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Integration and ROI of AI Technology in Healthcare

A White Paper for Healthcare Decision Makers

Author: Sara Mohamed Zetterström
(Next Generation Business Leaders Program, AI Sweden)

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Executive Summary

The Swedish healthcare system is under great pressure, facing huge deficits where estimates from the Swedish Association for Local Authorities and Regions (SKR) suggest that 17 out of the country's 21 regions are projected to accumulate deficits totaling over €2.1 billion in 2024 alone (Kleja, 2024). These could be attributed to a rapid increase in healthcare costs due to high inflation, rising pension costs, and a growing patient burden. Consequently, hospitals are severely understaffed not only because of budget cuts but also simply due to lack of competencies required (SKR, 2024). In addition, a recently accepted agreement by the Swedish Association of Health Professionals (Vårdförbundet) which reduces weekly work hours by up to four hours and is perceived to exacerbate the already strained financial situation (SKR, 2024).

Artificial Intelligence (AI) has emerged as a potential solution that could help alleviate some of the pressure on Sweden's healthcare system by automating routine tasks, improving operational efficiencies, and optimizing resource allocation. This paper explores the different methodologies that have been used across regions to procure and implement AI technology into their organizations, shedding light on the decision-making process and the factors considered when allocating resources for such investments. Through this project we aim to provide a framework for building a robust business case and assessing the potential value creation of AI implementations to support decision-makers in the procurement process.

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Furthermore, most of the AI applications currently adopted within the healthcare sector are primarily focused on diagnostics and prediction, while other areas, such as administrative AI, which could potentially offer quicker implementation processes and higher economic ROIs, remain largely unexplored. Consequently, this has led to a lack of diversification in the AI portfolio, with lengthy procurement processes often taking up to six years to complete.

Concerns surrounding data privacy and storage have also been brought up as obstacles, further slowing down the adoption and implementation of AI solutions as AI and data ethical assessments are carried out to determine the level of risk that could be undertaken which

also takes a significant amount of time. These concerns have been highlighted during interviews conducted as part of the research project, underscoring the complex challenges that decision-makers must navigate when considering AI investments. Ultimately, this comprehensive exploration will empower decision-makers to make informed and strategic choices regarding AI adoption in the healthcare sector.

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1. Background

1.1 Problem Statement

The Swedish Association of Health Professionals (Vårdförbundet) - has recently accepted a new offer presented by the mediators in Sobona's contract and a similar one from the Swedish Association for Local Authorities and Regions (SKR, 2024). This new agreement means a maximum reduction of 4 hours in the weekly work hours in addition to a sustainable increase in salaries with 3.05% (Vårdförbundet, 2024). This was no easy agreement to reach as it has faced significant opposition from municipalities and regions as it is perceived that this would not solve neither the challenge of available competencies nor the workplace challenges. Instead, it would cause an even bigger financial burden and worsen an already tough situation (SKR, 2024).

The Swedish healthcare sector is facing a strained financial situation, with an expected deficit of SEK 30 billion in 2024 which could be attributed to increased inflation, rising pension costs, and a growing healthcare demand. The mentioned reduction in working hours above is estimated to cost an additional SEK 36 billion, which would exacerbate the economic situation considerably. Furthermore, there is a demographic challenge with a shortage of labor, not just in municipalities and regions, but across the entire labor market. The employment increase of those of working age is estimated to be 169,000 people by 2031. The elderly care and healthcare sectors alone would need 81,000 of these, which is unlikely to be achieved according to many reports while at the same time, over 300,000 people are expected to retire during the same period. This would mean that a reduction in working hours under these current circumstances is not feasible and would rather add to the existing challenges within the sector (SKR, 2024).

Artificial intelligence (AI) has emerged as a potential solution to not only automate administrative tasks but also enhance healthcare through advanced prediction capabilities and individualized approaches, ultimately improving the precision and effectiveness of the healthcare system. By allowing AI systems to handle some of the tasks that could be automated, their work would be augmented where some of the workload could be lifted, shifting the focus more towards meeting the patients and delivering higher quality care. AI in healthcare has already demonstrated its ability to assist healthcare providers and patients throughout the entire care journey, ranging from precise diagnostic capabilities to monitoring acute conditions and enabling self-management of chronic diseases (Petersson et al., 2022). Healthcare leaders themselves acknowledge AI as a necessary development, without which the industry will be overwhelmed by the growing needs (Neher et al., 2023). This is because AI-enabled technologies, including advanced diagnostic tools like

computed tomography (CT) scans, magnetic resonance imaging (MRIs), and ultrasounds, can perform repetitive, simple tasks with greater accuracy, minimizing medical errors and promoting early diagnosis and intervention. Moreover, AI-based solutions are increasingly being leveraged by healthcare professionals to predict outcomes, enabling optimal medication selection based on patient profiles, ultimately contributing to lower long-term costs (Khanna et al. 2022).

1.2 Project Aim

By integrating the right AI solutions based on each organization's needs and gaps, reduction in working hours could potentially be realized without having to hire more staff or significantly increase costs. However, the implementation of AI in the Sweden public health system currently lacks a standardized and comprehensive framework that outlines the process, associated costs, and potential return on investment (ROI), making the process rather fragmented. Thus, this project aims to address this research gap by conducting an in-depth investigation into the current state and maturity of AI implementation in Sweden's public health systems to provide a robust framework for building and assessing AI in healthcare. Additionally, it will explore the different methods employed to justify AI investment to procurement boards, providing a clearer understanding of the decision-making process and the factors considered when allocating resources for AI adoption.

2. Situational Analysis

2.1 The Procurement Process

The Swedish healthcare system exhibits a complex and long process for the implementation of new technologies. (see figure 1) Although this is only one way to AI implementation in the healthcare sector (also possible through in-house development and one-time analyses), figure 1 illustrates the extensive pathway towards technology integration from the initial recognition of a need within a hospital setting to the subsequent development or procurement and implementation stages, where as many as 17 different steps involved. This pathway encompasses interactions with both internal stakeholders within the hospital and external actors for getting ethical approval for instance, contributing to the complexity and lengthiness of the process. Multiple layers of bureaucracy and cross-sectional consultations contribute to potential delays and inefficiencies where each stage involves validation, assessments, and approvals that can incrementally extend the time frame before a technology can be operationalized (Karolinska University Hospital, 2021). An example of this

is the AI for breast cancer screening which is a study that was initiated in 2017 by researchers from Lund University and where the technology developed is in the process of being procured and implemented in different clinics approximately 6 years later (see appendix 7.2).

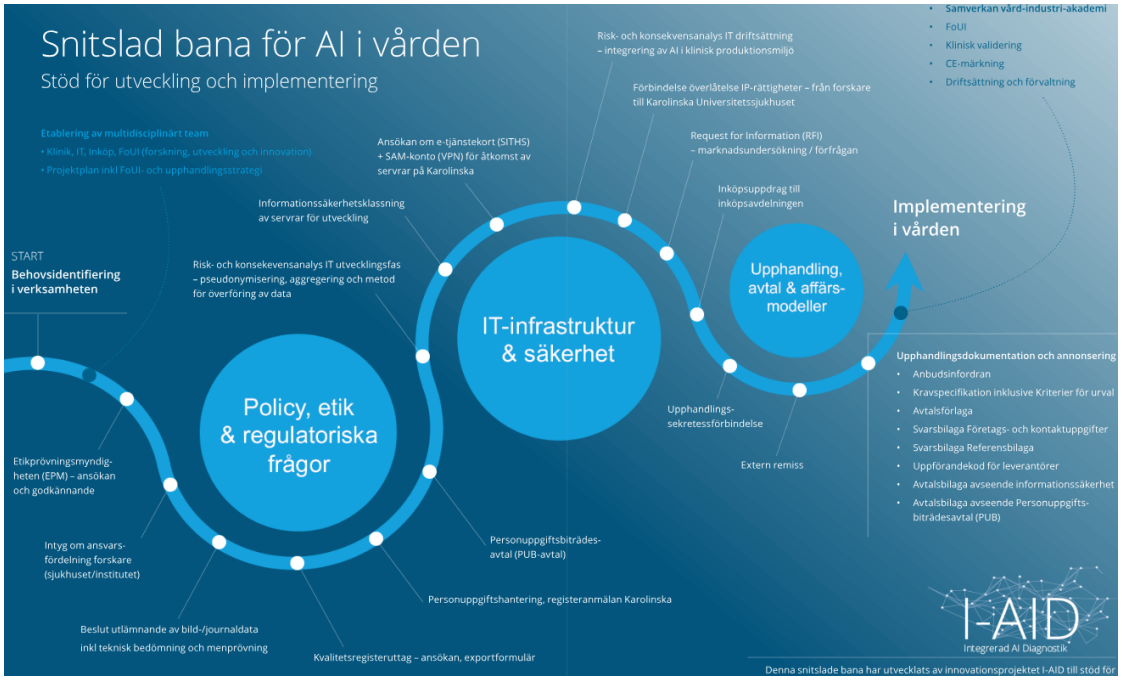

Fig. 1. Procurement Process for AI implementation in Public Healthcare

Source: Karolinska Universitetssjukhuset & Stockholms läns. (2021). I-AID - Integrerad Diagnostik.

The procurement process is not any less complex from the independent providers' side that are competing to sell their services to the public healthcare. Tyreholt, a representative at Visiba Care, reports that this process is lengthy and lacks clear guidelines and standards for evaluating the effectiveness and clinical performance of these innovative solutions. One major issue raised is the disproportionate emphasis placed on detailed technical requirements, such as the importance of having a CE mark, while the criteria for assessing the actual benefits and performance of the products remain ambiguous. This imbalance has led to a market situation where the true value and impact of these solutions are often overlooked, with the evaluation process becoming increasingly subjective. In addition, the procurement board or hospitals do not conduct any follow-ups or monitoring of the products' performance once they have been procured. Without proper evaluation and measurement of the effects, the integration of these technologies becomes a gamble, with some regions ending up with products that yield negative results and require more resources than the previous state (P. Tyreholt, Visiba Care, personal interview conducted Sara Mohamed by, 2024).

