved disease treatments, reduced rates of medical errors, and reduced costs, facilitating more easier access to healthcare. It should be noted that the benefits of AI are not necessarily going to be distributed equally and that the field is still developing rapidly. It remains to be seen how the implementation of AI will impact human vitality. Nevertheless, there is ample evidence that AI has the potential to promote health and well-being.

5.2 Gender Equality

Historically, the healthcare sector has been criticized for gender discrimination, with numerous instances of women being dismissed when reporting their symptoms (Forbes, 2021). Medical systems utilizing machine learning algorithms are programmed to make decisions based on carefully selected parameters rather than prejudiced assumptions and heuristics. These systems could thereby bring about a decrease in gender discrimination and an improvement in women's health, granted that the AI models are not biased (Trocin et al., 2021). However, it is important to be aware of the well-known maxim among AI developers, "Garbage In, Garbage Out". This means that if the training data is biased, the AI will be biased. This issue will be discussed in more detail in the section 5.5.

5.3 Affordable and Clean Energy

The usage of AI consumes large amounts of energy. For example, training a single model consumes more electricity than 100 US homes in one year; furthermore, training generally only represents 40% of the energy consumption related to using the model (Saul & Bass, n.d). If the energy originates from nonrenewable sources such as coal or gas, this can harm the sector's carbon footprint (Saul & Bass, n.d). Despite this, there are ways to reduce the carbon footprint generated by AI.

Lai et al. (2022) portrays the costs of AI and emphasizes that the negative effects are not discussed enough. Furthermore, as the models are becoming increasingly complex, analyzing more and more data, energy consumption increases too. Nevertheless, it is also worth pointing out that some models that are being developed consume less energy by utilizing sparser representations (Lai et al., 2022). In conclusion, the substantial energy requirements of AI, coupled with the increasing complexity of the models, pose a significant sustainability challenge that must be addressed to enable responsible development and deployment of this technology. The environmental consequences of this trend could be mitigated by developing more energy-efficient models, renewable energy sources, and other solutions.

5.4 Decent Work and Economic Growth

The implementation of AI in healthcare has the potential to change the daily life of medical professionals locally and generate more drastic changes to the field itself. The healthcare field is standing in front of major changes. As previously noted in this thesis, the sector is already under immense strain and is facing the increasingly daunting challenge of an aging population.

A belief in the transformative power of AI in the healthcare sector has been noted by stakeholders in the medical sphere and by chief technology leaders. Bajwa et al. (2021) mentioned when discussing collaborations in the medical sector that "AI is perhaps the most transformational technology of our time, and healthcare is perhaps AI's most pressing application.". Furthermore, healthcare is a business opportunity for the technology sector, saying, "If you look at it, medical health activity is the largest or second-largest component of the economy." (Lashinsky, 2020). This indicates that the development of AI in healthcare can help improve this sustainability goal.

5.5 Reduced Inequalities

Some people argue that AI will reduce inequalities, but not everyone agrees on this matter. An article mentioned, "The promise of AI in medicine was that it could help remove bias from a deeply biased institution and improve healthcare outcomes; instead, it threatens to automate this bias" American Civil Liberties Union (2022). In a study by Obermeyer et al. (2019), a widely used algorithm for identifying which patients need extra care in the U.S. healthcare system was shown to be significantly racially biased. According to their research, the algorithm "reduced the number of black patients identified for extra care by more than half." According to the authors, the bias occurs because the algorithm predicted healthcare costs as a proxy for illness and because access to care is unequally distributed. It is also pointed out that "effective proxies for ground truth can be an important source of algorithmic bias in many contexts."

Furthermore, research from National Institute for Health Care Management (2021-09-30) mentioned:

> Despite evidence that race is not a reliable proxy for genetic differences, how to allocate clinical resources or treatment adherence, using race as a factor has become a common practice when designing clinical algorithms.

Another explanation for biased models is that the training data is often extracted from industrialized Western settings, resulting in a lack of diversity and ethnic representation (Norori et al., 2021). To prevent biased algorithms and thereby improve this sustainability goal, AI models need to be trained on diversified and extensive data.

6 Discussion

It became evident from the results that the six identified stakeholders had diverse perceptions regarding the foremost barriers to implementing AI in healthcare. The main reason for this is probably because they operate in different parts of the implementation process and have different interests affected by or affecting the implementation of AI. However, there were some barriers that almost all stakeholders considered among the most important. An analysis of these findings, in combination with an understanding of the system and the relation between the six stakeholders, brought forward the most impactful barriers. These were data accessibility, competencies, and demonstrating the value of AI products. When comparing the results with Lee and Yoon (2021), Petersson et al. (2022), and Singh et al. (2020), who have also identified the barriers to AI implementation in healthcare, both similarities and differences can be observed. These differences highlight that adopting a stakeholder perspective in addressing the issue can uncover new barriers.

