Supporting the use of software design methods within an Enterprise Software Ecosystem

A Design Science Research study

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Abstract

Implementing generic enterprise software (ES) has become the primary way of integrating software systems. Such software systems are developed for many different users and organisations, which has led to usability issues due to misfits between the purposed business process of the ES and the local practices of the user organisation. This is due to the generic nature of the ES, which is made to fit many organisations and local practices having particular needs. Therefore, many ES vendors have added flexibility to make the ES configurable and adopted a platform strategy to support custom application development by implementation partners. While the platform owner grants the partner's boundary resources to achieve flexibility technically, they do not necessarily address usability. One way of improving usability could be for the platform owner to support the usage of methods including end-users in the partner's implementation process. In this thesis, these methods are referred to as software design methods. Even though there is much research on boundary resources, there is limited research on designing a knowledge boundary resource to support the usage of software design methods.

Through a one and a half year Design Science Research (DSR) project, I have, in collaboration with three other master students in the DHIS2 Design Lab, investigated the practices of implementing District Health Information System 2 (DHIS2). Through this endeavour, I have identified four challenges which may come up when creating a resource for supporting the use of software design methods for partners within an ES ecosystem: 1) Heterogeneous practices require different forms of support, 2) partner's knowledge of software design methods varies, 3) time and resource constraints affect partners' ability for process improvements and 4) resource constraints and quality concerns affect partners' ability to contribute to the resource. Based on the identified challenges and the theory of method tailoring, a prototype of the Design Method Toolkit (DMT) was created to support the usage of software design methods for partners within the DHIS2 ecosystem. After evaluating the prototype, design considerations for the DMT were formed.

The contribution of this thesis is twofold. To practice, I provide six design considerations a platform vendor should think about when designing a resource to support the use of software design methods within an ES ecosystem: 1) Accommodate diversity, 2) encourage and maintain partners' contributions, 3) indication of usefulness, 4) navigability, 5) relatability to partners and 6) support planning. Additionally, the thesis contributes to the Design Method Toolkit as a resource to support software design methods for DHIS2 partners and as an artefact for further research in the DHIS2 Design Lab. To research, I contribute to the body of knowledge on knowledge-boundary resources within the social aspect of implementation projects within ES ecosystems.

Keywords: enterprise software, enterprise software ecosystems, design science research, knowledge boundary resource, DHIS2, DHIS2 Design Lab

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Steffen Ekeberg Bråten
University of Oslo
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Acronyms

API Application Programming Interface. 3, 11, 12, 14, 21, 35, 52–54, 78

AR Action Research. 26, 27, 64, 83, 85

CMS Content Management System. 52

DHIS District Health Information System. 20, 21

DHIS2 District Health Information System 2. 2–5, 8, 16, 20–23, 25–27, 29–33, 35–39, 41, 42, 46, 50–53, 61–65, 68–72, 76, 78, 80–85

DMT Design Method Toolkit. 2, 4–6, 8, 16, 23, 25, 26, 30, 31, 33, 35, 37, 38, 41, 48, 51, 52, 54, 55, 63–76, 78–83, 85, 86

DSR Design Science Research. 2, 4, 5, 16, 23, 26–28, 33, 38, 83, 85

DSRM Design Science Research Methodology. 27, 28

ES Enterprise Software. 1–4, 6–9, 14, 15, 23, 25, 26, 63, 73, 78, 79, 84, 85

HISP Health Information System Programme. 4, 5, 16, 20–23, 25, 26, 29–33, 35–38, 41, 43, 46, 61–68, 70–73, 79, 82, 83, 85

HMIS Health Management Information System. 21

IDE Integrated Development Environment. 12

NSD Norwegian Center for Research Data. 62

SDK Software Development Kit. 3, 11, 12, 14, 21

UI User Interface. 53

UiO University of Oslo. 20, 51, 62

WHO World Health Organization. 31

1 Introduction

Acquiring generic Enterprise Software (ES) has since the mid-1990s been one of the most popular ways of incorporating IT systems within organisations (Davenport, 1998; Sommerville, 2008). This has been due to generic software being cheaper than developing custom software for different organisational use cases. With ES, maintenance and development have been outsourced to a third-party vendor, which allows the user organisation to focus more on their business goals. However, there are still challenges to bringing in generic software designed for an array of heterogeneous user organisations. Usability issues has been identified several times in ES when fitting the system to a specific context (Asif et al., 2022; Wong et al., 2016). This seems to be a consequence of fitting generic software into multiple different contexts (Li, 2019b). There has therefore been a focus on supporting flexibility within ES. A common way is by supporting implementation-level design (Li & Nielsen, 2019a) by making modules within the ES configurable and making it possible for the implementing organisation to create a custom application on top of the implementation.

Even though introducing flexibility in ES may allow solving usability issues, it is of no use if the system's end-users local practices are not considered. One example of this can be seen in the implementation of an ES in a hospital in Singapore where they practice with a co-payment policy for patients within a health facility (Soh & Sia, 2008). This practice is not used in western markets where the ES was implemented, and thus it was not accounted for in the configuration for the ES. This resulted in the ES not being able to calculate the cost of the patient bills and was addressed through customisation efforts in the ES (Soh & Sia, 2008). It has been recommended to include end-users in the process of implementing software for more good systems to be made, which takes into account both the social and technical parts of the system (Baxter & Sommerville, 2011). The use of such methods could help improve the usability of ES. Methods for including end-users in creating software are commonly found within design approaches such as participatory design and user-centred design. These approaches have been argued to be success factors when designing for usability (Gulliksen et al., 2003). There have been many studies on how to effectively integrate these approaches for user involvement with software development practices (Fox et al., 2008; Güncan & Durdu, 2020; Joshi et al., 2010; Jurca et al., 2014). I use the notion of software design methods through this thesis, which refers to methods used during implementation projects focusing on user involvement. Many ES vendors have adopted a platform strategy and created a ES ecosystem and become a platform owners in the process. By adopting a platform strategy, the ES opens up for more customisation by the ability to create custom applications (Tiwana, 2013). The implementation of the ES is outsourced to partner organisations which can involve configuring the ES to the user organisation's needs or creating custom applications for the user organisations (Dittrich, 2014; Rickmann et al., 2014). The user organisation is the organisation that is using the implemented system of the partner organisation (Dittrich, 2014).

This thesis explores how methods related to software design practices can be supported for partners within ES ecosystems. Support is understood as providing guidance and information for the related methods and activities to create a system that fits the user organisation's needs. Methods are specific ways of doing something, e.g. an interview, and are commonly used within user-oriented design and innovation projects. These methods are used for different purposes, to gather data, analyse data, prototype solutions, evaluate prototypes and facilitate projects. Activities are more extensive and can be compromised by different methods and sub-activities. These could be very specific (e.g., evaluating without end-users) and very abstract (e.g., how to do an implementation project). These activities can be compared to a methodology within academia that may have sub-activities (e.g. data collection) that again has its methods. By supporting these methods and activities, we may also be promoting software design methods to an ES ecosystem. Promoting encourages partners to leverage methods and activities when doing implementation projects. Implementation projects are projects where the partner is implementing the ES for the user organisation or creating custom application using the platform's resources.

Through a year and a half Design Science Research (DSR) project, we developed an artefact called the Design Method Toolkit (DMT) to explore how we can support the use of software design methods for partners within the ES platform District Health Information System 2 (DHIS2). The artefact contains activities and methods related to user-oriented design and innovation as well as user stories where partners of DHIS2 can read about other experiences and projects using methods and activities within the DHIS2 community. The main focus of this master thesis will be on activities and methods. The project has been carried out through the DHIS2 Design Lab, where I have collaborated with three master students in this project: Leia, Trilla and Reva. Leia and Trilla had their specific project, while Reva had hers. These are pseudo names for their real names to protect their privacy. I was supposed to be engaged in both of the projects. However, only Leia and Trilla's project was relevant. Thus, I dropped out of Reva's project during the early stages of the research project and became more involved with Leia and Trilla's project. We collaborated with data collection activities, defining the requirements of the DMT and prototyping of the DMT using Figma[1], which is a drag and drop prototyping tool, allowing for the creation of prototypes without the use of programming and some evaluation activities. I was the one who was responsible for developing and hosting the DMT during our project.

1.1 Motivation

Within platform ecosystems, there is something called boundary resources which enable third-party developers or partners to create custom applications on the platform (Tiwana, 2013). There are two types of boundary resources, technical boundary resources (Bianco et al., 2014) and knowledge boundary resources (Foerderer et al., 2019). Technical boundary resources

[1]https://www.figma.com/

refer to resources such as Software Development Kit (SDK) and Application Programming Interface (API), which allow the third-party developer to create custom applications on the platform. Knowledge boundary resources refer to resources to support the use of technical boundary resources or build capacity for using the technical boundary resources (Foerderer et al., 2019) and can refer to resources such as documentation, courses and user forums. There has been much research on knowledge boundary resources' ability to support the technical aspect of innovation in platform ecosystems, relating to using the technical boundary resources to create applications on the platform and their implications on the platform (Foerderer et al., 2019; Ghazawneh & Henfridsson, 2013; Ghazawneh & Henfridsson, 2010). Some examples of such knowledge boundary resource are documentation of using API's and courses for capacity building to create custom applications on the platform (Foerderer et al., 2019).

However, little attention has been given to knowledge boundary resources to support the social aspect of innovation and the less technical forms of innovation, such as prototyping in the ES ecosystem. As more ES is opening up its resources for supporting custom development and adopting a platform strategy, there comes a need for platform owners to provide tools to support the use of software design methods to overcome usability issues within generic ES. Platform owners have already created such resources for their partners. An example of this is SAP which has added an innovation toolkit through their SAP AppHaus to support design and innovation practices for their partners (SAP, 2022). There is not much knowledge on how such knowledge boundary resources are designed yet. I picked up the work of a former master's student in the DHIS2 Design Lab, who has done some research on what is needed for such a resource to be useful for partners for generic software (Kroken, 2021).