Another issue raised is the lack of requirements for continuous improvement and upgrades in the technology during the procurement process and since this is not reflected in the bidding process, it is often the case that these providers will lack the motivation to include that as it would come at their expense. This leaves healthcare providers with outdated technology which is especially a problem for AI applications that are continuously evolving and need constant updates to improve performance.

2.2 Lack of Standardization Within Procurement

For medical products that fall under the medical device regulations (MDR), the health economics evaluations done by national bodies like the Dental and Pharmaceutical Benefits Agency (TLV, Tandvårds- och läkemedelsförmånsverket). The Swedish Agency for Health Technology Assessment and Assessment of Social Services (SBU, Statens beredning för medicinsk och social utvärdering) and regional Health Technology Assessment (HTA) organizations carry more weight in enabling adoption by providing evidence of patient outcomes and cost-effectiveness. At the regional level however, the finance departments that usually build the business cases for product procurement, lack deep expertise in health economics analysis required for medical investments while healthcare staff also often lack experience with cost-benefit analysis. There is less rigor in formally calculating potential returns and cost-utility for these investments and decisions are often more subjective/rhetorical debates. Even when business cases are developed, there is poor follow-up tracking whether projected benefits were realized after implementation, which is simply due to tradition and a history of not doing so and it being an acceptable practice by management and where focus shifts to new projects as soon as procurement is done. Furthermore, getting sustained leadership commitment and follow-through on analysis and tracking can be difficult (M. Lingman & H. Nilsson, Region Halland, personal interviews conducted by Sara Mohamed, 2024).

The emphasis on presenting a business case or perceived ROI during the procurement process is thus highlighted as an unusual practice in many regions across Sweden. Nonetheless, there are regions like the Stockholm Region that have strict guidelines about presenting clear positive effects of the implementation of the technology before any procurement can take place. Incorporating this aspect could assist in providing a more holistic evaluation, considering not only the technical and clinical aspects but also the potential financial and operational benefits of adopting these technologies. A lack of adequate costing methods adds to the evaluation problem.

Accordingly, providers both private and public, strongly believe that a standardized approach to engaging in smaller pilot projects that is less bureaucratic is needed. These pilot projects would allow them to showcase the ROI of their products on a smaller scale, without

requiring extensive resources from either side. This approach could also help mitigate the risks associated with large-scale procurement and provide valuable data on the real-world impact of the solutions and accelerate knowledge sharing across the industry. When compared to countries like Finland and the United Kingdom, these have established more rigorous evaluation processes, requiring providers to present data on the performance of their products at every stage of the pilot phase before proceeding to the next phase. This approach fosters transparency and accountability, ensuring that procurement decisions are based on tangible evidence of efficacy and impact (P. Tyreholt, Visiba Care, personal interview conducted by Sara Mohamed, 2024).

2.3 Lack of Competencies Within Procurement

Multiple parties recognize the pressing need for increased competency within procurement teams regarding AI and software-based medical devices. A deeper understanding of how these technologies work and the appropriate requirements to set for their evaluation is crucial. This knowledge could facilitate a more objective and comprehensive assessment process, taking into account not only technical specifications but also clinical performance and overall benefits (P.Tyreholt, Visiba Care, personal interview conducted by Sara Mohamed, 2024).

Ongoing education for decision-makers at the procurement level is needed to bridge any knowledge gaps, ensuring a balanced approach that values both cost-effectiveness and quality (G. Bothma, Health Economist and innovation value strategist, personal interview conducted by Sara Mohamed, 2024).

Additionally, collaboration with organizations like Inera, which aims to achieve national integration of digital tools for healthcare, is seen as a potential solution to accelerate the adoption of AI and bridge the gap in knowledge. An ongoing dialogue between Inera and healthcare providers could facilitate a smoother integration of these products into the healthcare system where the independent providers could take charge of the whole process. Currently, providers are limited to have indirect dialogue via their customer (healthcare provider), leading to unnecessary burden on the healthcare provider rather than just solving their need of integrated systems (P.Tyreholt, Visiba Care, personal interview conducted by Sara Mohamed, 2024).

3. Identification of AI Use-Cases

3.1 Types of Strategic Investments

In the context of healthcare, mapping out projects or investment portfolios can assist in identifying gaps and potential hindrances that may impact an organization's ability to achieve its long-term objectives in delivering quality patient care and improving overall health outcomes. The question arises: why are we solely investing in projects or initiatives that fall within a specific domain or area of healthcare? It is crucial to consider not only where we want our healthcare organization to be currently but also where we envision it to be in the future. By evaluating the types of investments being made and understanding the rationale behind prioritizing certain areas over others, we can better comprehend the potential consequences on the long-term prosperity and sustainability of our healthcare services (see Figure 2 below).

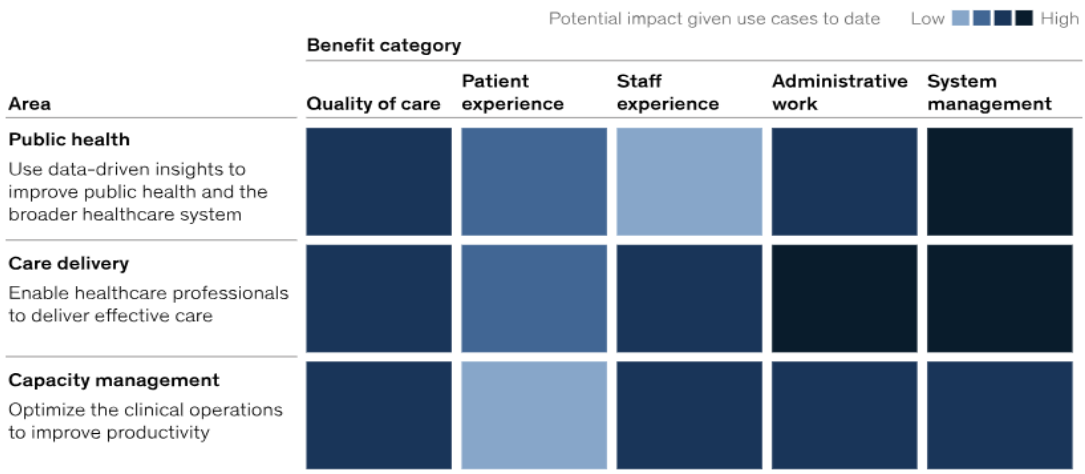

Fig. 2. AI Impact on Different Aspects of Healthcare

Source: *Mckinsey & Company (2024)*

In an interview with Michael Page, the director of AI commercialization at Unity Health Toronto, Canada, he explains that before starting an innovation journey, such as implementing AI projects in a healthcare organization, it is crucial to reflect on the organization's current innovation capability and identify any gaps that need to be addressed. Consultants and experts often make the mistake of starting with, for example, governance structures, policies, and procedures without fully understanding the organization's existing capabilities and resources. Instead, conducting a comprehensive assessment of these capabilities, assessing various elements such as people, processes,

policies, structures, budgets, and finally governance mechanisms can help in identifying the areas that should be prioritized. Thus, he emphasizes that leaders should evaluate whether they have the necessary components in place to effectively innovate, including the right leadership, compute resources, and organizational structures. By reflecting on their innovation capability and identifying gaps, organizations can develop a tailored strategy to bridge those gaps and create an environment conducive to successful innovation initiatives, such as the implementation of AI projects in healthcare settings. This approach helps organizations avoid common pitfalls and ensures that they have the necessary foundations in place before embarking on transformation journeys (M. Page, Unity Health, personal interview conducted by Sara Mohamed, 2024).

For example, the interviews conducted with stakeholders across regions revealed that most hospitals are focused on AI applications for diagnostics which is the most mature area, whereas other areas are lagging. In most AI-use cases studied, the identification of the problem itself was either neglected or not based on the organization's most pressing need and no internal assessment was made leading to a narrow AI portfolio and the value created is limited. Other areas that could have been invested in include administrative AI that would help for instance free up time for nurses.

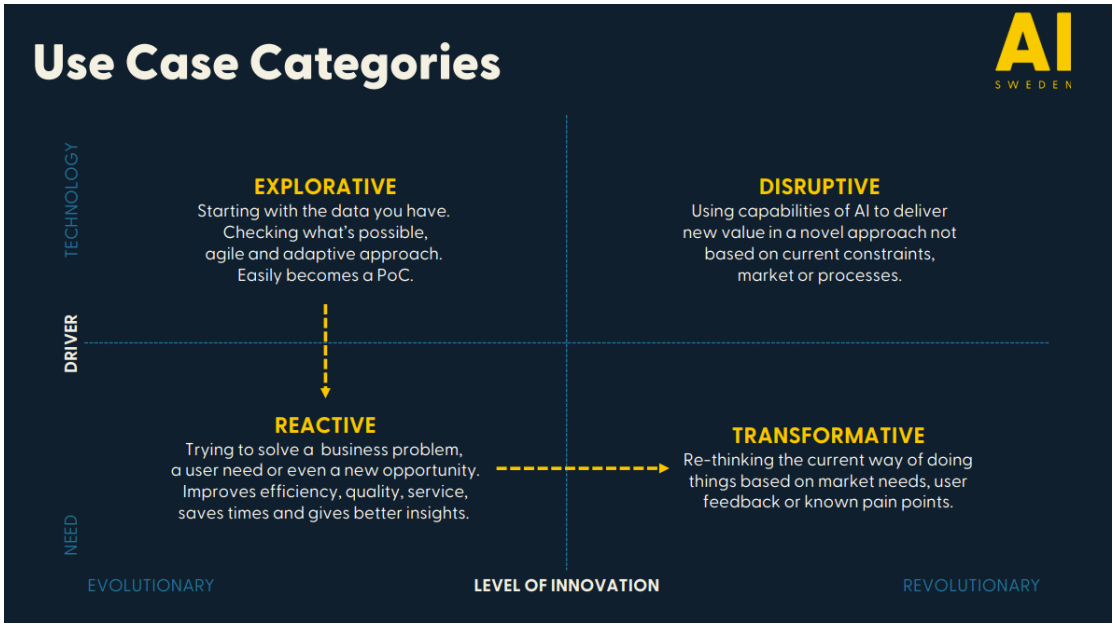

Fig. 3. Portfolio Mapping and Use Case Categorization of AI Projects

In addition, organizations should develop an approach towards evaluating and implementing AI where they define their own success rates and integrate risk assessment into their evaluation processes. This could involve assigning a likelihood of success or risk percentage to each project, based on factors such as novelty and complexity. This

approach can help mitigate the risk associated with AI implementation. It is important to keep in mind that not every project will achieve success, which is instead directly correlated to the level of innovation involved. As the level of innovation increases, so does the inherent risk associated with the project, and conversely, less innovative projects tend to carry lower risks. For instance, a novel AI project with limited precedent may have a lower likelihood of success, while more established applications may have a higher likelihood.