As discussed in chapter 4, one of the main barriers identified is proving the value of AI products to the customer. This barrier was not identified by Lee and Yoon (2021), Petersson et al. (2022), and Singh et al. (2020). However, the omission could be explained by previous research not focusing on MedTech companies, the stakeholder who most strongly asserted its significance. On the other hand, Singh et al. (2020) argues that adopting technologies in healthcare is slow and that it is uncommon for technologies to become widespread without reimbursement models. This is held true even when the technology is proven to reduce costs and improve efficiency and patient outcomes. It could therefore be argued that overcoming the challenge of proving value might not be enough to persuade healthcare investments in AI technology.

The problem of competencies was found to be another of the most impactful barriers in our research. Lee and Yoon (2021) and Petersson et al. (2022) both found that clinicians must be trained and learn new competencies to understand and interpret AI, both for patient safety and their trust in the system. This corresponds well with our findings that AI competence greatly contributes to a positive attitude and trust toward AI. This claim is also supported by Scott et al. (2021), who found that individuals with experience in AI were more positive toward AI than those without experience.

However, neither Lee and Yoon (2021), Petersson et al. (2022) nor Singh et al. (2020) found a competency mismatch in the judicial parts of the healthcare system which was evident in our findings. In our research, a competence gap could be found in the legislative branch, hospitals, and research departments. Policymakers lack technical knowledge, while researchers and clinicians lack judicial knowledge. This reinforces the problems of the already outdated and ambiguous regulations surrounding data sharing and ethics approval.

Most stakeholders agreed that access to data is a barrier. It was found that regulations regarding access to data are a significant problem in Sweden. Policymakers even stated that the regulations were created at different times and are now outdated. Like Lee and Yoon (2021), Petersson et al. (2022), and Singh et al. (2020), this thesis found that the regulations of patient privacy and data sharing are some of the greatest barriers to implementing AI in healthcare. Despite researchers' perception that MedTech companies face the lack of data access as a barrier, MedTech companies meant this could be difficult,

but it is not a primary concern. As mentioned in the limitations, this holds for larger organizations. In contrast, smaller companies aiming to break through might face a more significant issue with access to data, as they do not have the resources available to larger companies. In alignment with Singh et al. (2020) finding, this thesis also points out the annotation process as a contributing factor to the problem of obtaining sufficient data for AI development.

This thesis has identified barriers to transitioning from research to implementing AI in the Swedish healthcare sector. A relevant area for further research is to find solutions to the identified barriers. Solutions to some of the identified barriers are currently being investigated in Sweden, such as regulations regarding the usage of patient data in research (Regeringskansliet, 2022a) and the interoperability of patient data between regions (Regeringskansliet, 2022b). Another barrier warranting investigation is how to demonstrate the value of AI products. There is a pressing need for research that quantifies the value of AI models, providing measurable data that can inform decisions related to adopting AI technologies. As Singh et al. (2020) mentioned, reimbursements are often required for the widespread adoption of medical devices. However, it is still unclear if this is the case for AI as well, and it should be researched. If that is the case, it would be interesting also to research how these reimbursement models should be designed to balance the usage of public resources and improve healthcare

Another interesting area raised by the interviewees was the gap that occurred once the researchers had obtained their findings. Several interviewees suggested another actor should take researchers' innovations to the commercialization phase. It would be interesting to see a future study on what role such an actor might have. Lastly, it would be interesting to see comparative studies to understand how stakeholders in different regions perceive and experience barriers. There might exist cultural differences and cultural barriers interesting to investigate.

7 Conclusion

The integration of AI in Swedish healthcare involves numerous stakeholders, each with distinct interests. This thesis identified and examined six stakeholders: clinicians, healthcare executives, MedTech companies, patients, policymakers, and researchers. Their interactions and interdependencies form a complex system where each stakeholder has unique interests concerning the implementation of AI. The stakeholder perspective utilized in this thesis provided a comprehensive view of several, some previously not identified, barriers to implementing AI in Swedish healthcare.