1.2 Research question

The following research question will allow me to investigate how resources to support the usage of software design methods within ES ecosystems can be designed:

> RQ: What are design considerations for platform owners creating a resource to support the use of software design methods for partners in an ES ecosystem?

To address this research question, I have adopted the Design Science Research (DSR) methodology for this thesis. The methodology is concerned with creating solutions to problems and contributing to research and practice. The practical aim of this thesis was to create a resource, which became the Design Method Toolkit which is based on the former prototype made by Kroken (2021) and the practices of the HISP groups in the DHIS2 ecosystem. The DMT is influenced by a kernel theory called method tailoring theory. The theory is concerned with how software engineering practitioners adapt and apply software development methodologies by mixing and matching different methodologies to best suit a particular development context.

During this thesis, I have created two practical contributions. The first is the DMT to the DHIS2 ecosystem, which can be used to get support for the use of software design methods for partners when conducting implementation projects. This is a working system, and can be viewed at https://methodtoolkit.herokuapp.com/, for more information of the DMT see Section 5.7. My second practical contribution comes in the form of design considerations. Through the process of creating and evaluating the DMT, I formed six design considerations to help platform owners develop similar resources for the partners of their ES ecosystem. These design considerations are 1) Accommodate diversity, 2) encourage and maintain partners' contributions, 3) indication of usefulness, 4) navigability, 5) relatability to partners, and 6) support planning. These design considerations can be leveraged when a platform owner creates a resource for supporting the use of software design methods for partners within their ES ecosystem. My theoretical contribution is the addition to the body of knowledge on knowledge boundary resources. I discuss the DMT as an example of a knowledge boundary resource with the intent of supporting the social aspect of innovation in a platform ecosystem. This includes the implications such resources have on openness and control of the platform and what governing mechanisms platform owners must consider for such resources. This is done by analysing the findings of my research in light of the related research.

1.3 Thesis structure

Chapter 2 - Related research presents the literature on ES ecosystems, boundary resources and governing mechanisms for ES ecosystems.

Chapter 3 - Kernel theory includes a description on the method tailoring theory that influenced the design and development phase.

Chapter 4 - Background gives an overview of HISP, DHIS2 and the DHIS2 Design Lab.

Chapter 5 - Methodology explains how the teamwork was carried out and presents the research paradigm I have chosen as well as the methodology for this thesis - Design Science Research (DSR). I will present the data collection methods utilised and my research approach to this project, and how the evaluation of the DMT was done. I will show how DSR was applied to my project by going through all of the phases, and then I will show how I analysed data collected in the project. The chapter includes a description of the artefact, the DMT. Finally, I will go through the ethical considerations for my project.

Chapter 6 - Findings is where I will present the findings from the problem identification and motivation phase as well as from the evaluation of the artefact. These findings make it possible to form design considerations in a resource of this kind, answering my research question.

Chapter 7 - Discussion is where I will discuss the design considerations in light of the findings and related research.

Chapter 8 - Conclusion summarizes the thesis, findings and the contributions. I will also reflect over future work for these kinds of resources.

2 Related research

In my thesis, I am exploring what design considerations a platform owner must think of when creating a resource to support the use of software design methods for partners within ES Ecosystems. ES are generic in nature, which has resulted in usability issues when they are to be used in the local context of the end-user organisation. An ES could, for instance, measure something in another unit than the user organisation wants to, creating a need to convert between the two measurements (Strong & Volkoff, 2010). Several strategies have been implemented to relieve the tension between the generic and the specific. Adapting a platform strategy to the design of ES has been one way of addressing these issues, creating ES ecosystems for more stable forms of customisation. The resources which allow for customisation within ES ecosystems are called boundary resources which enable such customisation efforts on the platform, and they could function as a governing mechanism to keep control of the platform ecosystem. DMT can be viewed as a knowledge boundary resource to support the use of software design methods within these ecosystems. This kind of resource may bring new implications for ES ecosystem and bring both new challenges and opportunities for platform owners to address the tensions between local relevance and generic functionality. One challenge which may be introduced with a knowledge boundary resource to support usage of software design methods could be to make it relevant for and make partners want to use the resource. These kinds of resources can be seen as a soft form of governing mechanism (Halckenhaeusser et al., 2020). They may give platform owners the opportunity to shape the partners to conduct more software design methods to achieve better usability in their systems.

The structure of this section is as follows: I am first going to review what an ES is and how they are designed. Second, I will look at ES Ecosystem and the platform literature. Third, I review the literature on boundary resources. Finally, I will look at governing mechanisms for platform ecosystems.

2.1 Enterprise software

Generic software is seen as a system that is designed for general use and not being restricted to one specific user context, which makes it relevant for several different contexts within a domain (Bansler & Havn, 1994; Pollock et al., 2007). Enterprise Software (ES) is a type of generic software which

> *[...] are large integrated, process-oriented packages designed to meet most needs of organizations including accounting and control, manufacturing and distribution, sales and order entry, human resources, and management reporting"* (Strong & Volkoff, 2010, p. 731).

Li (2019a) propose two levels of design in relation to ES: *generic-level design* and *implementation-level design*. Generic-level design refers to the development of generic software which is to be used in multiple different organisations. Further, it is also concerned with "[...] the design of features and

resources that facilitate localization of the software during implementation [...]" (Li, 2019a, p. 2). The resources and features which are made during the generic-level design create the design infrastructure the implementer can leverage upon. Implementation-level design is the process where the implementer is tailoring a generic software to their local practices and business needs using the design infrastructure of the vendor (Li, 2019a).

Even though the ES is made to fit multiple different contexts, it is not uncommon to see that there are differences between the processes of the ES and the local practices of the user organisation (Hustad et al., 2016; Soh et al., 2000). It has been seen as crucial for vendors to strike a balance between generic functionality fit for all and local relevance (Rolland & Monteiro, 2002). The gaps between the ES capabilities and the user organisation's needs and requirements are referred to as misfits (Hustad et al., 2016, p. 430). An example of a misfit can be seen in Hustad et al. (2016) when the user organisation was required to send parts from one order to the warehouse and then to the order which needed the parts to update the ES. If a part was moved from one order to the next without being checked inside the warehouse, the customer could not be billed for that part. There are strategies the vendor can take to handle these misfits. The vendor of an ES can shape the user organisations through a process of generification, finding what is common between the user organisations and, in the process, forming the users organisation to be more alike to fit the processes of the ES (Pollock et al., 2007). This activity can be seen under generic-level design, where the vendor creates generic solutions for many organisations.

Generification has also been seen in the form of taking local innovations created by partners back into the generic-level design as functionality which can be utilised by other partners (Gizaw et al., 2017). On the first hand, you have disembedding, which is taking something local and bringing it back to the generic (Gizaw et al., 2017). On the other hand, you have embedding, where you take the generic functionality from the ES and make it locally relevant for the user-organisation (Gizaw et al., 2017). The vendor can create room for flexibility in the ES by building up a design infrastructure during generic-level design to support implementation-level design. This could range from allowing for configuration of the ES, software development kits for creating custom applications and documentation for using these resources (Li, 2019a).

Configuration can be seen as "[...] 'switching on and off' of functionality that is part of the blueprint of the software [...]" (Light, 2001, p. 417) and is supported by the majority of ES. Customisation can be viewed as "[...] changes or additions to the functionality available in the standard ERP software" (Light, 2001, p. 417) or "[...] subsequent extensions of its functionality, unforeseen at the time the software itself was designed, implemented and shipped" (Sestoft & Vaucouleur, 2008, p. 218). The difference between configuration and customisation is that configuration is supported by the ES to allow for some adaptation of the ES (Light, 2001) and customisation efforts generally related to voluntarily modifying the source code or creating add

ons in the ES (Soh & Sia, 2008). However, it is generally discouraged by the vendor, as it has maintenance implications for the ES (Light, 2005). Thus the user organisation may not be able to reap the benefits of continuous maintenance and improvements by the vendor (Soh & Sia, 2008). However, organisations still carry out customisation efforts rather than adapt their business model to the ES despite the maintenance implications this effort brings (Light, 2001). The user organisation can configure the ES to be able to do some customisation while still reaping the benefits of the ES. However, a configuration is limited as it is mainly for changing different parameters in the ES. So there is an ongoing tension for the user organisation to balance the between local relevance and standardisation of the ES (Soh & Sia, 2008).

My research project is concerned with creating the DMT which is a resource for partners within global software DHIS2 to support the use of software design methods. The DMT could be seen as a supporting mechanism for implementation-level design as part of the design infrastructure of the vendor of DHIS2. It could potentially help the user organisation make customisation efforts that have less impact on maintenance and reduce the misfits between the practices of the global software and the local conventions of the user organisation. However, suppose the vendor has not facilitated implementation-level design to allow advanced customisation efforts. In that case, the impact of the DMT will be limited by what the user organisation is available to do. To qualify for more advanced forms of customisation, there has been a shift in the design of ES.

2.2 Enterprise Software Ecosystems

Many ES vendors have started to adopt a platform strategy to accompany diversity between the different user organisations. Therefore, I view it as valuable to incorporate software platform theory to analyse this phenomenon as DHIS2 has evolved into a platform of multiple different actors for various purposes. By adopting this strategy, the vendor is ”opening up” their software and allowing the user organisation to modify the ES to their specific user needs needs (Farhoomand, 2007). This also entails that the vendor now creates an ecosystem where different actors interact and aim to govern and maintain this ecosystem (Dittrich, 2014). Within a platform ecosystem, we identify three main actors: the platform owner, partner organisation(s) and the user organisation (Dittrich, 2014; Tiwana, 2013). The platform owner is the actor who governs and maintains the platform. They are also responsible for creating boundary resources (which will be covered in Section 2.3) that partner organisations can use during implementation-level design. The partner organisations, also known as complementary and third-party developers (Rickmann et al., 2014; Tiwana, 2013), implement the generic solution of the platform to the end-user organisation. They are also interacting with the platform owner through the boundary resources they provide. They leverage these resources to configure the generic solutions and create custom solutions for the user organisation. The user organisation is the organisation that uses the system implemented by the partner organisation. An overview of the actors within an ES ecosystem can

be seen in Table 2.1.