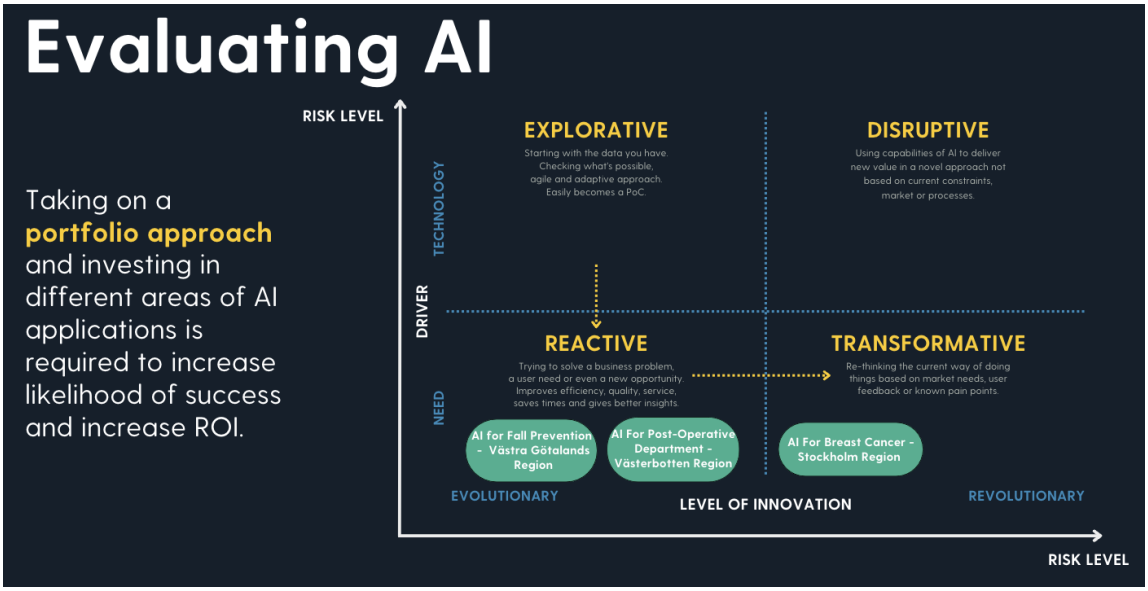

Fig. 4. Risk Level & AI Use-Cases Studied

This perspective underscores the need for a strategic approach in project selection and prioritization. The aim is to have a mixed portfolio of AI-use cases in different areas and with different risk levels which would compensate for each other and reach a success rate that is higher than the industry average for successful innovations. By considering the risk-innovation trade-off, organizations can make informed decisions regarding the allocation of resources. Prioritizing low-risk initiatives, can yield immediate benefits in terms of time and cost savings. These projects are characterized by their relatively predictable outcomes and lower chances of failure. A practical starting point would be to invest in automating administrative tasks that currently consume substantial amounts of time for doctors and nurses. Drafting emails, energy management, and back-office tasks like scheduling and meeting transcription are tasks that AI could enhance, increasing efficiency, cost-effectiveness, and scalability of care, are applications with higher success rates particularly in the context of public funding limitations. Thus, the approach involves directing investments towards enhancing the efficiency of back-office operations and in a later stage, when the organization is prepared to venture into more daring and risky projects, it can do so, albeit with a relatively diminished probability of success (M. Page, Unity Health, personal interview conducted by Sara Mohamed, 2024).

On the other hand, pursuing high-risk projects that involve greater levels of innovation may yield transformative results but come with increased uncertainty, a higher likelihood of failure and a longer time to implement. It is crucial for organizations to carefully assess their readiness and capacity to manage such risks before diving into these ventures. Building a strong foundation through successful implementation of low-risk projects can provide valuable experience and resources that can be leveraged when undertaking riskier initiatives (M. Page, Unity Health, personal interview conducted by Sara Mohamed, 2024).

Unity Health specifically has established a prioritization framework to determine which problems should be tackled first. Usually, problems must either improve patient care, significantly enhance workflow, or provide other tangible benefits to be considered for AI solution development.

Thus, to ensure a comprehensive and balanced approach, healthcare organizations should consider diversifying their investment portfolios to include a range of initiatives spanning primary care, health education, chronic disease management, diagnostics, administrative and organizational initiatives with different levels of risk associated with them. By allocating resources across various domains, healthcare organizations can better position themselves to address the multifaceted nature of healthcare challenges and meet the evolving needs of the communities they serve.

For more guidance on prioritizing and strategically selecting AI projects based on the driving factors and ease of implementation, please consult the "Assessing the ROI of AI Tools and Applications" white paper by AI Sweden, which provides a comprehensive overview.

3.2 AI-Maturity and IT-Infrastructure

The level of AI maturity plays a crucial role in the successful implementation of AI technologies. AI maturity refers to an organization's proficiency in utilizing AI technologies and applications, and it involves evaluating factors such as the organization's vision, strategy, data infrastructure, technology platforms, AI operating model, talent capabilities, and governance processes.

In an interview with Michael Fralick, a clinician scientist at Sinai Health and researcher at Unity Health, he revealed that there are a few key reasons why they are a leading hospital in the implementation of AI and seeing a high ROI. To be able to successfully implement AI, it is of utmost importance to create an ideal data infrastructure and pipeline for the entire hospital which often requires significant resources depending on the current IT and data infrastructure readiness. This is a foundational step to ensure data readiness, as the ability

to organize and structure data in an easily accessible and retrievable manner is crucial for developing and deploying AI models effectively (M. Fralick, Unity Health, personal interview conducted by Sara Mohamed, 2024).

Therefore, we must invest in the foundational standards and infrastructure that will enable AI to thrive within the healthcare ecosystem. This also means aligning leadership across the system to establish robust data governance frameworks, cross-functional risk management protocols, and public-private partnerships that leverage complementary capabilities and expand our capacity for innovation (Al-Haque et al. 2024).

Developing, implementing, and scaling the use of healthcare AI applications requires thinking differently about the healthcare system, not just one application at a time. A compelling vision for the value at stake and chart a clear path toward at-scale implementation must be communicated. By engaging multidisciplinary teams that include healthcare professionals, patient advocates, and data scientists, leaders can identify high-impact use cases, define meaningful metrics for success, and proactively address potential sources of negative value, such as patient risks or infrastructure costs (Al-Haque et al. 2024).

3.2.1 Data Infrastructure

AI systems rely on data for training and decision-making. Healthcare organizations need to assess their data infrastructure, including electronic health records (EHRs), medical imaging systems, and other data sources, to ensure data quality, accessibility, and interoperability. Robust data governance and security measures are also essential. This has been a major hurdle in the path towards effective AI implementation in healthcare where EHR datasets are characterized by their considerable variety, irregularity, and the heterogeneous nature of data sources. This complexity poses a substantial challenge for directly inputting EHR data into AI algorithms. Effective AI deployment necessitates the development of robust data management systems capable of harmonizing these diverse data streams into a standardized format that can be efficiently analyzed by AI technologies (A. Norén, Karolinska University Hospital, personal interview conducted by Sara Mohamed, 2024).

→ **Data Organization:** All relevant data sources must be well-organized and easily retrievable for model training. Disorganized or "messy" data is a major obstacle.

→ **Data Pipelines:** Robust data pipelines are needed to feed the predictive outputs of AI models back to end-users (doctors, nurses) in near real-time. Many organizations lack this capability.

3.2.2 Computing Power & Cloud Services

AI algorithms, particularly those involving deep learning and neural networks, require significant computing power specifically under the development and training phases. Healthcare organizations should evaluate their existing computing resources, such as servers, GPUs, and cloud computing capabilities, to determine if they are sufficient for AI workloads or if additional investments in hardware or cloud services are necessary.

In cases of AI implementation for breast cancer, fall prevention and planning for post-operative sections, the regions have built in-house servers to store and access data and have not used external cloud services. Interviewees from the three regions Region Västra Götaland, Region Västerbotten and Region Skåne, reported that this choice was made due to legal concerns and limitations, in addition to the costly nature of using an external cloud service provider. In the post-operative AI use-case, Lundsten from Region Västerbotten reports that the software that they built needed to call on a lot of instances and be updated every few seconds, which made using an external cloud service provider not a cost-effective solution, trying both Microsoft and IBM. This also helped them in dealing with any legal issues related to data storage in healthcare (S. Lundsten, Region Västerbotten, personal interview conducted by Sara Mohamed, 2024).

However, according to insights provided in an interview with Arrhenius this is a prevalent misconception among hospitals in Sweden that building an on-premises IT infrastructure is more cost-effective. While this might be true in certain cases (such as when the hardware is already available and is going to be updated continuously), there are advantages to using a cloud service provider, particularly in terms of elasticity, scalability and possibly cyber security (A. Arrhenius, AI Sweden, personal interview conducted by Sara Mohamed, 2024).

Indeed, the interview with both Arrhenius and Broms revealed that while storing data on-premises might seem cheaper initially, as operations expand, this approach becomes increasingly challenging and costly. Cloud service providers offer a significant advantage in this regard, as they do not require substantial upfront investments in hardware, security, and data privacy measures. Instead, they have specialized expertise in addressing these aspects, allowing them to offer services on a pay-per-use basis, ensuring that clients only pay for what they consume. One of the critical factors highlighted is the limited lifecycle management associated with on-premises hardware. As technology advances, the need to update and replace hardware arises, leading to higher costs over the long term. Cloud services, on the other hand, provide seamless updates and maintenance, ensuring that clients have access to the latest technology without the burden of managing physical infrastructure (A. Arrhenius, AI Sweden and A. Broms, Google, personal interviews conducted by Sara Mohamed, 2024).

