



# Potential of low-code in the healthcare sector

*An exploratory study of the potential of low-code development  
in the healthcare sector in Norway*

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## Executive summary

The Norwegian healthcare sector is currently facing significant challenges regarding electronic health records (EHRs) and information exchange. Several of today's EHR systems are outdated, and there is a lack of information exchange between different healthcare services. There is an ongoing planning project, termed Akson, which assigns these issues. Several technologies can be suited in the Akson project. A relatively new and unexplored technology in Norway, is low-code. The goal of this master thesis is to understand how low-code can be suited to develop an EHR for primary healthcare services and an interaction platform for all healthcare services in Norway. The study addressed two areas that helped increase our understanding. First, we examined the challenges in the Akson project. Second, we investigated the possible benefits of using low-code to develop the new solution. The data for our analysis were collected using semi-structured interviews with twelve representatives from ten different organizations, with regards to either the Akson project or low-code development.

When answering the overall research problem, we examined how the advantages of low-code can contribute to solving some of the main challenges in the Akson project. Our findings showed that the advantages of speed and innovation in low-code can help to solve the challenges related to the time horizon and flexibility of the Akson solution. Low-code can reduce the time horizon because low-code developers can build faster, and thus deliver a new solution in a shorter time. Not only is development quicker, but also the adaptation of a low-code solution takes less time than with traditional coding. Being able to adapt the solution to keep it up to date is an advantage of low-code that can reduce the risk of planning a solution for the future based on today's technology. Further, the innovation opportunities in low-code can contribute to solving the challenge of flexibility in Akson. By using low-code, it will be possible to adapt the solution to the actual needs of each healthcare service and municipality while maintaining a minimum of functionality for all. Finally, Sapphire Hospital Management System (HMS) served as an excellent example of a solution built on a low-code development platform (LCDP). In Sapphire HMS, they have managed to ensure privacy and information exchange across different healthcare services. We will argue that low-code can be a suited technology for the Akson project. However, we are aware that technology cannot solve all challenges, like for instance organizing and financing.

## Preface

This thesis is written as a part of the Master of Science in Economics and Business Administration, with a major in Business Analysis and Performance Management, at the Norwegian School of Economics (NHH). We wanted to write about a new and emerging topic and found low-code technology to be interesting.

Many people have contributed to this thesis, whom we would like to express our gratitude to. First, we would like to thank all the respondents who have been willing to participate in this study. Thank you for sharing your experiences, thoughts, and knowledge with us. Second, our supervisor Karen Sæbbø Osmundsen, which have been an excellent support in this process. Thank you for the good and constructive feedback. Third, we would also like to extend a big thanks to AVO Consulting, who introduced us to low-code.

It is a hectic, exciting, and educational period now approaching the end. Working on the master's thesis has been both challenging and exciting. We believe we have learned a lot and gained a deeper insight into the healthcare sector in Norway, low-code, and digitalization in general.

Bergen, December 2019

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# 1. Introduction

Lack of electronic health records (EHRs) that work well across different healthcare services has been a problem in Norway for many years. It is critical for patient safety that healthcare professionals can access all and accurate patient information. Today, patient health information is disseminated in different EHRs at different healthcare services (Direktoratet for e-helse, 2019a). A consequence is healthcare professionals having to spend a lot of time looking for and requesting patient information from other healthcare services. Today's EHR systems in primary healthcare are outdated and inefficient. The issue might get worse if the systems are not updated or replaced quickly. The population in Norway is getting older, and the clinical picture has become more complex as a result of new treatment methods and increased life expectancy. It is estimated that Norway will lack close to 76 000 healthcare professionals in 2035 (Direktoratet for e-helse, 2018).

The challenges in the healthcare sector cannot be solved by ICT alone. However, digital technology such as digitalization, digital innovation and digital transformation can contribute to enabling information exchange across different healthcare services (Direktoratet for e-helse, 2019b). There is a need for a common, digital infrastructure that connects the 17 000 different large and small players in the healthcare sector in Norway. In 2012, the Ministry of Health and Care Services published the governmental white paper "One citizen – one record". One of the strategic initiatives to realize the goal of "One citizen – one record" is the procurement and implementation of a national EHR solution for primary healthcare services outside Central Norway, and an interaction platform for all healthcare services. For this specific initiative, the Directorate of eHealth established a planning project, termed Akson. The realization of Akson will go on for many years, with a perspective until about 2030 (Direktoratet for e-helse, 2019a). The Akson project is described as one of Norway's largest IT projects and has recently been criticized for not being feasible as outlined (Storvik, 2019a).

At the same time, other countries, including Kuwait, Australia, and Austria, have managed to build functioning EHR systems across different healthcare services (OutSystems, 2019b; Australian Government, 2019; CEF Digital, 2019). Why is EHRs and information exchange still an issue in the healthcare sector in Norway? Building an EHR

solution and an interaction platform with low-code can be a solution to reach the goal of the Akson project. OutSystems (2019a), a leading low-code development platform (LCDP) for digital transformation, have stated that “*low-code is the future*” (paragraph 3). Low-code is a way of developing applications through configuration rather than coding. Estimates by Gartner have indicated that “*By 2024, low-code application development will be responsible for more than 65 percent of application development activity*” (Vincent, Driver & Wong, 2019, paragraph 4). Researchers at Forrester have agreed with the potential of low-code: “*We continue to recommend that enterprises adopt LCDPs to raise their capacity to deliver applications [...]*” (Richardson & Rymer, 2016, p. 16). They described how low-code development allows the organization to deliver new digital products and services at customer speed (Richardson & Rymer, 2016).

To summarize, today’s EHRs in the primary healthcare are outdated, inefficient and do not support information exchange between different healthcare services. The process of establishing a solution that integrates all healthcare services is expected to take a long time. This made us question why it is taking so long time, and if it is possible to deliver a new solution more efficiently. The healthcare services in Kuwait have experienced significant advantages of developing an EHR and an interaction platform on an LCDP. Is there a potential for developing a national EHR on an LCDP in Norway as well? This is an interesting study, as it has never been done before. The background described in this section contributed to the formulation of the following research problem:

**How is low-code suited to develop a national electronic health record (EHR) for primary healthcare services, and an interaction platform for all healthcare services in Norway?**

To gain insight to the research problem, we have defined two connected research questions that will be answered in the course of our study:

- What are the challenges of developing a national EHR for primary healthcare services, and an interaction platform for all healthcare services in Norway?
- What are the possible benefits of using low-code to develop a national EHR for primary healthcare services, and an interaction platform for all healthcare services?

The thesis proceeds as following: Chapter two will give the reader an overview of the literature on digital technology and low-code development. In addition to this, we describe the Sapphire Hospital Management System (HMS), developed using low-code. In chapter three, we introduce the research methodology used in this study, while chapter four covers the findings of the research. Further, chapter five discuss the findings. Finally, in chapter six, the conclusion is presented. The thesis also contains an appendix, where the interview guide and other relevant attachments can be found.

## 2. Literature

To investigate our research problem, a thorough understanding of some concepts is essential. We will start by presenting prevailing literature on digital technology, including digitalization, digital innovation, and digital transformation. Thereafter, we will present low-code development and the difference between declarative and programmatic tools. We have also included a section on modular and agile development, before presenting advantages and limitations of using an LCDP. Finally, we will describe the Sapphire HMS, which is developed on an LCDP.

### 2.1 Digital technology and related concepts

Bharadwaj, Sawy, Pavlou and Venkatraman (2013) viewed digital technology as “*combinations of information, computing, communication, and connectivity technologies*” (p.1). Digitalization, digital innovation and digital transformation are concepts that build on digital technology (Osmundsen, Iden & Bygstad, 2018a). Digital technology can be characterized as what Bygstad (2017) refers to as lightweight IT. This is in contrast to heavyweight IT, which includes the mainstream IT as currently delivered by IT departments over the world. Like back-end solutions such as enterprise resource planning- and other transaction systems (Stople, Steinsrud, Iden & Bygstad, 2017). Lightweight IT may be seen as complementary to heavyweight IT. It is well suited for tasks that heavyweight IT often has failed to support. Lightweight IT typically supports work processes with simple applications and the immediate needs of the user, (Bygstad, 2017).

One of the advantages of lightweight IT is that it is easier to change and customize to the end-user compared to heavyweight IT. Bygstad (2017) also pointed out that innovation occurs more easily with lightweight IT. The rapid pace of development and application of digital technology is reflected in that only a decade ago, companies focused mainly on heavyweight IT (Bygstad, 2017) like enterprise resource planning- and customer relationship management systems. Today, the focus is directed towards lightweight IT and phenomena such as smartphones, artificial intelligence, the Internet of things, robotic process automation and data analytics (Puthiyamadam, 2017). Another example of lightweight IT that has grown

big the last few years is low-code technology. Applying low-code to develop an EHR represents a form of digitalization. Hence, in the following, we will discuss the term more thoroughly. Although digitalization is most relevant for our thesis, we will also in short discuss the interconnected terms digital innovation and digital transformation, as low-code development of an EHR can be considered a part of the ongoing innovation and transformation in the healthcare sector.

### 2.1.1 Digitalization

The concept of digitalization is being used in ever-increasing contexts, from everyday conversations and newspaper articles to important discussions among politicians and top executives in leading organizations. Digitalization has gained increased interest among practitioners and scholars since the emergence of the Internet around the year 2000. Existing literature does not give a clear definition of digitalization. The term is used differently by scholars, companies and consultancy firms. Zott and Amit (2018) explained that digitalization is a new form of value creation and that it is a transformation process from analogue to digital. Bleicher and Stanley (2016) explained digitalization as a process of “[...] *converting data from an analogue to a digital format*” (p. 63). These definitions do not create an understanding of what the process from analogue to digital actually implies. Ross (2017) described digitalization in a business context as standardizing processes that have previously been carried out by individuals. McKinsey (2014) described digitalization as reinventing entire business processes by cutting the number of steps required, reducing the number of documents and developing automated decision making. Furthermore, it implies redesigning the organizational structure, roles, skills, and operating models to match the reinvented processes (McKinsey, 2014). Hageberg (2016) wrote that “*Digitalization is one of the most significant on-going transformations of contemporary society and encompasses many elements of business and everyday life*” (p. 694). Companies should understand the concept and how it impacts their business model. According to Zott and Amit (2017), digitalization has emerged hand in hand with product innovation. Digitalization brings new value creation opportunities for companies, through new markets, services and applications. In a literature study conducted by Osmundsen, Iden, and Bygstad (2018b), digitalization is defined as “*The process of using digital technology to alter one or more socio-technical structures*” (p.5).

As the preceding presentation of definitions illustrated, there are several different understandings of what digitalization actually implies. In our thesis, we have followed the definition of digitalization as presented by Osmundsen and colleagues (2018b), in that digitalization implies applying digital technology to alter one or many socio-technical structures. By this, we understood digitalization as more than merely a technical process, as it also involves and affects social aspects such as roles, relationships, and ways of working.

### **2.1.2 Digital innovation**

Another concept building on digital technology is digital innovation. Osmundsen et al. (2018b), discussed digital innovation to address products and services. They found that digital innovation is about digital technology as well as new combinations of physical and digital components. The result of digital innovation is understood as new for the market or the adopter (Osmundsen et al., 2018b). Therefore, Osmundsen et al., (2018b) defined digital innovation as *“A new product or service that creates new value for adopters has been developed by combining digital technology in new ways or with physical components”* (p.7).

### **2.1.3 Digital transformation**

As mentioned, digital transformation is a concept that is built on digital technology. A common form of digital transformation is to utilize digital technology to enable a new improvement in a company. Osmundsen et al. (2018a) have defined digital transformation as *“When digitalization and digital innovation are used over time to enable significant changes in the way we work, leading to significant transformation of an organization or an entire industry”* (p.2). Digital transformation can create unique changes in an organization where value creation, business process and operation can change (Libert, Beck & Wind, 2016). Low-code is seen as an enabler for digital transformation (Pega, 2019).

## 2.2 Low-code development

The term low-code has been popularized by Forrester, which first used it in a report called “New Development Platforms Emerge For Customer-Facing Applications” in 2014 (Richardson & Rymer, 2014). According to Revell (2019), “*Low-code is a way to design and develop software applications fast and with minimal hand-coding*” (paragraph 1). The idea is to be able to create applications through configuration rather than coding. An application is specified visually by creating models of the data, the process steps, and the user interface (Nyssen, 2017). Instead of coding an application line-by-line, the low-code developer begins with a drawing - like a flow chart (Appian, 2019). Elements are dragged and dropped onto the palette to create a flow of behaviours (Barker, 2017). Figure 1 shows an example of an environment for visually defining the user interface, workflows and data models of an application (Revell, 2019).

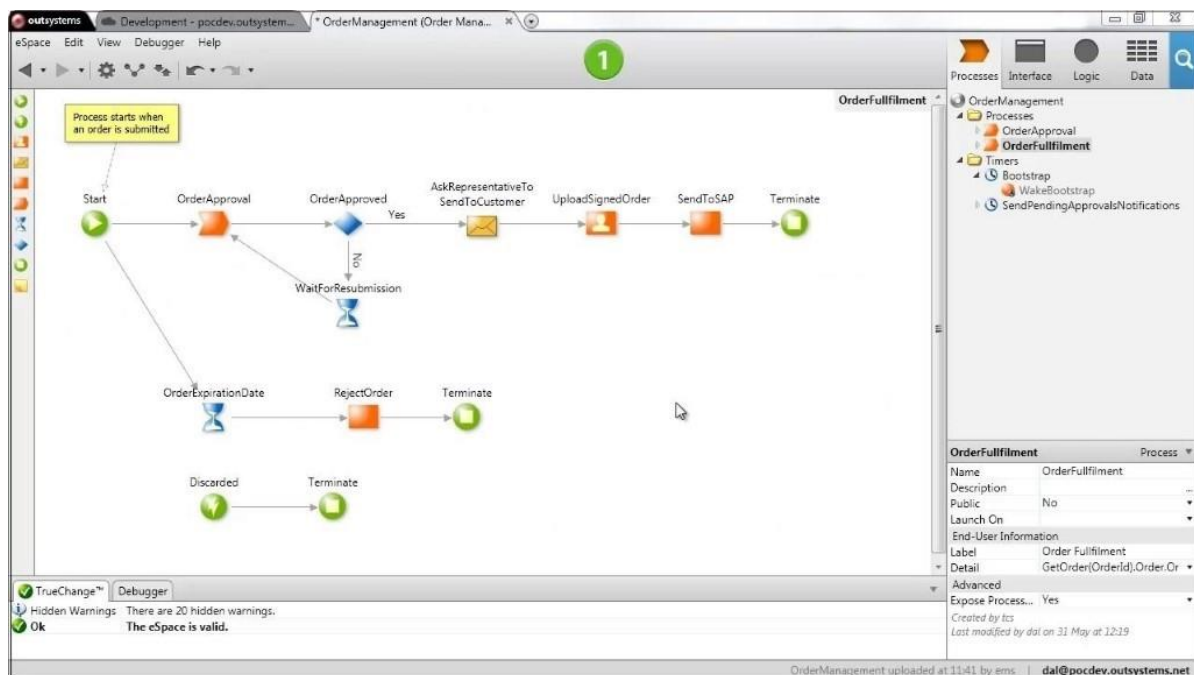


Figure 1: Environment for visual configuration (Bloomberg, 2017).

Next, the developer configures each element by drilling down and configuring forms and data integrations. All the elements that are configured are reusable (Barker, 2017). As such, development through low-code is often compared to building with Lego blocks (Shiah, 2018). The elements are made simply and graphically, but there is still possible to do additional customizations using script or code. In most major digitalization projects, about

80 percent of the needs are met by drag-and-drop functionality, while the remaining 10-20 percent are customized with code (Compose, 2019).

### **2.2.1 Low-code development platforms (LCDP)**

Low-code development is carried out on LCDPs. Forrester have defined LCDPs as: *“Products and/or cloud services for application development that employ visual, declarative techniques instead of programming and are available to customers at low or no cost in money and training time to begin, with costs rising in proportion of the business value of the platforms”* (Rymer, 2017, p. 4). Forrester pointed to two dimensions when distinguishing LCDPs from traditional development platforms such as Java (Richardson & Rymer, 2016). The first dimension regarded how applications are developed and delivered on the platform. While traditional platforms rely on programming languages, LCDPs use declarative development tools. The tools include domain languages, What You See Is What You Get (WYSIWYG) user experience definition, flow diagrams, and visual data models. The second dimension regarded how the development platforms are acquired and consumed. For enterprise software developed on traditional platforms, it is typical with a financial commitment made upfront. LCDPs stands out by offering free or low-cost-self-service features and being available as public cloud services. As developers create value with the platform, they will pay fees for named users, deployed applications, and capacity used.