Actor	**Role**
Platform Owner	Develop and maintain the generic solution. Provides and maintains resources for the partner organisations
Partner organisation (s)	Configures and customises the ES to the user organisation's needs.
User organisation	The organisation which uses and pays for the implemented software.

Table 2.1: Actors of an ES ecosystem

The main elements of a software platform ecosystem are defined by Tiwana (2013) as the platform core, apps and interfaces. The platform core is the extensible codebase that the platform owner governs and maintains. The apps are complementary applications that leverage platform cores capabilities. This is possible due to the interfaces between the platform core and the apps, also known as boundary resources (Section 2.3). An illustration of how the different actors interact with the different elements of the platform ecosystem can be seen in Figure 2.1. By leveraging on the platform's interfaces, the partner organisation can save time when developing their applications as they do not have to create everything from scratch. The partner organisations can also potentially create better-suited solutions for the user organisation than the generic solutions offered by the platform owner as they often have "[...] far greater expertise in their native markets" (Wareham et al., 2014, p. 1196). This could allow for the ES to reach a larger target audience than initially thought by the platform owner. As the partner organisations are implementing the ES as well as creating custom applications for the user organisation, the partner organisations are effectively extending the platform's core functionality (de Reuver et al., 2018). The platform owner is also benefiting because they are not required to have a relationship with every user organisation, as this responsibility is effectively outsourced to the partner organisations (Roland et al., 2017).

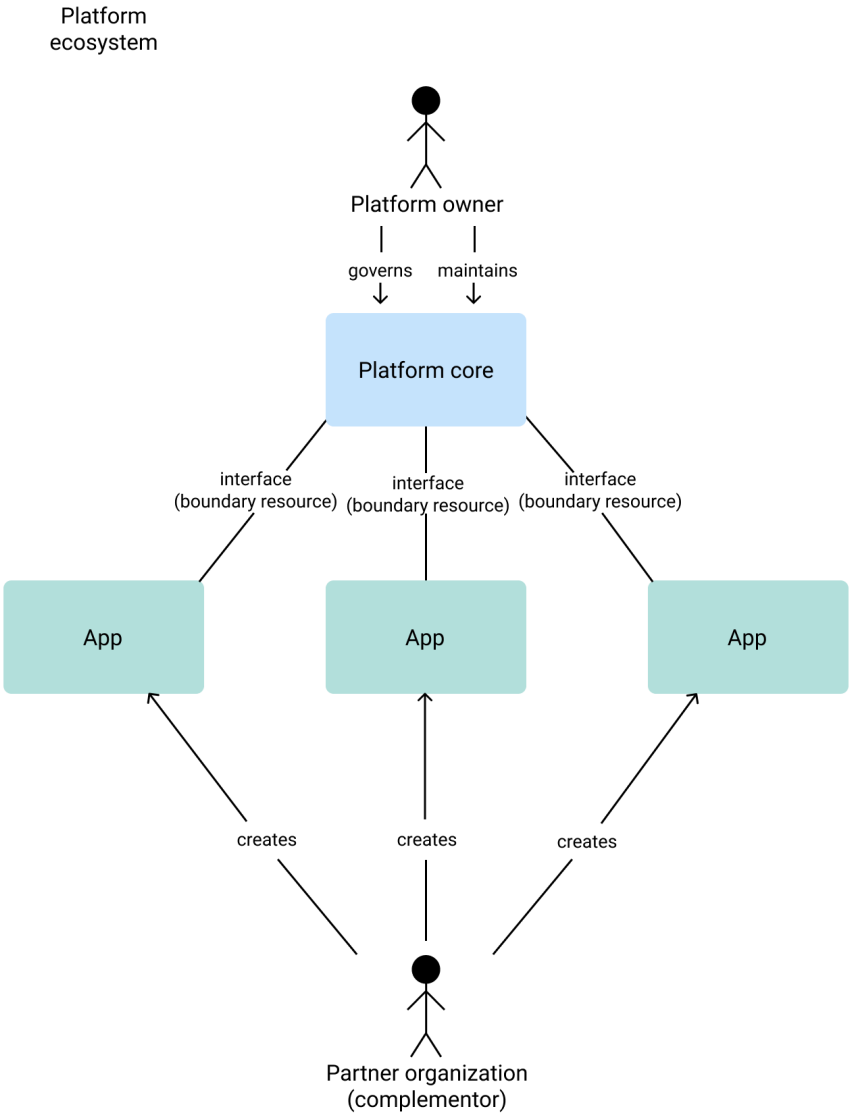

Figure 2.1: Platform ecosystem
Adapted illustration of a platform ecosystem from (Tiwana, 2013, p. 6)

2.3 Boundary resources

The importance of supporting third-party development within software platform ecosystems cannot be understated, as the variety of complementary applications makes platforms an attractive choice for user organisations (Tiwana, 2013). The platform owner, therefore, creates resources to facilitate and support third-party development activities, commonly known in the platform literature as boundary resources (Ghazawneh & Henfridsson, 2013; Tiwana, 2013). Boundary resources are "[...] the software tools and regulations that serve as the interface for the arm's-length relationship between the platform owner and the application developer" (Ghazawneh & Henfridsson, 2013, p. 174). These kinds of resources can relate to API's, Software Development Kit (SDK), documentation and online courses to learn how to use the platform (Foerderer et al., 2019; Ghazawneh & Henfridsson, 2013; Tiwana, 2013). These resources give access to the partner organisations for creating usable inventions on the local level for the user organisations (Li & Nielsen, 2019b). Boundary resources serve two different purposes: design and use, and resourcing and securing (Ghazawneh & Henfridsson, 2013). Design and use, where design refers to the act of designing boundary resources and use refers to the partner's use of boundary resources within third-party applications (Ghazawneh & Henfridsson, 2013). Resourcing and securing, where resourcing is the act of enhancing the scope and diversity of the platform and securing is the act of increasing the control of the platform (Ghazawneh & Henfridsson, 2013): I will elaborate further on the topic of governance mechanisms boundary resources offers for platform ecosystems in Section 2.3.1.

Ghazawneh and Henfridsson (2013) presents the "Boundary resources model", which is used to showcase the use and development of boundary resources and the balancing act of resourcing and secure boundary resources. Through the application of this model on the case of Apple's iPhone platform, there were identified four insights related to resourcing and securing: self-resourcing, regulated securing, diversity resourcing and sovereignty securing (Ghazawneh & Henfridsson, 2013). An overview of these insights can be seen in Table 2.2.

Self-resourcing can be seen "[...] as third-party developers' act of developing new boundary resources as a response to perceived limitations in existing boundary resources [...]" (Ghazawneh & Henfridsson, 2013, p. 186). An example of self-resourcing could be seen when partners were creating their boundary resources for creating applications on the iPhone (Ghazawneh & Henfridsson, 2013). These applications were not available through official means, so end-users and partners would have to "jailbreak" their iPhones to install native applications from unofficial installers. This act of self-resourcing was done in response to the absence of native applications on the platform, forcing Apple to rethink its design of boundary resources. Regulation-based securing can be seen "[...] as a platform owners' act of exercising control over the platform and its related services through administrative legislation [...]" (Ghazawneh & Henfridsson, 2013, p. 186). An example of regulation-based securing can be seen in Apple's application review

Insight	Definition
Self resourcing	”[...] third-party developers’ act of developing new boundary resources as a response to perceived limitations in existing boundary resources [...]” (Ghazawneh & Henfridsson, 2013, p. 186)
Regulation-based securing	”[...] a platform owners’ act of exercising control over the platform and its related services through administrative legislation [...]” (Ghazawneh & Henfridsson, 2013, p. 186)
Diversity resourcing	”[...] deliberate action taken by a platform owner to diversify the platform in a way that stimulates new application areas” (Ghazawneh & Henfridsson, 2013, p. 186)
Sovereignty securing	”[...] actions taken by a platform owner to maintain control of the platform’s evolution and avoid becoming a substitute platform for application developers” (Ghazawneh & Henfridsson, 2013, p. 186)

Table 2.2: Insights for resourcing and securing

process for a third-party application to be added to the official App Store or not. Diversity resourcing refers to the platform owner’s ability to create diversity in the platform beyond the initial scope (Ghazawneh & Henfridsson, 2013). When Apple decided to create both an API and a SDK, they initially opened up their platform for partners to create third-party applications on their platform (Ghazawneh & Henfridsson, 2013). This could be seen as a way of creating diversity, as Apple could leverage the partner’s creativity to diversity their platform with custom applications. Sovereignty securing ”[...] refers to actions taken by a platform owner to maintain control of the platform’s evolution and avoid becoming a substitute platform for application developers” (Ghazawneh & Henfridsson, 2013, p. 186). An example of sovereignty securing could be exemplified by Apple’s change in their developer license agreement which required applications created on the platform to use specific programming languages and only use documented API’s prescribed by Apple. This was most likely a response to Adobe’s ”Packager for iPhone” application which could turn Flash applications into iPhone applications, as the use of the application would be a direct violation of the new developer license agreement (Ghazawneh & Henfridsson, 2013, p. 184-185).