3.2.3 Cybersecurity and data privacy

The interviews with Arrhenius and Broms further shed light on the healthcare sector's adoption of cloud services in Sweden, where the interviewees believe the country is lagging due to legislative concerns and data sharing challenges surrounding sensitive information. However, the interviewee emphasizes that the classification of data as sensitive is nuanced, particularly regarding what constitutes a personal data point. Different interpretations exist, such as whether a piece of data is considered personal if only its creator can link it to an individual. Organizations must carefully evaluate what can be automated and what requires stricter control, considering these complex data classification considerations. Accordingly, organizations must carefully evaluate what can be automated and what requires stricter control (A. Arrhenius, AI Sweden, personal interview conducted by Sara Mohamed, 2024).

3.2.4 Scalability and elasticity

AI applications in healthcare may experience fluctuating demand or require scalability to handle large volumes of data or computations. Healthcare organizations should consider implementing scalable and elastic IT infrastructure. This is enabled through cloud computing services or containerized environments, to support the dynamic needs of AI applications. This means a hybrid approach combining on-premises cloud computing and service cloud computing options could be the most advantageous solution. This hybrid strategy allows organizations to leverage the benefits of both deployment models while mitigating potential risks (A. Arrhenius, AI Sweden, personal interview conducted by Sara Mohamed, 2024).

On one hand, on-premises cloud computing infrastructure enables healthcare organizations to maintain control over their IT resources and data within their own facilities. This approach provides a level of autonomy and ensures that AI systems used for time-sensitive or critical medical cases can continue to operate even in the event of service disruptions or outages affecting external cloud providers. By hosting these critical AI applications on-premises, healthcare organizations can safeguard against potential "catastrophe scenarios" where external services become unavailable, ensuring uninterrupted access to vital AI-driven decision support or diagnostic tools.

On the other hand, service cloud computing options offer the advantages of scalability and elasticity. Healthcare organizations can leverage the on-demand computing resources and storage capabilities provided by cloud service providers, allowing them to dynamically scale their AI workloads up or down based on fluctuating demands. This flexibility is particularly beneficial for AI applications that experience periodic spikes in usage or require substantial computational power for training and processing large datasets.

By adopting a hybrid approach, healthcare organizations can strike a balance between maintaining control over critical AI systems and leveraging the scalability and elasticity of service cloud computing. Non-critical or less time-sensitive AI applications could be deployed on service cloud platforms, taking advantage of the cost-efficiency and scalability offered by cloud providers. Simultaneously, mission-critical AI systems that require uninterrupted availability can be hosted on-premises, ensuring continuity of operations even in the event of external service disruptions.

This hybrid strategy also allows healthcare organizations to gradually transition their AI workloads to the cloud as their maturity and confidence in cloud service providers grow. They can start by hosting less critical applications in the cloud and gradually migrate more essential systems as they gain experience and establish robust governance, security, and compliance measures.

By assessing and addressing their IT infrastructure readiness, healthcare organizations can better understand their AI maturity level and take appropriate actions to support the successful implementation or internal development of AI projects. Markus Lingman reported that Region Halland has been on the mission to build out their IT infrastructure since 2014 and that this is an important investment and is not substantial in relation to the whole yearly grant received from the government (counted in millions out of 9000 BSEK). He estimates that if a Region in Sweden decides to start this process today, it would take a couple of years to build out as technology has evolved.

Fralick emphasized that this level of data infrastructure readiness is what makes Unity Health capable of both undertaking value assessment of AI tools and applications, as well as for maximizing their value potential. At Unity Health, approximately $5 million Canadian dollars (≈M39SEK) were spent on building a robust data infrastructure, including data engineering, cloud computing resources, and tools for handling various data modalities (medical records, imaging, waveforms). Healthcare organizations at different maturity levels can succeed by recognizing their strengths and weaknesses and taking appropriate remedial actions to bridge gaps and create an enabling environment for AI adoption and innovation.

3.3 Personnel Training and Hiring

The initial phase of AI implementation in healthcare settings requires specialized technical personnel which implies direct costs associated with hiring new staff or training existing employees to fulfill these specialized roles. These positions could span from AI system technicians responsible for the operation and maintenance of AI hardware, to data scientists and engineers tasked with the development, calibration, and improvement of AI

algorithms. The specific roles and titles may vary, but the underlying need for skilled technical labor is constant (Lujan et al., 2021).

Beyond the immediate technical operations, the support from IT staff becomes indispensable, particularly in managing the hardware and software components of AI systems. AI implementations in healthcare will likely involve data analysis tools, requiring ongoing IT support to address software updates, cybersecurity threats, and hardware maintenance. In addition, from the analyzed use-cases across different hospitals in Sweden, one of the important roles was to have a project manager and consultant which could be seen as an AI strategist and helped them in designing, running and implementing the projects. In the future, having also a procurement specialist with expertise within AI and technology could be beneficial to advise on product requirements and conduct risk assessments (Lujan et al., 2021).

3.3.1 Dedicated AI Implementation Team at Unity Health

According to Fralick, Unity Health has assembled a multidisciplinary team with the necessary competencies for successful AI implementation which enables end-to-end development, from identifying use cases and building AI models to establishing data pipelines for real-time deployment and ensuring user-friendly interfaces (M. Fralick, Unity Health, personal interview conducted by Sara Mohamed, 2024). This diverse skill set is lacking in many healthcare organizations in Sweden, where some regions are better than others in having this type of competency in-house. For example, Region Västra Götaland has software engineers in-house, but they are only able to dedicate around 5-10% of their time to AI projects.

In addition, Page explained that attracting and retaining top data talent can be challenging due to competition from big tech companies and oftentimes hospitals are not able to provide a competitive pay. Hence what they usually look for are people that are looking to make an impact and ideally have already worked at bigger organizations before (M. Page, Unity Health, personal interview conducted by Sara Mohamed, 2024).

Page further highlighted that their initial plans and their current state have undergone some adjustments. The organization's first strategic decision was to prioritize the establishment of a robust data infrastructure which required investing in data engineers whose primary focus was on tackling the challenge of integrating hospital data into their environment effectively. Over time, Unity Health acknowledged the need to expand their team by bringing data scientists on board. This addition further enhanced their capabilities in data analysis and modeling.

Furthermore, the implementation phase heavily relies on effective administrative and project management support. The deployment of AI systems in healthcare is a complex

project involving multiple stakeholders and requiring careful coordination. The project management efforts, while adding to the initial costs, are fundamental in ensuring that the AI system is implemented efficiently, avoiding delays and additional expenses that could arise from mismanagement (Lujan et al., 2021). Unity Health has thus hired project managers to address the coordination and tracking of tasks, ensuring adherence to timelines and milestone achievements (M. Page, Unity Health, personal interview conducted by Sara Mohamed, 2024).

For example, the same study mentioned earlier in section 2.1 on AI for breast cancer screening required the recruitment of new skills needed for the research project such as experts in legal and societal aspects of AI and health economists that they did not have in-house already (K. Lång, personal written interview conducted by Sara Mohamed, 2024).

It is very common to lack certain competencies when starting out, which Unity Health solved in the beginning by borrowing certain functions from other areas, which they later recognized as necessary for their team's success. One such function was the inclusion of clinical informatics specialists, individuals with a background in clinical practice and expertise in healthcare technology. These specialists supported the setup, integration, and training of new technologies, such as electronic medical record (EMR) systems and medical devices. Initially, the organization had to rely on the expertise of their IT department to fulfill these roles, but eventually, they decided to bring clinical informatics specialists onto their team to ensure a more seamless and integrated approach.

Another critical function that was initially overlooked was product development, encompassing front-end software development, user experience, and human factors design. The organization realized the importance of having a dedicated group responsible for creating software interfaces and ensuring optimal user experience. This realization came as they progressed from defining problems, acquiring data, building models, and generating outputs to the realization that they needed software solutions to make their work usable and accessible. Consequently, they established a product development team to fill this gap.

3.4 Approaches to Identifying the Use Case

There are two main approaches that one can take to identify the AI use-case outlined below. Once they have been identified, it is crucial to reassess how they align with the organizational needs and purpose of the AI implementation. Ultimately, the project should align with the overall mission and goals of the organization, regardless of its scale. This alignment is crucial not only for creating synergistic and complementary effects across projects, enabling them to work in a common direction, but also for justifying the significant effort required to successfully implement AI technology.

3.4.1 Top-Down Approach

A top-down approach is related to the identification of the needs of stakeholders and the further integration of AI solutions with internal systems and processes. It constitutes a more systematic process to communicate and translate the implementation of AI from top executives or AI teams to all levels and functions of the organization Cunha et al. 2022). This team would then outline a clear AI strategy and vision looking at the broader healthcare processes and provide clarity on areas where resources are concentrated, ultimately helping to identify impactful opportunities for AI deployment. This team collaborates with relevant departments and subject matter experts to develop and implement AI solutions tailored to the organization's specific needs. Accordingly, as previously mentioned Unity Health has established an AI team within the organization that has the competencies needed to take care of the whole process from need identification to solution implementation.

3.4.2 Bottom-Up Approach

The bottom-up approach is a strategic and collaborative approach that consists of consulting the needs of stakeholders through the creation of indicators that link to user requirements and organizational needs. In this sense, it is a systematic way to engage stakeholders in the decisions that will be taken regarding AI solutions and later incorporated into the organization's processes and systems (Cunha et al. 2022).

This approach has also been adopted within Unity Health towards identifying problems that can be effectively addressed through AI solutions, where they usually break down the patient flow to see AI can be of the biggest value. This has helped their organization reach a 70% success rate for AI implementation projects, which is significantly higher than the industry average of 20-30% reported in studies from MIT and Harvard Business Review.