### **2.2.2 Declarative VS. programmatic tools**

When should declarative tools be used, and when are programmatic tools favourable? Typical business applications require some programming and scripting. The use of LCDPs minimizes the need for coding. However, many enterprise applications built with these platforms will still require some coding to be complete (Rymer, 2017). Both Forrester and Salesforce<sup>1</sup> have described cases where programmatic tools are required. It applies to features that support specialized or complex business processes and provide highly

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<sup>1</sup> <https://www.salesforce.com/eu/?ir=1>



customized user interfaces or customized click-through paths (Salesforce developers, 2019). Some programming will also be required to integrate with other applications and databases, and to accommodate technologies that are not incorporated in the LCDP (Richardson & Rymer, 2016). Salesforce developers (2019) recommended considering both the problems the company must solve and the resources available to solve them when choosing between “clicks” and code. If the problem requires some code, businesses can use programming extensions within the low-code environment or rely on external programming languages and scripts (Richardson & Rymer, 2016).

### **2.2.3 Agile development approach and modularity**

Several of the advantages of low-code are related to low-code supporting an agile approach to application development. An agile development approach is focused on evolutionary development, early delivery and continuous improvement (Warren, 2019). The approach is suited for digital development initiatives that need to adapt continually. One of the principles of agile software development is “*To satisfy the customer through early and continuous delivery of valuable software*” (Beck et al., 2001, p.2). According to Rocha (2017), “*Agile is all about being lightweight, nimble and flexible [...]*” (paragraph 3). As a result, the approach allows adapting to change quickly.

One of the characteristics of agile processes is modularity. LCDPs use component-based architecture (Oberoi, 2019). According to Afonso (2019), “*Component-based architecture is a way of building software with independent, modular, and reusable pieces—the components*” (paragraph 1). Thus, developers have an opportunity to divide the work into smaller pieces and to reuse components in different applications. Modular development makes it possible to quickly expand on one aspect while another one stays the same. One of the best ways to reduce complexity is to decompose the overall system into a series of subsystems. Here, interactions within subsystems are relatively frequent and stronger, while interactions between subsystems are relatively rare and weaker. It allows subsystems to operate largely independently of one another in the short run, but to integrate into a more extensive complex system over the long run (Yoo, 2016).

## 2.3 Advantages of low-code

In 2017, Forrester conducted a study on challenges in building custom applications using traditional coding (Rymer, 2017). 41 application development and delivery (AD&D) leaders using LCDPs were interviewed. Multiple responses were accepted. Figure 2 shows what was highlighted as the main challenges with traditional coding. It is particularly pointed out that building custom applications with traditional coding is time-consuming, not very flexible and expensive. Another common challenge was the lack of qualified staff.



Figure 2: Challenges with traditional coding (Rymer, 2017).

In the study, Forrester also investigated if LCDPs had addressed the challenges in figure 2. 95 percent of those who participated in the study pointed out that LCDPs had addressed the challenges with significant or notable improvement. As the study done by Forrester indicated, low-code development has several advantages as compared to traditional coding. The four main advantages of low-code are listed in table 1, before elaborated in the following subsections.

ADVANTAGES OF LOW-CODE	
<b>Speed</b>	Low-code accelerates development and deployment time.
<b>Innovation</b>	Low-code facilitates innovation by allowing to build, launch and change powerful applications rapidly.
<b>Scalability</b>	Low-code applications are scalable.
<b>More available development talent</b>	Low-code reduces the technical barrier, enabling “citizen developers” to contribute to application development.

*Table 1: Advantages of low-code.*

### 2.3.1 Speed

Coding new applications is a time-consuming and labour-intensive process (Richardson & Rymer, 2016). As mentioned earlier, the development tools needed for creating applications with LCDPs are different from the programming languages used in traditional platforms. Developers save time using low-code because of the use of configuration rather than coding. In the study conducted by Forrester, they compared low-code to traditional coding. Table 2 illustrates a comparison of the results. Most of the companies Forrester interviewed reported that their LCDPs helped them accelerate development by five to ten times. The study showed that businesses were able to develop and deliver custom applications at a more rapid pace with LCDPs than with traditional platforms. As an example, a Spanish insurance provider developed a web channel and administration system in 13 weeks, by using low-code. The estimated time of coding the same solution at a traditional platform was 2,7 years. The result of using low-code depends on how the development tools are suited for the desired and planned applications (Richardson & Rymer, 2016).

ENTERPRISE	RESULT	TRADITIONAL CODING	LOW-CODE
Spanish insurance provider	Web channel and administration system	2.7 years (estimated)	13 weeks
US government (Affordable Care Act)	Document compliance module	100 person-months	5 person-months
Call center operator	Customer-specific application	4 months	3 weeks
British insurance provider	Agent portal	Unknown*	10 days to minimum viable product (MVP)

\*The project was on the technology management backlog list for years with a little hope of ever starting

Table 2: Comparison of low-code and traditional code (Richardson & Rymer, 2016).

### 2.3.2 Innovation

In addition to speed application delivery, LCDPs are designed to speed innovation delivery. To be innovative, it is central to use technology that enables digital transformation and that supports business agility (Nyssen, 2017). Code has become a bottleneck, and coding faster is not always an option, as writing code more quickly can increase the probability of bugs in the code (Idesis, 2017). According to Gartner, Forrester, and OutSystems, low-code development is the new software to make business agility happen (Nyssen, 2017). Lars Holth, the Chief Operating Officer of the Norwegian LCDP Genus, argued that low-code helps to raise the level of innovation throughout the organization (Grimstad, 2019). According to Appian (2019), “LCDPs are the fastest way to transform ideas into innovation” (p. 8). This is by allowing to build, launch, and change powerful applications rapidly.

LCDPs enable organizations to explore new ideas quickly and at a lower cost than with traditional coding (Goodman, 2018). The use of an LCDP allows organizations to test an idea in a working application quickly, gain feedback and iterate towards a finished product (Richardson & Rymer, 2016). As Steve Jobs once said: “People do not know what they want until you show it to them” (Reinhardt, 1998). It is, therefore, a big advantage to be able to create a low-cost working prototype that can be used to validate ideas and customer requirements. The real-time feedback from the customers makes it possible for the company to uncover precise requirements, and in this way, prove the value of the service before using resources on building the full offering (Richardson & Rymer, 2016).

### 2.3.3 Scalability

An application is said to be scalable if its performance does not degrade significantly as the load on the system increases (Juengst, 2017). A common misperception is that LCDPs are only applicable for small-scale applications. According to a study conducted by Forrester, LCDPs are also suitable for large-scale, complex applications, and more extensive application portfolios (Richardson & Rymer, 2016). Figure 3 shows the results when Forrester asked 41 AD&D leaders in which scale they develop low-code applications. The figure below is included to illustrate that LCDPs can be used to develop both small- and high-scale applications. The figure illustrates that the majority of the participants in the study use low-code to develop large-scale applications. The applications are in most cases used across the enterprise or by multiple departments (Rymer, 2017).

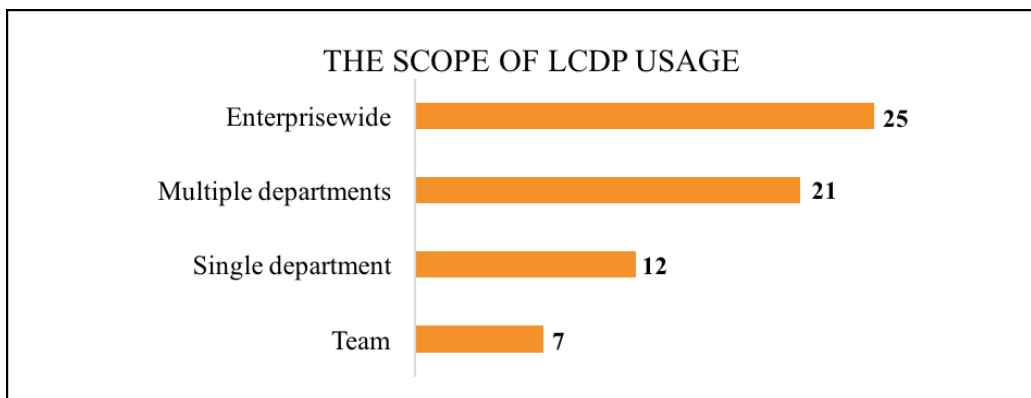


Figure 3: The scope of LCDP usage (Rymer, 2017).

A more concrete example is from the Norwegian LCDP, Genus. Genus have proved that their technology is suited for big volume. Their low-code solutions handle 10-12 million transactions for NorgesGruppen daily (Charlesen, 2018). In other words, LCDPs can deliver the enterprises' needs for large scale.

### 2.3.4 More available development talent

Businesses can have lengthy backlogs for delivering new applications and a strong need for more resources (Richardson & Rymer, 2016). Finding employees with the right IT skills can be a challenge for business leaders. The shortage of IT skills in the market can be referred to as a skill gap, meaning that there is a gap between the skills demanded to develop

a solution and the employees that are available. One of the advantages of low-code development is that *“The technical barrier is significantly lowered so that people without a professional software engineering background, so-called ‘citizen developers,’ are now enabled to create applications without the direct involvement of the IT department”* (Nissen 2017, paragraph 4). LCDPs are “self-service” development platforms, which allow business leaders to hire more affordable and available development talent. It is no longer necessary that all the developers have a formal programming background as long as they bring enough technical skills to configure new business applications visually, using LCDPs (Richardson & Rymer, 2016).

## 2.4 Limitations of low-code

As the preceding chapter illustrated, there are several advantages of developing with low-code. However, as with any technology, there are some limitations with LCDPs pointed out in the literature. One of the limitations brought forward in the literature is how low-code hides the code from the end-user. The hidden code is criticized for causing bad code. Shiah (2018) considered the most significant issue of LCDPs to be that they do not eliminate code; they just hide it from the end-user. Reselman (2018) said: *“Fixing bad code is more expensive than making good code”* (paragraph 13). He argued that low-code can create bad code and that it is always cheaper to do the software well the first time than to fix it later. Even though the code is more hidden in LCDPs than in traditional platforms, it is still possible to make changes to the code. The code should also be functioning, as the code is generated based on the application modelled in the visual editor (OutSystems, 2019c). The code generator checks for optimizations and adds monitoring capabilities so that developers can check for errors.

Reselman (2018) described that using low-code is not going to work without highly skilled developers. When using low-code, it is still necessary that the developer understands the basic concepts that are being abstracted away by the visual tool. Reselman argued that LCDPs will help skilled developers move faster. However, it will not help inexperienced developers to develop better. A limitation of low-code, argued by Nyssen (2017) is that the business logic that can be captured in applications which are configured instead of coded is

quite limited. Traditional coding will be necessary to capture complex business logic. For this, skilled developers are needed. Nevertheless, even though LCDPs do not remove the need for skilled developers, it might reduce the need. There are two reasons for this. First, “citizen developers” can contribute to a greater extent. Second, developers are more productive when using low-code. According to Afonso (2019), the reusability aspect of component-based architecture reduces the number of developers needed. Low-code is not about reducing the value of developers, but to let the developers produce more value quicker (Revell, 2019).

## 2.5 Sapphire Hospital Management System (HMS)

Sapphire HMS is an example of an application developed on an LCDP (OutSystems, 2019a). Using low-code, the developers saved years of development and deployment time. The system was developed by Advanced Technology Company (ATC), a distributor of healthcare technology services in Kuwait. The Ministry of Health in Kuwait needed a system that could gather, exchange and maintain accurate patient information. The reason why ATC chose an LCDP was all the challenges they met when using traditional platforms. The main challenges were that it was time-consuming, expensive, and resulted in a solution that was hard to use. ATC considered it to take two to five years to develop the system with traditional coding and the cost to be hundreds of millions of dollars. Besides, the system would be difficult for the healthcare professionals to use and would therefore demand much training. With low-code, ATC were able to develop Sapphire HMS, which is a complete system “*That can be deployed and customized for any hospital or healthcare service in weeks or months instead of several years*” (OutSystems, 2019a, paragraph 8). The first implementation was done in six months at one of the biggest hospitals in Kuwait (Lulu, 2017). Today, Sapphire HMS runs at five hospitals in Kuwait, four public and one private. Sapphire HMS has reduced errors in patient health records with 60 percent and improved communication across hospital departments, physicians, and nurses (OutSystems, 2019a). Other main gains are increased productivity and improved patient experience. It has also reduced the system licensing cost, and there is no longer a need for training of the end-users.

Sapphire HMS consists of five different modules, which together make up a complete solution for hospitals (Sapphire, 2018). What is particularly relevant for this thesis is the

Electronic Medical Record (EMR) in the Clinician-module, as EMR is equivalent to EHR in Norway. Sapphire's EMR gives a comprehensive view of the patient by giving immediate access to all patient health history. It is essential to point out that the EMR is only used at hospitals in Kuwait due to how the healthcare sector is organized in the country. However, one of our respondents explained how the system can also be applied to other healthcare services, like the general practitioner. The example of Sapphire HMS is included in our thesis, as it shows the possibility of developing a national EHR for primary healthcare services with low-code. It is not included as a direct answer, but for inspiration.



### 3. Research methodology

When choosing a research design, it is essential to consider the research problem, the existing research on the topic, and what type of data is desirable. There is a lack of existing research on the use of low-code in the healthcare sector in Norway. This led us to define a relatively broad and comprehensive research problem. For this, an exploratory design is appropriate as we wanted to explore and gain a deeper understanding of the use of low-code development in the Akson project (Saunders, Lewis & Thornhill, 2016). The goal of the research is not necessarily to provide a final and conclusive answer but to contribute with insights regarding the field of low-code. In this type of study, it is an advantage to be able to change the direction of the research. As we got a deeper understanding of the research concept, we were able to adapt the direction of the research. During the process, we redefined our research problem several times as we got new insight on the topic.

We have chosen a qualitative method for our research as it digs deep into the problem and provides detailed knowledge (Saunders et al., 2016). The result of the qualitative method is often descriptive data, such as statements from the respondents. We believed that such non-numerical data would give us the insight we needed to answer our research problem. As the field is relatively unexplored, our study is not based on hypotheses. We used an inductive research approach, as we wanted to develop a theory based on collected data, a so-called bottom-up approach. This approach is common in qualitative research, as it often generates rich insight. The purpose of the inductive approach is to understand and formulate assumptions (Saunders et al., 2016). Thus, we sought to explore the potential of low-code in the Akson project by relating our findings to existing literature about digital technology and low-code.

#### 3.1 Research setting

Before we present how we collected our data, we will briefly explain the setting of our research. It is necessary with an understanding of how the healthcare sector in Norway is composed, how today's EHR systems work and how the goal of "One citizen – one record" is

organized. Our research focus on the Akson project, which will be elaborated in the following.

There are four regional health authorities in Norway: Central Norway, North, West and South-East (Direktoratet for e-helse, 2019c). The healthcare sector is separated in the specialist healthcare services and the primary healthcare services. While the four regional health authorities compose the specialist healthcare services, the municipalities are responsible for the primary healthcare services. Primary healthcare services include general practitioners, out-of-hours emergency primary healthcare, health clinics, home health nursing, nursing homes and physiotherapy. One of the biggest challenges today is to achieve information exchange across Norwegian healthcare services. The different healthcare services use different EHR systems which are not integrated well enough, or at all. Today, it is not uncommon that patients and users bring paper transcripts of their health record from one healthcare service to the next healthcare service. This, to make sure that all relevant information is available. 50 percent of cancer patients have stated that they must take responsibility to communicate their health information to the healthcare professionals who need it (Direktoratet for e-helse, 2019d).

In 2012, the Ministry of Health and Care Services published the governmental white paper “One citizen - one record”. The report described the goal of a national EHR, creating a seamless flow of information across Norwegian healthcare services. The vision of “One citizen - one record” is extensive and will take years to accomplish. In 2013, the Norwegian Directorate of Health started to look at different opportunities to achieve the goal (Direktoratet for e-helse, 2019a). They are planning to implement the vision through three strategic initiatives:

<b>1)</b>	Implementing the solution “Helseplattformen” in Central Norway.
<b>2)</b>	Ongoing EHR upgrade and investment programs in the specialist healthcare regions of North, West and South-East.
<b>3)</b>	Procurement and implementation of a national EHR solution for primary healthcare services outside Central Norway, and a national solution for collaboration and information exchange for all healthcare services.