We can categorise boundary resources into two different categories: technical boundary resources (Bianco et al., 2014) and knowledge boundary resources (Foerderer et al., 2019). The focus of this thesis lies on the latter form of boundary resource as the prototype being developed can be categorised as a form of knowledge boundary resource. Technical boundary resources relate to the boundary resources, which can directly make a partner organisation able to create applications on the platform (Bianco et al., 2014). This can relate to API’s, SDK’s and sometimes even fully Integrated Development Environment (IDE). Knowledge boundary resources, also known as social boundary resources (Bianco et al., 2014), are ”[...] objects and ac-

tivities employed by platform owners to overcome knowledge boundaries and enable effective product development outcomes [...]" (Foerderer et al., 2019, p. 125). These resources can relate to documentation, guidelines, incentives, intellectual propriety rights (IPR), courses to build capacity for developing custom applications, help desks and online forums (Bianco et al., 2014; Foerderer et al., 2019).

Foerderer et al. (2019) identifies three types of knowledge boundary resources which go from high scalability and limited scope to low scalability and broad scope: broadcasting, brokering and bridging. An overview of these types of knowledge boundary resources can be seen in Table 2.3. Broadcasting resources are accessible to the partner without interacting directly with the platform owner and offering standardised and formalised knowledge (Foerderer et al., 2019, p. 135). Resources related to broadcasting need to anticipate partners' common needs and requirements. These kinds of resources include, but are not limited to, guidelines, handbooks, programming tutorials and documentation of technical boundary resources (Foerderer et al., 2019). Brokering resources relates to more personal contact between the partner and the platform owner in a semi-formal manner (Foerderer et al., 2019, p. 136). These resources relate to help desks, account managers, face-to-face or phone conversations about technical aspects of the platform (Foerderer et al., 2019, p. 136). While there is more personal contact between the two actors, it was seen as highly formal. Broadcasting resources were usually used as a means to disperse recently updated knowledge to partners (Foerderer et al., 2019). Bridging resources are "[...] based on ongoing, frequent interactions between experts of the platform owner and complementors" (Foerderer et al., 2019, p. 136). These resources can relate to alignment workshops, one-to-one assistance, technological coaching, and projects between the platform owner and one or more partners (Foerderer et al., 2019). Since these interactions between the platform owner and partners are more personal, there is also a limited scale of individual exchange.

Type	**Description**	**Example**
Broadcasting	Standard and formalised knowledge available without interaction with the platform owner	Documentation, guidelines, handbooks
Brokering	Semi-formal personal contact with the platform owner	Help desks, face-to-face conversations
Bridging	Frequent interactions between the platform owner and the complementor	Alignment workshops, one-to-one assistance

Table 2.3: Types of knowledge boundary resources

2.3.1 Governing Enterprise Software Ecosystems

By creating a platform and leveraging upon third-party partners to develop applications for end-users of the platforms, there comes a need for the platform owner to gain control over the platform to ensure quality in partner created application (Rickmann et al., 2014; Wareham et al., 2014). Therefore, the platform owner needs to find an appropriate level of openness for their respective platform, with ”open” being ”[...] the extent that it places fewer restrictions on participation, development, or use across its distinct roles, whether for developer or end user” (Parker & Van Alstyne, 2018, p. 3018). Platform governance is generally seen as who makes the decisions about a platform (Tiwana et al., 2010, p. 679). The need to both have sufficient control and provide the right level of openness creates a governance problem, as the platform owner needs to ”[...] retain sufficient control to ensure the integrity of the platform while relinquishing enough control to encourage innovation by the platform's module developers” (Tiwana et al., 2010, p. 679).

As a platform owner, you want to leverage upon the partners the creativity of the partners to bring diverse sets of applications to the platform (Tiwana, 2013). If the diversity goes out of hand, it could result in fragmentation, inefficiency, inferior user experience and overcrowding (Wareham et al., 2014, p. 1198). To gain a sustainable level of openness and control, there should be implemented governance mechanisms by the platform owner (Tiwana, 2013). We can see governance mechanisms in the form of ”soft” and ”hard” forms of governance. Soft governance mechanisms can be seen as ”[...] instruments emphasizing to persuade complementors to consider shared goals and visions” (Benlian et al., 2015, p. 212). Hard governance mechanisms can be seen in the form of financial incentives and sanctions (Benlian et al., 2015), and even licence agreements between the platform owner and partner, as previously discussed in Section 2.3 with Apple's developer license agreement. It is not uncommon for partners in platforms such as Apple to have to sign a standardised license agreement (Eaton et al., 2015). However, in ES Ecosystems, the platform owner is trying to implement scaleable governance mechanisms through rules which are enforced in the resources and partnership programs within the platform ecosystem (Hurni et al., 2021). Boundary resources can also be seen as a form of governing mechanism. As the platform owner creates SDK's, API's and knowledge boundary resources to accompany these resources, they are both in control of the resources while at the same time facilitating for third-party development (Ghazawneh & Henfridsson, 2010). A recent literature review has uncovered that there has been a lack of focus on soft forms of governance in comparison to hard forms (Halckenhaeusser et al., 2020). Thus we have little knowledge on the implications soft forms of governing mechanisms may bring on partners behaviours, innovation and platform governance as a whole (Halckenhaeusser et al., 2020).

I have in this section gone through ES, ES ecosystems, boundary resources and governing mechanisms for ES ecosystems. Further in this thesis, I take the concept of generification with disembedding and embedding, implementation-

level design and misfits from the literature on ES. From the ES ecosystems literature, I bring the actors and main elements from the ecosystem. In the literature on boundary resources, I bring the notion of knowledge of boundary resources and the type of broadcasting, as well as the concept of self resourcing and the governance mechanisms they may bring. I also bring the concept of soft governance into my discussion.

3 Kernel theory

A kernel theory in Design Science Research (DSR) is defined as ”[...] well-established theories in the natural and social sciences, which may exert some influence in the design process and should be considered by the researcher” (Dresch et al., 2015, p. 78), but has also been seen as ”[...] any descriptive theory that informs artifact construction [...]” (Gregor & Hevner, 2013, p. 340). The practical aim of my project was to create a resource to support the use of design methods for the implementation project. The HISP groups are working as the partners within the DHIS2 ecosystem. They are many located in different parts of the globe, and their practices vary from each other due to cultural differences, context and knowledge-levels. The Method Tailoring approach responds to standardised methods not being a one-fits-all and thus needs to be tailored or adapted to provide value for the practitioners. As there are varying practices from each HISP group, it may therefore be challenging to purpose a standardised method which would apply to all HISP groups within the DHIS2 ecosystem. Therefore, the DMT presents activities, methods and stories and can be seen as a fragment repository that partners can use to customise their processes. The methods and activities can be seen as method fragments and the collection of these methods can be seen as a fragment repository. Experiences often lead to method tailoring activities, and the stories element can be seen as a form of extended experiences repository, which is available for the entire HISP community. Thus, method tailoring influenced the design of the DMT in order to accommodate the different practices of the HISP groups. In the following subsection, I will present the theory of method tailoring.

3.1 Method tailoring

For the past decades, there has been a shift from using traditional software development methods, such as the waterfall model, to using agile methods, such as Scrum and Kanban, when developing software. This is due to the agile method's advantages of increased productivity, focusing on time to market and high flexibility compared to traditional software engineering methods. However, Fitzgerald (1998) found that only 6% use formalised methods as the book describes them. Due to the nature of building software and the complexity it brings, it is argued that there is no ”silver bullet” method for software engineering that can be reused in every project and produce consequently good results (Brooks, 1987). There are arguments that software development methods need to be adapted or tailored in some form to be effective (Basili & Rombach, 1987; Williams & Cockburn, 2003; Xu & Ramesh, 2007) as

> *[...] almost all software development projects are unique, and that the choice of method or method variant is dependent on many organizational, technical, or human factors, and the nature of the system being developed* (Conboy & Fitzgerald, 2010, p. 6).

Therefore, many organisations and teams end up customising the methods into their variants which are better suited for their projects and context,

which are based on the ”textbook” variant of the methods (Conboy & Fitzgerald, 2010; Fitzgerald et al., 2006). The existing literature has used different terms to explain the process of tailoring software development methods to different contexts and projects. Some examples of different variants are method tailoring (Campanelli & Parreiras, 2015; Conboy & Fitzgerald, 2010), method configuration (Karlsson & Ågerfalk, 2004), method adaptation (Aydin et al., 2004) and software process tailoring (Lee & Chen, 2020; Lee et al., 2021; Xu & Ramesh, 2007). Method tailoring can be defined as

> *[...] a process or capability in which agents through responsive changes in, and dynamic interplays between, contexts, intentions, and method fragments determine a system development approach for a specific project situation* (Aydin et al., 2004, p. 128).

Method fragments in the context of method tailoring refer to a software development method or part of one (Brinkkemper, 1996). An example could be if an organisation were to tailor a method to their process, they could take the stand-up meetings from Scrum and mix them with other software development methods, such as Kanban or Xtreme Programming and adapt them to their specific project. There are generally two overarching approaches of doing agile method tailoring: *contingency factor approaches* and *method engineering* (Campanelli & Parreiras, 2015; Conboy & Fitzgerald, 2010; Fitzgerald et al., 2006). However, a systematic literature review found that some papers do not classify or explain the approach which was used in terms of method tailoring (Campanelli & Parreiras, 2015). This makes it unclear if there are more approaches to tailoring than the presented two that have yet to be defined.

The contingency factor approach is a method tailoring strategy that involves selecting methods that are best suited for the project context from a broad range of different development methods with (Conboy & Fitzgerald, 2010). Additionally, the development context and tailoring criteria set by the organisation should be taken into account when customising a method (Campanelli & Parreiras, 2015). There exist many criteria for method tailoring and can be categorised into four different types: team, internal environment, external environment and objectives (Kalus & Kuhrmann, 2013). Criteria for the team can relate to turnover in the organisation, cooperation and domain knowledge. Internal environment criteria can relate to prototyping, technical support and measurements. External environment criteria can be user availability, client availability and legal aspects. Finally, objectives criteria can relate to complexity, conceptual solution and legacy systems. The contingency factor approach comes from the premise of there not being a ”silver bullet” or a universally applicable software development method (Conboy & Fitzgerald, 2010). A visualised example of the contingency factors process can be seen in Figure 3.1.