Unity Health places a strong emphasis on involving healthcare professionals, such as doctors and nurses, in the initial problem identification stage. Many of the AI use cases have originated from healthcare practitioners themselves, who have encountered specific challenges or inefficiencies in their daily workflows and reported it to the responsible team. This also means that their end-users which are usually clinicians and nurses are deeply engaged throughout the development process, meeting weekly/bi-weekly. Their work is however not increased when they have identified a problem as the goal is to reduce workload (M. Page, Unity Health, personal interview conducted by Sara Mohamed, 2024).

Ways in healthcare organizations can identify AI use cases through task decomposition and segmentation:

1. Clinical workflows: Healthcare organizations can break down complex clinical workflows, such as patient triage, diagnosis, treatment planning, and follow-up care, into individual tasks or steps. By analyzing these tasks, they can identify areas where AI could potentially streamline processes, improve efficiency, and enhance decision-making.

2. Administrative processes: Administrative tasks, such as scheduling, can be decomposed into smaller components. This segmentation can help identify repetitive, data-intensive, or error-prone tasks that could benefit from AI-enabled automation or decision support.

3. Diagnostic and imaging processes: Medical imaging and diagnostic processes can be segmented into tasks such as image acquisition, preprocessing, analysis, and interpretation. AI algorithms can be leveraged for tasks like image enhancement, pattern recognition, and computer-aided diagnosis, potentially improving accuracy and efficiency. *(see appendix 6.2 for a use-case example)*

3.4.3 The Combined Approach

The problems identified by healthcare professionals are not immediately assumed to be suitable for AI solutions. Instead, Unity Health validates the relevance and significance of the problem through a rigorous vetting process. This approach ensures that the AI solutions being developed are addressing real-world challenges that matter to the end-users, rather than pursuing AI implementation for its own sake. Furthermore, it is important to have a clear understanding of the problem, and the data required to solve it.

Once a potential problem is identified and validated, Unity Health involves a multidisciplinary team, to evaluate the feasibility and impact of developing an AI solution. This evaluation considers various factors, such as the availability of necessary data points, the potential benefits to patient care or workflow efficiency, and the alignment with Unity Health's overall objectives.

Unity Health’s approach seems to be iterative, allowing for refinement and adjustment based on feedback and lessons learned from previous implementations. Over the past five years, they have gained insights into which problems are more suitable for AI solutions and which ones might not be feasible, given certain constraints (M. Page, Unity Health, personal interview conducted by Sara Mohamed, 2024).

3.5 Risk Assessment

Evaluating risk tolerances is essential when implementing AI that could impact care decisions. The margin of error, for instance, depends on the context of the problem being addressed. For instance, a predictive model for patient flow in the emergency department can have a higher margin of error than a model for predicting patient outcomes. Indeed, the risk associated with mispredicting the number of people in the emergency room at any given time does not have the same consequences as mispredicting a patient as not having cancer when they actually do and require urgent treatment. The type of risk is therefore different and with each AI application having an ethical board that would discuss the different types of risks and what is an acceptable risk is important (M. Lingman, Region Halland, personal interview conducted by Sara Mohamed, 2024).

Figure 3 illustrates the risks that have been identified by Nacka commune that currently exist within primary care in relation to AI. These also extend to all AI projects within public healthcare and need to be evaluated and assessed before approving its implementation.

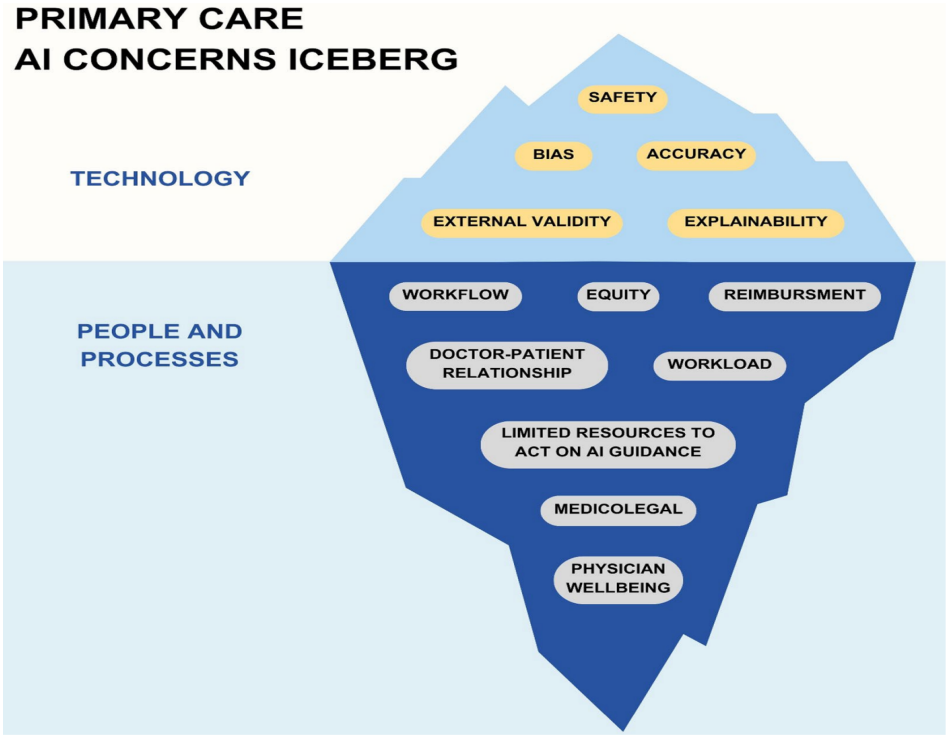

Fig. 5. Primary Care AI Concerns Iceberg

Source: Allen et al. (2024). Navigating the doctor-patient-AI relationship: A mixed-methods study of physician attitudes toward artificial intelligence in primary care.

4. ROI-Modelling

4.1 Introduction to ROI

ROI is a financial metric that quantifies the profitability of an investment by comparing its gains or losses to its initial cost. Traditional ROI calculations often assume a positive return from every project, which may not be realistic in the context of AI implementations for healthcare initiatives due to several reasons. These include first and second-order effects, uncertainties associated with the rapidly evolving nature of AI technology, and the effectiveness of AI technology, which depends on the quality of the AI model itself and the maturity of the healthcare organization adopting it.

One of the challenges highlighted by Tyreholt at Visiba Care is that the procurement process fails to account for this continuous evolution of technology. Once a technology is procured, there are no requirements or incentives for the provider to keep upgrading it (since they are not part of the procurement requirements for competing providers), leading to rapid obsolescence, particularly in the context of AI technology, where systems can become outdated within a year. Consequently, organizations may find themselves stuck with outdated systems for an extended period, as the procurement process itself is lengthy and does not facilitate subsequent procurements easily. To address this issue, provisions for continuous upgrades and timely replacements should be incorporated into the procurement system to prevent organizations from being saddled with obsolete technologies for prolonged periods.

While there is no single calculation that is used broadly across regions in Sweden, there are still a few ROI-calculators available.

1. **Region Halland and The Stockholm School of Economics Calculator**

This ROI model has been developed specifically for healthcare applications and aims to integrate economic return in a simplified way. It does not include qualitative social value that could be captured from technology integration which may include improvements in patient quality of life, enhanced access to care, reduced healthcare disparities, and the promotion of preventive and personalized medicine.

Building extensive business cases for AI investments for Region Halland has been a challenge and not a common practice as the benefits are currently hard to quantify, especially when assessing the whole effect chain. This could also be attributed to the ever-evolving nature of AI technologies where the realization of benefits may unfold gradually over time, with unforeseen ripple effects and emergent synergies that are difficult to predict or quantify accurately during the initial

investment evaluation phase.

2. **Nacka Municipality Calculator**

The approach of Nacka Municipalities calculator focuses on analyzing a so-called impact chain where benefits are connected with impact targets. This helps with identifying which change efforts are required to achieve this. The effect chain as a whole helps with visualizing the common thread in how different change efforts can be linked all the way to the municipality's overall strategic goals. This calculator has also a section considering remaining in current state and its implications considering change in external factors such as inflation and population growth. This calculator was developed for all types of investments made by the municipalities to help them with identifying the benefits and understanding what is required for these to occur and how to do the follow-up.

Find the calculator here: https://nacka.infocaption.com/2478.guide

3. **AI Sweden ROI Calculator**

The AI Sweden ROI calculator is under development and while it encompasses qualitative value capture, it has been perceived as rather complicated for healthcare applications. The different margins for each of the components would need to be adjusted and validated with different hospitals.

4. **Inera ROI Calculator**

Created to be used by independent service providers within the procurement process, this is another simplified version of an ROI calculator.

Find the calculator here:
https://inera.atlassian.net/wiki/spaces/OINK/pages/2356053310/Excelmall

Some of these calculators are overly complex and can make it difficult to determine which value factors should be included and which should be left out. This can result in an inflated or deflated ROI evaluation where inaccurate ROI results can be costly in both cases. For instance, an overinflated ROI-number can lead to a poor investment and an deflated ROI-number can lead to missed chances to improve healthcare practices and offerings.

In the Swedish healthcare system, it has been challenging to calculate the ROI for the various pilot projects, due to lack of documentation for current processes that could be compared to the results from implementing the new technology in a pilot setting. The interviews conducted also reveal that it is very unusual for these hospitals to follow up on the projects initiated once it has been approved for procurement even though on paper, they are required to (S. Lundsten, Region Västerbotten and H. Nilsson, Region Halland, personal interviews conducted by Sara Mohamed, 2024).

Investing time and resources into conducting ROI analyses for various projects can still be highly beneficial. By evaluating the potential economic returns and cost-effectiveness of proposed initiatives, regional authorities can make informed decisions that maximize the impact of their investments while ensuring responsible resource allocation.

ROI models provide a structured framework for assessing the financial viability and long-term sustainability of projects. By quantifying the potential returns and comparing them to the associated costs, ROI analyses enable decision-makers to prioritize projects that offer the most significant economic and social benefits to their respective regions. This can also help in justifying procurement of technologies that would bring on benefits to other departments than the one it will be utilized for. This is common in healthcare where the purchase of a technology can have significant impact on multiple parts of the effect chain.

Example

Consider the implementation of an electronic health record (EHR) system in a regional healthcare network. This initiative falls under the transformative category as the effects that come with it are not constrained to only that specific problem and the benefits can be realized in different areas.