*Table 3: Strategic initiatives for “One citizen – one record” (Direktoratet for e-helse, 2019e, p.2).*

The different initiatives are illustrated in figure 4. Helseplattformen (1) is an ongoing project, where a solution from Epic<sup>2</sup> is expected to be introduced at the first healthcare service in Central Norway from autumn 2021 (Helseplattformen, 2019). In the remaining health authorities (2), DIPS<sup>3</sup> is doing the EHR upgrade (DIPS, 2019a). In July 2018 the Directorate of eHealth recommended a concept for a national EHR and an interaction platform. The concept, termed Akson, is planned to serve the last initiative (3) (Direktoratet for e-helse, 2019f).

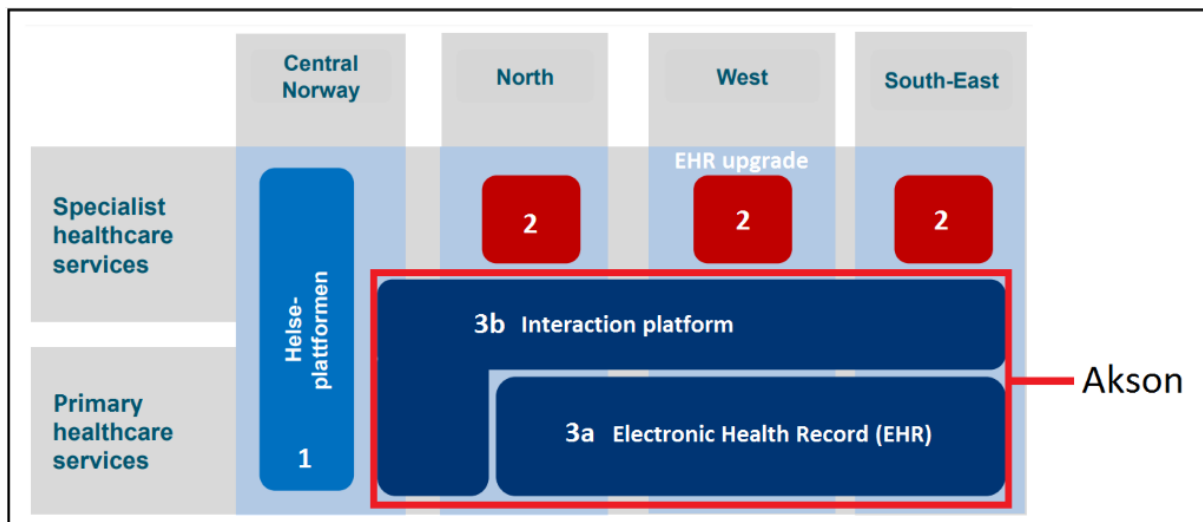


Figure 4: An illustration of the three strategic initiatives.

In our thesis, we chose to focus on the Akson project, whose goal is to create a national EHR for primary healthcare services and a national solution for information exchange for all healthcare services in Norway (Direktoratet for e-helse, 2019c). To make it clear, we have used the term “EHR solution” (3a) for the national EHR for primary healthcare services and the term “interaction platform” (3b) for the national solution for information exchange for all healthcare services. The term Akson includes both the EHR solution and the interaction platform. Notice that the Akson project does not include primary- and specialist healthcare services in the region of Central Norway, as they have their own large health record project, Helseplattformen (Storvik, 2019b). We considered it to be particularly

<sup>2</sup> <https://www.epic.com/>

<sup>3</sup> <https://www.dips.com/no>

interesting to investigate how low-code is suited in the Akson project, for at least three reasons. First, the EHRs in the primary healthcare services are at least 15 years behind the specialist healthcare services regarding digitalization (Enoksen, 2019). Second, the Akson project is still in the initial phase, in contrast to the two other strategic initiatives where contracts already have been signed with solution providers of EHRs. Focusing on an ongoing project makes our thesis more relevant and useful. Third, the Akson initiative is critical as the population is getting older, and there will be a lack of healthcare professionals in the future. This will affect the primary healthcare massively and create an even higher pressure on efficiency in the sector. Digital technology cannot solve this challenge alone. However, the development of effective and well-functioning EHR systems can improve the situation.

There are many arguments for why Norway need a national EHR for primary healthcare services and a national interaction platform. It is crucial for both the patients, the healthcare professionals, and the management at the different healthcare services (Direktoratet for e-helse, 2019c). Today, the patients experience a lack of control as they have to retell their medical story multiple times. Besides, there is an increased risk of malpractice and patient injuries, due to the lack of information exchange. For the healthcare professionals, the main issue is that relevant patient health information is not available. Information is often outdated, and the healthcare professionals spend a lot of time searching for patient health information and trying to coordinate with other healthcare services. It also affects the management, who are unsure of the quality of their services, as they lack proper tools to monitor quality improvement and improve patient safety. Besides, there are likely thousands of man-years tied up in meaningless and ineffective labour, scanning incoming information to get it into the systems. This is time, cost and resources that could have been used for more important tasks (Moberg, 2019). The municipalities need a better EHR solution and an interaction platform to easier exchange information with other healthcare services. Today's systems are silo-based and are mainly limited to each healthcare service. A new solution should aim at improving interaction and provide healthcare professionals with better access to up to date and relevant information about the patient. Accordingly, the patient is expected to experience a more holistic and coordinated healthcare service and get increased patient safety (Direktoratet for e-helse, 2019f).

The current situation is that the Directorate of eHealth is doing a planning project. They are now working on a report, which will serve as the basis for the government and municipalities' investment decision process (Direktoratet for e-helse, 2019c). The report will be submitted to the Ministry of Health and Care Services in February 2020. In the report, the Directorate of eHealth should, among others (Direktoratet for e-helse, 2019f, paragraph 16; 2019g):

- Consider how Akson can be implemented step by step to reduce risk, complexity and cost.
- Deliver a plan for realization of benefits.
- Recommend financing.
- Recommend organization and responsibilities.
- Consider the mandatory use of the interaction platform.

We have included figure 5 to illustrate the tentative timeline for the establishment of a national EHR solution. The planning project is followed by a second quality assurance (QA2). After procurement, establishment and adaption, the EHR solution will be implemented at the healthcare services in the municipalities during 2025-2030.

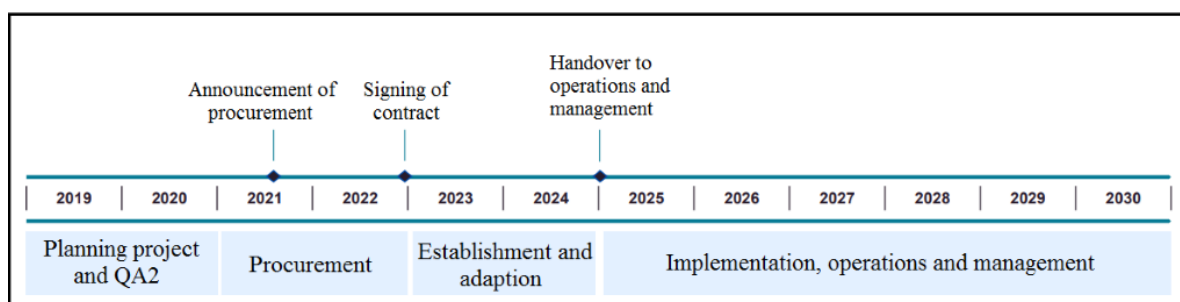


Figure 5: Tentative timeline for the EHR solution (Direktoratet for e-helse, 2019h).

Regarding the interaction platform, it is not decided yet if there will be a procurement. The other alternative is to build on today's components and solutions. The plan is that the interaction platform should be complete in 2030 (Direktoratet for e-helse, 2019h). In the short term, the Directorate of eHealth are working with the sector to enable document sharing through the summary care record, with standards for data sharing and with common languages for better interaction (Storvik, 2019c). The summary care record acts as a supplementary health register in addition to the EHR and does not give as much and detailed information as the EHR (helsenorge.no, 2019). So far, the Akson project is estimated to cost NOK 11,4 billion (Direktoratet for e-helse, 2019h).

## 3.2 Data collection

### 3.2.1 Interview as a research method

To be able to answer the research problem, we needed information from different representatives with insight relevant to our research questions. We needed detailed, valuable and reliable information. Our primary source of data has therefore been in-depth interviews, where we gave the respondents time to answer the questions in detail. We chose to conduct semi-structured interviews because of the explorative purpose of this thesis (Kvale & Brinkmann, 2015). Semi-structured interviews were useful to get the respondent's interpretation of the research topic. Based on the interview guide, we ensured that we got through the topics required to answer the research problem. Using a semi-structured interview approach, allowed us to vary the order of the questions and to ask follow-up questions if some answers were unclear.

### 3.2.2 Selection of respondents

When conducting interviews in qualitative studies, there are no specific requirements for the number of respondents. Kvale and Brinkmann (2015) argued that one should interview as many people as it takes to find out what you need to know. However, others have recommended that a sample size between six and twelve persons is suitable (Gubrium, Holstein, Marvasti, & McKinney, 2012). We interviewed twelve persons from ten different organizations. To find respondents relevant for our research, we started by doing a Google search on low-code development and the Akson project. This way, we found organizations that were involved in the Akson project and were engaged in the topic. We contacted the top management of the organizations or employees that were mentioned in relevant articles. In some cases, we were directed to co-workers with more specific knowledge on the topic. We also found contact persons who had insight on Sapphire HMS this way. Some of our interviews about low-code were planned through a contact person we got when attending a low-code course. When we started interviewing, respondents informed us about other relevant organizations with knowledge on the topic, that we later contacted and interviewed. As table 4 illustrates, we interviewed people from various organizations who had valuable experience and knowledge of either the Akson project or low-code development.

RESPONDENT	ORGANIZATION	JOB TITLE
<b>A</b>	The Ministry of Health and Care Services	Special Adviser
<b>B</b>	KS	Head of Department: Strategic ICT and digitalization
<b>C</b>	KS	Program Manager: Strategic ICT and digitalization
<b>D</b>	Norwegian Health Network	Head of Digital Interaction
<b>E</b>	Helseplattformen	Head of Communication
<b>F</b>	Norwegian Centre for eHealth Research	PhD Student
<b>G</b>	The Norwegian Data Protection Authority	Data Protection Commissioner
<b>H</b>	DIPS Front	Chief Executive Officer
<b>I</b>	OutSystems	Regional Success Director
<b>J</b>	OutSystems	Solutions Architect
<b>K</b>	Advanced Technology Company (ATC)	Operations Senior Manager
<b>L</b>	Avo Consulting	Senior Consultant

*Table 4: Overview of respondents.*

To gain insight on the goal of “One citizen – one record”, we conducted an interview with the Ministry of Health and Care Services, which set the national goal. As mentioned earlier, the Ministry of Health and Care Services have provisioned the Norwegian Directorate of eHealth, a sub-ordinate institution, to conduct a planning project for establishing a national EHR for primary healthcare services and an interaction platform for all healthcare services in Norway (Direktoratet for e-helse, 2019f; 2019i). To get more detailed information about the Akson project, we conducted interviews with KS, the Norwegian Health Network and Helseplattformen. These organizations are all represented in the project board of Akson. KS is an organization for the municipal sector and the development partner of the municipalities (KS, 2019). The Norwegian Health Network is a state-owned enterprise with a mission to deliver and further develop a national ICT infrastructure for effective interaction between the healthcare services (norskelsenett, 2019). Helseplattformen were introduced in chapter 3.1, as being responsible for implementing a new EHR solution in Central Norway. Their experiences will be valuable for the Akson project, as they have already been through several of the project phases that awaits Akson.

To learn more about previous and current research relevant to our topic, we conducted an interview with the Norwegian Centre for eHealth Research. They are working with the Norwegian Directorate of eHealth and other stakeholders to find the best eHealth solutions for the sector (Norwegian Centre for eHealth Research, 2019). Another important perspective was the one of the Norwegian Data Protection Authority, which is a public authority and an independent body set up to protect the individual's right to privacy (Datatilsynet, 2019). What was relevant to us was the supervision they do regarding privacy and information security in the EHR solutions. We also interviewed DIPS Front, which is the leading provider of eHealth to Norwegian hospitals and one of the three largest players in the primary healthcare market. They have one of the same goals as the Akson project, to increase interaction and information exchange between hospitals and municipalities (DIPS, 2019b). The reason why we interviewed them was to hear how they work to realize this goal.

To get some insight into the use of low-code development of a national EHR and an interaction platform, we conducted interviews with OutSystems and ATC. OutSystems is a low-code platform, while ATC is a healthcare solution provider (ATC, 2015). They both have experience with how low-code can be used to develop a national EHR with information exchange. Finally, we interviewed a Senior Consultant in Avo Consulting with great knowledge of low-code. This was to hear her thoughts about the potential of the technology in the healthcare sector in Norway. We believe that our selection of respondents provided us with valuable and nuanced information on the topic.

Figure 6 below provides a graphic overview of our respondents. It illustrates how eight (A-H) of the respondents are considered as key respondents with regards to the Akson project, and four (I-L) with regards to low-code development. Concerning low-code, we have got the insight we need, even though the number of key respondents is lower compared to the key respondents for the Akson project. We found it appropriate to have more key respondents with regards to the Akon project, as it is such a comprehensive project with many players involved. The higher number of respondents was to ensure that we covered the different perspectives on the project.





Figure 6: Illustration of respondents.

### 3.2.3 Interview guide

We worked thoroughly with the interview guide, as it helped to set the direction and purpose of the interview (Saunders et al., 2016). Since we interviewed different organizations, we started by reading available information about the organizations and our respondents. This way, we were able to customize the questions to their role and thus get more detailed answers. Each interview guide consisted of some key questions which were derived from our two research questions and the literature presented. It was natural to add emphasis to different research questions in different interviews. For example, in the interview with The Ministry of Health and Care Services, we focused on the first research question about the challenges of developing a national EHR for primary healthcare services, and an interaction platform for all healthcare services in Norway. In our interview with OutSystems, we focused on the second research question about the possible benefits of using low-code to develop such a solution. In addition to preparing some open questions, we also discussed different follow-up questions that could be used to get greater insight. To get the interview to flow more like a conversation, we organized the questions in a logical order. We have included two examples of our interview guides in appendix 1 and 2.

### 3.2.4 Interview execution

We conducted the interviews during October and November 2019. Given that the respondents were living in different places in Norway and some abroad, we conducted some of the interviews through Skype and some in person. Each interview lasted between 30 to 60 minutes. For the interviews that were conducted in person, we went to the respondent's workplace. The respondent took responsibility for finding an available meeting room, or we

used the office of the respondent to avoid interruptions during the interview. We started each interview by introducing ourselves and our thesis. We then repeated some of the information that was written in the information letter we had sent in advance (see appendix 3). We also asked for permission to use the audio recorder, which all the respondents accepted. This contributed to a more relaxed and natural situation where we were able to engage and listen in the conversation, as we did not have to take notes. We divided the interviews between us, meaning we were responsible for leading a number of interviews each. However, both researchers asked open and non-leading follow-up questions where this was necessary. We also emphasized that we wanted a dynamic conversation to achieve the most natural answers and flow in the conversation. The respondents were very engaged in the topic and gave thorough answers to our questions.

### **3.2.5 Other data sources**

Besides using interview as a research method, we also found it appropriate to use media articles, reports, and governmental white papers to gather relevant information on the topic. We found a lot of information about the Akson project in the newspaper called Dagens Medisin, which is Norway's largest independent news channel for health-related topics. While writing this thesis, there was an ongoing debate about the Akson project in Dagens Medisin. It has been essential for us to act neutral and highlight different perspectives when citing the articles from the newspaper. We have been aware of conflicts of interest, and how the role of a person can have influenced their statements to the newspaper. When we presented our findings on the challenges in the Akson project, we have made it clear that the planning project is not finalized yet. We have commented if the challenge mentioned is a part of the considerations that are being made in the ongoing planning project. We were planning on interviewing representatives from the Directorate of eHealth. They would have been valuable contributors to our thesis as they are the ones responsible for the Akson project. Unfortunately, the interview was not conducted. However, we have included data from several reports and documents that stated their opinions and thoughts on the project.