The method engineering approach implies that methods should be created from method fragments and then applied to the specific project context (Brinkkemper, 1996). As all projects are inherently different, it is argued that there is a need to create new software development methods for each

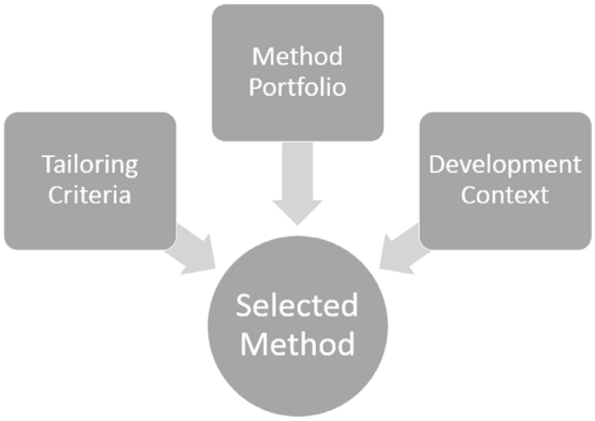

Figure 3.1: Method tailoring with the contingency factors approach
From Campanelli and Parreiras (2015)

project to best fit the context. Thus the project environment and characteristics need to be taken into detail (Brinkkemper, 1996). The approach requires a fragment repository, which contains different software development methods and a method engineer to tailor the method (Campanelli & Parreiras, 2015). The fragments are selected, assembled and measured so that the process can be adapted throughout the project (Brinkkemper, 1996). Based on experiences in method tailoring projects, the fragment repository is updated (Brinkkemper, 1996). A visualised example of the method engineering approach to method tailoring can be seen in Figure 3.2.

One of the challenges both contingency factor and method engineering face is that a high level of resources and formality is required to use or implement any of the approaches (Campanelli & Parreiras, 2015; Fitzgerald et al., 2006). Method tailoring has been seen conducted based on an understanding of agile software methods and practices and previous experiences (Conboy & Fitzgerald, 2010; Fitzgerald et al., 2006). Dittrich (2016) purpose to see and teach methods as ”practice patterns”, which are a set of formalised rules and understandings that have to be adopted and adapted to the specific project and context. Thus, the method or practice pattern in this sense can be seen in the same way as a design pattern, meaning that the application of the design pattern will not mean that you use it in the exact same way as another practitioner is using it (Dittrich, 2014).

In this section, I have presented the method tailoring theory. Method tailoring is argued to be carried out as there is no perfect universal applicable method for every project, and the textbook version of these methods needs to be applied. I have gone through two approaches for method tailoring, contingency factors and method engineering. Methods are argued to be seen as practice patterns, which need to be adopted and adapted to the specific context it is to be used. I take the concept of fragment repository and method fragments from the method engineering approach and the idea of viewing

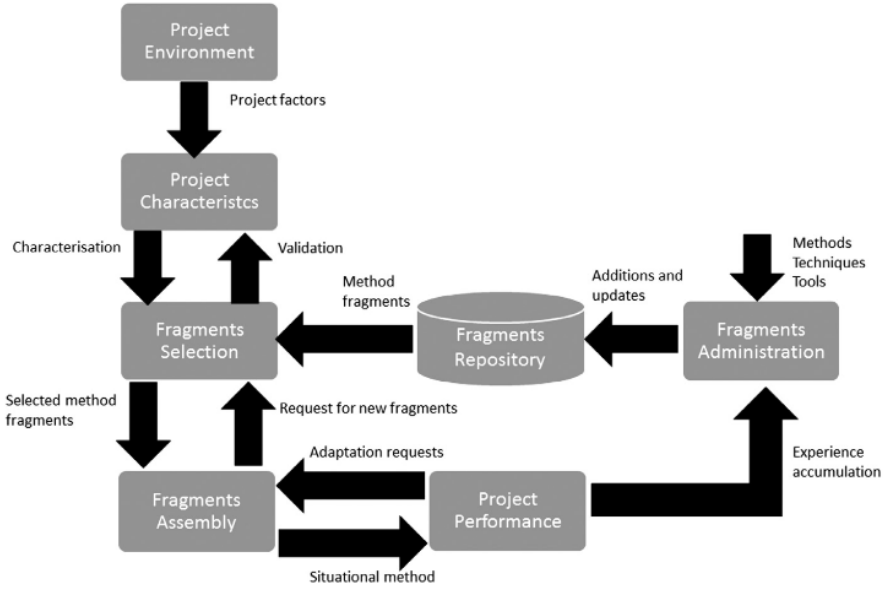

Figure 3.2: Method tailoring with the method engineering approach
From Campanelli and Parreiras (2015)

methods as practice patterns further in my thesis.

4 Background

This section will introduce background information about the context in which this thesis is set within. First, we take a look at the Health Information System Programme (HISP), then DHIS2 will be presented, and finally, the DHIS2 Design Lab will be presented, which this project has been a part of.

4.1 HISP

”HISP is a global movement to support DHIS2 implementation, local customization and configuration, offer in-country and regional training, and to promote DHIS2 as a global public good” (UiO, 2022a). It was initiated during the political aspects of post-apartheid South Africa in 1994 (Adu-Gyamfi et al., 2019). There was a planned reconstruction of the country's health sector in the different provinces (Adu-Gyamfi et al., 2019) as the current health system and data requirements created challenges as it was rapidly changing and fragmented (Braa & Sahay, 2012, p. 140). A collaborative project to create a district-based health information system was formed and was made up of the University of Cape Town, the University of Western Cape, and a PhD candidate from UiO (Adu-Gyamfi et al., 2019). Their strategy to realise this was to ”[...] was through tools and data standardisation, development of essential datasets and a software application to support its implementation” (Adu-Gyamfi et al., 2019, p. 74). The project led to the first version of DHIS2, known as District Health Information System (DHIS).

After the success of DHIS, HISP has grown into ”[...] a global network of independent organizations and individuals” (Nielsen, 2021). Some of these partners are seen as HISP Groups, and they are ”[...] long term and trusted partners located in developing countries and collaborating with us [...]” (Nielsen, 2021). Traditionally, HISP UiO was responsible for the conducting participatory design efforts in countries implementing DHIS2 (Roland et al., 2017). However, over the years, as DHIS2 has grown into an ecosystem with the different HISP groups, the responsibility of conducting participatory design efforts has been transferred to the HISP (Roland et al., 2017). The HISP groups are working tightly with HISP UiO, who coordinates the development of DHIS2 and is responsible for the development of the generic core of the platform. Some examples of collaboration between the HISP groups and HISP UiO can be open source development on DHIS2, capacity building, research activities and supporting Ministries of Health and health programmes with implementation of DHIS2 (Nielsen, 2021). The HISP groups are giving support to different regions based on where they are located (DHIS2, 2022f). They have therefore been seen as the main partner groups in the DHIS2 ecosystem and provide support for the user organisations, which can, for example, be the health facilities in various countries. An overview of which regions the HISP groups support can be seen in Table 4.1.

Region	HISP Groups
East & Southern Africa	HISP Uganda, HISP Tanzania, HISP South Africa, HISP Rwanda, Saudigitus (HISP Mozambique), HISP Malawi, HISP Ethiopia and HISP Kenya
West & Central Africa	HISP West & Central Africa, HISP South Africa, HISP Nigeria and Saudigitus (HISP Mozambique)
Asia & the Pacific	HISP Vietnam, HISP Sri Lanka, HISP India, HISP Bangladesh and HISP Indonesia
Latin America & the Caribbean	HISP Colombia

Table 4.1: The HISP Network and their regions

4.2 DHIS2

The District Health Information System 2, the second version of DHIS, is an open-source, web-based software which is primarily being used as a Health Management Information System (HMIS) (DHIS2, 2022a). DHIS2 is used by more than 73 low and middle-income countries globally for data collection and analyses (DHIS2, 2022j), making it one of the largest HMIS platforms in the world. Figure 4.1 illustrates the global usage of DHIS2. As the generic software core is being maintained and developed by HISP UiO, they can be seen as the platform owner of DHIS2. As DHIS2 has grown, it can be viewed as a platform where the implementing organisation can build on top of their implemented version of DHIS2. They provide both technical and knowledge boundary resources such as API's, SDK's, user forums and documentation for configuring and developing DHIS2 (DHIS2, 2022b).

The process of configuring DHIS2 is complex as there are a lot of different options available in order to configure the system to the user organisation. Therefore DHIS2 Academy has been created, which aims to build capacity for implementing, maintaining and building custom applications on top of DHIS2 (DHIS2, 2022c). They create different courses partners can take in order to get certifications and an annual conference where experts of DHIS2 get together to present and discuss DHIS2. They are, in other words, the ones who provide knowledge boundary resources in terms of capacity building in the platform. There are four different types of courses offered by DHIS2 Academy: DHIS2 Fundamentals, Level 1 Academies, Level 2 Academies and In-Country Academies (DHIS2, 2022c). DHIS2 Fundamentals are free, self-paced online courses which allow you to learn about how DHIS2 can be used and basic principles and terminology (DHIS2, 2022d). Level 1 Academies are in person or online live academies held by DHIS2 experts which builds upon the knowledge from the DHIS2 fundamentals courses and covers design, configuration and use of DHIS2 (DHIS2, 2022h). Level 2 Academies builds upon Level 1 Academies and offer courses for more specialised skills which can be not specifically DHIS2, such as application development (DHIS2, 2022i). These courses are also in person or live online

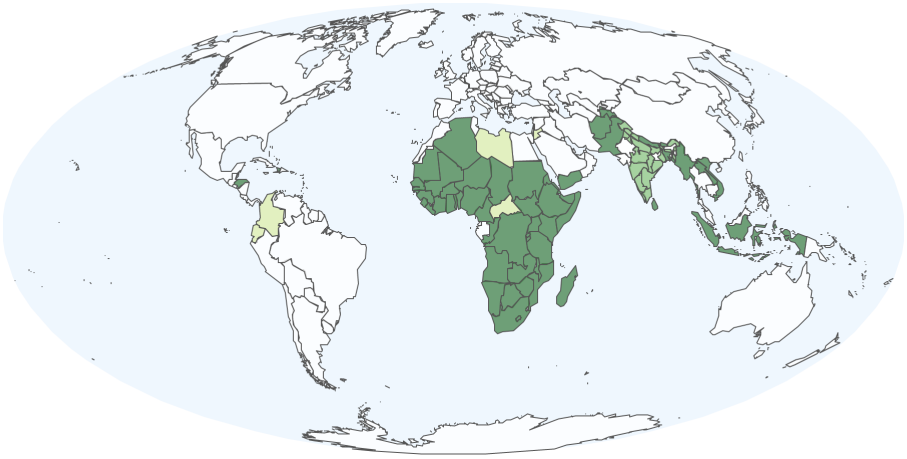

Figure 4.1: The global use of DHIS2
From DHIS2 (2022e)

courses but are held by the DHIS2 Core Team and are meant for a global audience. In-Country Academies are customised training for a country's specific needs, goals and their specific DHIS2 structure (DHIS2, 2022g). These academies are hosted by the HISP groups and focus on improving the data quality and data use in a specific country.