The most impactful barriers identified were: competencies, data accessibility, and demonstrating the value of AI products. These barriers were critical to effectively implementing AI in Swedish healthcare. Data accessibility is fundamental to implementing AI in healthcare since access to sensitive patient data is required to train AI models. Currently, obtaining this data is a lengthy and arduous process for researchers. The need for competencies across the healthcare system is also a considerable challenge. This barrier, the absence of competency where needed, is at the root of many other obstacles discussed in the thesis. Finally, demonstrating the value of AI products was highlighted due to its fundamental role in the implementation process. This barrier can directly halt the adoption of AI in healthcare. Due to Swedish procurement laws, health executives cannot procure the technologies without demonstrated value.

Concluding, applying a stakeholder perspective when identifying the barriers to implementing AI in Swedish healthcare has uncovered new barriers, showing the importance of including multiple perspectives. Solving these barriers would accelerate the implementation of AI in Swedish healthcare. Lastly, this thesis calls for further research to understand and solve the most prominent barriers identified. If these barriers are solved, it can pave the way for more informed, effective strategies for the successful implementation of AI in healthcare.

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A List of Interviewees

Table 8 displays all interviewees who took part in this thesis. For each interviewee, it also shows what role they currently have, what date the interview took place, and which language was used.

Table 8: All interviewees with additional information.

Interviewee	Role	Organization	Date	Language	Length
1	Assistant Professor at Data Science and AI	Chalmers University of Technology	20-02-2023	Swedish	49:50
2	Strategist Life Science	Sahlgrenska University Hospital	23-02-2023	Swedish	1:02:05
3	Strategist Life Science	Sahlgrenska University Hospital	23-02-2023	Swedish	1:02:05
4	Director of AI Competence Center	Sahlgrenska University Hospital	23-02-2023	Swedish	1:02:05
5	Head physician in radiology and clinical physiology	Sahlgrenska University Hospital	28-02-2023	Swedish	59:34
6	Postdoctoral Researcher in Computer Vision	Chalmers University of Technology	01-03-2023	Swedish	54:37
7	Associate Professor at Computer Vision and Medical Image Analysis	Chalmers University of Technology	01-03-2023	Swedish	54:40
8	Specialist Physician at Section for Intensive Care	Uppsala University Hospital	16-03-2023	Swedish	56:13
9	Specialist Physician in Dermatological	Sahlgrenska University Hospital	15-03-2023	Swedish	1:05:40
10	Associate Professor in Machine Learning	Halmstad University	20-03-2023	English	57:41
11	Professor Emeritus	Not Available	10-03-2023	Swedish	51:28
12	Investigator	Swedish Government Inquiries	15-03-2023	Swedish	45:02
13	Investigator	Swedish Ministry of Health and Social Affairs	20-03-2023	Swedish	29:58
14	Deputy Hospital Director	Sahlgrenska University Hospital	22-03-2023	Swedish	51:26
15	Doctoral student at Department of Computing Science	Umeå University	23-03-2023	English	39:24

Interviewee	Role	Organization	Date	Language	Length
16	Head of Division	Sahlgrenska University Hospital	30-03-2023	Swedish	44:59
17	Chairperson	Melanoma Association (Melanomföreningen)	28-03-2023	Swedish	22:10
18	Senior Lecturer at Science, Technology and Society	Chalmers University of Technology	04-04-2023	Swedish	44:50
19	AI Lead	Sectra	13-04-2023	Swedish	49:22
20	Vice President of Healthcare Global	Brainomix	20-04-2023	English	24:29
21	Healthcare Manager	Brainomix	20-04-2023	English	24:29
22	Product Manager for AI and Clinical Decision Making	siemens Healthineers	25-04-2023	Swedish	49:10

B List of Original Quotes

Table 9 shows quotes that were given during the interviews. The Swedish quotes can be seen both in their original language and in the translated version which was used in this thesis. If the quote was given in English, the last column is empty. There is also a column explaining which of the interviewees exclaimed the quote and in which section in the thesis the quote can be found.

Table 9: Translated quotes within this thesis.