We accumulated knowledge and deeper insight on low-code, by attending a low-code course by OutSystems in collaboration with Avo Consulting. During the course, we developed a

simple application using an LCDP, which we believe has contributed to our broad understanding of low-code. This understanding served as a supplement to the insight we gained on low-code through interviews.

### 3.3 Data analysis

In qualitative research, data analysis is about structuring and interpreting data according to different themes (Saunders et al., 2016). The first step in the data analysis was to transcribe our interviews. Transcripts of the audio recordings were made continuously after each interview. To ensure that we did not affect the results with our preconceived opinions, we transcribed the whole interview and not just what we initially thought would be interesting to analyse. The transcribing process was time-consuming, but it provided a holistic overview of the data collected from the interviews.

In the next step, we had to be systematic and sort out the data we considered relevant and wanted to use in the analysis. To systematize the quotations from the interviews, we were inspired by the method from Gioia, Coreley and Hamilton (2012). Their method is based on initial data coding using informant-centric terms, referred to as 1<sup>st</sup> order analysis. Further, 2<sup>nd</sup> order analysis is done by using researcher-centric themes. When the 1<sup>st</sup> order concepts and 2<sup>nd</sup> order themes are structured, they lay the basis for creating aggregate dimensions. Our aggregate dimensions are related to our two research questions. This method helped us secure credible interpretations of the data collected. We translated the quotes that were in Norwegian into English and structured the data in an Excel file. Table 5 illustrates how we structured our data, using 1<sup>st</sup> order concepts, 2<sup>nd</sup> order themes and aggregate dimensions. We have included one quotation per 2<sup>nd</sup> order theme, as an example. In reality, we have several quotes within each 2<sup>nd</sup> order theme. This way of structuring the data made it straightforward and easy to organize our findings in chapter 4. The 2<sup>nd</sup> order themes are used as headings in our findings, for each aggregate dimension, which is equivalent to our two research questions.

1ST ORDER CONCEPTS (QUOTATIONS)	2ND ORDER THEMES	AGGREGATE DIMENSIONS
The challenge when starting a project is that you are not able to take into account all the complexity.	<b>Size and complexity</b>	<b>Challenges in Akson</b>
When you think 10 years forward in time, there is quite a lot happening. We are not innovative enough to think about where we are and what technology we use [...]. It will be very strange to decide how the future solution is going to be, now.	<b>Time horizon</b>	
It is very difficult for us to invest in our solutions until Akson is rolled out. [...] Both regarding product development, interaction and everything, in the next, at least, 10 years. And we believe that this is a huge risk in Norway.	<b>Stagnation</b>	
One consequence when there are so long projects, is that many municipalities have such old systems that they cannot wait for this. They must make acquisitions now or during the project period.	<b>Urgency</b>	
Much of what is demanded now is national management strategies.	<b>Organizing</b>	
You pay for your own EHR today, but we are talking about a significant boost. To enable the municipalities to pay for this boost, we believe that the state must help	<b>Financing</b>	
To implement one solution for 16 service areas with totally different needs for 291 municipalities at the same time. It is not reasonable	<b>Flexibility</b>	
There is nothing in the way of the systems talking together, in terms of privacy. But managing access is a challenge.	<b>Privacy</b>	
The needs of the specialist healthcare services are different from the needs of the primary healthcare services, but sharing information is important.	<b>Information exchange</b>	

1ST ORDER CONCEPTS (QUOTATIONS)	2ND ORDER THEMES	AGGREGATE DIMENSIONS
It is three-four times faster at least. At the very least.	<b>Speed</b>	<b>Advantages of low-code</b>
By being low-code, it is very easy for us to tailor a certain area of the product, to meet specific requirements, of specific customers. And you do it through plug-ins to avoid compromising the product, the product structure and the product quality.	<b>Innovation</b>	
Another advantage is that it is default a component-based architecture. [...] So together with containers, it allows you to set up an architecture that is scalable.	<b>Scale</b>	
I think anyone can learn it, anyone can work with it, but you have to invest some time to really become good at it.	<b>More available development talent</b>	

Table 5: Example of how we categorized our data.

### 3.4 Validity and Reliability

According to Yin (2018), four criteria must be in place for a study to be reliable and credible. These criteria are internal validity, external validity, concept validity and reliability. Internal validity is not relevant in an exploratory design. In the following, we will discuss the remaining three criteria in relation to our research.

### **3.4.1 External validity**

External validity is based on whether one can generalize the findings from the research to the entire population. It is also called the study of generalization value, as the findings may apply to other organizations or entities. One of the most well-known weaknesses of a qualitative study is that the study often has a limited selection of interview subjects (Saunders et al., 2016). As mentioned, we have interviewed twelve persons. This is not enough for the findings from the research to be directly generalizable. The sample in our in-depth interviews is not necessarily representative. Therefore, we have been careful about drawing general conclusions. However, this study is explorative, and the aim of the study was not that the findings should be generalizable. The study aimed to gain insight into how low-code is suited to develop a national EHR for primary healthcare services and an interaction platform for all healthcare services in Norway. We have given a rich and detailed description of the research setting so that the reader has satisfactory background data to consider how relevant the result of the study is for other settings. The detailed description of the research setting has, according to Mehmetoglu (2004), contributed to strengthen the generalization value of the study.

### **3.4.2 Concept validity**

Concept validity is about whether the theoretical concepts are operationalized and how well we have measured what we intended to measure (Gripsrud et al., 2016). In order to strengthen concept validity, it has been crucial to define given concepts, use good sources and obtain supplementary information from the respondents (Saunders et al., 2016). We studied the literature thoroughly to establish a good measurement system. The use of individual in-depth interviews has strengthened the concept validity, as we got detailed and full descriptions from the respondents. It was essential that all respondents in the in-depth interviews understood the questions (Saunders et al., 2016). We ensured this by testing the interview guides on others before conducting the interviews. Also, during the interviews, we asked control questions to ensure that we had a common understanding of the questions.

### 3.4.3 Reliability

Reliability regards being able to rely on the results to be reliable (Gripsrud et al., 2016). According to Leseth and Tellmann (2014), "*The reliability of research will depend on the assessment of the quality of the data and on the process of data collection itself*" (p. 22). Unlike a quantitative method, it is not possible to repeat a qualitative study and obtain the same results. This is a known weakness in qualitative studies as attitudes and behaviour change over time and data from the interviews may differ. Due to the researcher's influence on the study results, the reader must know the method, behaviour and interpretation that are used for the results presented (Leseth & Tellmann, 2014). We have therefore, been careful in the description of our research design. Openness and transparency about the method of data collection and data analysis have been essential. By describing our research approach, sharing the interview guide, and explaining how data analysis has been conducted, we have increased the transparency of the study.

Saunders et al. (2016) have described four threats to reliability; respondent bias, respondent error, researcher bias and researcher error. Respondent bias is if the respondents answer the question with answers they think we as interviewers wanted to hear rather than the reality. We have given our respondents the freedom to share by not leading the conversation in any direction. Respondent error is if the respondents are not being confident whether they can answer the questions honestly. Respondent errors may not be that relevant in our thesis, as our research does not involve any sensitive topics. We do not believe that there have been any situations where the respondents have felt that they could not answer the questions honestly. At the beginning of each interview, we made it clear that we, as researches are neutral when discussing the topic and that we were interested in the perspective of the respondent.

Other threats to the reliability may come from the researcher, and these are called researcher bias and researcher errors. Researcher bias assumes that the researcher can misinterpret the answers if they are very focused on one specific angle and wanted the answer to be according to their thoughts (Saunders et al., 2016). In order to increase the reliability of the thesis and to reduce the threat of researcher bias, we asked follow-up questions during the interviews. We also got the respondents to explain if some answers were unclear. We did this to ensure that we interpreted the respondents correctly. We were also aware that we

could not let our subjective view affect the interviews, the later transcription or analysis. The fact that we were two researchers present during all the interviews reduced the possibility of research bias because we could discuss whether we agreed with each other's opinion and interpretations.

Researcher errors are if the researchers make mistakes in collecting and analysing the data, which further weakens the reliability (Saunders et al., 2016). By being two researchers, the threat of researcher errors was reduced, as we could control each other's work. The use of an audio recorder during the interviews also helped us to reduce the researcher errors as it ensured accurate reproduction of data. Furthermore, we conducted a thorough analysis of the transcripts. By going through the data material several times, we ensured that we had captured the overall meaning. We coded and analysed the data in parallel processes, which, according to Johannessen, Christoffersen and Tufte (2016), contributed in strengthening the reliability. Most of our interviews were conducted in Norwegian, while the master thesis is written in English. Even though we have tried to translate the interviews to the best of our ability, some of the intended meaning can have been altered. To reduce this effect on the reliability, we have had some of our respondents approve their quotes.

### 3.5 Ethical guidelines

When doing research, it is vital to adhere to ethical guidelines. We have chosen to work according to the guidelines of the Norwegian National Research Ethics Committees. They recommended following the following four principles in research:

ETHICAL GUIDELINES	
<b>Respect</b>	People who participate in research, as respondents or otherwise, shall be treated with respect.
<b>Good consequences</b>	Researchers shall seek to ensure that their activities produce good consequences and that any adverse consequences are within the limits of acceptability.
<b>Fairness</b>	All research projects shall be designed and implemented fairly.
<b>Integrity</b>	Researchers shall comply with recognized norms and to behave responsibly, openly and honestly towards their colleagues and the public.

Table 6: Ethical guidelines (The Norwegian National Research Ethics Committees, 2014, paragraph 4).

Based on these four principles, we have explained what we have been concerned with, how we have worked and methodically progressed, as well as conducted the semi-structured interviews.

### **3.5.1 Respect**

Respondents in qualitative studies are vulnerable in terms of confidentiality, and their best well-being must come before a desired research result (The Norwegian National Research Ethics Committees, 2014). A challenge in qualitative studies is the use of few respondents. In our thesis, we found it essential that the reader knows which organizations that have contributed and made statements. We have therefore, included an overview of respondents based on which organization they work in and their job title. The quotations in the thesis are marked with respondent A-L. As researchers, we have strived to be cautious and wise when using the information each respondent has shared with us.

### **3.5.2 Good consequences**

As researchers it was our responsibility to reflect on the future implications of the information provided. This applied to both the consequences for the respondents, but also for the organizations they represented (Kvale & Brinkmann, 2015). Quotations or information that could have led to negative consequences for the respondent or the organization have been excluded. We wanted our findings in this study to be useful for the Norwegian healthcare sector and to inspire for continued digitalization in the sector, as well as in other sectors.

### **3.5.3 Fairness**

Prior to conducting interviews, we gained knowledge about the qualitative methodology, challenges in the Akson project and low-code development. This made us formulate relevant questions and conduct the interviews professionally.



### 3.5.4 Integrity

Before we conducted the interviews, we got the approval of the Norwegian Center for Research Data (NSD, see appendix 4), as well as the consent of respondents. The research participants were informed about the purpose of the research project and their role in it. Informed consent regards the participants' voluntary involvement and option to withdraw from the study at any time (Kvale & Brinkmann, 2015). We got the respondents' consent confirmed orally or in writing. Since we as researchers were an essential tool for gathering information from the respondents, it was vital to impose strict requirements for our integrity. In our semi-structured interviews, we have given our respondents the freedom to share by not leading the conversation in any direction, other than guided the respondents back to topic if they lost track. Throughout the process, we were conscious of acting professionally and did not let our prejudices or personal opinions affect the study.

## 3.6 Summary

Based on the purpose and the problem of the thesis, we found an exploratory design and qualitative method as appropriate. With an inductive approach, we sought to explore the potential of low-code in the Akson project by relating our findings to existing literature about digital technology and low-code. The individual semi-structured interviews helped us to get in-depth information from our respondents, and thus a deeper understanding of the topic. The choice of method had some weaknesses. However, we did several actions to strengthen the validity and reliability of the study. Regarding the guidelines for research ethics, we applied these throughout the whole process. We are positive that our method choice gave us an excellent foundation to answer our research problem.

## 4. Findings

Based on the interviews, we have discovered interesting findings on how low-code is suited to develop a national EHR for primary healthcare services, and an interaction platform for all healthcare services in Norway. The findings are presented in chapters according to our two research questions:

- What are the challenges of developing a national EHR for primary healthcare services, and an interaction platform for all healthcare services in Norway?
- What are the possible benefits of using low-code to develop a national EHR for primary healthcare services, and an interaction platform for all healthcare services?

We have included quotations to substantiate the findings.

### 4.1 Challenges in the Akson project

Our findings revealed five central challenges of developing a national EHR for primary healthcare services and an interaction platform for all healthcare services in Norway. There are a variety of main challenges of developing a national EHR and an interaction platform. As such, the challenges are not merely technological. Respondent K pointed out that “*The digital transformation is not only about the technology.*” Findings showed that the challenges are related to Akson being a comprehensive project with a long time perspective, the organizing of the project, the financing, the flexibility of the solution, and privacy in terms of access management. In addition to these five challenges, we found it appropriate to include a section about information exchange, as the respondent pointed it out as essential in the new EHR solution.

#### 4.1.1 Comprehensive project with a long time perspective

There is an agreement among our respondents that the Akson project is a comprehensive project with a long time perspective. Our respondents have discussed several aspects related to this challenge, which are elaborated below: (1) size and complexity, (2) time

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horizon, (3) stagnation, and (4) urgency. In short, the first subsection about size and complexity focuses on the challenges related to Akson being a large and complex IT project. The second subsection, regarding the time horizon, focuses on the challenge of developing a solution for the future, based on today's technology. The third subsection describes how some of our respondents believed that the Akson project can lead to stagnation in the Norwegian eHealth market. The fourth subsection elaborates on how there is an urgent need for a new solution, and that some municipalities do not have the time to wait.

#### *4.1.1.1 Size and complexity*

A part of the ongoing planning project is to consider how Akson can be implemented step by step to reduce risk, complexity and cost (Direktoratet for e-helse, 2019f). The Director of Business Development (DBD) in ICT-Norway, Fredrik Syversen, described Akson as one of Norway's largest IT projects (Storvik, 2019a). The Minister of Health and Care Services, Bent Høie, did not agree with the DBD in ICT-Norway and stated that the Directorate of eHealth have divided the project into manageable pieces (Storvik, 2019d). It is not certain if Akson is one of Norway's largest IT projects or not. What is certain is that it is a complex project, both due to its size and its importance. Respondent F reported that *"The challenge when starting a project is that you are not able to take into account all the complexity."* The respondent then pointed out how *"The EHR by far is the most important tool healthcare professionals have when treating patients today."* It will take time to implement a new core solution in such a large and complex sector. The healthcare services in Norway is a huge sector, and the Akson project affects a large number of employees across different municipalities. In each of the 291 municipalities in Norway, there are 16 different areas where the solution is to be expanded (Storvik, 2019a). The service areas include, among others, general practitioners, out-of-hours emergency primary healthcare, health clinics, home health nursing, nursing homes and physiotherapy. Besides, the solution must interact with the specialist healthcare services (Storvik, 2019e).

The Chief Commissioner of Health in Oslo, Robert Steen, described the complexity as almost extreme, while the Chief Executive Officer (CEO) of DIPS, Kolbjørn Haarr, said that he has never been anywhere near such complexity, with all the treatment areas and the municipalities (Storvik, 2019a;2019e). Due to its complexity, Akson received strong criticism from the Norwegian Medical Association, ICT Norway, and the eHealth company

DIPS (Storvik, 2019b; 2019f). They stated that the project is unrealistic and impossible to carry out as outlined – partly because it is very big and complex (Storvik, 2019b). The Director of ICT in the Regional Health Authority in South-Eastern Norway, Rune Simensen, stated that he does not believe in such giant projects like Akson. His opinion is based on the Health Authority in South-Eastern Norway's experience as they were subject to much criticism for their big and expensive project called "Digital renewal". Here, four out of six projects were either stopped, delayed, or scaled down. The criticism towards the Akson project is further supported by Bendik Bygstad, a professor at the Norwegian School of Economics, who has researched large IT-projects in Norway and the Nordic countries. He stated that the time for the giant projects is over (Storvik, 2019g). In 2015, the government promised that there would be an end to gigantic IT-projects in Norway (Storvik, 2019h). The Minister of Digitalization, Nikolai Astrup, said that the recommendation to have smaller projects still applies.