4.3 DHIS2 Design Lab

The DHIS2 Design Lab is a *generic software design lab* which has the goal of "[...] strengthen the usability and local relevance of the generic software DHIS2 for end-users [...]" (Li, 2019b, p. 11). The lab consists of postgraduates and researchers who work on projects within the DHIS2 ecosystem related to the exploration of existing and new design and innovation practices, exploration of resources which can support application development, and exploration of resources (UiO, 2022b). Some examples of other projects are building a resource to build capacity for app development on the DHIS2 platform and exploration of collaborative development. The DHIS2 Design Lab is described as being independent of the DHIS2 core team and the HISP groups (Li, 2019b). While being independent, the DHIS2 Design Labs participants work tightly with the DHIS2 core team and the different HISP groups concerning their projects. We have had several seminars in the lab related to our master thesis, which has helped me form my study and communication of both the problem and contributions.

5 Method

My thesis has been concerned with creating design considerations for a platform owner creating a resource to support the use of software design methods for partners within a ES ecosystem. Additionally, another aim was to contribute to the body of knowledge on knowledge boundary resources, which aim to support the social side of implementation projects within ES ecosystems. My project's aims could be supported by creating a prototype that aimed to support the use of software design methods. The Design Science Research methodology seemed like an appropriate choice, as it could support both of these goals. This is due to DSR being concerned with generating new knowledge through the creation of artefacts (Baskerville et al., 2018).

During this project, I collaborated with three students. Leia and Trilla, who are writing a thesis together, had a specific project and Reva, who is writing alone, had her project. They are given pseudo names to protect their real names. We collaborated since our projects were related to software design methods in some way or another, and the DMT could be a relevant prototype for all of the members of the team to further investigate within DHIS2. I was supposed to be engaged in both of their projects. However, only the project of Leia and Trilla ended up being relevant (further elaborated in Section 5.5.1). Leia and Trilla's project was concerned with understanding how implementation projects were carried out by partners of DHIS2 and what challenges they faced when conducting software design methods during these projects. To learn about this methods such as interviews and a digital workshop was carried out. Leia and Trilla were the ones who conducted the interviews while I joined in on the digital workshop. This was due to me being very involved in Reva's project at the time of the interviews and is further elaborated on in Section 5.5.1. Together with Reva, we created prototypes of how the DMT should look like and what elements it should have. The prototypes were created using Figma. I was the only one who was responsible for developing the DMT using web technologies. Through the formative evaluation with HISP partners using a feedback session and a usability test of the DMT, I decided to go forward with the DMT as a form of fragment repository the partner can utilise during their project. An overview of the activities conducted during the project regarding interacting with participants can be seen in Table 5.1.

This section is structured as follows: First, in Section 5.1, I will present my philosophical assumptions for this thesis. Second, in Section 5.2, I will describe the methodology I have used in my thesis, Design Science Research (DSR). Thirdly, in Section 5.3, I will go through the data collection methods used in my thesis. Forth, in Section 5.4, I will describe how evaluations are carried out in DSR, as well as the methods which were used for evaluations during my thesis. Fifth, in Section 5.5, I show how DSR was applied to my project by going through how the project was carried out. Sixth, in Section 5.6, I describe how the data used in this thesis was analysed. Seventh, in Section 5.7, I describe the DMT of how it can be applied, how it is built

Date	**Activity**	**Participant from**	**Who was present**
12. February, 2021	Interview	HISP Malawi	Leia and Trilla
19. February, 2021	Interview	HISP Tanzania	Leia and Trilla
25. February, 2021	Interview	DHIS2 Core Team	Leia and Trilla
5. March, 2021	Interview	DHIS2 Academy	Leia and Trilla
19. April, 2021	Digital workshop	DHIS2 Academy	Me, Leia and Trilla
27. August, 2021	Feedback session	HISP Malawi	Trilla
13. September, 2021	Usability test	HISP Malawi	Me, Leia and Trilla
8. December, 2021	Evaluation workshop	HISP Mozambique, HISP Sri Lanka, HISP India	Me
20. December, 2021	Evaluation workshop	DHIS2 Core Team	Me
12. January, 2022	Evaluation workshop	IN5320 student	Me
13. January, 2022	Evaluation workshop	IN5320 student	Me
14. January, 2022	Evaluation workshop	IN5320 student	Me
17. January, 2022	Evaluation workshop	IN5320 student	Me
18. January, 2022	Evaluation workshop	IN5320 student	Me
20. January, 2022	Evaluation workshop	HISP Malawi	Me
21. January, 2022	Evaluation workshop	DHIS2 Core Team	Me, Leia and Trilla
24. January, 2022	Evaluation workshop	HISP Sri Lanka	Me
24. January, 2022	Evaluation workshop	DHIS2 Academy	Me

Table 5.1: Activities related to data collection and evaluations with participants conducted during the project

and what elements it includes. Finally, in Section 5.8, I will go through the ethical considerations for this project.

5.1 Philosophical assumptions

When conducting research, the researcher must understand that "All research [...] is based on some underlying assumptions about what constitutes 'valid' research and which research methods are appropriate" (Myers, 1997). Additionally, "[...] it is necessary to understand the principles and assumptions of scientific research, in other words, philosophy" (Moon & Blackman, 2014, p. 1168) to understand and acquire knowledge. Two main branches within philosophy are crucial for research within social and natural sciences: *ontology*, which refers to what exists in the world and what we can acquire knowledge from, and *epistemology*, which are assumptions we make about knowledge and how this knowledge can be obtained (Moon & Blackman, 2014; Myers, 1997). The branches of ontology and epistemology are interconnected and create a holistic view of knowledge, in other words, the *philosophical perspective*, which then guides the researcher's action (Moon & Blackman, 2014). Three classifications of philosophical perspectives are usually suggested: positivist, interpretive and critical studies (Chua, 1986; Orlikowski & Baroudi, 1991).

My thesis can be classified as an interpretive study (Klein & Myers, 1991), as I am concerned with studying the socio-technical context of implementation projects through interactions with practitioners. The epistemological foundation of my study has not been focused on exploring the research question through large-scale samples of quantifiable metrics, nor has it been focused on critiquing existing social systems and revealing contradictions within the social system (Orlikowski & Baroudi, 1991). Instead, it has been focused on exploring a social context through developing a prototype to understand the intersubjective meanings and experiences of the participants of the study (Klein & Myers, 1991). Through discussions about the prototype, I could learn about their context and how the prototype either does or does not support this particular context. For instance, by presenting a prototype of a generic implementation process, the partners could give information on if that process was accurate to what they were doing in the field.

My study has aimed to achieve both a practical and a theoretical goal. The first and practical one was to develop a resource to provide support for the use of software design methods to ES Ecosystem partners. The second and theoretical goal was to develop a more general knowledge of what a platform owner needs to consider when creating a resource to support the use of software design methods within an ES ecosystem in the form of design considerations. To achieve these goals, I had to acquire knowledge on how the implementation process of the HISP groups was, as they were the partners of the DHIS2 ecosystem. Understanding their implementation processes could allow to see what the DMT needed to support to be seen as a relevant tool for the HISP groups. The DHIS2 core team is also collaborating with

HISP groups on specific projects, and it would thus be interesting to get an insight into how this collaboration works out. It was also interesting to know how the process of DHIS2 Academy concerning gathering requirements for their courses, as the resource could potentially be utilised as a supplement to these courses. Thus obtaining insights through these goals provided a deeper understanding of the DHIS2 Academy experiences with people from the DHIS2 community and how the prototype could potentially fit their social context.

The knowledge gained from the interviews with the HISP Groups and DHIS2 Academy has allowed me to understand what challenges may occur for a platform owner when creating a resource to support partners within implementation projects, such as the course materials from the DHIS2 Academy. As this is a highly socio-technical relationship between the technical system and the social setting it is to be implemented, it would be hard to generate knowledge from strictly quantifiable metrics on these complex relationships. The artefact itself is considered technical since the DMT would provide partners with software design methods and be presented as a digital tool on a website. The use of the DMT is embedded in a social context. For example, partners' work practices during their implementation process. Therefore, qualitative methods have been utilised in this project. This is due to the qualitative method's ability to help the researcher of gaining an understanding of the social context in which the participants reside in (Myers, 1997). These methods helped gather in-depth knowledge on the HISP groups' practices during projects, the DHIS2 Academies' processes for gathering requirements for courses and how the core team of DHIS2 collaborate with the HISP groups. The interviews with actors within the DHIS2 ecosystem have allowed me to gather the individual meanings of people who have experience with implementation projects in ES Ecosystems. It should be noted that the HISP groups are implementing these systems in the context of low-and-middle-income countries, which is a vastly different context than my own. Within the interpretive paradigm, this is important to be aware of as the researcher needs to be reflective about the social context in which the knowledge is acquired from (Klein & Myers, 1991).

