Sociotechnical Debt in Health Information Systems

How Culture, Structure, and Vendors Shape Digital Risk

Taimo Paavola

Supervisor: Antti Sekki, Principal Lecturer, Laurea University of Applied Sciences

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Dedication / Acknowledgements

A sincere thank you to my supervisor, Antti Sekki for creating a supportive environment for this project giving expertise at any time. The valuable insights with relaxed but in a highly professional manner create trust and a positive outlook.

My profound gratitude goes to my supportive family who understands the importance of education and academics.

Sofia, my dear new-born. You have created a lot of drive and energy for a new parent to succeed in these endeavors. I hope you can be proud of your father one day and fulfill your own dreams in the future. My task is to guide you toward your own journey and to help build a future-ready foundation upon which you can shape your world.

Taimo Paavola

Abstract

Digital transformation in the healthcare sector is in constant change. The technical costs are sometimes hidden and slow the operational work. This research offers perspectives on how technical debt and its extended socio aspect affect future costs.

Technical debt refers to the future costs incurred when short-term solutions are chosen instead of investing in a more sustainable approach. Recent research has expanded this perspective not only as a technical artifact challenge but rather by bringing human, organizational, and systemic factors into a broader discussion referred to as sociotechnical debt.

This research curates the literature part, making a distinction between technical debt and sociotechnical debt. The method in this research uses semi-structured interviews with five Healthcare IT professionals to explore the phenomenon further, creating new insights into how sociotechnical debt is perceived and is present in organizations. This explorative design offers data points in three categories: how culture, organizational structure, and third-party dependence affect sociotechnical debt.

In conclusion, the findings provide a broader view of sociotechnical debt in the healthcare sector, demonstrating that these three categories are closely related to the challenge. Sociotechnical debt is a complex and highly relevant issue, shaped by multiple dimensions, including organizational culture, governance, and third-party dependence. Increasing transparency among stakeholders, including at national levels, as well as promoting localized and modular IT solutions, may support future efforts to address this issue.

Keywords: technical debt; sociotechnical debt; healthcare IT; digital transformation; organizational culture

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Introduction

In the past decade healthcare systems have internationally undergone a rapid digital transformation. Electronic Health records (EHRs), supporting tools for decision making as well as telemedicine platforms have been drivers for a constant digital initiative. The transformation has enhanced clinical reporting, efficiency and improved the patient outcomes and overall experiences while lowering the operational costs. The modernization of health information systems has been a huge investment for data accessibility and streamlining interoperability. (OECD, 2025; WHO, 2021.)

At the same time, this transition in the digital health infrastructure comes with underlying challenges. Health Information Systems (HIS) operate with a lot of legacy processes, governance which might entangle the digital systems to make it more agile or in many cases to replace or evolve. At this point investigating technical debt matters becomes relevant. (WHO, 2021.)

Technical debt refers to the future costs of choosing to do a quick fix rather than investing the time and effort for a better approach. Overtime these easy solutions stack and create undocumented bugs or a compromised case in the maintainability. Mostly this term is utilized in a coding field. (Yang et al.,2023.)

However, the emerging research has broadened the topic matter to a larger view which includes humans, organizations and systemic factors and not only technical artifacts. This can be called sociotechnical debt. Often these decisions that lead to debt are shaped by the organizational culture, human dynamics, vendor relations and other bureaucracy. These factors are the hidden risks that come with a long-lasting effect that can slow down the operations and create security risks. (Rinta-Kahila et al., 2023; Saeeda et al., 2024).

It seems that the health care sector is highly vulnerable to technical debt. The amount of governance and administrative workflows between all the stakeholders can lead to a lot of technical debt. Simultaneously, long-term vendor lock-ins or misaligned functions between clinicians and IT can limit the adaptability or innovation for better digital transformation.

Researching this topic makes it worth investigating as the consequences of a large amount of sociotechnical debt can be crucial. As an example:

- Patient safety, slower decision making and clinical data errors
- Operational costs, expensive overheads, costly updates and unmotivated staff members
- Digital transformation, making future adaptations of new technologies harder.

All in all, sociotechnical debt can affect under the radar the operational efficiency and the whole value proposition of digital transformation. Understanding where the technical debt originates and what kind of pipeline it undergoes is essential for building more resilient health information structures and policies.

Purpose of the study

This thesis investigates how non-coding related factors contribute to technical debt in healthcare IT systems. It is a question of interoperability challenges rather than focusing on software architecture or best practices in engineering. It explores the dynamics of organizational matters and how it shapes a digital risk. This means the organizational culture including values and the overall attitude towards risk and change.

Other things to note are decision making models as well as hierarchies. In addition, vendor relationships or dependencies of a third-party supplier. The study focuses on real-world reported cases of interoperability challenges or stalls in order to identify patterns that accumulate digital risks.

Research questions

How does organization culture affect the sociotechnical debt in healthcare IT systems?

This research question aims to understand how the members of the organizations' expectations and objectives affect the technical debt.

How does the organizational structure affect the sociotechnical debt in Healthcare IT systems?

How e.g. team structure and alignment can affect the technical debt as well as policy and governance in the organization.

How do third-party dependencies contribute to the sociotechnical debt in Healthcare IT systems?

Any underlying challenges of the legacy systems or merging problems that affect the sociotechnical debt.

By answering these questions, the thesis aims to find solutions to the less visible digital risks in healthcare and mitigate the long-term system stalls. The objective is to understand how these environments shape the digital world and infrastructure.

In the following chapters, the thesis will map the concept of sociotechnical debt onto the healthcare context, review key literature from health informatics and systems theory, analyze illustrative examples from healthcare sector and offer recommendations for governance, vendors, and organizational change. Overall, the objective is to understand better the sociotechnical part of technical debt as a phenomenon.

Chapter 1 - Literature review

According to Yang et al. (2023) the definition of technical debt started to form from Ward Cunningham in 1992 as delayed tasks that might concur extra costs in the future. As an example, coding for the first time seems like going into debt and a little debt speeds up the process as long as it is paid back. It appears that technical debt does not refer to "bad coding" but it is a kind of a trade-off of a short term and long-term benefits.

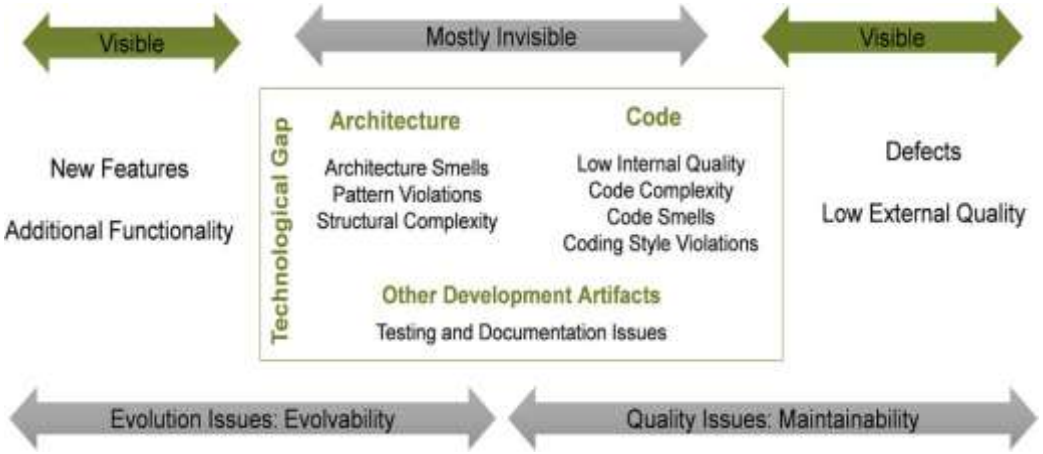


Figure 1.1 Technical debt in the engineering of complex systems (Yang et al. 2023)

Kruchten et al.'s (2012) technical debt landscape explains the different types of technical debt, especially the parts users don't see but that can affect how a system changes over time. As shown in Figure 1, it separates hidden technical issues (inside the box) from more obvious ones like bugs or missing features (outside the box), which users notice.

Inside the "Technological Gap" box, there are three main types:

- Architecture includes things like bad design decisions, breaking design rules, or overly complex system structure.

- Code has to do with messy code, bad coding practices, or anything that makes the code hard to understand or maintain.
- Production infrastructure refers to problems with tools and systems used to build, test, or deploy the software—like outdated tools or inefficient processes.

At the bottom of the figure, there are two main ideas: evolvability (how easy it is to change the system) and maintainability (how easy it is to keep it working). These help in thinking about how technical debt can grow or change over time and how to deal with it.

Technical debt matters can be seen as an important topic for the technical leaders to understand at least on a conceptual level. This can be helpful to make time-sensitive decisions or strategic decisions in order to check if it's viable to take shortcuts during product development to achieve short-term goals or meet a go-to-market deadline faster.

According to Yang et al. (2023) there are different types of technical debt matters and root causes:

1. Functional where there is a gap between what the technical matter needs and what the actual commercial product does
2. Performance failure where the system is not working at adequate level
3. Interoperability challenges where interface mismatches or some interdependency issues
4. Version conflicts, staying current or skipping new updates
5. Missing documentation or support causing errors
6. Organic Technical debt where the underlying cause is made by humans

According to Clark & Clark (2007), commercial tech vendors release new versions of their products, e.g., every 6 to 12 months. Due to this reason, teams working on the system might be forced to constantly re-check or redo parts of their work just to make sure everything still works together and stays up-to-date with the latest tech. The organic technical debt refers to all the policies and more process-centric perspective of the technical debt. For example, the practices and behaviors of decision-making. The version conflicts could hit this category as well. Often skipping updates might be done.

Li & Liang (2015) had a very similar systematic mapping as above mentioned for different technical debt categories as well as how to measure and prioritize. Including estimation models, cost categorization, solution comparison, and modeling/simulation. Usually, these cost-benefit analyses are used to support this decision-making process. They emphasize that this kind of evaluation should be

integrated into major milestone reviews and involve all key stakeholders. The authors also point out that not all technical debt can or should be addressed. Given limited resources and urgent needs, some gaps between what is required and what is delivered are to be expected. The objective should be setting clear priorities what is crucial to guide which issues should be tackled and which one should be left unresolved.