Said by	**Found in section**	**English**	**Swedish**
Interviewee 8	(3.3.1) Clinicians	”though it is very hard, it probably must remain this way due to the nature of the data. If handled incorrectly, there is a great risk that something fails and leads to data leakage of sensitive information.”	”även om det är svårt måste det nog förbli på detta sätt på grund av datans natur. Om det hanteras inkorrekt, finns det en stor risk att något misslyckas och leder till dataläckage av känslig information.
Interviewee 8	(3.3.1) Clinicians	”The risk is that the machine learning model gets to know patient 623.”	”Risken är att maskininlärningsmodellen lär känna patient 623.”
Interviewee 8	(3.3.1) Clinicians	”You have to be able to say based on what we knew, we did this and it was wrong”	”Man måste kunna säga baserat på det vi visste gjorde vi såhär och det var fel”
Interviewee 5	(3.3.1) Clinicians	”A doctor has training that involves knowing a number of specific cases but also being able to handle things that you don’t know.”	”En doktor har ju en träning som går ut på att kunna ett antal specifika fall men också att kunna hantera saker som man inte vet.”
Interviewee 14	(3.3.2) Healthcare executives	”Now I go with the old cliché; will machines take over our thinking completely and utterly?”	”Nu går jag på den gamla klyschan; kommer maskinerna ta över vårt tänkande helt och hållet och hela den biten?”
Interviewee 4	(3.2.2) Decision-makers	”After all, we use a lot of drugs, where the doctors don’t know exactly how they work, etc. But they are still used. They are based on a long, clear validation process. Maybe we should think in that way when we deal with AI, i.e. a good validation process. There is so other ways to build trust in these types of systems.”	”Vi använder ju mycket läkemedel, där läkarna inte vet exakt hur de funkar osv. Men de används ändå. De är baserat på en lång tydlig valideringsprocess. Vi kanske ska tänka på det sättet när vi hanterar AI, dvs en bra valideringsprocess. Det finns alltså andra sätt att skapa förtroende för dessa typer av system.”

Said by	Found in section	English	Swedish
Interviewee 2	(3.3.2) Decision-makers	"...already drowning in the current workload. Consequently, many might not have the time to think about AI solutions."	"...drunknar redan i den nuvarande arbetsbördan. Därför kanske många inte har tiden att tänka på AI-lösningar"
Interviewee 19	(3.3.3) MedTech Companies	"AI is not just a new medical device, it is an organizational transformation."	"AI är inte bare en ny medicisk maskin, det är en organisatorisk transformation."
Interviewee 20	(3.3.3) MedTech Companies	"There's no point going in saying we have 90% sensitivity and specificity which most products should do, but you still have in every case, you know, five in every 100 You're going to miss with the software. So what does the physician do? How do they manage that?"	-
Interviewee 20	(3.3.3) MedTech Companies	"Obviously, any commercial company keeps the IP (intellectual property) for the AIs separate. But if you don't allow the clinician to understand how the software is working, and what it is actually saying, then you have to have very, very accurate algorithms that people can see. Yeah, it's a binary output. I get it. I agree with it, and I move forward. In health care, it's much more nuanced."	-
Interviewee 22	(3.3.3) MedTech Companies	"the best data in the world"	"Den bästa datan i världen"
Interviewee 19	(3.3.3) MedTech Companies	"its relevance for clinical professionals is up for discussion"	"dess relevans för kliniska proffs kan diskuteras"
Interviewee 19	(3.3.3) MedTech Companies	"a question of time and money"	"en fråga om tid och pengar"
Interviewee 19	(3.3.3) MedTech Companies	"How can companies prove that their technology makes a certain process quicker when the hospitals themselves don't know how long the process takes?"	"Hur kan företag bevisa att deras teknologi gör en viss process snabbare när sjukhusen själva inte vet hur lång tid processen tar?"

Said by	Found in section	English	Swedish
Interviewee 17	(3.3.4) Patients	”It’s very difficult because the AI is no better than what it’s been trained on.”	”Det är jättesvårt för AI är inte bättre än vad den har tränats på.”
Interviewee 17	(3.3.4) Patients	”I actually think GDPR has its advantages despite the problems it has. The problem is that it is sometimes bureaucratic, but forces you to think of privacy by design. But you might think that things should go a little easier.”	”Jag tror faktiskt att GDPR har sina fördelar trots de problem det har. Problemet är att det ibland är byråkratiskt, men genom dess design tvingar den dig att tänka på integretet. Men du kan nog tycka att saker borde gå lite enklare.”
Inteviewee 17	(3.3.4) Patients	”We are hoping that the European Health Data Space will solve some of the problems that GDPR has but still protect the patient.”	Vi hoppas att det europeiska hälsodataområde kommer lösa några av de problem som GDPR har men fortafrande skydda patienten.”
Interviewee 12	(3.3.5) Policymakers	”These questions and problems are very technical, they sound easy but in reality, they are very hard, kinda like the tunnel through Hallandsåsen”	”De här frågorna och problemen är väldigt tekniska, de låter lätta men är egentligen oerhört svåra, lite som tunneln genom Hallandsåsen”
Interviewee 12	(3.3.5) Policymakers	”We have seen that the conceptualization is not great, some were written in the 1970s but it feels like it was written in the 700s”	”Vi har sett att begreppsbildningen inte är toppen, vissa skrevs på 1970-talet men ser ut att ha skrivits på 700-talet”
Interviewee 9	(3.3.6) Researchers	”I am not a paper specialist. I am a specialist in dermatology. All the paperwork makes me nervous, so therefore, I move on to the next project, my curiosity is driving me to the next project.”	”Jag är inte en pappersspecialist. Jag är en specialist inom dermatologi. Allt pappersarbete gör mig nervös, så därför går jag vidare till nästa projekt, min nyfikenhet drar mig till nästa projekt.”