5.2 Research methodology - Design Science Research

The chosen methodology for this study has been Design Science Research (DSR). The difference between DSR and descriptive methodologies, such as case studies that aims to understand reality (Stake, 2005) is that DSR seeks to both contribute to practice and science by creating an evaluation artefacts (Baskerville et al., 2018). My project is concerned with building an artefact to support design and development activities within the DHIS2 ecosystem, based on the previous work of Kroken (2021), which resulted in a prototype of such an artefact. Action Research (AR) was initially considered for the study as "[...] AR involves solving organizational problems through intervention while at the same time contributing to knowledge" (Davison et al., 2004, p. 65). AR is also concerned with creating artefacts by introducing them to the organisation and evaluating their use, generating knowledge. The initial plan was to work closely with a HISP Group to develop an arte-

fact and put it to use in a project based on their challenges. This would involve travelling to their location and being more involved in their projects. This would have proved an ideal situation for conducting AR in this study. However, travel was not possible due to the COVID-19 pandemic, and thus an all online intervention would not have been feasible. DSR, on the other hand, does not require intervention and close collaboration with a specific organisation, and thus I argue that DSR can support my study. DSR aims to design and evaluate artefacts that are set out to solve a specific problem. The methodology can thus be is viewed as a problem-solving paradigm that:

> *[...] seeks to create innovations that define the ideas, practices, technical capabilities, and products through which the analysis, design, implementation, management, and use of information systems can be effectively and efficiently accomplished.* (Hevner et al., 2004, p. 76)

The artefact being developed in DSR can be constructs, models, methods and instantiations (Hevner et al., 2004). Additionally, DSR contributes to science by generating new knowledge, which could be beneficial for both practitioners and scientists. This knowledge comes from designing and developing artefacts and is prescriptive knowledge in the form of design theories. The contributing factors of DSR fit well with my project, which is to create a resource to support design and development methods for implementation partners within the DHIS2 ecosystem, which contributes to practice. Through designing, developing and evaluating the artefact, abstract knowledge can be generated. In my case, this could be applicable for other platform owners when they are designing resources of a similar kind and researchers on the design of knowledge boundary resources, which covers contributions to science.

There exists different models for conducting DSR studies (Hevner et al., 2004; Peffers et al., 2007). However, the Design Science Research Methodology (DSRM) purposed by Peffers et al. (2007) (Figure 5.1) is the most widely cited model (vom Brocke et al., 2020), and is the model I have been following during my project. In Section 5.5 I show how the model was applied to my project. The model is cyclical and consists of six steps: *Problem identification and motivation*, *define the objectives for a solution*, *design and development*, *demonstration*, *evaluation* and *communication* (Peffers et al., 2007). In the problem identification and motivation step, the research problem is identified and defined. The second step is to define the objectives for a solution. The third step, design and development, is concerned with designing and developing the artefact of the study. The fourth activity, demonstration, is concerned with showcasing the use of the "[...] artifact to solve one or more instances of the problem" (Peffers et al., 2007, p. 55). The fifth activity, evaluation, concerns observing and measuring how well the developed artefact supports a solution to the problem. Metrics of evaluation could take many forms depending on the nature of the problem and the developed artefact, such as objective quantitative measures and client feedback (Peffers et al., 2007, p. 56). Evaluation is of high importance in DSR. As such, I will go

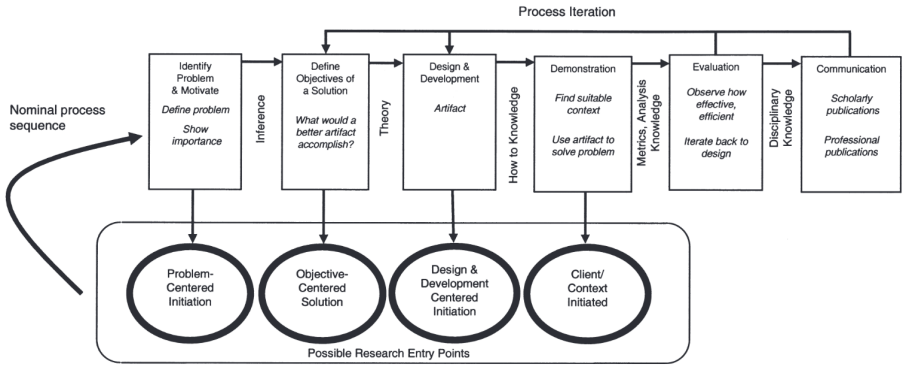

Figure 5.1: Design Science Research Methodology
From Peffers et al. (2007, p. 54)

through the step in Section 5.4. The sixth and final step, communication, relates to communicating the problem, the artefact and the results from the DSR study. The communication of DSR research is commonly done through scholarly publications, which in my case is this master thesis. Due to the model's cyclic nature, the researcher may iterate back to previous steps of the model to improve the artefact if they have the opportunity to do so. For example, the researcher may want to iterate back to the design and development step after evaluating to use the data from the evaluation to improve the artefact.

DSRM does not assume that the researcher will follow an sequential order of the activities, and therefore it has four different entry points (Peffers et al., 2007): *problem-centered approach*, *objective-centered solution*, *design- and development-centered approach* and *client-/context initiated*. The problem-centred approach starts with the first step, problem identification and motivation. The objective-centred solution starts at the define the objectives for a solution step. The design- and development-centred approach starts at the design and development step. The client-/context initiated entry point starts with the demonstration step.

In DSR, there are different levels of contributions. Gregor and Hevner (2013) have identified three levels of maturity for DSR contributions, which goes from "More specific, limited, and less mature" to "More abstract, complete, and mature knowledge" (p. 342). The first level and least mature contribution cover the situated implementation of the artefact. Even though the artefact is context-specific, it is argued that "Demonstration of a novel artefact can be a research contribution that embodies design ideas and theories yet to be articulated, formalised, and fully understood" (Gregor & Hevner, 2013, p. 341). The second level of contribution is in the form of nascent design theory, which could take the form of constructs, methods, models, design principles and technological rules. The third and highest level of maturity in the form of contributions is in the form of "[...] well-developed design theories about the phenomena under study [...]" (Gregor & Hevner,

2013, p. 341). An overview of the contribution levels can be seen in Table 5.2. The artefact I have created can be seen in the form of a level 1 contribution, as it is an instantiation in the form of a software product. The design considerations I have developed could be seen as a level 2 contribution as they could be used to inform the design of similar artefacts.

Level	Contribution to knowledge	Example of contribution
3	Well-developed design theory about embedded phenomena	Design theories
2	Nascent design theory - knowledge as operational principles/architecture	Constructs, methods, models, design principles, technological rules
1	Situated implementation of artifact	Instantiations (software products or implemented processes)

Table 5.2: DSR contribution levels
Note: Adapted table from Gregor and Hevner (2013) (p. 342)

5.3 Data collection

During my study, I collected data at various phases of the project. In this section, I will go through which methods were used for the project's problem identification and motivation phase. During this phase, I collaborated with Leia, Trilla and Reva. We all did the document analysis together. Leia and Trilla were the ones who conducted the interviews, and Leia, Trilla and I conducted a digital workshop with a participant from DHIS2 Academy. In Section 5.3.1, I will present the goals of the data collection sessions. In Section 5.3.2, I will describe the process of selecting participants for the data collection sessions. In Section 5.3.3, I will present document analysis and how it was used in the study. In Section 5.3.4, I present interviews and go through how they were used in the process. An overview of all the data collection sessions with direct communication with participants can be seen in Table 5.3.

5.3.1 Goals

A common denominator among the team members was to investigate how the HISP groups were using software design methods in their projects. As we had little to no experience with the DHIS2 ecosystem and how it worked, we set a goal to learn more about the implementation process of the HISP groups when developing DHIS2. This could make us learn more about how they utilise different software design methods in their implementation process. After the interviews with the HISP groups, Leia and Trilla were encouraged to get in touch with the DHIS2 core team. This was due to the DHIS2 core team having collaboration projects with the HISP groups. Another goal was set to learn more about how the DHIS2 core team collaborated with the HISP groups. We could thus learn more about what software design methods they may use for collaborations between partners and the platform owner. When the interviews with the DHIS2 core team were done,

Date	Data collection method	Participants	Number of participants
12. February, 2021	Interview	HISP Malawi	2
19. February, 2021	Interview	HISP Tanzania	2
25. February, 2021	Interview	Core Team	2
5. March, 2021	Interview	DHIS2 Academy	1
19. April, 2021	Digital Workshop	DHIS2 Academy*	1

Table 5.3: Data collection sessions for the problem identification and motivation and define objectives of a solution

Note: "*" shows the data collection session I was present at

Leia and Trilla were recommended to get into contact with DHIS2 Academy, as they had collaborations with the HISP groups about the capacity building courses they provide. So another goal was to understand how the DHIS2 Academy was collaborating with the HISP groups and see what software design methods they may utilise for these collaborations. At this point, I had created an early version of the DMT based on the data from the interviews conducted in Table 5.3. As we had more knowledge of the DHIS2 ecosystem and the implementation processes of the HISP groups, our data collection became more specific. We wanted to hear more explicitly from DHIS2 Academy how they used software design methods. So we set another goal of learning about methods for user involvement within DHIS2 Academy and the HISP groups, as well as introducing the DMT to hear how it may fit into the HISP groups implementation project and the DHIS2 ecosystem. This was done to get input from the platform owner, who could further support the design and development phase of the DMT.