Respondent B commented that some of the criticism related to Akson being a gigantic and complex project is received quite early in the project. He argued that it is crucial to keep in mind that the project still is in an initial phase, with an ongoing planning project.

*We must also remember that they are now commenting quite early in a project phase, as if the planning project is done. So how to break it down, how to manage a step by step implementation, how to reduce the risk, that is discussed now. - B*

The Directorate of eHealth, which is responsible for the project, brought more nuances to the discussion (Storvik, 2019i). The Director of the Directorate of eHealth, Christine Bergland, reported that they have not communicated well enough how the Akson project is going to be carried out step by step. The Directorate of eHealth have found that the best solution is to do the project jointly for all the willing municipalities. The Director elaborated on how it is unnecessary for each municipality to do the required processes in an EHR project separately, as it is a big job and a rather expensive solution to operate and manage. She explained that there will be a gradual and controlled introduction of the solution in the municipalities. As mentioned, how to implement Akson step by step are under consideration in the ongoing planning project, with a deadline in February 2020 (Direktoratet for e-helse, 2019f)

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#### 4.1.1.2 Time horizon

By time horizon, we mean the time from the establishment of Akson in 2018 to the solution is implemented, tentatively during 2025-2030. The current situation in primary healthcare is that many of the EHR systems are outdated and inconvenient to use. Respondent E pointed out that this has become a problem: *“We know that healthcare professionals today feel that the healthcare sector has a large backlog. They work in many different and some outdated systems.”* Respondent A added to this by describing how the municipalities have not been ready for changes.

*The municipal sector is not so digitally mature. So, one simply needs time to mature. You need time to understand how everything is connected. This is at least one reason why it has taken a long time for now. - A*

Finding a supplier, or several suppliers, for an EHR in primary healthcare services in Norway, was not emphasized as a challenge by our respondents. Respondent F described how existing medical records must be migrated from an old system to a new system to include all the existing health information. It requires the right technical integrations between the medical record system itself, lab systems, to national solutions such as a prescription intermediary, summary care record, and a load of specialist systems. It is extensive, but respondent A have not described it as challenging: *“It is not the technology that is demanding. I think we can handle to find a supplier that can deliver a system. Or several suppliers for that matter.”* There exist several good technological solutions on the market that can be used to ensure that healthcare professionals have easy access to the right information at the right time. Respondent A stated that: *“After all, new technology has been launched and there are new ways to share the information that we want to use in the future.”*

Based on the tentative timeline, the implementation of a national EHR solution for primary healthcare services outside Central Norway will not occur until 2025-2030. According to the plans, the interaction platform should be complete in 2030 (Direktoratet for e-helse, 2019h). When asked specifically about why it takes so long, both respondent A and K started to break the project down in parts. They both explained the different phases of the project with the planning project, quality assurance, procurement, establishment and adaptation and finally implementation, operation and management. There are requirements

regarding governance, methodology, and quality for large investment projects in the Norwegian public sector that Akson must comply with (Regjeringen, 2019a). To illustrate how time-consuming such projects are, respondent A refers to Helseplattformen, which is the ongoing EHR project in Central Norway.

*And you see that Helseplattformen, they started their process in 2012-2013, and signed a contract this spring [2019]. And the first users in Central Norway will be in autumn 2021. I also think it takes too long. But that is how it is. – A*

One concern that was raised by several of our respondents is that the Directorate of eHealth is planning a solution for the future, based on today's knowledge and technology. Accordingly, respondent H spent some time discussing how the Akson project is based on the reality at the time but will be implemented long after.

*The things they criticized in 2012, we have come a long way with a lot of it. And the technology has changed, opportunities have changed. It will also change a lot more by 2030. - H*

The respondent argued that the time perspective of the project is not in line with how fast the technology in the market is developing. The respondent stated that it will be a mistake to use today's technology to create a solution to be implemented many years from now. Today, technology is developing fast, and new solutions are constantly being introduced to the market. Predicting the technology needs of the future is a major challenge. Respondent H mentioned this as a criticism of big IT projects:

*When you think ten years forward in time, there is quite a lot happening. We are not innovative enough to think about where we are and what technology we use [...]. It will be very strange to decide how the future solution is going to be, now. - H*

The CEO of Visma, Leif Arne Brandsæter, stated that technology will change a lot by 2030 (Brandsæter, 2019). A delivery of Akson will hardly appear much more modern than other solutions, and the technology may be outdated long before the solution is delivered. He said that this is, unfortunately, the nature of large and protracted IT projects. The CEO of DIPS, Kolbjørn Haarr, stated that Akson is based on outdated knowledge and technology (Storvik, 2019a). On the other side, respondent A reported that it is not necessarily a big issue. He used an example from the hospitals in Norway, which have used today's EHRs for a long time, even though the decisions about the systems were made several years ago. He

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described how the technology development is fast, but that things are not changing as fast in the healthcare sector.

Respondent B discussed the challenge of continuous development in a longer perspective:

*A challenge in a slightly longer perspective is to make sure that you get a development, so that you do not jump five years ahead of time and then you are stuck there again for fifteen years. - B*

The respondent discussed how it is challenging to find the right management mechanisms and incentives to achieve continuous development in the new solution. The relationship with the supplier, or the suppliers, is also central for continuous development. Respondent B reported that there must be a dialogue with the supplier market, which secures the best solution at the time. When the contract or contracts are signed, it should secure that the solution is being developed further at a fast enough rate. A part of the planning project is to clarify the possibilities for the new solution to facilitate future innovation, based on technological innovation and the opportunities that arise in the market (Storvik, 2019i).

#### **4.1.1.3 Stagnation**

The continuous development of the existing solutions during the project period was a concern to several of our respondents. Respondent H reported that the long project period hinders development.

*It is very difficult for us to invest in our solutions until Akson is rolled out. [...] Both regarding product development, interaction and everything, in the next, at least, 10 years. And we believe that this is a huge risk in Norway. - H*

The respondent elaborated by describing how it is challenging for them to make major investments in their existing solutions, knowing that they soon will be replaced. It implies that there will be no innovation in the next ten years, which they believe is a considerable risk. Respondent D supported this opinion. He discussed how the long project period will affect the Norwegian eHealth suppliers during the project period. He described how the suppliers will focus more on positioning themselves than developing their existing systems. Accordingly, he argued that the development will stagnate during the project period. However, the CEO of Visma, Leif Arne Brandsæter, stated that Visma have invested and will still invest substantial funds in their solution (Brandsæter, 2019). Respondent A highlighted that even though the existing technology is old, it is still maintained and

developed further: *“After all, the existing technology is also developed further. So, it is not like everything is standing still. It is not static.”*

A report on the healthcare sector was published to the Norwegian Parliament in 2019 (Ministry of Trade, Industry, and Fisheries, 2019). The report described a need for a better ecosystem where Norwegian technology companies can interact with the public healthcare service (Storvik, 2019b). A member of the Committee on Health and Care Services in the Norwegian Parliament, Ingvild Kjerkol, stated that gigantic projects, such as Akson, tend to move in the wrong direction and will not contribute to develop Norwegian healthcare. Tarje Bjørgum, the Head of Sustainability and Health in Abelia, the NHO’s association of knowledge and technology companies, agreed (Storvik, 2019j). He stated that if the Directorate goes ahead as outlined, it can contribute to less innovation, which is the opposite of the intention. He continued by describing how this will weaken the competition and leave the municipalities with worse solutions than they otherwise would have got.

#### *4.1.1.4 Urgency*

There is an urgent need for a new EHR solution and interaction platform. Kjellaug Enoksen, the leader of the Norwegian Association of Elderly and Nursing Home Medicine, a special association in the Norwegian Medical Association, stated that there is a need for immediate action: *“Neither patients nor doctors can wait ten years for Akson. The municipal leaders must ensure that we have a proper patient record solution in place - now!”* (Enoksen, 2019c, paragraph 7). The CEO of Visma, Leif Arne Brandsæter, agreed and stated that the deliveries from Akson take too long (Brandsæter, 2019). Healthcare professionals do not have time to wait until 2030 to get new solutions. Nor do the municipalities have time for it with today’s population development. The population is getting older. As mentioned, initially, it is estimated that Norway will lack close to 76 000 healthcare professionals in 2035 (Direktoratet for e-helse, 2018). More efficient EHR systems are one of the actions that can improve this situation.

As the healthcare services in the municipalities are trying to modernize their systems, we see another consequence of the project’s long time perspective. Respondent A reported that many of the municipalities must make acquisitions now or during the project period. They have outdated and inefficient systems that do not cover today’s needs. As such, they cannot



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wait until the project is finished. Several replacements must, therefore, be done along the way. It is central to mention that this has been taken into account in the Akson project and its budget.

### 4.1.2 Organizing

Through the interviews, we understood that there are several reasons why the primary healthcare services in Norway do not have a common EHR yet. The majority of the respondents mentioned that one of the main reasons is that each healthcare services in the municipalities are free to choose which EHR system to use. Respondent A described it like this:

*The main reason why we are stuck in the healthcare sector is that every man has his own solution. It has been the tradition. It has been the responsibility of each healthcare service to procure the solution, or specify what they need, make acquisitions, implement it, run it... – A*

Respondent F reported that “*much of what is demanded now is national management strategies*”, while the Minister of Health and Care Services, Bent Høie, have experienced “[...] *that many have demanded it for a long time; that one should control the development of this sector nationally*” (Storvik, 2019d). The municipalities have the right to self-determination. However, several of our respondents reported that the municipalities do not have the capacity, the competence, nor the organizational structure to make such large changes on their own. Respondent B highlighted the span in municipality size as a demanding factor.

*What is an incredibly demanding factor, is this span in municipality size, with Utsira municipality as the smallest with 196 inhabitants to Oslo with soon 700 000 inhabitants. It is obvious that the municipalities have a vastly different ability to be in dialogue with the suppliers, to manage the suppliers and to order from the suppliers.*

The respondent described how some municipalities will have enough resources to go through a procurement and delivery process of an EHR, themselves. While other municipalities will not have the capacity and will take what they get. He described how not all municipalities are capable of working closely with a supplier to achieve a new solution.

Therefore, the municipalities should choose a supplier in fellowship. He further explained how it will be demanding to manage all the municipalities. Respondent B stated “[...] *when you have to do something in fellowship, then you have to find a model, which looks after this breadth of municipalities. And that is a demanding aspect.*” Respondent A spent some time discussing how municipalities in Norway are going to work together to achieve a national EHR for primary healthcare services. To elaborate, he compared the primary healthcare services to the specialist healthcare services. It is easier for the hospitals in the regions to upgrade their systems as they have the regional health authorities as driving forces for development. The municipalities have no equivalent to this. Respondent A described it in the following way:

*You have KS, which is an interest organization, but there is no such thing as a project organization that can run any such big projects. So, organizing this is one of the big questions now in the planning project. – A*

Accordingly, the municipalities need help from the authorities through national management strategies. A new eHealth law is sent to hearing, which will strengthen the Directorate of eHealth’s authority role and is intended to ensure national management strategies (Storvik, 2019d). The law aims to strengthen the digitalization in the healthcare sector and to contribute to faster implementation of eHealth solutions (Regjeringen, 2019b). Many of the issues regarding the organization and national management strategies will be answered in the ongoing planning project. The Akson project has not drawn any conclusions yet, as it is still in the initial phase. However, recommendations on how to organize the project should be included in the report that is delivered to the Ministry of Health and Care Services in February 2020 (Direktoratet for e-helse, 2019f). Respondent C reported that it is the first time the municipalities work together to establish common management models, which means that it will be challenging. The Directorate of eHealth is in the process of setting up these management models, which respondent C described like this:

*It means that there will be an organization which accomplishes this on behalf of the municipalities, unlike today, where they do it themselves. Creating common specifications and doing procurement jointly. - C*

Respondent C further reported that it is voluntary for the municipalities to join the Akson project: “*It is important to note that it is the municipalities themselves who must want to participate in this initiative. [...] It is not imposed on the municipalities.*” The

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Minister of Health and Care Services, Bent Høie, stated that it is crucial to ensure that enough municipalities commit themselves to the project (Storvik, 2019d). If some municipalities, choose not to participate in the Akson project, they are free to acquire their own EHR solution. Respondent C reported that they must still use the existing national eHealth solutions and the common components. This includes the summary care record, electronic prescriptions and helsenorge.no (Direktoratet for e-helse, 2019k). Respondent C further described how parts of the information are shared through these national eHealth solutions and common components: *“Collaboration also happens through the common EHR for primary healthcare services. You lose something by not participating.”* According to the respondent’s statement, the collaboration will be reduced if some municipalities do not want to participate in the Akson project, as not all information is shared through the existing national solutions. The Minister of Health and Care Service, Bent Høie, stated that one of the most important risk-reducing measures, is to secure that municipalities that together represent at least half of the country’s population, commit to taking responsibility for the implementation (Storvik, 2019d). Besides, in the ongoing planning project, the Directorate of eHealth are considering the mandatory use of the interaction platform (Direktoratet for e-helse, 2019f).

### **4.1.3 Financing**

Financing of the project was described as challenging by several of our respondents. Respondent A stated that: *“Financing of the project will be some of the most demanding in the project.”* The background for the respondent’s statement is the challenge of finding money for the project in the state budget and in the municipalities. Less money in the state budget gives less room for manoeuvre. Today, the municipalities are responsible for financing their own EHR solutions (Storvik, 2019k), but it remains unclear who is going to pay for the Akson solution (Storvik, 2019g). Respondent B described how the municipalities, in principle, are responsible for funding the EHR. However, the respondent continued to describe how the boost desired by the state will require grants: *“You pay for your own EHR today, but we are talking about a significant boost. To enable the municipalities to pay for this boost, we believe that the state must help.”* In addition to state grants for the EHR, respondent B described how the national eHealth solutions and the common components should be financed by the state, as it is a part of social infrastructure.

Respondent H described the municipalities as having a low ability and willingness to pay for a new solution. The respondent exemplified by making this pointed remark: *“They are struggling with either having to care for a patient or buying a new PC. It is put somewhat extremely, but these are the considerations they must make.”* The CEO of Visma, Leif Arne Brandsæter, reported how the problem in the municipal economy is that it will be a choice between “warm hands” and expensive IT projects. Even with state grants, it is unlikely that the municipalities can afford it (Brandsæter, 2019). The Chief Commissioner of Health in Oslo, Robert Steen, was asked if Oslo would join the Akson project as it is outlined now. He stated that a basic condition is that the municipality’s ability to provide welfare services must not be compromised if joining the project (Storvik, 2019e). As an example, he described how they cannot use the school budget for this. That would go against the self-determination right of the municipalities.

The Director of Research, Innovation and Digitalization in KS, Kristin Weidemann Wieland, stated that the municipalities must undergo considerable changes when the new solution is introduced and that a large part of the costs are related to this (Storvik, 2019k). KS reported that the municipalities need state grants until the benefits can be reaped so that they avoid a situation where schools have to close down to finance a new EHR. It is not sustainable for the municipalities to fund a big part of Akson (Kommunal Rapport, 2019). The Director of the Insight and Innovation Department in the Directorate of eHealth, Robert Nystuen, pointed out that they must have payment models that ensure that the systems are maintained, also for the future (Storvik, 2019g). The Director of the Directorate of eHealth, Christine Bergland, reported that they are in the final stages of landing the financing model. It is a part of the planning project which will be completed early 2020 (Storvik, 2019i).

#### **4.1.4 Flexibility**

Another challenge was the flexibility of the EHR solution. Respondent D spent some time discussing the big differences, both between the healthcare services and between the municipalities. It is a challenge to get a solution that fits all. Respondent H also saw this as a challenge: *“To implement one solution for 16 service areas with totally different needs for 291 municipalities at the same time. It is not reasonable.”* A major point of concern for the

Norwegian Medical Association was related to flexibility (Storvik, 2019l). They feared that a large, common solution would not be able to give every group of professionals a tool that suits their workday. A general practitioner, ophthalmologist or a nurse work very differently. They need different tools and flexibility.