While the primary beneficiary of this technology would be the clinical departments directly utilizing the EHR for patient record management, the potential benefits extend far beyond a single department. An effective EHR system can streamline administrative processes, reduce redundancies, and enhance data sharing among various departments. Thus, using an ROI-calculator can be beneficial in the short-term to assess the direct value creation of the use-case.

However, an ROI-model is usually limited and does not account for the spillover effects that happen from AI implementation. For instance, an integrated EHR system can facilitate better coordination of care among different healthcare providers, leading to improved patient outcomes and reduced readmission rates. This, in turn, can result in cost savings for the entire healthcare system by reducing unnecessary hospitalizations and minimizing the risk of costly medical errors.

ROI evaluations can also support the transition towards more outcome-based decision-making, aligning regional investments with measurable outcomes and value-based care models that prioritize cost-effectiveness and optimal resource allocation. By considering the long-term impact and potential cost savings associated with various healthcare initiatives, regions can make strategic investments that improve the overall quality of care while maximizing resource utilization.

Furthermore, ROI models can facilitate transparency and stakeholder engagement by providing a common language and shared understanding of the potential benefits and costs associated with various initiatives. By involving stakeholders in the ROI evaluation process, regions can foster collaboration across the whole value-chain, build consensus,

and ensure that proposed projects align with the broader economic and social priorities of the organization and community.

However, an excessive emphasis on ROI for individual projects or initiatives in the healthcare sector, can inadvertently hinder innovation by fostering a narrow perspective that overlooks the broader implications and long-term success factors. For instance, in some regions such as Region Stockholm and Region Västerbotten, it became clear that without a business case that clearly outlines the economical ROI from an AI application, it became hard to convince the procurement board to go through with the investment. Instead, they had to rely on completing pilot projects to showcase the potential value first, which in turn drains resources. Therefore, it is crucial for healthcare organizations to strike a balance between ROI considerations and a broader vision that extends beyond their immediate organizational boundaries where the ROI becomes one item in an analyst's toolkit, rather than a decisive factor (A. Norén, Karolinska University Hospital and S. Lundsten, Region Västerbotten, personal interviews conducted by Sara Mohamed, 2024).

4.2 A balance between short- and long-term ROI

An ROI-model should not be a mere calculator but rather an attempt to understand how it could affect multiple stakeholders along the value chain, requiring a paradigm shift from product-centricity to customer-centric. While ROI is undoubtedly a critical factor in determining the feasibility and financial viability of healthcare investments, an overly rigid adherence to short-term ROI metrics (especially the economic factors without considering the broader social factors that are harder to quantify) may lead to overlooking initiatives that have the potential to drive transformative change and improve overall population health outcomes. For instance, investments in preventive care programs, community outreach initiatives, or cutting-edge medical research may not yield immediate financial returns but can significantly impact public health and pave the way for future breakthroughs.

To ensure long-term success, healthcare organizations must adopt a holistic approach that considers the broader ecosystem in which they operate. This includes understanding the evolving healthcare landscape, anticipating demographic shifts where the aging population has severe consequences on the functioning of the healthcare system, monitoring emerging health trends, and adapting to changing societal needs and expectations. By expanding their perspective beyond immediate organizational boundaries, healthcare providers can better align their investments with the long-term needs of the communities they serve, fostering sustainable growth and delivering comprehensive healthcare solutions.

4.3 Consequences of Inaction

Additionally, it is imperative to address the implications of inaction in the face of a rapidly changing healthcare environment. Failure to adapt and innovate could have severe consequences in the medium to long-term. For example, if a healthcare organization does not invest in digital health technologies and telehealth solutions, it may struggle to meet the growing demand for convenient and accessible healthcare services. Page anticipates a decline in quality, increased costs, recruitment difficulties, and higher staff turnover as potential outcomes. From his perspective, neglecting to create an environment conducive to AI implementation sends a message that the organization is unwilling to invest in its business and people (M. Page, Unity Health, personal interview conducted by Sara Mohamed, 2024).

Another risk that comes with inaction is that the public healthcare system will not be able to manage the challenges posed by population growth and an aging population. A future scenario that is not unlikely as we are already experiencing it today but on a smaller scale is the ratio of physicians to patients that would become increasingly strained. In this case, for Unity Health, AI and other technologies are crucial for meeting the growing demand for healthcare services. Already today they are leveraging AI to predict patient no-shows for medical imaging appointments and proactively offering earlier slots to patients on waiting lists (M. Page, Unity Health, personal interview conducted by Sara Mohamed, 2024).

Similarly, if healthcare organizations do not prioritize investments in areas such as preventive care, chronic disease management, and population health initiatives, they may face increased healthcare costs and strain on their resources as the prevalence of chronic conditions and associated complications rises within the communities they serve.

4.4 Building a business case

4.4.1 Starting with a specific use case

Starting with very specific use cases helps to ensure focused analysis when building a business case. This is because broad evaluations dilute the focus and often miss the nuanced data critical for a meaningful analysis. Instead, going in depth in particular scenarios, such as AI for forecasting patient discharge, ensures that evaluations are precise and contextually relevant. By focusing on specific, data-rich use cases, and understanding how they affect the entire treatment pathway, quantifying behavioral impacts, and fostering an environment of continuous learning and adaptation, healthcare providers and AI developers can build robust ROI-models and overcome implementation hurdles effectively

(G. Bothma, Health Economist and innovation value strategist, personal interview conducted by Sara Mohamed, 2024).

AI For Postoperative Department – Region Västerbotten

Note: this case will be used as a case-example for how business cases could be constructed and evaluated throughout this section.

At Norrlands University Hospital in Umeå, a need to optimize hospital resource allocation when it comes to utilization of beds for post operations was identified and a new algorithm using AI was developed accordingly. Specifically, a pilot project has been initiated to employ AI for forecasting patient discharge times in a postoperative care unit scheduling surgeries in an optimized way. This project is designed to enhance efficiency within the hospital's postoperative stays, aiming to mitigate delays and prevent patient complications by better managing hospital resources.

4.4.2 Baseline Assessment

Establishing a clear and agreed-upon baseline for existing care pathways and processes is a critical step in building an ROI-model for an AI application in healthcare. Failure to achieve early consensus among key stakeholders on the current standard of care can lead to inconsistent and unreliable ROI evaluations, hindering the adoption and implementation of the AI innovation. (G. Bothma, Health Economist and innovation value strategist, personal interview conducted by Sara Mohamed, 2024).)

Baseline assessment plays a crucial role in accurately measuring the potential impact and return on investment of the proposed AI solution. By collecting comprehensive data on the current standard of care for the specific use-case, stakeholders can benchmark the existing processes, identify inefficiencies, and quantify the potential improvements offered by the AI application.

Without a thorough understanding of the baseline, it becomes challenging to accurately assess the potential cost savings, improved patient outcomes, or streamlined workflows that the AI solution can deliver. Inconsistencies in the baseline data can lead to unreliable ROI projections, which may undermine stakeholder confidence and hinder decision-making processes.

4.4.3 Comparative Pathway Analysis

Traditional medical technology evaluations often focus solely on comparing the performance of a new device or application against an existing one within the same care setting. However, AI applications have the potential to fundamentally transform and streamline entire clinical pathways, potentially shifting portions of care to different settings

like the home environment. By evaluating and quantifying these systemic pathway changes, healthcare providers can more accurately project the ROI, identify process redesign opportunities, and build a stronger business case for adopting transformative AI applications (G. Bothma, Health Economist and innovation value strategist, personal interview conducted by Sara Mohamed, 2024).

This approach helps to account for the broader systemic impacts of AI implementation where the end-to-end patient journey and care processes are evaluated holistically, rather than just the specific task or diagnostic step where the AI is directly applied. This wider lens is essential because AI's effects can ripple across the entire treatment pathway, impacting factors like workflow efficiency, resource utilization, patient experience, and healthcare costs. For example, in the case of AI-assisted breast cancer screening, the analysis shouldn't just compare the diagnostic accuracy of the AI system against current methods. It should also consider how the AI could enable earlier or more accurate detection, leading to expedited treatment planning, reduced need for invasive procedures, improved patient outcomes, and lower overall care costs. Additionally, AI could potentially shift some monitoring or follow-up care to home settings, further impacting the care pathway economics (G. Bothma, Health Economist and innovation value strategist, personal interview conducted by Sara Mohamed, 2024).

This comprehensive "pathway to pathway" comparative analysis provides a more complete picture of AI's true clinical and financial impacts across the entire continuum of care. It accounts for potential trade-offs, such as upfront investment costs balanced against long-term savings from streamlined processes or improved outcomes. Without this wider lens, the business case risks being shortsighted or missing key value drivers.

AI For Postoperative Department – Region Västerbotten

The ability to calculate the ROI for the Postoperative AI project that has been deployed in Region Västerbotten has been limited. The lack of data on current processes made it impossible to do a comparative analysis and assess the value creation. Thus, more resources will now be spent on conducting studies on before and after implementation of the AI in this particular use-case, to be able to quantify the benefits.

4.4.4 Internal Capability Assessment

Conducting an internal capability assessment helps organizations understand their strengths, weaknesses, and readiness to undertake the proposed project. By asking the right questions, organizations can identify potential gaps, risks, and opportunities, enabling them to make informed decisions and increase their chances of success.

These questions prompt organizations to carefully examine the resources, skills, expertise, and financial considerations required to execute the project effectively. They encourage organizations to consider factors such as personnel, technology, infrastructure, specialized knowledge, and any potential skill gaps or resource constraints. Some of the questions to be answered are:

- Does our current IT infrastructure support such a project?
- Do we have what we need in-house, or do we need to outsource? In the case of in-house development, do we have the necessary data and competency?
- Do we have the financial resources to do this?
- What is our budget for this project and do we need external funding?
- What potential challenges would we potentially face and how will we overcome them?

AI For Postoperative Department - Region Västerbotten

Capability Assessment:
Competencies

To carry out the pilot, there was a need for different competencies, some of which they already had in-house and others they had to hire such as the consultant that designed the AI project for them. Furthermore, this hospital already had software engineers and technical capabilities in-house.