In Li & Liang (2015) some thoughts are presented on how to prevent technical debt. Examples of techniques for preventing are improving the current process, early testing planning and human factors analysis. Moreover, organic technical debt can be prevented by training programs and making sure that technical teams avoid creating or mitigate technical debt. Especially in the three categories: performance, functionality and interoperability. In addition, exploring more supportive contracts with vendors was recommended. As for repaying technical debt, it seems to be important to have specific strategies for repaying different types. For example, when it comes to configuration versions, some possible approaches could be skipping certain updates or the complete opposite upgrading with every new release, or following a regular schedule like every 18 months. It is stated that not everything has to be repaid. Since time and resources are limited, it's about figuring out what's worth fixing and what can be left for later.

According to Martini et al. (2018) a study reported that the cost of managing technical debt in large software organizations is estimated to be, on average, 25% of the whole development cost. Furthermore, Nugroho et al. (2011) present an empirical model to quantify and measure technical debt with three components that create technical debt when multiplied together. rework fraction, meaning how much work is needed to re-test or re-work it to make sure it works well in our system. So basically, the more changes or testing needed, the higher the rework fraction. Rebuild value tells us how much effort is required to fix or change. It's a measure of how much time and resources are needed to make things work as intended. Refactor adjustment measures how much we can improve our work efficiency when fixing or improving the system. This is dependent on team's experience and the tools they use.

Yang et al. (2023) present a model to measure and monitor technical debt focusing on a few key indicators. The first step is to identify cost drivers that are connected to technical debt. Cost drivers are the factors that can increase or decrease project costs depending on how they are rated. These are first labeled with descriptions. This might help to identify the underlying causes contributing to technical debt.

The next step is to find clashing synergies with cost drivers, determining how likely are to clash. These are pinned and color-coded to show resemblances, a clash with two items both rated poorly could lead to negative outcomes.

The final step is calculating the probability of technical debt interest. This analysis shows how probable it is that the cost drivers across different areas e.g. vendors or system interfaces could lead to issues in the future. The risk levels are ranked on a 4-level scale to help organizations understand the prioritization level. Below is an example of the model.

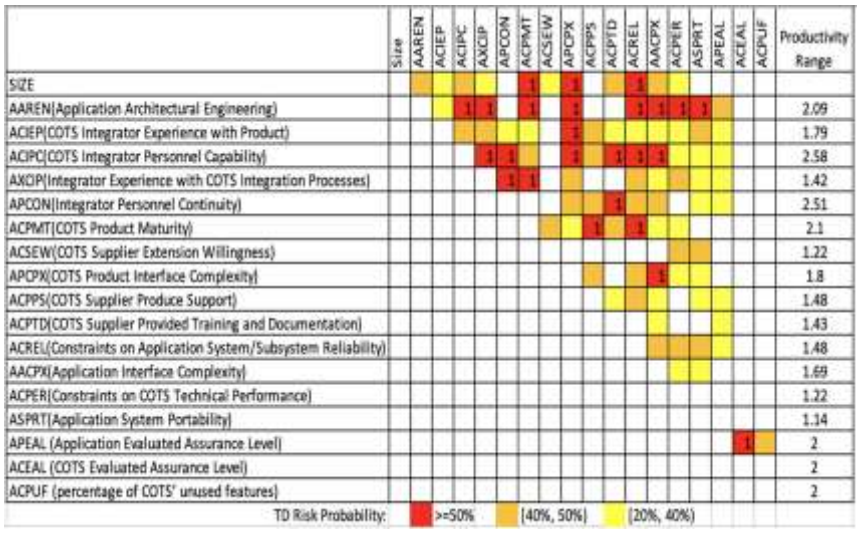


Figure 1.2 Technical debt model example (Yang et al. 2022)

Other key components seem to involve training and education for the staff members on the topic of technical debt. Making it more key focus on performance and evaluations. Building awareness in the organization culture about the negative impacts technical debt can create in the long run. Probably, setting some dedicated time and resources for addressing it especially, in the technical teams. Also, agile development processes such as scrum are popular. Reviewing technical debt as part of the sprint regularly might be important on some occasions. In addition, cross-collaboration between different organization's functions may be resolved or at least give some valuable insights into how to tackle technical debt. In some cases, it can help to identify underlying challenges that accumulate, thus making it simpler to align.

1.1 Sociotechnical debt

Sociotechnical debt is defined as the unforeseen costs in a project that makes it suboptimal in the organization. Sociotechnical debt is tied to people, processes and organization. In addition, these occur with poor organizational practices. Examples such as unclear communication of the objectives, lack of functional collaboration between different departments and silos. As well as when knowledge is not transferred adequately in handovers or replacements. (Spain, 2023.)

The definition of the concept sociotechnical debt refers to past social or technical decisions that lead to increased risks and inefficiencies in several aspects such as design, use or maintenance of the information systems. Ultimately it creates devaluation in organizations to achieve strategic goals or create new value. It is a cumulative liability, the longer the debt remains unpaid the more complex it becomes to unsolved. (Spain, 2023.)

Saeeda et al (2024) research findings showcase that social debt is a cumulative and increasing cost which is connected and invisible with negative effects in the developmental part. Large teams and organizations suffer from social debt that makes large-scale implementation difficult. Often, this is represented as poor communication, delays, rework, and decreased productivity. Ineffective departmental or cross-collaboration result in redundancy, competing objectives and efficiency. Cultural differences between teams can increase sociotechnical debt. This impacts resource allocation, overall project collaboration with timelines, quality and productivity All in all, these accumulate integration difficulties, operational challenges and system complexity.

The performance of any organization can only be optimized when both the social and technical elements are designed and utilized and interdependent. Healthcare is a prime example of complex processes in workflows or safety protocols, technologies such as EHR, CDS and imaging and networks of people (e.g. clinicians, patients, administrators). Any changes to these elements can have effects on other interconnected elements. (Sittig & Singh, 2010.) Below is a short summary of the sociotechnical debt matters.

Technical Debt	Root Cause	Impact
EHRs	Vendor selection without long-term decision making or planning.	Workarounds: Clinicians develop complex, undocumented shadow work to overcome system limitations (e.g., paper notes, manual data entry), increasing error rates and social debt (lack of process compliance).
Fragmented Data	Rushed decisions and adoptions in siloed teams.	Communication errors in cross functions (e.g., billing vs. clinical) sharing data, leading to friction, delays in care, and wasted effort navigating in organizational challenges (Spain 2023).
Security Gaps	Neglecting patches on legacy systems.	Unmotivated staff due to frequent system failures, breaches, or regulatory challenges, leading to increased turnover (Spain 2023). Patient safety is compromised as well.

Table 1. Summary adapted from socio-technical debt by Spain, 2023.

According to Laviola (2024), a critical risk of technical debt is the threat of cyberattacks, the breach usually traces back to some software that wasn't updated and usually at the operating system level. It is important especially, in healthcare setups to prioritize technical debt matters.

According to Rinta-Kahila et al. (2023) sociotechnical debt compounds rapidly and often invisibly leading to organizational lock-in in several aspects:

1. Increased organizational inertia which makes it hard and risky to fully withdraw from the system. The technical components are deeply rooted in the business logic.
2. Constraints on strategic goals. More resources are needed to pay sociotechnical debt interest in the form of maintenance, error correction and compliance which leads to stalled strategic goals.
3. Impact on working culture making community and collaboration harder with decreased satisfaction among staff members.

The strategy for sociotechnical management needs a holistic approach with a focus on collaborative optimization. According to Devroey et al. (2024) making social technical debt risk visible in the organization includes making a governance framework that captures all the debt elements from all stakeholders from technical to clinical staff. Prioritize interoperability to break down silos, provide

training for staff members and support strategic goals by addressing and communicating across all functions actively.

In a recent empirical study Ciancarini & Russo (2020.) state that technical debt literature is not adequate to explain this powerful phenomenon as the social part is missing. The reason is that technical debt is a sociotechnical matter, and it needs to be treated and addressed in its complex form. All in all, technical debt matters mean managing people.

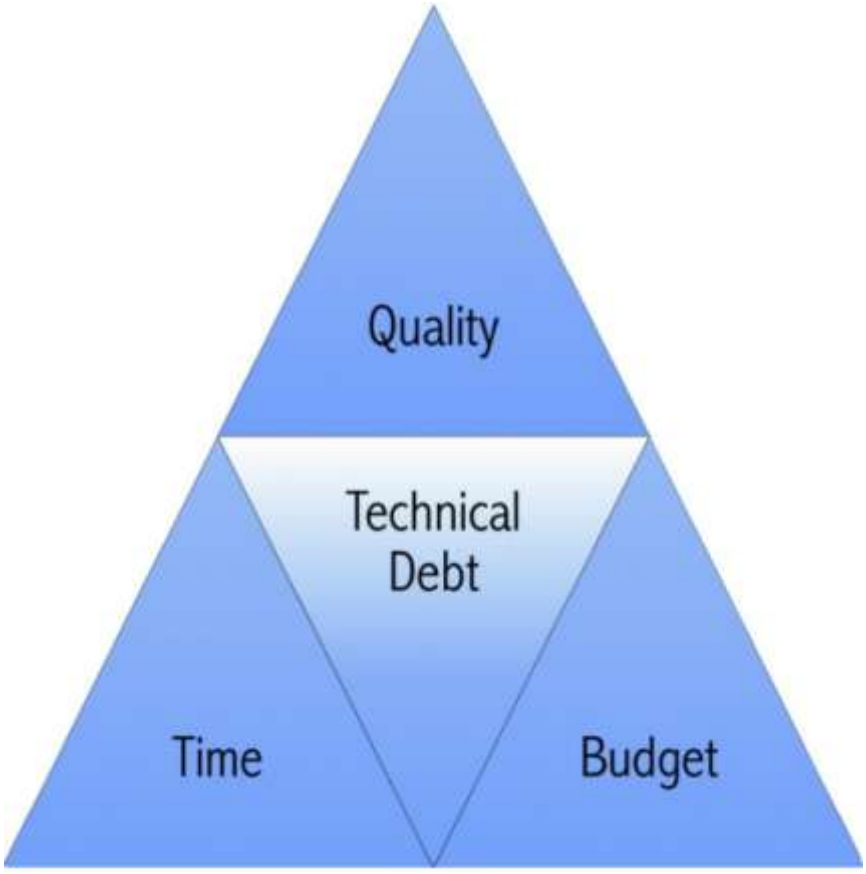


Figure 1.3 technical debt triangle Ciancarini & Russo (2020)

Ciancarini & Russo (2020) present three different dimensions for technical debt as budget, time, and scope. These themes are conflicting as high-quality software with a low budget in a short time is not

feasible. This triangle works as the base for any strategic development model since the assumption is that there are always limited resources. If the focus goes to one corner of this dimension, it is going to weaken the other two. For example, low budget is in focus then a fewer people can work on it, the quality decreases and with fewer people working on it, the timeline is extended. Usually, the technical debt is uncontrolled or unplanned. As an example, it becomes exploitable if new applications are introduced and it can make the organization struggle even more. No exit strategy leads to challenges in how to start repaying the technical debt.