The Chief Commissioner of Health in Oslo stated that with the complexity of the project being almost extreme, the flexibility of the solution must be enormous and optimal (Storvik, 2019e). The CEO of DIPS, Kolbjørn Haarr, described how the solution should embrace both the smallest and the biggest municipalities in Norway (Storvik, 2019a). It must be possible to adapt the solution to the actual needs of the individual municipality while maintaining a minimum of functionality for all. Respondent C discussed this in the following way:

*It is important for the municipalities to organize their services in relation to their local conditions. That is one perspective. Another perspective is that if one is to have a joint record solution then one must agree on some common, relatively similar ways of doing things. - C*

This implies that healthcare professionals must be able to accept a specific way of working, that is decided by a bigger group than just their colleagues. Respondent C reported that this will take some time. However, the respondent believed that it is possible to find technology that supports the need for both standardization and flexibility.

#### **4.1.5 Privacy**

In the healthcare sector, there is a balance between ensuring patient privacy and securing patient safety. Regarding patient safety, healthcare professionals should have access to patient information in the EHR at all time. However, concerning privacy, not all healthcare professionals should have access to patient information. Our respondent at The Norwegian Data Protection Authority gave us insight on important considerations about privacy in today's EHRs. To ensure patient privacy, the EHR must only be accessible to healthcare professionals who need patient information to provide healthcare.

*To find the balance between the fact that healthcare professionals should have access to patient information, and that patient information should not be visible to anyone other than just the healthcare professionals treating the patient.*

*These are two considerations that are not taken care of in today's EHRs. Healthcare professionals get very easy access to information about others than just their patients. - G*

However, according to the Health Personnel Act, it is not allowed for healthcare professionals to access information about other patients than their own (the Health Personnel Act, 1999, § 45). Through the interviews, we got the impression that this is a weakness of today's EHRs. The access management in the systems is not optimal. It leads to healthcare professionals having access to more patient records than they should, even though this is illegal according to the law.

There are some challenges with privacy in today's systems, but it is not the reason why we do not have a common EHR yet. Respondent G argued that *"Privacy is not standing in the way of integrating the systems"*. However, according to respondent G, it will be a challenge to manage access in the new solution: *"There is nothing in the way of the systems talking together, in terms of privacy. But managing access is a challenge."* In a new solution, it will be important to focus on access management to make sure that patient information is available for the right healthcare professionals. Respondent G explained this in a good way:

*You have to build the systems in a way that ensures that if you have a key to a hotel, you will not automatically have access to all the hotel rooms. You must have your own key for each room. - G*

#### **4.1.6 Information exchange**

In addition to the challenges presented above, our respondents highlighted information exchange as essential when developing a national EHR and an interaction platform. One of the biggest problems with today's EHRs is the information exchange between the various healthcare services. This is stated in the report "One citizen - one record" to the Norwegian Parliament (Ministry of Health and Care Services, 2012). To illustrate why information exchange is essential, we will start by explaining the challenges related to information exchange in today's solution. Then, we will explain the consequences of not having good enough information exchange. Finally, the findings on what is important regarding information exchange when developing a new solution will be presented.

#### 4.1.6.1 Information exchange in today's EHRs

Respondent C stated that the biggest issue with today's EHR solution is that healthcare professionals do not have the information they need to treat the patients. This is mainly due to the missing information exchange. The goal of the Akson project is to solve this problem. We can distinguish between the information exchange internally in the primary healthcare services, and the information exchange between the primary healthcare service and the specialist healthcare service. Among the respondents, it is widely agreed that today's information exchange within the primary healthcare service is not good enough. The same applies to the information exchange between the primary and the specialist healthcare services.

*The different record solutions do not work together very well. As a patient, you can have several medical records, one at the general practitioner, one at the specialist, one at the hospital, but the different healthcare professionals do not have access to the different records. – E*

When explicitly asked about today's systems in primary healthcare, respondent G indicated that the existing systems are not designed to cover the needs of information exchange. According to the respondent, the systems are not modern enough. He reported: *"Today's systems are not made for a digital world"*. He explained that several of the systems initially were developed as document and case management systems. However, over the years, the systems have evolved to include a record functionality. Respondent C explained that this leads to systems that are fragmented. A municipality can have four to seven EHRs that do not exchange information. Respondent B stated that the municipalities rarely change the systems because the switching costs in the EHR market is very high, maybe every 20 years or because the supplier gets bankrupt. As a result, the systems over time become outdated and thus do not facilitate information exchange between different healthcare services.

#### 4.1.6.2 Consequences of lack of information exchange

The consequences of not having good enough information exchange between the systems can be numerous and severe. It affects both healthcare professionals and patients. Healthcare

professionals use a lot of time searching for documentation and information about the patient in different systems. This is explained as a very time-consuming task by the respondent from the Norwegian Centre for eHealth Research:

*When we do research projects about healthcare professionals, exchanging information is one of their biggest annoyances at work, and we see that they spend an enormous amount of time on it. - F*

Previous research on time use among healthcare professionals showed that nursing home doctors spend 18 minutes each day on gathering and providing information that is not documented in the record. In comparison, general practitioners spend five minutes (Malm et al., 2018). It is stated in Dagens Medisin that the work environment of healthcare professionals can be affected by having to spend time on finding information instead of nursing and care. It can lead to stress and time pressure for healthcare professionals. As a result of this, many healthcare professionals quit their job, and some go out on long sick leaves (Enoksen, 2019).

Another consequence is repetitive examinations, only at different healthcare services. A healthcare professional at a hospital can experience having to do an identical examination as the general practitioner just did, because of the lack of information exchange. This can also cause extra stress for the patients. Respondent F discussed the major challenges with limited information exchange between primary and specialist healthcare services.

*A patient who is at the general practitioner to take a blood test, and then referred to the specialist healthcare service, must probably in 9 out of 10 cases repeat the same blood test, even if there is no clinical need. A lot of the examinations are done because there is not enough information on the same examination that has been done recently. - F*

Besides having to undergo repetitive examinations, patients also experience having to retell their medical history. Another consequence of the lack of information exchange between healthcare services is how patients can get incorrect medication because the medicine list can be outdated. In the worst case, patients can die as a result of information not being available.

*In today's systems, there are major challenges with the medicine list; many get sick and even die from incorrect medication in Norway. This is partly because the medicine list has not been updated. - E*



#### 4.1.6.3 Information exchange in the new solution

The EHR is the doctors' most important tool (Enoksen, 2019). Therefore, the new solution must be designed to enable information exchange between the different healthcare services. One prerequisite for achieving this is to use standardized data. According to respondent A: *“In order to be able to exchange information between the systems, one must make sure that the systems speak the same language.”* In the short term, the Directorate of eHealth are working with standards for data sharing and with common languages for better interaction (Storvik, 2019c). Using standards and common languages makes it easier to move data from one system to another. Respondent F stated: *“Everyone agrees that things should be standardized and that standardization must be done in a thoughtful way.”* Lack of standardization of data in the systems results in little information exchange between the systems. However, it is incorrect to say that the information exchange between the different EHRs and healthcare services is not working at all. As discussed previously in the thesis, parts of the patient information are shared through the national eHealth solutions and common components. However, the information exchange is not optimal, as there is some limitation on which information can be shared.

As the findings showed, having access to the right information at the right time is crucial, both for the patient and the healthcare professionals. Information exchange is, therefore, critical when developing a new solution. The information exchange within the primary healthcare service must work, but also the information exchange between the primary and specialist healthcare services. Respondent H explained that in a new solution with information exchange across different healthcare services, it will be essential to distinguish which information that is relevant for the treatment. The respondent further explained that some of the patient information in the medical record might not be relevant if the patient is hospitalized. Therefore, it will be important to distinguish between relevant and irrelevant information for the treatment that is planned. This is especially important when the new solution will lead to information exchange between primary and specialist healthcare services. Respondent H stated: *“The needs of the specialist healthcare services are different from the needs of the primary healthcare services, but sharing information is important.”*

### 4.1.7 Summary

Our study identified five challenges when developing a national EHR for healthcare services and an interaction platform for all healthcare services in Norway. To make it clear, we have gathered a summary of our findings in table 7.

WHAT IS SEEN AS CHALLENGING IN THE AKSON PROJECT?	
<b>Comprehensive project with a long time horizon</b>	First, our respondents have discussed several aspects related to the challenge of Akson being a comprehensive project with along time horizon.
- Size and complexity	There are concerns regarding the size and complexity of the project.
- Time horizon	There are concerns regarding developing a solution for the future, based on today's technology.
- Stagnation	The Akson project can lead to stagnation in the Norwegian eHealth market.
- Urgency	There is an urgent need for a new solution, and some municipalities do not have the time to wait.
<b>Organizing</b>	Second, how to organize the project to unite all municipalities for a decision.
<b>Financing</b>	Third, to find an agreement on who will pay for the new solution.
<b>Flexibility</b>	Fourth, to develop a solution that is flexible enough to fit the different needs of healthcare services and municipalities.
<b>Privacy</b>	Fifth, to develop a solution with the right access management to secure the patient privacy.

*Table 7: Overview of challenges in the Akson project.*

Besides the challenges presented in table 7, information exchange is seen as essential in the Akson project.

## 4.2 Possible benefits of low-code

The choice of technology can contribute to solving some of the challenges discussed in 4.1. It is therefore interesting to study the possible benefits of using low-code to develop a national EHR for primary healthcare services, and an interaction platform for all healthcare services in Norway. We have also included a subsection where we have discussed the possible limitations of low-code, to find out if there are some limitations of the technology that is important to be aware of. Our findings in this chapter are categorized in relation to the

literature presented in chapter 2.3. The possible benefits of low-code are related to speed, innovation, scale and more available development talent. In chapter 5, we will discuss the advantages of low-code more directly against the challenges we found in Akson.

To start out, we would like to include some of the insight we got on the use of low-code, in Norway, in general. It was interesting to hear how respondent L compared the use of low-code in the Netherlands, to the use of low-code in Norway. The respondent described the low-code market in the Netherlands as mature, while it in Norway is growing. Nearly every big company in the Netherlands use low-code, to some extent. The respondent believed that there has been somewhat more resistance in Norway, regarding completely replacing systems based on traditional technology, with low-code. She described that it was similar in the Netherlands in the beginning, Norway is just a bit behind. The respondent believed that the Norwegian firms are starting to see that low-code brings some advantages. She stated that: *“I can hear the demand from the market already.”* The challenge of convincing Norwegian firms can be to make them see the value of the advantages of low-code. When the Netherlands understood the value, low-code had explosive growth.

### **4.2.1 Speed**

According to respondent J, the main advantage of low-code was the development speed, based on the ease of developing. The developers do not need to know the exact syntaxes, as they can model the functionality within the constraints of the LCDP. As a result, the developers can build faster and thus deliver on shorter time. According to respondent I: *“It is three-four times faster at least. At the very least.”* Respondent L agreed that the main advantage was connected to the speed of development. The respondent reported that *“My productivity as a developer in low-code is much higher than when I do high-code.”* Respondent K supported this and stated that the LCDP focuses on productivity more than the development itself, which makes it possible to *“[...]deliver a solution within record time”*. Respondent L added that the advantage of the speed of development helps the client save money. Both due to reduced development time and that the finished product focus on freeing up time for the users of the solution.

Low-code has gains on development-time but does not change all the different project steps. Our respondents pointed out that the development itself is not the biggest part of a project overall. Respondent I described how development “[...] *Is only a portion of the effort that you spend [...]*” in complex projects. Everything regarding governance and planning is still highly needed, and often time-consuming. It is not enough to ensure the quality of the development; the quality of the product design and product delivery must also be of high quality. In the following quote, respondent I described the importance of the processes before and after the developing:

*Low-code is fantastic to develop fast. But we need to make sure that everything that happens before starting development, and everything that goes after that development, is done properly. Then the advantage is that the developing time is shorter. – I*

Regarding Sapphire HMS, the developers were able to have a minimal viable product (MVP) ready only three months after starting the development. The MVP did not consist of all the different modules and functionalities, only the patient management and appointment scheduling. Our respondents with regards to Sapphire HMS could not give us concrete development time on the EMR (equivalent to EHR) in Sapphire, as it is in continuous development. Respondent I reported that Sapphire HMS has been under development for the past six years. However, respondent K stated the following:

*The required time to develop the basic functionalities for the EMR using a low-code development platform, will be at least x percent of the time required to develop the same functionalities using traditional development platforms. - K*

### **4.2.2 Innovation**

Low-code makes it possible to customize a solution to each healthcare service and to react when new needs arise. Respondent I stated that Sapphire HMS was built on low-code for that reason in particular. He argued that the low-code approach is more focused on adaptation than traditional technology. Respondent J agreed and stated that low-code easily can adapt to the specific priority of each healthcare service.

*By being low-code, it is very easy for us to tailor a certain area of the product, to meet specific requirements, of specific customers. And you do it through*

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*plug-ins to avoid compromising the product, the product structure and the product quality. – I*

After a solution is customized, it is vital to be able to keep the functionality up to date. According to respondent J: “*The main advantage is that you are able to maintain the application much easier than if you are using a high-code platform*”. Regarding the Sapphire HMS, respondent I described the continuous development like this:

*This is a constant evolution. It will never end while the product is alive. Medicine is always evolving and so need the tools supporting the practitioners, in order to provide better care, better outcomes and at lowers costs. - I*

Respondent J explained the ease of maintenance as a result of low-code being configured rather than hand-coded. He continued explaining how using a module driven development environment enables the developer to easily dive into the application and follow the functionality that is built on the platform. This contrasts with diving into lots of lines of code, especially as documentation often is lacking. By looking at the model, respondent J described it as relatively easy to see the functionality that is being implemented, and how it fits in the broad application itself. Respondent L agreed in how improvements of a solution can be made much faster in an LCDP. She also highlighted the reason being how things are modularly set up. Modular development makes it possible to easily expand on one aspect while another one stays the same.

The ease of maintenance is important for at least two reasons. First, it is necessary to avoid outdated functionality. Respondent J explained how this is the reason why the wrapped application development platforms in the early 2000s failed. They enabled the developer to quite quickly set up the first application or functionality, but after this, they did not have any lifecycle maintenance. In other words, it is not enough being able to build an application quickly. It must be possible to maintain it easily. Second, maintenance is a large part of the cost of an application, as stated in the following quote:

*At least 80 percent of the cost of an application is in the lifetime maintenance. And it will also save massively in that part, because low-code are mostly lifecycle management platforms, also. They manage the full lifecycle of the application. And because it is low-code, it will be easier to maintain the application, or change the application, to create new functionality. – J*

The possibility to adapt and maintain the solution is necessary for innovation, so is the pace of development. Our finding is that it is not the developer's ability to deliver fast that is the hindrance, but the pace and the mindset of the healthcare services. The following statements regarding Sapphire HMS underline this:

*Another advantage of using the low-code tool is that we are able to release new versions every three-four months. - J*

*We could deliver new features every two weeks, which is the duration of our sprints. -J*

*The challenge is that we go faster than what the structure we touch, go. We try to be more disruptive than what the organizations are used to. - I*

Change management was pointed out as a challenge when using low-code, as it is in any digital transformation. In the example of Sapphire HMS in Kuwait, the releases are not more frequent than every three-four months. This is due to the slow pace in the healthcare sector. The pace of releases depends on the ability of the healthcare services to receive new versions and certify them, more than the LCDP and the developer's ability to deliver fast. Respondent I reported that he wanted to speed up the time to market of their work, but it is not compatible with the pace of the healthcare services who have other mindsets. Naturally, they are more focused on helping patients than the technology itself.

### **4.2.3 Scalability**

Our respondents within the low-code field agreed on how low-code applications are scalable. Respondent J stated, "*Another advantage is that it is default a component-based architecture [...]. So together with containers, it allows you to set up an architecture that is scalable.*" Respondent L described how there are many ways to scale the functionality and thus grow in an LCDP. When talking about the Sapphire HMS, respondent K stated the following: "*It is ready for many users. The scalability of the system can support nationwide level.*"

The Sapphire HMS is currently only in Kuwait, but they see Canada and US as appealing markets. The scalability of the system is not a hindrance to explore and eventually enter new markets. Respondent L described how it is possible to start developing in one municipality

and then have a multitenant architecture to include several municipalities. Multi-tenancy means having a single application serving several client organizations (tenants) (OutSystems, 2019d).

#### **4.2.4 More available development talent**

In the literature, we presented how there is a lack of development talent, a so-called skill gap. Many businesses experience a gap between the skills needed to develop a solution and the resources available. As respondent J stated: *“If you look for skilled developers, they are quite hard to find and can be quite expensive”*. Respondent K agreed that it is not easy to find the right developers. However, several of our respondents highlighted how low-code gives more available development talent and a quicker learning process. Both helps to close the skill gap. Respondent L reported that *“I think anyone can learn it, anyone can work with it, but you have to invest some time to really become good at it.”* The respondent described how low-code is for everyone, which implies that there is more available development talent. However, it will require a certain level of knowledge of software engineering to develop complicated systems.