When assessing the decision to either outsource AI development or to build an AI system in-house, the project leader pointed out that typically, procuring technology externally is more cost-effective than creating a solution from scratch. This advantage often stems from leveraging existing solutions that have been refined through competitive market forces and gone through rigorous clinical testing which saves crucial time. However, in her specific scenario, the absence of a tailor-made solution in the market prompted the decision to develop the AI system internally. This decision was significantly supported by the presence of necessary data within the organization, which provided a strong foundation for building a customized AI solution that fit exactly what they needed, an advantage compared to procured solutions. Moreover, the availability of funding further facilitated this in-house development process.

Thus, to accommodate this project, members from the software development and engineering teams dedicated sections of their work schedules to this initiative, although it is worth noting that they only dedicated 5-20% of their working time to this. This strategy was chosen to ensure that the AI system was synergistic with the hospital's current infrastructure and perfectly tailored to meet specific operational needs.

Financial Resources

To run this pilot, the hospital had received an innovation grant of 4.2 million SEK from Tillväxtverket and was divided into two parts where 2.1 MSEK was paid out directly to the hospital and the rest was paid out as personnel salaries. The total cost of the project however, amounted to 6.4 million SEK and therefore needed to invest an additional 2.2 million SEK once they had consumed the grant.

Some of the biggest cost contributors were personnel salaries, attending necessary conferences, and procuring hardware such as bigger screens that were needed.

Challenges

One challenge faced during the project was the limited time allocated by staff members who combined this project with their regular duties. This constraint affected the project's timeline, especially when debugging was required during the testing phase. Since the team could only intermittently address issues within the AI system, resolving technical bugs was often delayed, leading to prolonged periods before the system could be fully functional again and the pilot project up and running.

These limited in-house resources resulted in slow progress leading to further challenges when it comes to sustaining the project beyond the grant funds. Despite the initial investments, the project is still in the pilot phase 4 years later, and the biggest problem faced as of now is that once the hospital ran out of the innovation grant, the project was expected to end as there is no more funding and hospital resources are limited. Lundsten continued financing the project herself by paying the personnel salaries from the hospital's budget while not being able to report the project. This means that the time that can be spent on this project is limited as other duties need to be prioritized. Not only that but they also have the running costs of the servers where the AI model is hosted and in addition to maintenance costs to ensure that the technology is running as it should.

The choice to develop the system internally came also with its set of challenges. One of the challenges was the packaging of the AI-algorithm that was built making sure that it is easy to use for the staff that will be working with it as it required other competencies than what they had access to. This is one of the parts that consumed the most time during the project. On the other hand, this also meant that there was no need to train the staff in order to be able to use it nor did they need to convince them as they were involved during the whole process and got to learn it while it was being developed.

4.4.5 Behavioral Impact Quantification

Changes in stakeholder behavior, such as how clinicians interact with and utilize the AI system, can significantly impact the overall efficiency, outcomes, and ultimately, the realized ROI. By quantitatively modeling these behavioral changes, healthcare organizations can capture their impact on the ROI accurately and build a more robust business case. For instance, the model could compare the ROI projections for a scenario with high AI utilization

rates due to effective change management versus a scenario with low adoption due to resistance or inadequate training.

This approach can inform strategies to maximize the ROI by identifying potential adoption barriers and developing targeted interventions to address them. For example, the analysis may highlight the need for comprehensive clinician training programs or user interface improvements to facilitate seamless AI integration into existing workflows.

Region Västerbotten Real-life Example

The head of this project sees potential challenges that would need to be addressed and different scenarios would need to be modeled when quantifying the value of this AI-application, as even though the AI system would be able to prioritize which surgeries to be done first by which surgeon, they are still dealing with humans that have preferences and might not agree with the AI on the times allocated. This means that while AI has the capacity to optimize their operations and increase the number of beds available to be able to treat more patients in the same amount of time, this might not be feasible if the users of the AI system do not adhere to it or utilize it according to its full potential.

4.4.6 ROI Analysis

Conducting ROI analyses involves straightforward calculations to determine the financial impact and limitations of the new technology. By modeling various scenarios, healthcare organizations can identify when the break-even point for their investment can be achieved and uncover any weaknesses or limitations in the economic argument for adopting the AI solution. The break-even point refers to the point at which the cumulative benefits of the AI implementation surpass the cumulative costs, indicating a positive ROI. This is what eventually will inform decision-makers on whether to go forward with the project or not. The analysis may reveal that the upfront implementation costs are prohibitively high, requiring organizations to explore alternative financing options or phased rollout strategies.

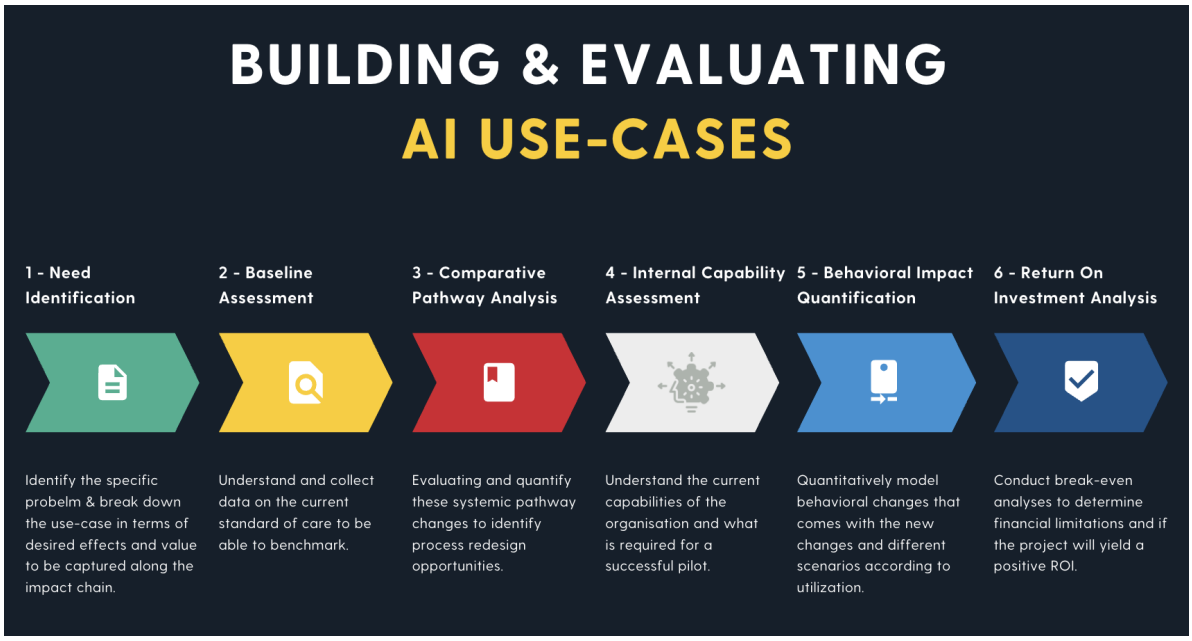

Fig. 6. Steps of Business Case Development

5. Discussion & Recommendations

Based on the current findings from the interviews, it is clear that there is no standardized way across hospitals in the public healthcare in Sweden when it comes to need identification for different problems encountered, how to build a business case to support the decision-making nor an AI adoption team.

One approach to streamlining the implementation process might involve the establishment of a specialized task force either within the bigger hospitals such Sahlgrenska University Hospital and Karolinska University Hospital or on a regional level, dedicated exclusively to managing the lifecycle of AI technology implementation. This team could be equipped with decision-making authority and resources to expedite evaluations related to risk, feasibility, and potential benefits. By centralizing this function, hospitals could adopt a more agile approach, enhancing their capacity to adapt to new technologies swiftly and efficiently. This means that the initial phase involves a top-down approach to establish the necessary IT infrastructure and framework to support AI implementation. This centralized strategy will involve identifying and implementing the required technological foundations, data management protocols, and governance policies to create an environment conducive to AI adoption based on each organization's unique needs.

Once this overarching infrastructure is in place, the second phase can employ a bottom-up approach, empowering individual healthcare facilities, departments, and practitioners to

identify their specific needs and adopt AI applications tailored to their unique requirements. This decentralized approach allows for a more localized and customized adoption of AI solutions, catering to the diverse challenges and contexts encountered across the healthcare landscape.

This two-fold strategy combines the benefits of centralized planning and localized customization. The top-down approach ensures a consistent and robust foundation for AI implementation, while the bottom-up approach fosters a sense of ownership and empowerment among healthcare professionals, enabling them to adopt solutions that directly address their specific needs. Once these cases have been identified, the AI team could work together with the responsible department or doctor to validate it, assess feasibility and to build a business case leveraging the ROI-model to assess potential value creation.

One potential challenge with the bottom-up approach is that currently many healthcare providers are facing the dual challenges of sustaining existing workloads while engaging in innovation. Adequate resources and upper management would need to encourage its staff to think critically about the problems that they face on a daily basis and provide them with the time to do so.

However, if done successfully, this more streamlined approach would allow for a quicker reaction to the rapidly evolving medical technology landscape, ensuring that innovations that can significantly improve patient care or operational efficiency are not unduly delayed by systemic inertia. By fostering a more dynamic environment for technology adoption, the Swedish healthcare system could potentially see improvements in both patient outcomes and overall system productivity.