Ciancarini & Russo (2020) did not find any scientific literature addressing the social dimension of the technical debt. Therefore, they proposed a managerial model mapping the social dimension. This mapping led to strategic perspective for technical debt management model. Mapping the social dimension of technical debt management considers not only the technical artifacts. A few models are presented below in the figures.

Technical Debt type mapping

Social		**Technical [13]**	
TD type	**Items**	**TD type**	**Items**
Staffing & Seniority	20, 21	Requirements	6, 14, 23, 24, 25
Skills & Training	16, 17, 21, 22	Design & Architecture	1, 2, 4, 6, 9, 11, 26, 27
Risk & Contracting	3, 5, 12, 17, 19, 20	Code	1, 4, 5, 10, 19, 23
Stakeholder involvement & Outsourcing	14, 17, 19, 25	Test & Defect	3, 4, 5, 6, 13, 15, 16
		Build & Versioning	4, 15, 18
		Documentation	4, 7, 8, 10, 11, 12, 28

Figure 1.4 Technical debt type mapping Russo et al. (2020)

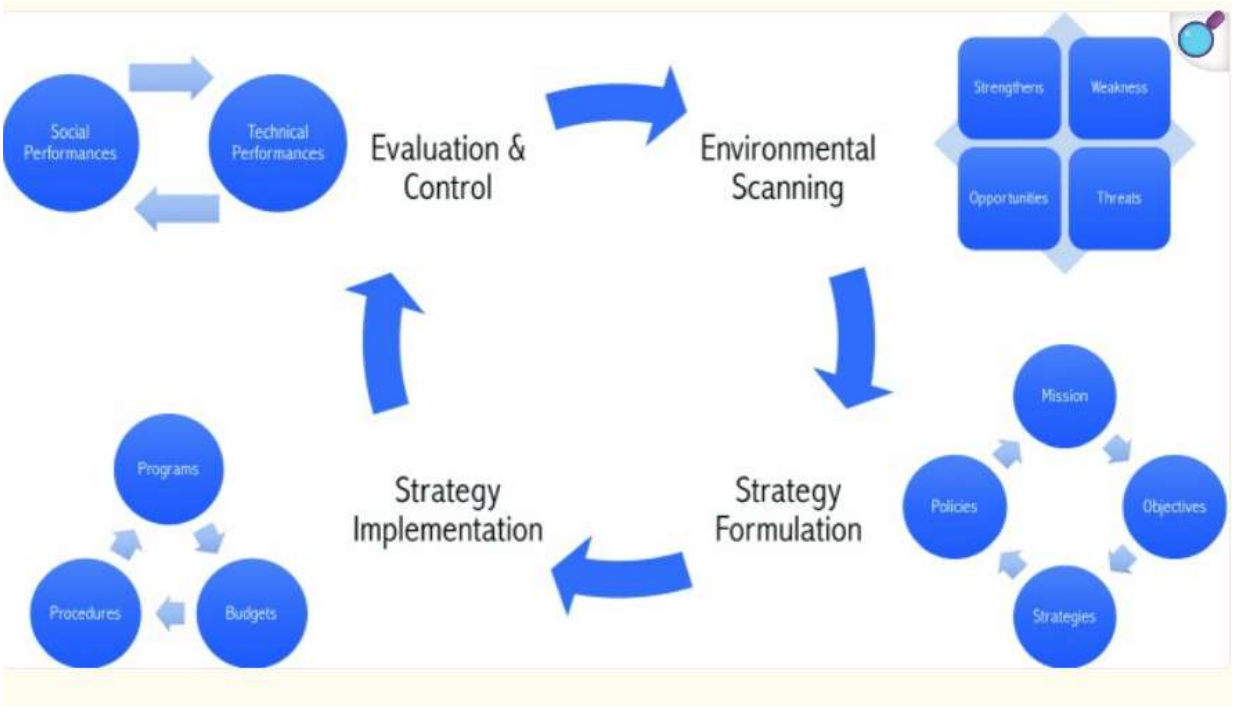


Figure 1.5. Technical debt mapping Ciancarini & Russo (2020)

1. Environmental scanning goals are to raise awareness of both internal and external factors that influence how technical debt is accumulated and managed. For the external factors, the market context needs to be understood by benchmarking competitors and understanding industry requirements. As for the internal environment investigating where the organization's resources are invested, whether there are any metrics for technical debt, and what is the internal culture regarding quality vs speed.
2. Defining a clear strategy formulation for managing technical debt, making it explicit, goal-oriented and measurable. This includes questions about the four pillars mission, objectives, strategy and policies.
3. Strategy Implementation includes concrete programs and activities with regular technical debt audits, architectural reviews and budgeting.
4. Evaluation & control establishes continuous feedback to assess how the technical debt strategy works from technical and social dimensions. Including stakeholder involvement and a structured training plan.

Ciancarini & Russo (2020.)

1.2 Technical debt literature in health care sector

The Yle news (2022) stated that over 600 doctors in Finland filed a complaint over Apotti electronic health record software. The complaints were mostly made about the patient's safety stating that patient's information might get lost in the system or was hard to transfer. Apotti is supplied by the American company Epic Systems, and it was introduced in the Finnish market in late 2018. Developing the system cost around 626 million euros between 2016 and 2021.

According to Kaipio et al. (2020) researchers in Finland are the first in the world to carry out a nation-wide survey on experiences of using Electronic Health Records from different professional aspects. The study reveals that nurses and physicians are dissatisfied with the usability of EHR system. The study shows that both groups had different views on what is working in current EHR systems. Some systems seem to work better for nurses while others satisfy the needs of physicians. Kaipio et. al. (2020) findings might suggest that a one-size-fits- all system does not work even though the implementation is done for one and the same organization, The development work needs to include all the end-users in collaboration.

Simultaneously, Zuuring (2024) examined the implementation of the Finnish electronic health record system Apotti and identified challenges in the Helsinki region. It shows whether the usability of the software has impacted on the overall outcome. The study identified that there was a lack of trust among the users. Dissatisfaction with the design and user interfaces might lead users to find loopholes. The number of tabs and navigation became clear that it led to frustration, and it created delays in the workflow. Also, the study found that the professionals in different departments utilized different versions which raises questions of re-learning when there are some changes in teams.



Figure 1.6 Epic software example (Epic, 2024)

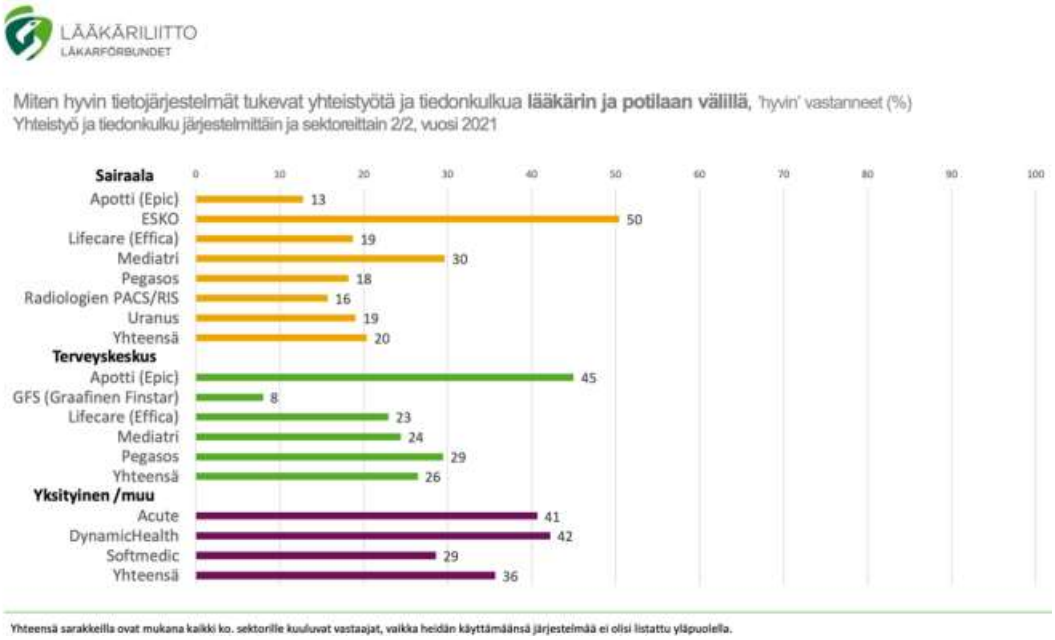


Figure 1.7 Results from FMA study on health information systems (Lääkäriliitto, 2022).