Respondent J added how the quicker learning process also helps to close the skill gap, as *“[...]it is easy to ramp-up the developer”*. He reported that it will take a developer two-three months to learn most of what he needs to do, in low-code. This speed up the process of getting developers productive. He compared it to languages like Java, C or C++ where it would take one year to become as productive. Respondent K reported that the investment of educating low-code developers is less than the investment required when using other development platforms. In addition to having more available development talent and a quicker learning process, the need for resources is reduced. According to respondent K, an advantage of low-code is resource efficiency, which is tied to the speed of low-code development. Respondent K described how they are able to reduce the required number of resources in their team as *“you can have the same resources do multiple tasks or features with less time”*.

### 4.2.5 Discussing limitations of low-code

In the literature, we presented how low-code have been criticized for hiding the code from the end-user. When asked about this, respondent J agreed on how the code is hidden in LCDPs. However, the respondent did not emphasize this as an issue. He described how a low-code developer, in most cases, does not have any reason to go into the code. Respondent J stated that only three-five percent of a low-code application is created with traditional code. The need for programming depends on the application, with regards to size and difficulty. Programming is needed, especially for some integrations with devices that require specific drivers. The rest is done visually. A possible limitation we presented in the literature is how low-code can create bad code, as a result of it being hidden. Respondent J strongly disagreed, saying that there is no risk of bad code, just because it is hidden. The respondent explained it like this: *“If you build functionality in a model-driven way, then anything will function because the code generating patterns below that model makes sure that it is functioning code.”* Here, respondent J described the code generator in LCDPs, which is based on the application modelled in the visual editor. The code generator will make sure that the code functions well.

We have earlier presented how low-code is easier to use, compared to traditional technology. As respondent L stated: *“I think anyone can learn it [...]”* However, a limitation that was presented in the literature is that skilled developers are needed to capture complex business logic in low-code. Our respondents agreed in how skilled developers cannot be replaced. They described how it is typically the skilled developers that develops the most advanced systems, and the core of the systems. This implies that skilled developers are still needed, even though low-code is for everyone. Nevertheless, less experienced developers are welcomed to do tasks that support the research and development (R&D) work. Respondent I explained: *“We sometimes welcome some ramp-ups to do some lateral tasks in the team. Just for ramp-up and to put them up-to-speed to become a part of our delivery teams.”* Skilled developers cannot be replaced directly, but there are characteristics of low-code that can reduce the need for skilled developers. First, as the quotation implies, less-experienced developers can contribute to a greater extent. Second, skilled developers are also more productive using low-code, which also can reduce the need for resources.



## 4.2.6 Summary

To summarize, we found four possible benefits of low-code. These were in line with the theory presented. However, our respondents brought some new insight and nuances. Table 8 gives an overview of our findings for the second research question.

WHAT IS SEEN AS THE POSSIBLE BENEFITS OF USING LOW-CODE?	
<b>Speed</b>	First, the development speed, based on developing through configuration rather than coding.
<b>Innovation</b>	Second, low-code facilitates innovation, by being focused on adaptation.
<b>Scalability</b>	Third, low-code applications are scalable.
<b>More available development talent</b>	Fourth, low-code can contribute in closing the skill gap, as it reduces the technical barrier.

*Table 8: Overview of possible benefits of low-code.*

Besides the advantages presented in table 8, our respondents provided us with a more nuanced picture on the limitations presented in chapter 2.4. Our findings showed no critical limitations of using low-code to develop a national EHR for primary healthcare services, and an interaction platform for all healthcare services in Norway.

## 5. Discussion

After numerous interviews, we are left with a deeper insight into both low-code and the Akson project. The scope of the Akson project has surprised us in many ways. First, how strong the need for a new solution is. Second, how comprehensive the project is. The Akson project cannot be defined as a digital transformation alone but as a part of the ongoing transformation in the healthcare sector. The project intends to utilize digital technology to enable a new improvement in the Norwegian healthcare sector. During our interviews, our impression of low-code being relatively new in Norway was confirmed. The term was new to all our key respondents with regards to the Akson project. However, the respondents seemed genuinely interested as they took notes of our brief description of low-code and asked questions to learn more about the technology. Several of them had also done some Google-searches on their own to explore low-code. It was interesting to see how respondents in high and influential positions were curious and interested in learning about low-code. It may indicate that low-code has unexplored potential in Norway.

The goal of this master thesis was to understand how low-code can be suited to develop an EHR for primary healthcare services and an interaction platform for all healthcare services in Norway. Findings showed that low-code, with its advantages, presented in chapter 4.2, can contribute to solving several of the challenges pointed at in chapter 4.1. In the following, we will highlight which advantages of low-code that can contribute to solving which challenges in Akson. Our findings are illustrated in figure 7.

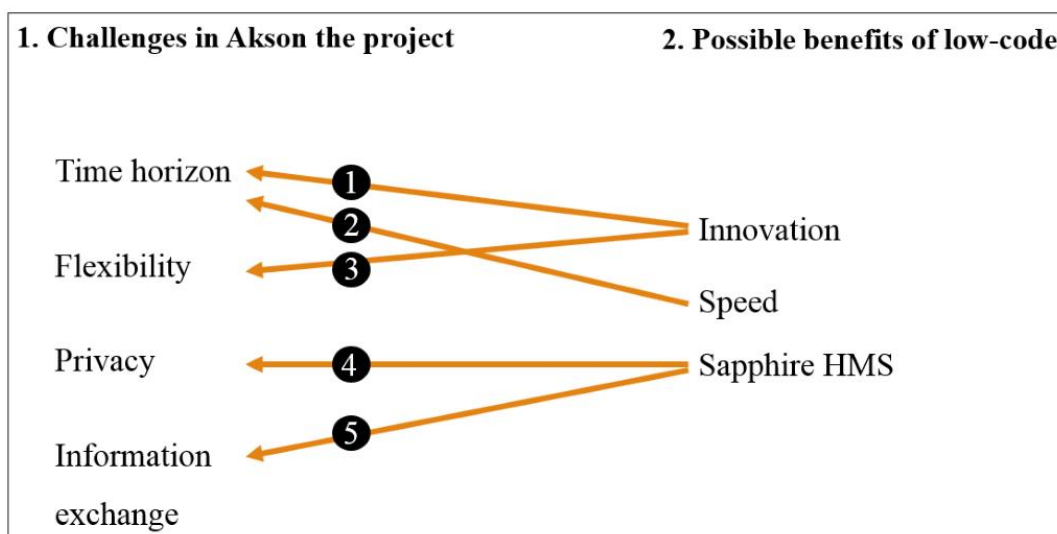


Figure 7: Advantages of low-code linked to challenges in Akson.

Our first finding was how innovation in low-code can reduce the risk of developing a solution for the future. Based on the tentative timeline, the implementation of a national EHR solution will not occur until 2025-2030, while the interaction platform should be complete in 2030 (Direktoratet for e-helse, 2019g). Several respondents questioned how the Directorate of eHealth are planning a solution for the future based on today's technology. The concerns were about how the chosen technology may be outdated long before the Akson solution is delivered. However, one of our respondents were not as pessimistic, as he described how the technology development is fast, but that things are not changing as fast in the healthcare sector. A part of the planning project is to clarify the possibilities for the new solution to facilitate future innovation, based on technological innovation and the opportunities that arise in the market (Direktoratet for e-helse, 2019h). Our findings showed that one of the major benefits of low-code is how LCDPs are designed to speed innovation delivery. Innovation occurs more easily with lightweight IT (Bygstad, 2017), such as low-code. Low-code applications can easily be adapted and kept up to date. This advantage is related to low-code supporting an agile approach to application development, which focuses on evolutionary development and continuous improvement (Warren, 2019). The approach is suited in the Akson project, as it is essential to adapt continually. According to Gartner, Forrester, and OutSystems, low-code development is the new software to make business agility happen (Nyssen, 2017). Our respondents described how modularity in LCDPs makes it possible to do improvements much faster. Modular development makes it possible to quickly expand on one aspect while another one stays the same. Being able to react when new needs arise is an advantage of low-code that can reduce the risk of planning a solution for the future based on today's technology.

Finding two regarded how the development speed in low-code can contribute to reduce the time horizon. For some municipalities it is urgent with a new solution and they cannot wait until 2030 for Akson. As stated in Dagens Medisin: "*Neither patients nor doctors can wait ten years for Akson*" (Enoksen, 2019, paragraph 7). One of the main findings related to the possible benefits of low-code is that developers can build faster and thus deliver a new solution in a shorter time. Low-code cannot reduce the time spent on planning and governance. However, the ease of development through configuration rather than code saves massively on development time. In the existing literature, we read that in most major digitalization projects, about 80 percent of the needs are met by drag-and-drop functionality,

while the remaining 10-20 percent are customized with code (Compose, 2019). Respondent J stated that only three-five percent of a low-code application is created with traditional code. The need for programming depends on the application, with regards to size and difficulty. In a study conducted by Forrester, companies reported that their LCDPs helped them accelerate development by five to ten times (Richardson & Rymer, 2016). According to respondent I, low-code development is at least three-four times faster than traditional coding. Even though the given numbers are slightly different between the existing literature and our respondents, the development speed is seen as one of the main advantages of low-code. The time spent on adaption is also less. Therefore, the use of low-code can contribute in reducing the time horizon of the Akson project, by speeding up the development time or the time used for adaptation and customization of an existing low-code solution.

Our third finding was how the innovation opportunities in low-code can contribute to create a flexible EHR solution. It is challenging to get a solution that fits all 16 service areas in each of the 291 municipalities. The fear is that a large, standard solution will not be able to give every group of professionals the tools that suit their workday. Therefore, an interesting finding was how low-code quickly can adapt to the specific priority of each healthcare service. It was an expected finding based on how customization is an advantage of lightweight IT (Bygstad, 2017). We found that the low-code approach is more focused on adaptation than traditional technology, which was one of the reasons why Sapphire HMS was built on low-code. By using low-code, it will be possible to adapt the solution to the actual needs of each healthcare service and municipality while maintaining a minimum of functionality for all.

Finding four was how it is possible to secure patient privacy in terms of access management in a low-code solution. We got a deeper understanding of the balance between ensuring the privacy of the patient and securing patient safety. It is central for patient privacy that patient information is not available to all healthcare professionals, but readily available to the healthcare professionals treating the patient. Better access management is seen as crucial to ensure privacy in the new solution. We cannot see that low-code has any specific advantages to ensure privacy, compared to traditional technology. However, the low-code solution Sapphire HMS worked as a great example of how it is possible to ensure the privacy of the patient by having sufficient access management. In Sapphire HMS, the patient information is only available for the healthcare professionals who need the information for

treatments. According to respondent L, privacy receives a high priority in OutSystems, the LCDP used for Sapphire HMS.

Finding five showed how it is possible to ensure information exchange between different healthcare services in a low-code solution. One aim of the Akson project is to provide better interaction and give healthcare professionals better access to up to date and relevant patient information. Through our interviews, we learned how this is an issue in today's EHRs and why it is an essential need in the new solution. What surprised us is how serious this issue is. Consequences are patients having to undergo repeated examinations and retell their medical stories, medication errors, and in worst-case, deaths - all due to lack of information exchange. As one of our respondents pointed out, there is some information exchange, but it is far from optimal. Our respondents reported that adequate information exchange within and between the primary and specialist healthcare services is crucial in the new solution. We did not find any clear advantages of using low-code for this specific purpose. However, Sapphire HMS served as an example of how it is possible to facilitate information exchange in a low-code solution. Sapphire HMS has information exchange across multiple healthcare facilities. As a result, they have managed to reduce errors in patients' health records with 60 percent (OutSystems, 2019a). Thus, Sapphire HMS acted as an example of how great effect information exchange can have on patient safety, and how the use of low-code solutions can contribute to this.

The purpose of this thesis was to answer whether low-code is suited to develop a national EHR for primary healthcare services and an interaction platform for all healthcare services in Norway. As we have discussed above, findings showed that low-code can contribute in solving several of the challenges in the Akson project. However, it is important to point out that low-code or other technologies cannot solve all the challenges associated with Akson. For example, regardless of the chosen technology, there will be challenges with organization and financing. Regarding public procurement, compliance with laws and regulations is required to ensure that it is done carefully and correctly. Based on our findings, we will argue that low-code can be a suited technology for the Akson project. However, there will still be some challenges for this type of project that cannot be solved by technology alone.

## 6. Conclusion

The purpose of this master thesis was to get a deeper insight into low-code and how it can contribute in solving some of the challenges in the Akson project. Since low-code is a relatively new and unexplored phenomenon in the Norwegian healthcare sector, we wanted to contribute and increase the knowledge about this technology. Hence, we wanted to answer the following research problem:

**How is low-code suited to develop a national electronic health record (EHR) for primary healthcare services, and an interaction platform for all healthcare services in Norway?**

We found it appropriate to divide the study into two research questions in order to answer the research problem:

- What are the challenges of developing a national EHR for primary healthcare services, and an interaction platform for all healthcare services in Norway?
- What are the possible benefits of using low-code to develop a national EHR for primary healthcare services, and an interaction platform for all healthcare services?

When we examined the challenges of developing a national EHR and an interaction platform, we identified five main challenges. The first challenge was that Akson is a comprehensive project with a long time perspective. There are several aspects related to this challenge which in short are: size and complexity, time horizon, stagnation, and urgency. Several respondents are negative to Akson as a large IT project. Furthermore, there were a concern about planning a solution for the future, based on today's knowledge and technology. The Akson project can also hinder development and thus lead to stagnation at the Norwegian eHealth market. The last aspect related to Akson being a comprehensive project with a long time perspective was the urgent need for a new solution. The second challenge in the Akson project concerned the organizing of the project. There is a need of national management strategies to control the development in the sector. Third, financing was pointed out as a challenge. It remains unclear who is going to pay for the Akson solution. Fourth, flexibility was seen as a challenge. Findings showed that it can be challenging to find a solution that is flexible enough to fit the needs of the different healthcare services and municipalities. The fifth challenge was related to privacy. The

challenge is to design the new solution with the right access management. In addition to the challenges presented above, information exchange was pointed out as essential in the new solution.

When studying the possible benefits of using low-code, we identified the most significant advantages being related to speed, innovation, scalability and available development talent. Our findings on the advantages of low-code were in line with the theory. First, the speed of development was pointed out as a main advantage of low-code. The speed is a result of the ease of developing, using configuration rather than coding. Second, low-code facilitates innovation. It is a significant advantage how low-code can customize a solution to each healthcare service and react when new needs arise. The latter is one of the reasons for why Sapphire HMS was built on low-code. Third, the scalability was seen as an advantage of low-code. Millions of users can use a low-code application, without degrading the performance of the application significantly. Fourth, there is more available development talent when using low-code. This is due to how low-code reduces the technical barrier.

When answering the overall research problem, we examined how the advantages of low-code can contribute to solving some of the main challenges in the Akson project. The first finding was how innovation in low-code can reduce the risk of developing a solution for the future. Finding two regarded how the development speed in low-code can contribute to reduce the time horizon. Finding three showed that innovation in low-code can contribute to creating a flexible solution. Finding four was how it is possible to secure patient privacy in terms of access management in a low-code solution. Finding five showed how it is possible to ensure information exchange between different healthcare services in a low-code solution.

The purpose of this master thesis was to identify the potential of low-code, not necessarily to provide an answer for which technology to choose in the Akson project. To conclude, we can say that low-code is suited to develop a national EHR for primary healthcare services in Norway, and a national solution for information exchange for all healthcare services in Norway. This is based on our findings on how advantages of low-code can help to solve some of the main challenges in the Akson project. With that said, it is important to highlight that technology cannot solve all challenges related to the project. However, we believe that the low-code approach is suited in the project, as it speeds both application and innovation

delivery. Both are seen as crucial in the Akson project, as there were concerns about the long time horizon and developing a solution for the future based on today's technology. Besides, Sapphire HMS goes as an example of how a low-code application can ensure both information exchange between different healthcare facilities and patient privacy.