By adopting this approach and creating successful AI implementation cases, these can be leveraged as blueprints for implementation in smaller hospitals. Documented success stories reduce the inclination to start from scratch and foster confidence in the potential of AI solutions and hence these hospitals or primary care providers can adopt these technologies without having to go through the whole procurement process as they would have already been approved. This can be done through facilitating knowledge sharing among municipalities to maximize learning and efficiency gains. Lundsten anticipates that the adoption of AI and advanced technologies by an increasing number of hospitals will facilitate a streamlined learning and procurement process. For example, if one region is good at structuring data, then the hope is to be able to access that knowledge and make it transferable to other regions. This is expected to mitigate the need for redundant project repetition, thus enhancing operational efficiency and removing the building and testing phase. She mentions that having contact with AI Sweden has been instrumental in realizing this project by getting access to expertise within AI and their network to learn more about

what other hospitals are doing which built the bridge between them that was missing. Dalåsen from Region Västra Götaland states that there is a lack of trust where a lot of the projects are being redone before implemented meaning lost time and money. Instead the best practices should simply be transferred from one hospital to another if it is successful without having to rerun a pilot project. One challenge that can come with this is that regions have different IT infrastructures and collect data differently which makes it more difficult to create a standardized framework that can work for any organization and there is still a need to understand one's circumstances to tailor it and be able to measure the value creation. (T. Dalåsen, Region Västra Götaland, personal interview conducted by Sara Mohamed, 2024)

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7. Appendices

7.1 CASE STUDY: AI for Fall Prevention (Region Västra Götaland)

Need Identification

In 2023, Region Västra Götaland (VGR) had 1,800 registered physical fall injuries during care periods, which means that a fall injury occurs in approximately 1 percent of care instances. This is significantly higher than the regional target set by VGR at a maximum of 0.5 percent.

Baseline Assessment

Currently, in order to reduce the number of falls, assistive devices such as alarm mats, motion detectors, bed rails, lighting, and non-slip socks are implemented. In cases where the patient has a high risk of falling, supervision is increased with staff on hand around the clock in the form of a "restless watch". The assistive devices currently in use are not sufficient to prevent falls and cannot detect when a fall is about to occur.

Comparative Pathway Comparison

To improve the situation, it is proposed that a new working method with associated technology be introduced which consists of a radar sensor that reads movement patterns in three dimensions, and an associated algorithm that interprets the pattern and alerts staff if a fall is at risk of occurring. With the help of this new method, VGR's operations can proactively work to prevent falls in inpatient care.

Internal Capability Assessment

<u>Competencies Required</u>

Considering that this is a mature product use-case, it was more cost effective to look for external providers to provide the technology needed which eliminated some of the competencies needed to develop something in-house.

The project was a side project just like in the previous case, where the participants had to dedicate time on the side to be able to realize this project except for one project coordinator that was working full time on this. This meant that the project was a lot slower than it should have been. Falls are the third biggest problem at the hospital and that is how they identified the need to implement new technology for it to reduce the incidents.

Financial Resources

The initial investment was 1.6 million SEK over the period of 2 and a half years. For this case study, two hospitals implemented sensors to detect the motion of patients in the stroke department. Each sensor costs around 500-1000SEK per month depending on the chosen provider and the negotiated deal. With these sensors, there is also the potential to use them for other cases such as detecting no movement in patients that can develop the risk of ulcers and having the nurses check on them at the right time. During the pilot project, most of the costs went into paying consultants to work on this project in the beginning while the provider stood for the costs of the sensors.

Challenges

During the test, they encountered a few hindrances such as the different classification of the technology and whether it falls under the MDR or not.

One opinion is that the implementation of AI in healthcare is slow due to the fact that nurses are already overworked and do not have the time to actually think about where technology could be beneficial and save resources.

The implementation of the project will incur another 40MSEK, which is a sum that the hospital currently does not have, and which will be covered by the digitalization budget. The purchase of sensors will be paid for by the operations through their operational budget, and administration costs including license fees will be invoiced through the digitization agreement (DÖK).

ROI Analysis

Now that the pilot project has shown to be successful, and the negotiations have started, the forecasted costs for this project fall in the 40 million SEK over a year period while the savings for the same period amount to 140 million SEK. The majority of these savings are related to time savings and the fact that they do not need to employ extra nurses anymore to account for the falls that would usually happen. They also cover the costs of the returning patients that have fallen and that need extra care.

During the pilot studies, the sensors helped prevent 67% of the otherwise occurred falls and the results are even more optimistic in other hospitals.

ROI-model:

The cost analysis reveals that the project will incur financial costs amounting to 78 million SEK, covering expenses such as sensor purchases, implementation project costs, license fees, and other related expenses. Additionally, there will be reallocation costs of 5 million

SEK, which account for the time invested by personnel in training and preparation for the new working method.

On the benefit side, the analysis identifies three main categories: financial, reallocation, and qualitative benefits. The financial and reallocation benefits are quantified in monetary terms, while the quality benefits are considered but not assigned a monetary value and hence not included in this model.

The financial benefit of 38 million SEK is expected to arise from a reduction in the number of "restless watches" currently performed by hourly staff. This benefit represents cost savings achieved by optimizing staffing resources.

The substantial reallocation benefit of 185 million SEK is projected to result from the new working method being more time-efficient compared to the current practices. This benefit reflects the potential for staff to reallocate their time to other productive tasks, leading to increased operational efficiency.

Combining the financial and reallocation benefits yields a total benefit of 223 million SEK over the six-year period. By contrasting the total benefit of 223 million SEK with the total cost of 83 million SEK, the analysis reveals a net positive gain of 140 million SEK for the region. This positive net gain translates into a ROI of approximately 68.67% for the project.

The analysis suggests that the proposed project presents a favorable ROI, with the potential benefits outweighing the costs. The significant reallocation benefit, coupled with financial savings, contributes to the project's overall positive financial impact on the region.

Typ	Nytta	Kostnad	**Resultat**
Finansiell (Värderas i pengar, kan vara besparingar, ökade intäkter eller större utgifter)	38 000 000 kr	-78 000 000 kr	**-40 000 000 kr**
Omfördelning (Frigjorda resurser som kan värderas i pengar, men som hämtas hem när de används på nya sätt)	185 000 000 kr	-5 000 000 kr	**180 000 000 kr**
Totalt			**140 000 000 kr**

Fig. 7. ROI for AI for Fall Prevention

7.2 CASE STUDY: AI for Breast Cancer Detection

The MASAI Trial at Unilabs Mammography Screening Center, Lund, Sweden

Need Identification

With approximately one million women requiring annual mammography screenings, the current standard practice requires two breast radiologists to review each examination (double reading). This approach, while ensuring high sensitivity, places substantial strain on the limited available workforce of radiologists. The shortage of specialized radiologists threatens the sustainability and efficiency of the screening service, creating an urgent need for innovative solutions to maintain quality while managing workload. (Lund University, 2023)

The Mammography Screening with Artificial Intelligence (MASAI) trial represents a randomized controlled trial (RCT) evaluating the clinical safety and effectiveness of AI-supported mammography screening. Conducted at on a single site in a Swedish setting by Kristina Lång who is a researcher and associate professor in diagnostic radiology at Lund University and consultant at Skåne University Hospital, the study evolved through several distinct phases:

- 2017: Initial implementation of AI in the clinic to test and provide feedback to the AI developer.
- 2018: Continuation of retrospective studies
- 2020: RCT planning phase
- 2021-2022: Trial execution, enrolling 100,000 women by December 2022
- 2023: Publication of initial results in The Lancet Oncology
- 2024: Decision by Unilabs to implement the AI according to the screen-reading protocol evaluated in the trial.

The core study included 80,033 women, divided between an intervention group (40,003 women) receiving AI-supported screening and a control group (40,030 women) undergoing traditional double reading (Lund University, 2023).

In addition, this study is part of a broader national initiative to integrate AI into mammography screening. Similar projects are ongoing in the Stockholm region, including a clinical study at Capio St. Göran's Hospital and research at Karolinska University Hospital, where teams are evaluating different AI approaches to enhance breast cancer detection. (Karolinska Institutet, 2024)

Capability Assessment

Competencies Required

Lång has dedicated half of her research time to this study, which has varied during the project's duration. What began as a small core research group gradually grew into a comprehensive team of approximately ten researchers. As the project matured, it incorporated specialized expertise from legal experts, societal AI specialists, and health economists, ensuring a comprehensive approach to both the technical and broader societal implications of AI implementation in healthcare (K. Lång, personal written interview conducted by Sara Mohamed, 2024).

Financial Resources

The total cost of the project is not disclosed, but the largest expenditure has been salaries for involved researchers with 90% of the costs spent on staff. The project was funded by The Swedish Cancer Society, Regional Cancer Centers in Sweden and grants from research and education of doctors, ALF. Furthermore, the AI technology used in the project was a commercial tool, and not developed in-house. The research team opted for a server-based infrastructure implementation rather than cloud solutions after cost considerations revealed that cloud-based services were unexpectedly expensive, leading them to defer cloud adoption for the time being (K. Lång, personal written interview conducted by Sara Mohamed, 2024).

Risk Assessment

As defined in the study, a false positive occurs when a woman is recalled for additional examination but is subsequently cleared of cancer suspicion after workup. This metric is crucial as false positives can cause unnecessary anxiety and additional medical procedures. The study demonstrated that the AI-supported screening maintained the same false positive rate as traditional double reading, even while detecting 20% more cancers. This achievement was particularly significant as it showed that increased cancer detection did not come at the cost of more false recalls. The risk management approach was validated through the randomized controlled trial methodology, which allowed direct comparison between AI-supported screening and standard practice. Quality assurance was maintained through systematic comparison with traditional double reading protocols, ensuring that the implementation of AI support did not compromise the careful balance between sensitivity and specificity in mammography screening (Lund University, 2023).

Furthermore, according to Strand, a researcher and radiologist at Karolinska University Hospital (Karolinska Institute, 2024) it is inevitable that some women will receive a false negative diagnosis, only to discover a lump in their breast six months later. This is not a new

phenomenon, as it already occurs in nearly one-third of cancer cases, particularly in women with specific breast anatomies and tumor types. Strand emphasizes the need to expand the discussion surrounding the use of AI in breast cancer detection, specifically highlighting the importance of acknowledging and accepting the margins of error that come with relying on AI technology.

Quantified Value Creation

The study demonstrated substantial measurable value across multiple dimensions of healthcare delivery. First, the workload reduction data is quite specific: the AI-supported screening reduced the total number of screen readings from 83,231 in standard screening to 46,345, representing a 44% reduction in screen-reading workload. To put this in practical terms, the study estimated that for approximately 40,000 screening examinations, this reduction translated to about five months less of a radiologist's time. This calculation was based on the standard rate of radiologist reading, which is approximately 50 screening examinations per hour. Secondly, in terms of clinical outcomes, the system achieved a 20% increase in cancer detection, identifying 41 additional cases while maintaining existing false positive rates (Lund University, 2023).