Above is a figure from Lääkäriliitto (2022) showing how well the interoperability between different software systems works in patient work. Apotti ratings are quite low. A study conducted by Kaipio (2018) involved physicians with no prior experience with the system to check their reactions to the usability of the Apotti system. The physicians were able to find several flaws with the interface in addition to patient safety. Technical debt arises when the end-users are creating loopholes, or it creates

more shattered work for the workflow to be actually a smoother experience. As stated in theoretical literature above, the vendor selection without adequate information for making correct decisions, leads to workarounds, increasing error rates and friction in data.

A quite similar event from England's National Health Service which all started in 1998 as the objective was to move all the health records to electronic ones by the year 2005. The national program was one of the largest investments in the public sector. The ambitious program goal was to achieve information flow electronically and ended up in confidentiality and security issues with around a 30% failure rate. (Hendy et al. 2005.)

The program was primarily designed to reduce the reliance on paper files. The procurement was divided into five different local service providers. For each cluster, a different service provider was assigned to avoid the risk of committing to a single supplier and to create competition. (Wachter 2016.)

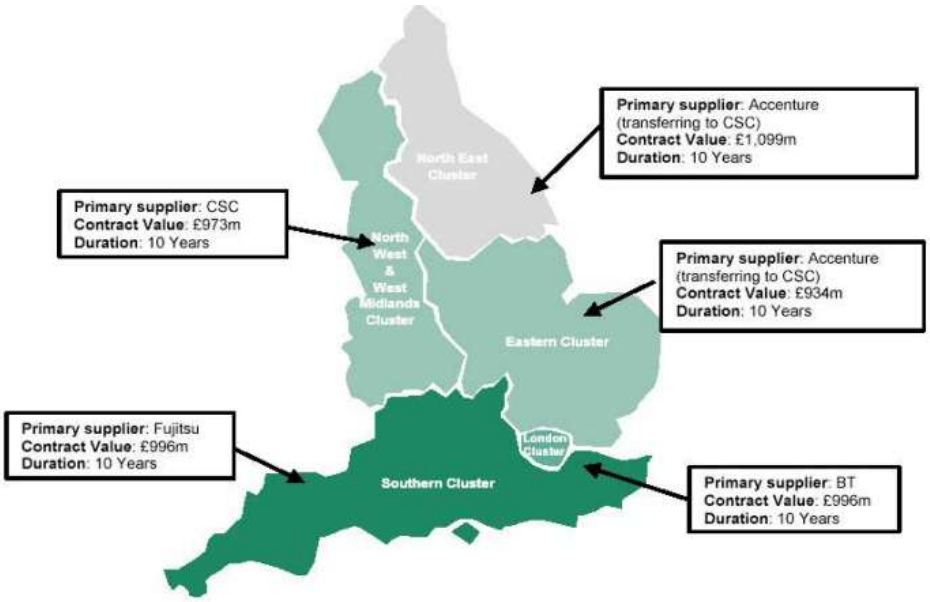


Figure 1.8 Service providers regional clusters (Wachter 2016)

In Hendy et al. (2005) the paper identifies key problems by utilizing qualitative interviews. There were unrealistic timetables and legacy system that was already well established, giving a good amount of functionality. This created distrust for the new system, as well as a risk of losing this flexibility. Also, the change management part including alignment with local needs and requirements was not in place. This led to poor communication for integrating the system. Adaptation process was making staff members cut corners and postponing the integration with a lot of mismatches.

Adams, Blandford and Attfield (2005) discuss the National Health Service issue as a kind of trade-off between risk and reward being a pitfall for the EHR system to fail. Many small failures with crucial privacy risks. Also, a large-scale design problem which was mentioned in the above paper as well. This occurred because adoption rate was not adequate. The project should have had decentralized methods in place which led to architectural debt, design debt and misalignment with organizational goals and users.

On the other hand, Sauer & Willcocks (2007) examined how institutional pressure and governance make mismatches in vendor selection or procurement. In other words, there are many stakeholders, which create a lot of delays and resistance from many parties. This leads to unrealistic expectations and often the end-user of the IT projects might suffer from adaptability issues as well as from a poorly communicated end-goal.

Wachter (2016) identifies that the case was lacking clinical engagement, meaning that most of the focus was on technology rather than the service itself or workflow changes. Contracts were unrealistic and there were volatile changes in the leadership positions around the time of the project. There were root causes for the technical debt. Postponing service design, under-specifying requirements as well as contracts that were clashing with the frontline work that needed a lot of rework.

Moen (2010) highlights several challenges associated with the NHS case which can be interpreted from sociotechnical perspective. As an example, the Legacy versus the new EHR replacement created these “pockets” where workarounds or original functions that were in place were tried to be replaced with a worse solution. This made the system work similar to paying interest for all the lost data. Also, the changes in leadership and the lack of change leadership accumulated interest in the added challenge. The unrealistic timeline for the project left a lot of unresolved technical issues that piled up in the organization, in this case it means that the debt incurred through shortcuts in design and integration. Also, it is worth noting that a centralized architectural plan might make it harder to evolve systems for different departmental needs. In addition, it creates a lack of engagement with the end-user.

This case demonstrates quite clearly that communication and change management become inevitable in large EHR integrations. Based on Spain (2023) it can be interpreted that technical debt gathers around in unclear communication of the objectives as well as when knowledge is not transferred adequately. This shows that frontline users become unmotivated if they don’t have clear objectives or concurring training for that system.

A similar Electronic Health Record software implementation was done in Norway. According to Ellingsen et al. (2022) there were a lot of post-implementation challenges that compounded. The municipalities began relying on workarounds, creating similar duplicating systems and getting additional maintenance issues. These represent as a form of architectural debt which is due to temporary fixes and misalignments in the core system.

In addition, the concept of path dependence was discussed in (Ellingsen et al. 2022). The reason why improving the implementation is difficult. Once the vendor is locked-in and the architecture is established, undoing and reversing becomes too costly. Finding an alternative course of action is almost impossible. This results in a cumulative state of compounding technical debt. The vendor constraints and limitations lead to low user satisfaction. These patterns might underline sociotechnical planning and governance to be an important part when implementing large-scale EHR systems.

Another similar critical event of implementation was done Cerner Millenium in Sweden with large-scale EHR implementation that held large investments and political support. The system had a rapid rollback after the complex deployment was found that clinical practices, governance models as well as user expectations are highly localized. The failure was not purely software errors but rather a sociotechnical misalignment. (Heise 2025.)

One clear issue was the adaptation of local workflows and language requirements. Clinical staff highlighted that there were concerns with the basic functions' usability, prescription handling as well as patient record navigation. The default system was not customized or tailored to the Swedish healthcare context. (Heise 2025.) Also, the patient safety concerns were flagged the integration collapsed quite shortly as there was a mismatch with software design and operational realities in Swedish healthcare.

In addition, these functional issues incorporating clinician feedback were seen as a challenge throughout the planning and implementation phase. While there were public announcements that engagement with stakeholders was highlighted. The frontline concerns and software users were ignored. The open resistance was expressed with published letters and complaints, that showcase that the system might not have been done as collaborative at least from the end-user's perspective (Herald 2024).



Figure 1.9 Concurring themes (created by the author).

Above a recap of the concurring themes from the four events concurred in healthcare setup. All the examples had a governance model with a lot of bureaucracy, many shareholders with own objectives which leads to a long procurement process and with an objective that does not require the end-user's perspective.

While the legacy system and routines are in place, it seems that all these events suffered from change resistance from the EHR end-users while on-going processes already established a digital system made an additional step rather than leaning out the current routine. While in some cases e.g. in Norway there was mentioned a high effort of communicating the changes in the workflow with workshops, but their research shows that it was not adequate. In addition, the different workflows and departments in all examples showcased that they are heavily localized and one size fits all was not a viable solution. In addition, we can find a key pattern in theory and with these examples that vendor lock-in in large EHR systems can easily lead to workarounds between reporting and data-entry. This later becomes a technical debt issue and security risk.

Chapter 2 -Theoretical Framework

2.1 Introduction

This chapter outlines the foundations that guide this study on sociotechnical debt aspects in the healthcare sector. The chapter integrates perspectives from sociotechnical systems theory, technical debt theory and organizational theory in order to build a conceptual basis for understanding three main parts: how organizational culture, structure and third-party dependencies affect and contribute to the accumulation of sociotechnical debt in the healthcare sector.

Healthcare organizations are often characterized as highly regulated with complex workflows. In addition, there are strong relations between clinical, administrative and technical departments. These make healthcare IT systems vulnerable to misalignments and more prone to sociotechnical challenges. The framework here provides tools to analyze such misalignments and how to interpret them in the organizational context.

2.2 Concept of sociotechnical debt

Sociotechnical systems theory was introduced by Trist and Emery (1951) which emphasizes that organizations comprise two interrelated elements, the technical systems consisting of tools, technologies and processes while the second category has people, roles and responsibilities. For the system to function, these two must work in relation to each other and be optimized.

When changes occur, such as the introduction of a new EHR system, organizational processes may also need to be reorganized. For example, data governance practices may need to be adapted and coordinated between departments. However, these dimensions usually evolve at different paces or even in conflicting directions. The result often occurs in misalignments in technological design and how staff members work. Tamburri (2020) describes this as sociotechnical debt.

Sociotechnical debt can be defined as accumulated costs and inefficiencies that arise between social and technical systems. In real situations, this can be seen as poor data quality, workflow disruptions and difficulties in integrating new systems.

2.3 Technical debt and its sociotechnical extension

The study investigates the evolving conceptualization of technical debt, which was originally defined in the field of software engineering as the cost of expedient coding decisions (Cunningham, 1992). The concept has since expanded to include architectural, processual, and organizational dimensions (Kruchten et al., 2012; Avgeriou et al., 2016), alongside emerging research on sociotechnical debt. In this paper, sociotechnical debt is referred to as non-coding operations but from the human error aspects, such as neglected stakeholder engagement and insufficient understanding of the end-users' needs. (Nord et al. 2012; Tamburri, 2020). This investigates how design and decision-making accumulate in invisible costs that over time show as resistance, workflow challenges or failures.