## 6.1 Limitations

Our thesis is based on interviews with twelve persons, from ten different organizations. The information given by the respondents gave us a solid base to answer the research problem. However, we acknowledge that our study has several limitations that need to be considered. There are few people with knowledge of both low-code development and the Akson project. This is a result of low-code being a relatively new phenomenon in Norway and that the Akson project still is in the planning phase. Thus, little research exists on the topic. Therefore, it was not possible to compare our findings with other research. However, through the interviews and published information about both low-code and the Akson project, we acquired the necessary knowledge to answer the research problem.

We have covered different perspectives on the Akson project by interviewing eight key respondents with regards to the project. Some were more positive to the project than others and vice versa. Respondents' personal opinions about the project may have influenced the statements they made on behalf of the organization they represented. Further, much information about the Akson project has not yet been published, and details are still uncertain. Therefore, some statements from the respondents may be based on assumptions. If all the facts about the Akson project had been decided and published, the respondents might have had other points of views. To reduce this limitation, we have been critical to personal opinions and opinions based on assumptions. In order to ensure that the thesis is based on correct information, we have spent time understanding the literature and carefully monitored the ongoing debate in *Dagens Medisin* for additional perspectives. Also, we have commented if the information presented is a part of the considerations that are being made in the ongoing planning project.

The generalization value of our results is subject to certain limitations. With a small sample size, findings might not be transferable to other settings. As we discussed in chapter 3.4.1



about external validity, generalizability of findings is one of the known weaknesses of qualitative research (Saunders et al., 2016). Our research setting, with the organization and management of the healthcare sector in Norway and the Akson project, is unique. Therefore, it can be difficult to directly transfer the findings of this study to other IT projects, countries or sectors. However, the healthcare sector in Norway and the Akson project, face a number of the same challenges with digitalization and digital transformation as other IT projects, countries and sectors. Besides, the advantages of low-code will stay the same. Thus, other IT projects, countries and sectors can still benefit from the insight this thesis provides. We have given a rich and detailed description of our research setting so that the reader has satisfactory background data to consider how relevant the result of the study is for other settings. Further, the research approach itself can be transferred to others who wish to study the potential of low-code.

## 6.2 Implications

When discussing the implications of our findings, it is central to repeat that there is no earlier research on this specific research problem. As mentioned, we experienced that low-code has unexplored potential. Practical implications of our thesis can be to inspire the Directorate of eHealth to explore the use of low-code in the Akson project. It can also work as an inspiration for other IT projects in the healthcare sector or other sectors in general. With this in mind, it will be interesting to see if low-code will be used to a greater extent in Norway, in the future. Regarding theoretical implications, our findings add to the literature on the advantages of low-code. How the advantages of low-code can assign some of the challenges in the Akson project has never been studied before. Our insight on the advantages of low-code connected to challenges in the Akson project can, therefore, serve as a basis for further research.

## 6.3 Further research

As we knew from the start, low-code is a relatively unexplored research field. Due to the scope of the thesis and our background, we have not covered the technological potential in detail. As such, our comparison of low-code and traditional technologies has been on a

general level, and not very detailed on the technical aspects. However, it would be interesting to see a similar study with the eye of a software engineer, focusing on more detailed, technical specifications. Such research could deepen the general insight on the potential of low-code within the healthcare sector.

We decided to only focus on the Akson project. However, it would be interesting to study how low-code is suited for other projects in the healthcare sector. Since low-code development in Norway is fairly new, it would be useful to consider other possible projects for low-code. Further research on low-code in the healthcare sector, as well as in other sectors in Norway, would provide a deeper understanding of the potential of low-code. As mentioned, Gartner (Vincent et al., 2019) have estimated that low-code will be responsible for more than 65 percent of application development activity by 2024, whereas OutSystems have stated that “low-code is the future” (OutSystems, 2019b, paragraph 3). Respondent L also believed that low-code will be used in several projects in Norway in the coming years. Consequently, the potential for future research within the low-code area appears to be interesting.

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## **Appendix 1: Interview guide Akson**

*For respondents with regards to Akson. This interview guide serves as an example as we had different questions based on which organization the respondent represented. For instance, in the interview with the Norwegian Data Protection Authority we focused more specifically on the privacy.*

### **PRACTICAL INFORMATION**

- Present the purpose of the master thesis. A briefly description, as the respondent receives an information letter prior to the interview.
- Get the respondent's consent, if not confirmed in writing prior to the interview.

### **INTRODUCTION**

1. What is the role of your organization in the Akson project?

### **TODAY'S SITUATION**

2. Why do you think the Norwegian healthcare sector is lagging behind on digitalization, compared to other sectors in Norway?
3. Can you describe the situation of today's EHRs systems in the primary healthcare services?
4. What are the main challenges of today's EHRs in the primary healthcare services?

### **THE AKSON PROJECT IN GENERAL**

5. What is important when developing a new EHR solution?
6. How will Akson affect the interaction within primary healthcare services?
7. How will Akson affect the interaction between primary and specialist healthcare services?

### **CHALLENGES IN THE AKSON PROJECT**

8. What are the main challenges in the Akson project?
9. How is the project organized?
10. What are your opinions on the financing of the project?
11. What are your opinions on finding the right technology for this project?

12. What are your opinions on the patient privacy in the new solution?
13. How is the new solution going to fit each healthcare service and municipality?
14. The tentative timeline illustrates how the new EHR solution is planned implemented in 2025-2030. What do you believe is the reason for why it is taking so long?
  - a. What are possible consequences of such a long project period?
  - b. Which new needs can arise in the project period?
  - c. How is the situation in the municipalities? Do they have time to wait?
  
15. Do you have any other input? Is there anything you feel you haven't said that you think is relevant to the topic?

## Appendix 2: Interview guide low-code

*For respondents with regards to low-code. All low-code respondents were asked about the advantages and limitations of low-code. Thereafter, depending on the background of the respondent, we used either the “Sapphire HMS” section or the “Low-code in Norway” questions.*

### **PRACTICAL INFORMATION**

- Present the purpose of the master thesis. A briefly description, as the respondent receives an information letter prior to the interview.
- Get the respondent’s consent, if not confirmed in writing prior to the interview.

### **INTRODUCTION**

1. How do you work with low-code in your company?

### **ADVANTAGES OF LOW-CODE**

2. What do you see as the main advantages of using low-code?
  - a. Which problems are low-code solving, which traditional coding cannot?
3. How is the development time with low-code, compared to traditional technology?
4. Who can develop with low-code?
  - a. Only highly skilled developers or also people without a professional software engineering background (citizen developers)?
5. How can a low-code solution be customized for different needs?
6. When new needs arise, how is low-code applications maintained/developed further?
7. How scalable is a low-code solution?

### **LIMITATIONS OF LOW-CODE**

8. Are there any challenges of using low-code?
9. What challenges can occur when using low-code in the healthcare sector?
10. Are there any concerns with the drag-and-drop functionality?
  - a. Can the “hiding” of the code create bad code?

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**SAPPHIRE HMS**

11. What was your role in the Sapphire HMS project?
12. Why did you choose low-code to develop Sapphire HMS?
13. How much time did you save by developing Sapphire HMS with low-code instead of traditional technology?
14. Who was involved in the development process?
15. When new needs arise, how is Sapphire updated?
16. Who is using the Sapphire HMS today?
  - a. Different countries? Number of hospitals/healthcare services?
  - b. Do you know the number of users in total?
  - c. Are you thinking about entering new markets?
17. How have the users experienced the Sapphire HMS?
18. How is the privacy, in terms of access management, in the Electronic Medical Record (EMR) in Sapphire HMS?
19. How is the information exchange in the EMR in Sapphire HMS?
20. What was the cost and resources used in this project?

**LOW-CODE IN NORWAY**

21. Do you have any examples of the use of low-code in the healthcare sector in Norway?
  - a. In the healthcare sector in general? Or in Norway in general?
  - b. If yes:
    - i. Did you save resources or reduce the cost by using low-code instead of traditional technologies?
    - ii. How have the developers experienced using a low-code platform?
    - iii. How have the users experienced the applications?
22. Are you planning on any projects using low-code?
  - a. If yes: Why in this sector/business?
23. How do you consider the potential of using low-code in the healthcare sector in Norway?
24. Gartner estimates that low-code will be responsible for more than 65% of application development activity by 2024. How do you think the usage of low-code will be in Norway in the coming years?

## Appendix 3: Information letter to respondents

In this post, we provide you with information about the goals of the project and what participation will mean for you.

### **Purpose**

The research project is a master's thesis at the Norwegian School of Economics. Our thesis attempts to answer the following research problem:

- How is low-code suited to develop a national electronic health record (EHR) for primary healthcare services, and an interaction platform for all healthcare services in Norway?

To answer the research problem, we will focus on answering these two connected research questions:

- What are the challenges of developing a national EHR for primary healthcare services, and an interaction platform for all healthcare services in Norway?
- What are the possible benefits of using low-code to develop a national EHR for primary healthcare services, and an interaction platform for all healthcare services?

### **Who is responsible for the research project?**

The Department of Strategy and Management at the Norwegian School of Economics is responsible for the project.

### **Why are you asked to participate?**

We have contacted about ten persons who either know the Akson project or low-code development.

### **What does it mean for you to participate?**

If you choose to participate in the project, it means that you will be interviewed. It will take you approximately one hour. The interview guide may include questions about how the current EHRs work, the challenges of developing a national EHR for primary healthcare and



an interaction platform for all healthcare services, as well as possible benefits of using low-code. Sound recording will be taken.

### **Participation is voluntary**

Participation in the project is voluntary. If you choose to participate, you may withdraw your consent at any time without giving any reason. All information about you will then be anonymized. It will not have any negative consequences for you if you do not want to participate or later choose to withdraw.

### **Your privacy - how we store and use your information**

We will only use the information about you for the purposes we have stated in this letter. We treat the information confidentially and by the privacy policy. Only we and the supervisor will have access to the data material, and it will be encrypted. Quotations will be marked with the organization and job title.

### **What happens to your information when we finish the research project?**

The project is scheduled to end on 20.12.2019. The audio recording will be deleted within that time. Personal data will not be used after the project is completed.

### **Your rights**

If you can be identified in the data material, you are entitled to:

- get insight into what personal information is registered about you,
- get your personal information corrected,
- get deleted personal information about you,
- get a copy of your personal data (data portability), and
- to submit a complaint to the data protection office or The Norwegian Data Protection Authority.

### **What gives us the right to process personal information about you?**

We process information about you based on your consent. On behalf of the Norwegian School of Economics, NSD - Norwegian Center for Research Data AS has considered that the processing of personal data in this project is within the privacy regulations.

**Where can I find out more?**

If you have questions about the study or wish to use your rights, please contact:

- Norwegian School of Economics at  
Marita Eltvik Hansen: [marita.hansen@student.nhh.no](mailto:marita.hansen@student.nhh.no),  
Cecilie Ness: [cecilie.ness@student.nhh.no](mailto:cecilie.ness@student.nhh.no) or  
Karen Sæbbø Osmundsen (supervisor): [karen.osmundsen@nhh.no](mailto:karen.osmundsen@nhh.no)
- Our data protection office: [personvernombud@nhh.no](mailto:personvernombud@nhh.no)
- NSD - Norwegian Center for Research Data AS, by e-mail ([personverntjenester@nsd.no](mailto:personverntjenester@nsd.no)) or by phone: 55 58 21 17.

Kind regards,

Marita Eltvik Hansen and Cecilie Ness  
Project managers

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**Written Consent**

I have received and understood information about the project “How is low-code suited to develop a national electronic health record (EHR) for primary healthcare services, and an interaction platform for all healthcare services in Norway?” and have had the opportunity to ask questions. I agree to:

Participate in the interview

I agree that my information will be processed until the project is completed, 20th December 2019.

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(Signed by project participant, date)

## Appendix 4: NSD Data Protection Services Approval

**Prosjekttittel**

The potential of low-code development of a national electronic health record (EHR) in Norway

**Referansenummer**

901306

**Registrert**

02.10.2019 av Marita Eltvik Hansen - [Marita.Hansen@student.nhh.no](mailto:Marita.Hansen@student.nhh.no)

**Behandlingsansvarlig institusjon**

Norges Handelshøyskole / Institutt for strategi og ledelse

**Prosjektansvarlig (vitenskapelig ansatt/veileder eller stipendiat)**

Karen Sæbbø Osmundsen, [Karen.Osmundsen@nhh.no](mailto:Karen.Osmundsen@nhh.no), tlf: 95967359

**Type prosjekt**

Studentprosjekt, masterstudium

**Kontaktinformasjon, student**

Marita Eltvik Hansen, [Maritaen@hotmail.com](mailto:Maritaen@hotmail.com), tlf: 90931870

**Prosjektperiode**

16.09.2019 - 20.12.2019

**Status**

03.10.2019 - Vurdert

### **03.10.2019 - Vurdert**

Det er vår vurdering at behandlingen av personopplysninger i prosjektet vil være i samsvar med personvernlovgivningen så fremt den gjennomføres i tråd med det som er dokumentert i meldeskjemaet med vedlegg den 3.10.2019, samt i meldingsdialogen mellom innmelder og NSD. Behandlingen kan starte.

Bruk av private enheter til behandling av personopplysninger må være i tråd med din institusjons retningslinjer for behandling av personopplysninger på private enheter.

### **MELD VESENTLIGE ENDRINGER**

Dersom det skjer vesentlige endringer i behandlingen av personopplysninger, kan det være nødvendig å melde dette til NSD ved å oppdatere meldeskjemaet. Før du melder inn en endring, oppfordrer vi deg til å lese om hvilke typer endringer det er nødvendig å melde: [https://nsd.no/personvernombud/meld\\_prosjekt/meld\\_endringer.html](https://nsd.no/personvernombud/meld_prosjekt/meld_endringer.html)

Du må vente på svar fra NSD før endringen gjennomføres.

### **TYPE OPPLYSNINGER OG VARIGHET**

Prosjektet vil behandle alminnelige kategorier av personopplysninger frem til 20.12.2020.

### **LOVLIG GRUNNLAG**

Prosjektet vil innhente samtykke fra de registrerte til behandlingen av personopplysninger. Vår vurdering er at prosjektet legger opp til et samtykke i samsvar med kravene i art. 4 og 7, ved at det er en frivillig, spesifikk, informert og utvetydig bekreftelse som kan dokumenteres, og som den registrerte kan trekke tilbake. Lovlig grunnlag for behandlingen vil dermed være den registrertes samtykke, jf. personvernforordningen art. 6 nr. 1 bokstav a.

### **PERSONVERNPRINSIPPER**

NSD vurderer at den planlagte behandlingen av personopplysninger vil følge prinsippene i personvernforordningen om:

- lovlighet, rettferdighet og åpenhet (art. 5.1 a), ved at de registrerte får tilfredsstillende informasjon om og samtykker til behandlingen
- formålsbegrensning (art. 5.1 b), ved at personopplysninger samles inn for spesifikke, uttrykkelig angitte og berettigede formål, og ikke behandles til nye, uforenlige formål

- dataminimering (art. 5.1 c), ved at det kun behandles opplysninger som er adekvate, relevante og nødvendige for formålet med prosjektet
- lagringsbegrensning (art. 5.1 e), ved at personopplysningene ikke lagres lengre enn nødvendig for å oppfylle formålet

### **DE REGISTRERTES RETTIGHETER**

Så lenge de registrerte kan identifiseres i datamaterialet vil de ha følgende rettigheter: åpenhet (art. 12), informasjon (art. 13), innsyn (art. 15), retting (art. 16), sletting (art. 17), begrensning (art. 18), underretning (art. 19), dataportabilitet (art. 20). NSD vurderer at informasjonen om behandlingen som de registrerte vil motta oppfyller lovens krav til form og innhold, jf. art. 12.1 og art. 13. Vi minner om at hvis en registrert tar kontakt om sine rettigheter, har behandlingsansvarlig institusjon plikt til å svare innen en måned.

### **FØLG DIN INSTITUSJONS RETNINGSLINJER**

NSD legger til grunn at behandlingen oppfyller kravene i personvernforordningen om riktighet (art. 5.1 d), integritet og konfidensialitet (art. 5.1. f) og sikkerhet (art. 32). For å forsikre dere om at kravene oppfylles, må dere følge interne retningslinjer og/eller rådføre dere med behandlingsansvarlig institusjon.

### **OPPFØLGING AV PROSJEKTET**

NSD vil følge opp ved planlagt avslutning for å avklare om behandlingen av personopplysningene er avsluttet.

Tlf. Personverntjenester: 55 58 21 17 (tast 1)