C Glossary

This appendix contains relevant vocabulary used within this thesis. All words are explained when they are used yet these sections give a deeper explanation.

C.1 Artificial Intelligence

The European Parliament defines AI as follows: "AI is the ability of a machine to display human-like capabilities such as reasoning, learning, planning, and creativity." (European Parliament, 2021). In its simplest form, AI is a field in which computer science and robust datasets are combined to enable the solving of problems (IBM, n.d).

C.2 Machine Learning

One of the subfields of AI is machine learning (Butterfield et al., 2016). The concept of machine learning is to take advantage of statistical and optimization methods to enable computers to identify patterns in data sets (UC Berekely, 2020).

One example of machine learning in healthcare is the use of precision medicine (Davenport & Kalakota, 2019). Here, the AI models predict likely treatments based on the patient's attributes and treatment context. To succeed with this, large training datasets with known outcomes are required. Consequently, having access to vast amounts of data is crucial in the development of high-performing AI models. Generally, the more accurate data an AI model can be trained with, the better it can learn and perform (MacEachern & Forkert, 2021). However, when it comes to AI applications in healthcare, it is not enough to only obtain large data sets. Most AI models developed for healthcare applications require personalized patient data, which are sensitive and highly regulated in accessibility in Sweden.

C.3 Deep Learning

A subset of machine learning is deep learning. In essence, it attempts to replicate the behavior of the human brain by using neural networks. By doing this, it can learn from large amounts of data. The main difference between deep learning and machine learning is what data they can learn from. Deep learning models can process unstructured data such as images and texts. Figure 14 shows the correlation between AI, machine learning, and deep learning.

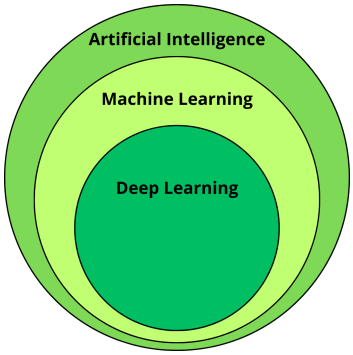

Figure 14: Artificial intelligence and its different subfields.

C.4 Different Forms of Data

As with all models that use machine learning, they require a lot of data (Google Developers, 2022). The model only becomes so good as the data it trains on. All data is not equal and is usually divided into structured and unstructured data (IBM, 2021).

Structured data refers to data that is highly organized, making it easy for machine learning algorithms to manipulate, query, and decipher the data (IBM, 2021). The data is in the form of numbers and values, with examples being dates, names, credit card numbers, etc. Use cases of this type of data can be seen in Customer Relationship Management (CRM) software, which uses structured data to analyze customer behavior patterns and trends.

Unstructured data, on the other hand, is generally categorized as qualitative data. Rather than numbers, the data consists of sensors, text files, audio and video files, et cetera. Unstructured data is becoming increasingly important, as more than 80% of enterprises' data is projected to be unstructured (Dialani, 2020).

C.5 Explainable AI

During the past years, there has been a rapid advancement of AI, making the models more and more complex (Inam et al., 2021). Consequently, one significant fact to consider when dealing with AI is that humans no longer understand the complex mechanisms of how AI works and makes certain decisions. Consequently, there has been an increasing need for AI to be interpretable, understandable, and explainable when generating its output. This has led to the rise of explainable AI, which are models that produce accurate explanations of why and how it made its specific decision (Inam et al., 2021).

C.6 Transparent AI

A transparent AI is similar to an explainable AI in the sense that it must be able to explain why it made its particular decision. For it to be transparent, however, "the developer of the model has to be able to explain how they approached the problem, why a certain technology was used, and what data sets were used. Others have to be able to audit or replicate the process if needed." (Deloitte, 2019). Moreover, the outcome of the model must also be statistically sound, meaning that the AI is not biased. It has to be trained on a large amount of data that is not skewed in any way. For example, in healthcare, men and women have different effects on different diseases (Ratini, 2021). Thus, to prevent biased outcomes, it is crucial to employ training data that encompasses all genders. Acquiring unbiased data is a challenge since the majority of data sets have not been collected explicitly for training AI.

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