2.4. Organizational Culture and Sociotechnical Debt

Organizational culture refers to shared values and beliefs and the idea of behavior within the organization (Schein, 2010). The healthcare sector culture often reflects a mix of different professions in different hierarchies, patient-centered ethics and high levels of governance and regulatory. This culture might profoundly shape how different technologies are adapted and used.

A culture that values short-term wins over sustainability, for instance, may tolerate more the accumulation of sociotechnical debt. E.g. teams might prioritize system functionality over integrations or overlook the importance of documentation. At the same time a culture of learning and openness can support mitigation of sociotechnical debt.

The competing values framework (Cameron & Quinn 2011) offers a useful perspective to analyze this phenomenon. Organizations with a high hierarchy culture may accumulate more debt due to high governance and slow decision-making while more agile one's value innovation and flexibility; however, they may accumulate debt in a different form through the uncoordinated change. All in all, organizational culture influences how members interpret, prioritize and respond to technological change.

2.5. Organizational structure and sociotechnical debt

The second research question focuses on organizational structure which refers to how the roles, responsibilities and cross-cultural communication are managed in the organization. The healthcare sector underpins the coordination between developers, clinicians and administrators comprising the governance hierarchies.

The theory of sociotechnical congruence (Cataldo et al., 2008) is relevant here as it highlights that IT system effectiveness is dependent on how the actual communication among team members is coordinated. Low congruence where teams do not interact creates inefficiencies.

In healthcare sector low sociotechnical congruence might represent itself in a situation where a department develops a system without the input of the practical staff members or where policies are not reflected in system updates. Simultaneously, fragmented team alignments, or high hierarchy can create structural debt in the sociotechnical debt dimension. This means that organizational structure not only determines how information flow works but also how technical challenges are identified and resolved.

2.6 Third-party dependencies and sociotechnical debt

One scenario in healthcare sector ecosystem can be its heavy reliance on third party vendors and partners. Organizations are usually integrated with EHR systems, medical devices and software solutions created by external partners that these creates additional layer of sociotechnical debt possibilities.

From system thinking perspective (Senge, 1990) third-party relationships can be viewed as feedback loops in a broader setup. For example, updates, pricing models, interoperability choices which affect the health care staff members in the organization. When coordination is weak between these artifacts the misalignments occur thus creating sociotechnical debt.

Such debt may manifest as legacy integration challenges or dependency on an old model that hinders the innovation or progression of the digital system. This external debt being locked into suboptimal configuration makes it difficult for the organization to evolve or reach a new goal.

2.7. An Integrated Conceptual Model

The integrated conceptual model here integrates the above elements into a holistic view of sociotechnical debt in healthcare sector. As well as the thematic patterns that were presented in the above theory.

1. Organizational culture shapes behaviors, decision-making and prioritization. This includes the themes that came up in the theory such as change resistance and challenges in change management.

2. Organizational structure defines coordination and communication between departments. The themes that came up from literature affect this part such as lack of alignment and localization.

3. Third-party dependencies, an external layer of complexity that can hinder sustainable efforts in the long-term. The theme that occurred in the literature is how digital systems disrupt the workflow.

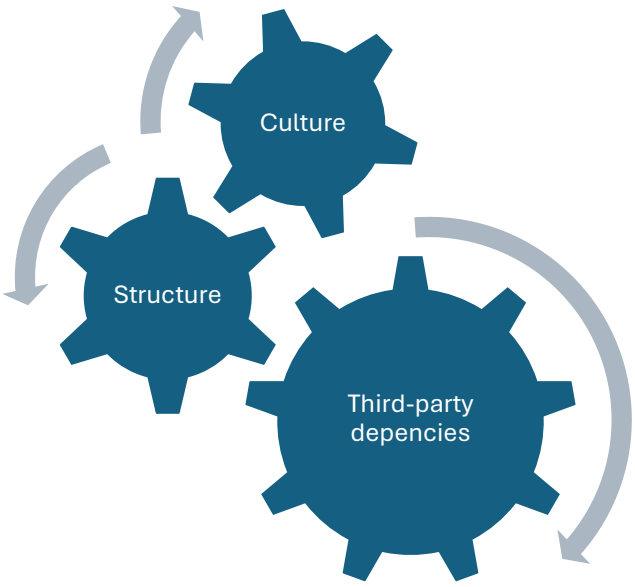


Figure 2.1 Integrated Conceptual Model of Sociotechnical debt (created by the author).

These dimensions interact dynamically together e.g. culture that does not want to change with structural misalignments can reinforce the challenge. Therefore, this framework conceptualizes this as an interdependent phenomenon for this challenge.

Chapter 3 - Methodology

This chapter introduces the methodological framework utilized when investigating how sociotechnical debt emerges and is present in health care sector. The technical debt as a concept is complex and has limited empirical studies. This research is narrowed down to the sociotechnical dimension with qualitative, exploratory research design. The groundwork is the theory literature backed by semi-structured interviews with industry experts. The objective is to build a blueprint to understand and generate insights especially, to avoid pitfalls in larger integrations and understand the sociotechnical debt as a phenomenon.

3.1. Research approach

This study utilizes a qualitative research approach and a style of abductive reasoning where facts are investigated and pieced together to make an educated guess from limited clues. Abductive reasoning is probabilistic but not certain. The reasoning comes from observation and finding the most probable or best explanation.

Abduction gives a way to theorize and to describe the theoretical concepts and how they are constructed during the qualitative research process. Abductive reasoning is well suited especially when the objective is to understand a phenomenon from the participants' perspective. (Hoffmann et al. 2024.)

3.2 Research design

This paper is exploratory in nature. It seeks to detect underlying patterns, mechanisms and explanations for sociotechnical debt that might not have been fully covered in the current literature. This design aimed for an analytical generalization rather than distinguishing between technical and

governance models. The study's goal is to deepen understanding of sociotechnical dynamics in a complex system (Eisenhardt 1989.)

Rather than constituting a case study method, this paper adopts an exploratory qualitative interview approach aiming to capture cross-context professional perspectives on sociotechnical debt. Given the lack of extensive prior research, an exploratory qualitative design was selected to give a more broader perspective to investigate the phenomenon. Research design prioritizes understanding in more depth rather than being quantifiable or generalized.

Semi-structured interviews were deployed to capture rich and experience-based insights from professionals in the healthcare sector. An interview-based approach allows participants to communicate and interpret their own experiences of sociotechnical debt. This allows the identification of patterns and any clashes that may or may not be reflected in existing literature.

The paper does not focus on a single organization, project or system and hence it does not resemble a case study method. The perspectives are drawn from multiple professionals in the healthcare sector rather than giving an in-depth answer to one single case.

The concept of sociotechnical debt is used as a theoretical framework that provides guidance and clues for data collection without constraining any insights. The study explores how it resonates with and how it is interpreted by the professionals.

The examples from the health care literature work as one unit of analysis seeking to uncover sociotechnical debt and how it is visible over time in the digital system. How the accumulation happens and how it is seen in stakeholder relationships and organizational processes. These investigative examples from healthcare sector as well as the theory part of the technical debt overall work as a base for understanding and analyzing patterns and emerging themes. The primary data from the interviews will test if the underlying patterns have similarities or differences. Due to the exploratory nature of this study the qualitative method is chosen. Sociotechnical challenges are often very subjective experiences rather than quantifiable.

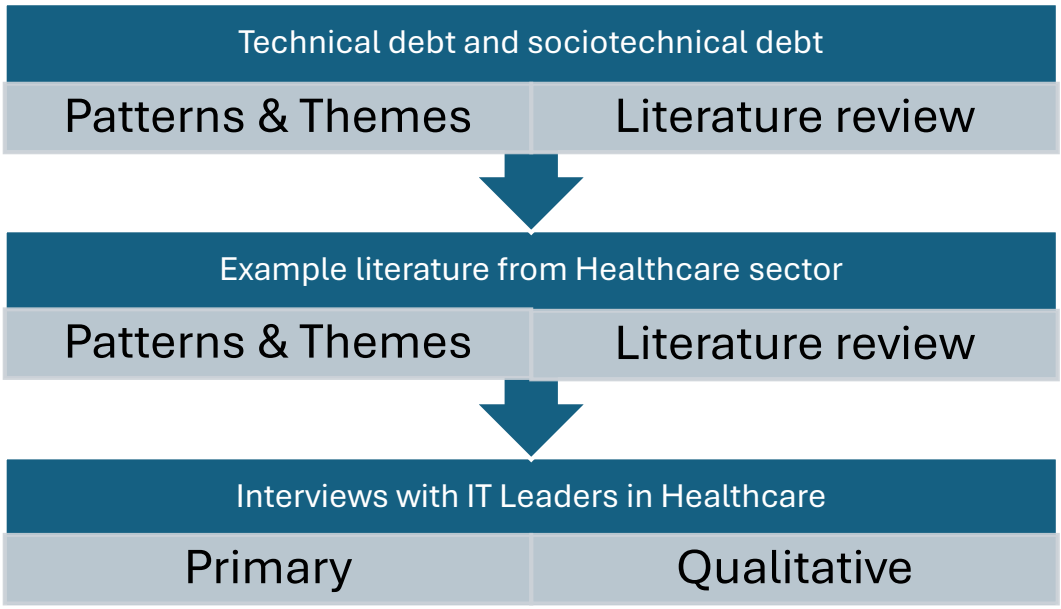


Figure 3.1 Data collection overview (created by the author).

23.3 Data Collection Methods

The primary method of data collection was conducted through semi-structured interviews supplemented by secondary sources with public statements and research papers and investigations. This approach is appropriate as the context is in the public sector with comprehensive documentation. (Bowen 2009) The documents that were utilized include research papers, news media articles, investigative journalism, academic articles. The interviews that were previously conducted in the statements were collected as secondary data to circulate the findings. All documents were assessed for credibility, context and relevance to the sociotechnical debt topic.

The research questions are as follows:

How does organization culture affect sociotechnical debt in healthcare IT systems?

This research aims to understand how the members' of the organizations ,expectations as well as objectives affect the technical debt.

How organizational structure affect sociotechnical debt in Healthcare IT systems?

How e.g team structure and alignment can affect the technical debt as well as policy and governance in the organization.

How do third-party dependencies contribute to sociotechnical debt in Healthcare IT systems?

Any underlying challenges of the legacy systems or merging problems that affect sociotechnical debt.

As the nature of the research questions focuses on in depth and detailed understanding of the phenomenon the qualitative method is chosen. According to Mcleod (2025) the qualitative method is well-suited for research questions starting with “why and how” and quantitative method aligns with research questions e.g “how many or how often” the relationship between variables, where precise measurement or stastistical analysis can be done.

3.4 Data Analysis

3.4.1 Primary data analysis

This study utilizes semi-structured interviews. As it supports understanding about the topic before implementing any interview questions. In addition, making a well-structured plan for an interview builds more trust between the researcher and the person being interviewed. Before heading to questions the person doing the interview must think, after reading the literature, about the topic whether there were any gaps or something that needs more explanation. The purpose of the main research questions serve as indicators for all the questions made during the interviews and all the questions should align with the main research questions. (Galletta 2012.)

A semi-structured interview method was chosen, which gives a great opportunity to stick to the topic yet, gives time to the person to consider the answers. (Galletta 2012.) As sociotechnical debt is quite complex and could be interpreted in multiple ways the semi-structured interviews give a flexible method to conduct the interviews. The questions can be modified a bit depending on the scenario and giving space for interpreting the answers.

For each interview, a code is given to understand whose perspective is given and since there are already themes from secondary data, the primary data will emerge inductively in a hybrid approach as well as there is a conceptual framework above but the primary data will allow to find reoccurring

patterns or new ones to emerge and these will be mapped to sociotechnical dimensions. The primary data will answer the question of whether these themes hold meaning or whether they capture the same essence as the primary data. Clear definitions will be set for each theme and how they relate to the research questions.

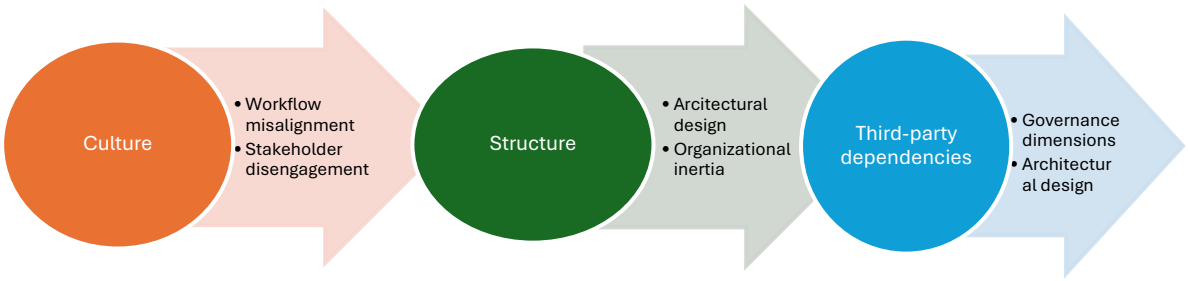


Figure 3.2 Primary data analysis (created by the author).

These three main research questions work as the top-level headings, presenting the identified themes and the evidence within each section. This analysis is supported by subthemes under each broader theme in order to categorize and understand the challenge and phenomenon. The subthemes emerge from the key literature review presented above. These themes are then interpreted and discussed in the findings section.

The analysis consisted of several stages. To bridge the theoretical framework with the empirical data, the three core research questions were operationalized to structure both the interview protocol and the thematic analysis. Before conducting the semi-structured interviews, initial subthemes derived from the literature review were used to design targeted, open-ended interview questions. These preliminary subthemes served as contextual anchors during data collection, allowing them to probe specific dimensions of sociotechnical debt. First, the interview recordings were transcribed, and the transcripts were reviewed to become familiar with the data. Second, relevant sections of the transcripts were coded according to their meaning and relevance to the research questions.

These subthemes served as analytical anchors to aggregate participant quotes, identify recurring patterns across healthcare IT roles, and evaluate whether the primary findings reinforced, extended, or challenged the concepts identified in the secondary literature.

Culture Q1
Subthemes
1.1 Workflow misalignment e.g. Short termism or resource issues
1.2 Change management challenges or stakeholder disengagement.
Organization Structure Q2
Sub-themes
2.1 Architectural challenge, team silos or frictions between functional divisions
2.2 Governance and policy challenges
Third-party dependencies Q3
Sub-themes
3.1 Legacy system political barrier
3.2 Vendor updates, complex rework

Table 2. Thematic data analysis (created by author).

3.4.2 Participant Selection Process

The four participants were chosen via LinkedIn. The key selection criteria were being an active member of LinkedIn with recent posts regarding technical debt in the healthcare sector or, the profile had to have a very extensive background working closely with or in the IT Health industry for at least 10 years.

The selection criteria included being that the profile could be a consultant, working in the organization or a third-party solution provider, namely an executive in the field.

The hit-rate for this selection process was high, as the profiles already had some public statements on LinkedIn about the topic or a background that demonstrated an understanding of the phenomenon in general. The research topic attracted considerable interest, and participants were willing to engage because it was viewed as an important subject. Invitation was made by connecting and sending a private message explaining the assignment with the invitation for a 30-minute Teams interview. The selection was not limited to specific countries or regions, rather a worldwide search in order to understand if the concepts are the same globally.

3.4.3 Overview of participants

The first participant had over 15 years of international experience in the Health IT Industry working with global health related information systems and deploying critical systems globally. Focusing on interoperability and architectural IT designs. The experience spanned to multiple countries as a health sector consultant for large projects namely in a governmental or public setting and working as a partner and president in the organization.

The second participant worked for many years in healthcare technology projects including many patient applications, hospital operational systems, RPA and integration in a larger transformation. The participant had over 15 years of experience in IT sales. In the current position, the participant worked as an IT service leader working with different industries helping organizations to modernize their operations.

The third participant had a clinician background working with digital health products, creating AI-powered and data-driven healthcare solutions for over 15 years. Utilizing their clinician background and understanding the operational challenges using automation and large language models and taking a digital health product from concept to scaling. In the participant's current position, as a Founder and advisor, participant had projects in many health platforms from governments to enterprises of different sizes

The fourth participant had over 10 years of experience working as a Chief Information Officer and Chief Digitalization Officer in a well-being services county. The background experience reached

over to different well-being counties with a lot of extensive experience in stakeholder management and understanding governance as well as integrating large different IT systems into the healthcare sector.

The fifth participant had over 10 years of experience in the healthcare sector, working in leadership, health informatics, and software development. Participant had served as a director and worked on both clinical and technical sides, including as a lead clinician and on large-scale IT projects, with a strong understanding of healthcare operations and IT system optimization.

Participant countries represented in a random order:

1. USA
2. Switzerland
3. Finland
4. Finland
5. United Arab Emirates

3.4.4 Thematic Analysis of Literature

The coding process was inspired by the principles of Braun & Clarke, (2006) Thematic analysis. This includes six phrase process:

1. Familiarization with data
2. Generating Initial codes
3. Searching for themes
4. Reviewing potential themes
5. Defining and naming
6. Producing the results

This step-by-step approach ensured an analytical path for finding the key components and patterns from literature. Coding was conducted inductively, allowing themes to emerge from the data.

The review and refinement stage supports finding sub-categories for the emerging themes as well as giving a structured analytical framework. Also, this supported the interpretation of the primary data, as themes generated from literature provided context and foundation for the qualitative research. By situating the primary findings with established themes giving depth to the evidence.

Themes that arise from the literature:

- Architectural design
- Governance dimensions
- Stakeholder disengagement
- Workflow misalignment
- Organizational inertia

After this a cluster of the categories was aligned with key dimensions of sociotechnical debt. Comparison was then conducted to identify recurring patterns and findings in the specific key aspects and themes that emerge. Attention was paid to dynamics, how these steps contributed to incurring costs or failures in the project lifecycle which is a central part of the technical debt concept.

3.4.5 Ethical Considerations

All data used in this paper was sourced from publicly available academic materials. Including open-access academic databases. The ethical etiquette standards were followed by citing and understanding the data integrity referring to full attribution and only using sources published in public forums. This research has accepted the standards of academics. Only materials that have been published in the public domain are included.

The researcher has done the qualitative research part in an ethical manner such as confidentiality, transparency and trust. As an example, the process and selection for data analysis have been documented and guidelines such as data integrity, security and accuracy have been addressed. (Silverman 2021.)

3.5 Limitations

As with all qualitative research, this study is limited to generalization. The specific examples in literature were selected and identified based on recurring patterns with a lot of data already available. Conclusions are not intended to apply uniformly across all digital transformation cases in public sector. In addition, reliance on theme analysis may introduce bias or gaps in understanding while academic analysis might mitigate these limitations.

Secondly, the heavy reliance on literature introduces biases and gaps, some materials mean that not all subtle practices or stakeholder perceptions is captured. Also, thematic analysis offers rich explorative ideas of sociotechnical debt phenomena which is quite new research area thus not having a lot of confirmed or approved practices in place yet. Subjectivity and assumptions might be the elements of qualitative research. Efforts to mitigate this volatility are made by documenting and grouping themes.

Thirdly, the specific focus area on socio-technical debt in healthcare sector mainly in public organizations means that the findings might not be applicable for other small-scale, private or different industries. Despite it, this paper offers perspectives of the phenomenon that might need more attention in many organizations and a clear roadmap for generic practical guidelines and implementation. Especially, for organizations to be aware of this phenomenon.

Chapter 4 -Findings

This chapter provides the findings of the interviews with the professionals. The themes are categorized as mentioned in the methodology chapter above. The chapter includes the respondents' perspectives in different themes including culture, organizational structure and third-party dependencies.

4.1. Culture impacting technical debt

This theme identifies organizational culture as a contributor to the accumulation of technical debt in healthcare IT systems. The findings indicate that culture shapes how technology is perceived, designed and implemented. Often in a way that promotes short-term solutions over sustainable system design.

The viewpoint in the healthcare sector is very different compared to as an example the aviation industry. A pilot and air traffic controller, how they perceive their technology and how important it is for them to achieve objectives via data. So, Healthcare industry might not have the similar culture of optimization and utilization making decisions from real-time data or on an ongoing basis. The Healthcare industry domain is very heavily dominated by clinicians' perspectives, and not as business oriented. In other words, the perspectives and many choices are coming more from academic thinking. (R1)

The findings suggest that healthcare sector operates fundamentally in a different perspective when it comes to technology compared to other industries, healthcare technology adoption is not typically driven by enterprise-wide or business-oriented thinking, but the roots are rather academic and clinical practice.

The clinician-dominated culture influences how IT systems are perceived and implemented. The findings indicate that often healthcare IT systems are approached in a manner similar to clinical treatment which is designed to cure one specific or immediate problem rather than having an engineered mindset to see interconnected systems and a bigger picture. A narrow focus increases fragmented solutions and increases long-term technical debt.

These findings are reflected in expert observations noting that the healthcare industry is heavily shaped by clinicians' perspectives rather than enterprise-level thinking and often these decisions emerge from academic views rather than system-oriented considerations. Similarly, IT implementations are often treated as targeted inventions rather than components of a larger IT ecosystem. A pattern that aligns with the identified influence of culture in technical debt.

In the Apotti case, allowing clinicians to design new inputs for the IT system proved ineffective. Instead, greater reliance on IT experts with deep expertise in system user experience should have been emphasized (R4)

The Apotti case further reinforces these findings. The results indicate that when clinicians are primarily chosen for creating a system design it might lead to ineffective outcomes. Findings showcase that insufficient utilization and placement of IT professionals in system designs contributed to usability challenges and long-term maintenance challenges. This aligns with the expert commentary suggesting that greater reliance on IT experts should have been prioritized over clinician-led system input.

Culture Q1.1–1.2: Stakeholder Disengagement and Workflow Misalignment

This sub-theme examines how stakeholder disengagement, communication and siloed organizational structures contribute to sociotechnical debt. The findings indicate that misalignment between stakeholders especially across clinical, IT and operational ones create fragmented system designs that fail to support the integration of IT system workflows.

Findings on Stakeholder Disengagement and Workflow Misalignment

The findings reveal a cultural difference between an engineering-oriented development approach and healthcare leadership models which are often characterized by deep specialization and a narrow scope where engineering mindset tries to adopt a holistic modular one.

The holistic and a more engineering approach where a team is hired and you figure out all the modules clashes with the healthcare leadership approach. This culture of isolation and heavy specialization in one area creates friction and technical debt. Especially, in most cases where you are trying to fix only one problem without thinking about the larger picture (R1)

The core problem with legacy systems often begins with siloed operations. In many hospitals, different functions such as IT, finance, clinical leadership, and operations run on separate applications and make decisions independently. This lack of coordination leads to overlapping systems and duplicated solutions that do not work seamlessly together. Without a cross-functional governance process in place, technical complexity and technical debt continue to grow over time, eventually becoming difficult to manage. In healthcare, this often results in workflow misalignments that directly impact efficiency and service delivery. (R2)

This pattern is reflected in the experts' comments noting that siloed operations are a central cause of technical debt. Especially in legacy systems. Hospitals usually operate with different applications and decision-making processes across departments resulting in overlapping systems, duplicated functions and interoperability challenges. This structure usually leads to workflow misalignments and without cross-functional governance this leads to technical debt.

The culture where most IT solutions are made for clinicians tends to suffer from localization. Extracting the right data for many different stakeholders is a challenge that creates technical debt. In a hospital setting, it is quite typical that clinicians feel that the data that they're putting into the system is more administrative than it necessarily is to help them out. (R1)

In the case of Apotti, localization was an issue. Creating one size fits all for different professions as well as being too large project rather than starting from one small component and adding and subtracting from there (R4)

"Data integrations and interoperability in a larger project e.g. in the case of Apotti is challenging, creating modularity in large IT projects is quite hard" (R5)

In the case of Apotti the findings show that "one-size-fits-all" design approach created workflow challenges. Instead of creating localized design, the project prioritized broad standardization across all operational roles. This increased the use of workarounds, a well-known source of technical debt. This aligns with the expert comments on how lack of localization and incremental development leads to challenges.

The findings further indicate that inadequate localization complicates interoperability when systems are not adapted to local workflows, all data workflows tend to become more challenging for cross system integration. This challenge was highlighted by experts noting that achieving localization in large IT healthcare projects is difficult especially when the localization requirements are not an inherent early part of the design.

Furthermore, this showcases that healthcare IT solutions are usually designed for clinicians but lacks localization in system design. In large scale healthcare IT implementations, the attempt to standardize workflows and interfaces across different departments creates challenges in workflow and usability, ultimately leading to the accumulation of technical debt.

Universal Nature of the Challenge

The findings further indicate that technical debt in healthcare IT is a universal challenge affecting both high-income and low-income countries. While the underlying issues remains in similar the drivers like resource availability, governance structures and investment priorities influence how technical debt manifests.

In resource constrained settings prioritization decisions often favor immediate clinical needs such as drug availability over investments in data infrastructure. In contrast, high-income countries experience stronger legislative and governance driven pressure to invest in IT systems, and this can increase the complexity of challenges if not managed. Technical debt challenges are a Universal issue; there is discrepancy between digital tools and clinical work in the healthcare sector. Also, the

healthcare sector is a very critical industry where any project needs to consider governance and legislative side very heavily.

4.2 Organizational structure Impacting technical debt

This theme examines how organizational structure, governance and policy influence technical debt in healthcare IT systems. The findings indicate that technical debt is strongly shaped by fragmentation, multi-layered governance, short-term decision making and high numbers of stakeholders. Several patterns emerge from the respondents.

Q2.1 Organizational Structure & Governance

The findings show that competing stakeholder agendas on both national and organizational levels significantly contribute to technical debt. Healthcare IT systems requirements usually heavily involve a wide range of stakeholders from clinical to political levels with each having their own objectives. This complexity adds even more friction in different IT system designs.

"Also, there are a lot of stakeholders at a national level with own agendas, objectives and investments that needs to extract data rather than prioritizing or supporting the clinicians work" (R1)

"Heavy governance structures and multiple national-level stakeholders can hold investments based on their own objectives, which leads to some departments being prioritized over others " (R5)

National-level stakeholders frequently prioritize their own data extraction objectives and reporting over direct clinical operations. This results in systems that are optimized for oversight rather than frontline usability. This was reinforced by another respondent's observation by stating that heavy governance structures and multiple national-level stakeholders can delay or redirect investments leading to uneven prioritization in different departments. This indicates that governance with numerous competing agendas increases architectural complexity and long-term technical debt.

Q2 2.2. Governance and policy

Another strong pattern in the findings relates to the impact of governance and policy on data management and system performance. Respondents consistently reported high levels of regulations in healthcare where data governance and privacy matters slow down any digital transformation.

The difficulty of stakeholder mapping and data governance in international standards such as HL7 have helped structure how healthcare data should be structured and exchanged. However, findings show also that these standards promote centralization of sensitive data, adding another layer of challenges in compliance. HL7 is inherently slow due to the sensitivity of healthcare data.

This pattern shows that while standards aim to reduce technical debt in the long run it can increase the challenge in adoption especially, when legacy systems must be maintained in parallel.

Most common patterns are when decisions are driven mainly by short term budgets. I have seen hospitals where they have selected low-cost vendors for an EMR module because it looks very attractive to them. Six months later the system can't scale or integrate well with other modules or upgrades, and the hospital ends up spending far more than they expected. (R2)

The findings strongly indicate that organizational inertia around legacy systems is a major driver of technical debt matters. The poor documentation and high staff turnover lead to critical knowledge loss, making legacy systems increasingly difficult to modify or retire. At the same time, healthcare organizations are often reluctant to change these systems due to risks and costs associated with data migration.

As a result, legacy systems remain in minimal but mandatory usage requiring constant security updates and operational support. The findings highlight a critical insight, when these hidden maintenance costs are fully accounted for time, they often exceed the original investment. This pattern shows that the risk of knowledge transformation in legacy systems creates long term technical debt liabilities.

Long-term planning is essential. Especially, the IT Roadmap should span even 5-10 -year cycles. Without scalable architecture in place, organizations are forced into repeated rework, leading to a rapid accumulation of technical debt. To avoid this, IT budgets must be clearly defined on a year-by-year basis to support informed procurement decisions. Managing lifecycle costs is critical, especially in healthcare, where decision-making processes tend to be slower than in other industries. Taking proactive, upfront steps in areas such as architecture and budgeting helps prevent larger issues later. (R2)

I have been working in a scenario where budget and strategies are considered in a five year-term and a public governance model that gives budget and strategy one-year at a time, this short-termism creates a lot of technical debt in different forms. (R4)

Another dominant pattern across multiple respondents is short-term decision making especially, in procurement. The findings show that immediate budget constraints create challenges in the long term. The findings show that without multi-year strategy with stable architectural planning and funding model healthcare organizations tend to lean and be pushed toward technical debt.

Lastly, the findings reveal a strong link between organizational silos and fragmented technical ecosystems. Departments such as cardiology, diagnostics, operations and administration often operate on separate EHR or EMR systems. These siloed structures create an incomplete patient view and make accessing complete patient data difficult. This fragmentation is not a cause of technical issues but reflects a deeper organizational structural challenge. Increasing the interoperability to a more complex and overtime accruing technical debt.

4.3 Third-party dependencies affecting technical debt

Q3 Third-Party dependency

This theme investigates how dependencies on third-party systems, vendors and external technologies influence technical debt and constrain the future decision-making. The findings indicate that third-party dependencies play a big role in the accumulation of technical debt with costly updates and long-term legacy investments. Several consistent comments emerge across respondents.

The findings show that the impact of third-party legacy systems strongly influences future technological choices. In many low-income countries the burden of legacy systems is often lighter. However, the findings indicate that there are challenges within technology adoption. The data requirements to run AI and large language models are often high, and data is usually poorly structured or fragmented. Even though the legacy constraints are lower, getting the right data limits technological progress.

Another respondent reinforced this by contrasting that in some counties, the burden of legacy systems is much lighter, making strategic pivots easier. In others, significant investments have already been placed in legacy systems, making it reluctant to replace a costly infrastructure. even if a lighter, more effective solution would be the better option.

Q3.2 Vendor updates or complex rework

A strong recurring pattern is the role of vendor-driven customization and updates that generate technical debt. Healthcare workflows vary significantly from department, leading organizations to rely heavily on vendor customization during initial system implementation,

Healthcare workflows can vary a lot from department to department. At first, they get an IT vendor who fully customizes the model and usually it works for the first year but as soon as the EMR or vendor releases a new version or update the technical debt matters start as it becomes nearly impossible without rewriting many parts. Another typical scenario is that many organizations keep adding new systems without taking off the older systems. On the other hand, there are organizations that are postponing third-party services due to too many legacy systems that are already in place. (R2)

The systems vary in counties and in many cases changing the third-party budget-wisely becomes unbearable with all the updates and rework. Especially, in a volatile economic situation where cutting costs should be prioritized. (R4)

A common scenario where a highly customized EMR solution works effectively in the short term, often during the first year. However, when the new release updates start, these customizations become difficult or impossible to maintain without extensive rework. Also, the respondent highlighted two contrasting situations in the organization. Some organizations continue to add new systems without retiring the old ones while others postpone adopting new third-party services due to complexity of the existing legacy systems. Both approaches according to the findings lead to long-term technical debt through stagnation

The findings further indicate that budget constraints intensify the third-party dependence challenge. In many countries the cost of updating or replacing the third-party systems becomes unsustainable due to the cumulative burden of updates and rework. This reinforces when cost-cutting is prioritized, making a delay in decisions to modernize. The findings indicate that these kinds of environments, with even minor system change, can affect across multiple components without proper interoperability strategy. Maintenance becomes increasingly complex and costly and often exceeding the original investment plan.

Another respondent added that in some cases incremental modification to existing systems is more feasible than fully replacing them not for technical reasons but for the extensive tendering processes and policy requirements. The findings suggest that governance and procurement structures often favor short-termism and feasibility over long-term digital architecture.

Another escalation of technical debt is happening through tightly coupled architecture. Respondent described a case where a new legacy information system was introduced while 15-20 older application continued running in parallel. These systems were connected through point-to-point interfaces, creating a lot of challenges.

4.4 Other Emerging Themes

This section captures additional findings that cut across the themes above but insights on how technical debt is recognized and managed within healthcare organizations. The findings highlight gaps in documentation, expectations and emerging technologies. Also, indicating that technical debt is rarely managed systematically within healthcare organizations.

The importance of keeping technical debt in register is emphasized. It should be used as a diagnostic tool rather than an afterthought. According to the findings, this should be supported by cross-functional governance with clear ownership and accountability. The need for standardized interoperability across electronic medical record systems, patient care platforms, laboratories as well as a multi-year IT roadmap is essential for interdependence across systems and to reduce long term technical debt.

Another pattern is the misalignment between the expectations of AI and realities of healthcare IT infrastructure. While broader AI adoption is advancing at a rapid pace the core challenges of interoperability remain unsolved.

A respondent highlighted that patients often move between specialists who rely on separate systems and do not effectively share information. As a result, clinicians may lack access to patients complete medical history or ongoing treatments forcing patients to act as intermediaries of their own data. This highlights that data fragmentation is a global issue and cannot be solved by AI alone without improvements in data integration and system alignment.

Also, findings reveal that there can be a gap between technical and non-technical teams while technical teams often understand the presence and implications of technical debt, non-technical stakeholders might not recognize it as many effects become later visible in the project stages. Also, if the technical debt is poorly understood outside of the technical teams or it is insufficiently documented it can be difficult to manage.

Been working for a long time with new product development in healthcare industry besides technical debt, another recurring theme that reminds me of the technical debt is product debt. The things we do today to save budget or resources become a burden of tomorrow. It's basically easier to add features than removing them. And in many cases, unnecessary features that were created in a development phase become a burden to remove due to resource or budget constraints. (R3)

Beyond technical debt the findings reveal a closely related concept called product debt. The decisions made in product development to save time, or resources often become a burden later. Adding features is easier than removing them. Unnecessary features added earlier remain due to high cost of removal. Also, product debt and technical debt can usually go in parallel with smaller organizations such as start-ups. Excessive features and customizations end up as complexity for the end users while technical debt manifest internally as maintenance challenge. Respondent states that product debt shows in for the end-user as technical debt is more an internal issue. Often, the real issue could be the lack of documentation and past technical decisions.

Conclusion

The literature review of the thesis gave an understanding of how the technical debt phenomenon is defined and how the transition to sociotechnical debt is seen. The emerging themes were architectural design, governance dimensions, stakeholder disengagement, workflow misalignment and organizational inertia. Also, these themes arose and were backed by the four large IT integration examples in literature.

This gave a theoretical framework and definition for sociotechnical debt. It can be defined as accumulated costs and inefficiencies that arise between social and technical systems. This provided a basis to research deeper the social aspects of technical debt in healthcare sector. Three main categories were established, such as organization culture, organization structure and third-party dependence.

The methodology part covered how the selection process for semi-structured interviews was done as well as why qualitative method was chosen with the established research question how organization structure, culture and third-party dependency affects technical debt. Along with discussing how research design was implemented for the exploratory nature of the thesis, the sub-categories for the main questions were introduced. In the findings section the five participant profiles were introduced as well as pairing the comments in a categorized manner. Making themes emerge from the data.

The first research question How do organization culture affects the sociotechnical debt in healthcare it systems?

In the findings section of the expert comments there was a clear sign that the healthcare sector and IT are sometimes clashing with different viewpoint of how work process is carried out as well as having a very different work landscape affecting it. This was illustrated as having a different lens of view e.g. an engineering mindset vs clinicians being skilled only in a specific task. This cultural dimension was only captured through the interviews while the literature review may not adequately explain this as one of the root causes. The healthcare industry is naturally very reliant on curing patients rather than creating IT solutions in parallel which might be very different from some industries. At the same time localization of the IT system was the biggest challenge. As from the literature review as well as from the experts' comments the tendency to create a one-size-fits-all created a lot of friction and workarounds.

The Second research questions How do organization structure affects the sociotechnical debt in healthcare IT systems?

In the literature review the examples from health sector demonstrate a lot of bureaucracy around large IT projects as well as difficulties in stakeholder engagement. For instance, Sauer & Willcocks (2007) demonstrated how the complexity of large-scale IT projects can contribute to implementation difficulties. The experts' comments gave more insights into how the healthcare sector is heavily affected by governmental level decision making, tendering challenges as well as budget and resource constraints. A high level of governance with short-term budgeting creates inertia in the long run with diminished returns. Heavy regulation and policies create a lot of room for change management and from the literature review we can see that there is an on-going challenge to create a more transparent roadmap for technical debt matters.

The third research question How do third-party dependencies affect the sociotechnical debt in healthcare IT systems?

The literature part showcases, especially, in the health sector examples some adaptability issues while the expert comments in findings gave more insights into how the third-party system dependencies or older systems in place created sociotechnical debt. Limited budget with a heavy governance model including tendering for new procurement creates a situation where old systems are not updated and a lot of interoperability challenges between many systems happen. Even so, in some statements choosing a newer system would have been a more cost-effective solution rather than using and updating the old one. Another example is that some organizations become locked-in with one third-party provider making any changes too expensive. Specifically, Wachter (2016) noted how most of the procurement focus was on technology rather than integrating the service itself or understanding the workflow changes.

The healthcare industry's main task is to serve in a very practical method the patient compared to many other industries where datapoints might be the part or even the main driver for making customer solutions. At the same time heavy governance from the national level affects and creates sociotechnical debt. technical debt can be seen in third-party dependencies where rework, investment

and system changes become increasingly difficult even though some IT systems might be more beneficial than the original ones. The culture of the healthcare sector might affect in the long run how decisions or how IT solutions are seen. Is the IT department an integrated part of the organization or seen as supporting only the practical work.

The Healthcare sector would benefit from creating IT systems in a modular way by breaking larger systems into smaller components so they can be tested, updated and replaced more easily. This could offer greater flexibility when addressing one of the key challenges such as localization where a specific service can be tailored to meet the needs of a particular group or region. This requires a clear IT roadmap for several years which can be a challenge as many counties or decisions are made in a one-year manner or there are budget and other constraints that require a one-size-fits-all model. Managing stakeholders at all levels and transparently communicating the challenges related to interoperability might be the solution in the long run. The healthcare sector operates in a complex, government-influenced environment, which can limit how quickly challenges are resolved.

In the larger picture where technical, organizational and political layers are tightly interconnected. Future considerations should focus on how governmental decision making can be influenced. There are three suggested areas from this research to consider:

Technical:

1. Systems should not only be evaluated based on costs and risks but also by adaptability
2. Transparency is needed when modernizing a system or making future policies more flexible
3. Increasing modularity and modular thinking making future IT decisions more digestible

Organizational and governance level

1. Decision making structures should be reduced
2. Governance bodies should align transparently to support long-term digital strategy
3. Procurement flexibility to avoid being locked into outdated solutions

Policy and political level

1. Documenting and making digital infrastructure visible for the stakeholders.
2. Policymakers need a tool to evaluate long-term digital consequences of short-term decisions
3. Budgeting cycles should allow for a long-term IT roadmap and not short-term savings.

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