5.3.2 Participants selection

The sampling of participants is seen as necessary, as it can have an impact on the findings and results of the research project (Bordens & Abbot, 2018). The study is concerned with finding design considerations for an artefact to support the use of design and development methods within the DHIS2 ecosystem. When considering the aims of the study, it is essential to include the actors who engage in design and development activities within the DHIS2 ecosystem. The participants of the data collection of the artefact thus need to be representative of the prototype's intended user group, which relates to being engaged in design and development activities within the DHIS2 ecosystem and be willing to share their experiences. Therefore a nonrandom sample strategy was adopted for this study, which is "A specialized sample of subjects used in a study who are not randomly chosen from a population" (Bordens & Abbot, 2018, G-8).

The HISP groups are the ones who are primarily doing implementation projects within the DHIS2 ecosystem and use methods related to design and development in these projects. They are the target group who was needed for our project. Thus, we wanted to include them in the problem identification and motivation phase to understand and learn about their process. To get in contact with the HISP groups, we started by sending emails to known persons of our supervisors, as this was a way of increasing our chances of establishing contacts with the groups. Two members from HISP Malawi and two members from HISP Tanzania agreed to join in on the data collection. We also made contact with two members of the DHIS2 core team who were working closely with courses related to DHIS2 academy and the creation of metadata packages for the World Health Organization (WHO). They had also been involved in projects where they had been working together with the HISP groups. Interviewing the members of the core team allowed us to explore how these courses were made and how they worked with HISP groups with these courses. This interview also led us to get a new contact within DHIS2 Academy, where we talked about the requirements gathering process of courses. This was valuable, as we got an insight into how the process of creating these courses was. We also got to know how HISP groups were involved in the process. We also held a workshop with another member of DHIS2 academy to explore how user involvement was facilitated in DHIS2 Academy and in general. Additionally, in this workshop, an early version of the DMT was shown to the participant, which helped us understand what this resource may give in terms of benefits and the opportunities it may bring and the challenges. An overview of the groups of participants, their general role and why they were included in the data collection sessions can be seen in Table 5.4.

5.3.3 Document analysis

Document analysis can be defined as "[...] a systematic procedure for reviewing or evaluating documents—both printed and electronic (computer-based and Internet-transmitted) material" (Bowen, 2009, p. 27). The method was used to analyse the prototype of Kroken (2021), which is elaborated further on in Section 5.5.1. The analysis was done by going through the prototype sketch for sketch and noting down the different elements inside the prototype. Then we could get an overview of how these elements were structured and connected. Doing document analysis helped define the artefact's requirements later on when we understood the problem.

5.3.4 Interviews

Interviews were the main data gathering method used during problem identification and motivation and evaluations. Semi-structured interviews were used as they "[...] set some broad parameters to a discussion [...]" (Crang & Cook, 2007, p. 60). Several interview guides have been created during the problem identification and motivation (Appendix B, Appendix C, Appendix D) for different interviews which helped focus the discussion with the participants. Some examples of questions from the interview guides are:

Participant	Role	Reason to include
HISP Groups	Partner organisation within the DHIS2 ecosystem	The main target group for the artefact. Can learn about their processes when conducting implementation projects, and how they are using design methods in these projects.
Core team	Platform owner	Can give knowledge on the whole ecosystems and insights on collaboration with HISP groups
DHIS2 Academy	Part of platform owner. Creates and distributes knowledge-boundary resources for capacity building within DHIS2.	Can give knowledge on how the knowledge-boundary resources within DHIS2 are created, how they are evaluated and how the HISP Groups are involved in these processes.

Table 5.4: Participants for the data collection sessions

1. How do you start the process of making a DHIS2 academies course?
2. How is your development process structured? For example, do you use an agile process or a waterfall process?
3. Who do you collect requirements from?

Doing semi-structured interviews allowed for delving deeper into topics which came up during the interview. The flexibility was useful as the HISP groups, and DHIS2 is new territory for both my teammates and me. As previously mentioned, I could not join in on any of the interviews carried out by Leia and Trilla in the research process due to me being heavily involved in Reva's project at this time. Therefore, I could not directly affect the follow-up questions asked during the interviews. However, I joined in on creating the interview guides and influenced what would be asked during the interviews. The information gained from the interviews gave the team useful insights for defining objectives for a solution. After analysing, I realised that a good amount of what was said in the interviews was not relevant to the goals set for the data collection. Thus, it is left out of the findings of this study. This was probably a result of working as a team with three different master thesis, and the research problem was not well defined at the start of the process.

5.3.5 Digital workshop

We conducted a digital workshop with a participant from DHIS2 Academy to explore how software design methods were used in DHIS2 Academy and present an early version of the DMT. Prior to the workshop, we had set up a Miro[2] board for the different themes we were going through during the workshop, and the participant was going to write post-it notes and post them near the topics during the workshop. This was done as he was discussing with us what he meant. The first part of the workshop was concerned with learning about method usage in DHIS2 Academies and the benefits, challenges and opportunities of conducting user involvement in this setting. After this part, an early version of the DMT was showcased, and the second part was focused on the benefits, challenges and opportunities of introducing such a resource for the HISP groups within the DHIS2 community. The agenda for the digital workshop can be seen in Appendix E.

5.4 Artefact evaluation

The evaluation phase in DSR is seen as important as it provides feedback back to the artefact to be used for further improvements on it, as well as uncovering how well the artefact achieves its intended utility (Venable et al., 2016). Two important categories of evaluation are discussed in the literature which are "[...] (1) formative [and] summative and (2) *ex ante* [and] *ex post* evaluation" (Venable et al., 2016, p. 78). Formative and summative evaluation is concerned with *why* we evaluate. Formative evaluations are used for further improvements on the artefact. On the other hand, summative evaluations aim to evaluate how effective the artefact is in utility. In terms of *why* the evaluation was carried out, consider that I have been doing both formative and summative evaluations during my study. The feedback session and usability test were a formative evaluation, as the results from these were used to further guide the development of the DMT. In my case, these evaluations were to determine if the DMT would be tied to a standardised process or not. I consider the evaluation sessions conducted at the end of the research process as summative. This is due to them being focused on the utility of the DMT in terms of how it could support the HISP groups. However, another focus was on how the DMT could become a better resource by incorporating new elements and functionality and redesigning the current state of the prototype, which could be seen in terms of a formative evaluation. An overview of all the evaluation activities can be seen in Table 5.5.

The category of *ex ante* and *ex post* evaluations are concerned with *when* we evaluate and they are occupying the two extremes of when to evaluate (Venable et al., 2016, p. 79). *Ex ante* is concerned with evaluation before the design and development activity to evaluate if one should develop the artefact in question or not. *Ex post*, on the other hand, happens after the implementation of the artefact has taken place and set into production so that the value of the system can be evaluated (Venable et al., 2016, p.79).

[2]https://miro.com/

Date	Type of evaluation	Evaluation activity	Participants	Number of participants
27. August, 2021	Formative	Feedback session	HISP Malawi	2
13. September, 2021	Formative	Usability test	HISP Malawi	2
8. December, 2021	Summative	Evaluation Workshop	HISP Mozambique, HISP Sri Lanka, HISP India *P*	3
20. December, 2021	Summative	Evaluation Workshop	DHIS2 Core Team	1
12. January, 2022	Summative	Evaluation Workshop	IN5320 Student	1
13. January, 2022	Summative	Evaluation Workshop	IN5320 Student	1
14. January, 2022	Summative	Evaluation Workshop	IN5320 Student	1
17. January, 2022	Summative	Evaluation Workshop	IN5320 Student	1
18. January, 2022	Summative	Evaluation Workshop	IN5320 Student	1
20. January, 2022	Summative	Evaluation Workshop	HISP Malawi*	1
21. January, 2022	Summative	Evaluation Workshop	DHIS2 Core Team	2
24. January, 2022	Summative	Evaluation Workshop	HISP Sri Lanka	1
24. January, 2022	Summative	Evaluation Workshop	DHIS2 Academy	1

Table 5.5: Evaluation activities conducted during the research process
Note: "*" indicates internet connection issues with the participant which could have affected the data collection session. *P* indicates that the evaluation workshop was conducted physically.

The researcher may do in-between evaluations between these two extremes when they are not in either of them. In terms of *when* the evaluations were done, the feedback session and usability test can be seen as an in-between evaluation, as they are neither *ex ante* nor *ex post*. I would also consider the evaluation sessions conducted in the final part of my research process an in-between evaluation. This is due to the artefact not being set into production and being used by the HISP groups. This also has implications for how I evaluate the utility of the DMT, as the utility of the prototype would become clearer after it was used in a real-life setting in different contexts.

However, it is important to note that the utility of knowledge artefacts such as methods, techniques and tools for the support of information systems is difficult to assess, as all projects are unique (Goldkuhl & Karlsson, 2020). Metrics cannot measure the utility of such resources as two different teams using the same knowledge artefact will be vastly different, as different teams "[...] brings different background knowledge into the project [...]" (Goldkuhl & Karlsson, 2020, p. 1258) which will determine how the project is carried out. Hence, different projects and practices give implications of requiring different types of support, as one project does not necessarily need the same support as the next. The DMT could fit into this description as it is concerned with supporting the use of software design methods during implementation projects. Thus, a more holistic approach for evaluating the prototype is needed, and I have therefore conducted what I call evaluation workshops to conduct the summative evaluation of the artefact, further described in Section 5.4.4.

5.4.1 Participants of the evaluations

The first demonstration and evaluation phase of the project was done with members from HISP Malawi. This relates to the feedback session and usability test conducted in August and September 2021. Only one HISP group was with us on this evaluation as we wanted quick feedback which could guide the direction of the DMT further. For the demonstration and evaluation of the artefact, I included the previously mentioned groups of people as I had in the problem identification and motivation and the defining objectives for the solution phases, described in Section 5.3.2. The HISP Groups were included as they are the main partners of DHIS2 members from different HISP groups to get different HISP group members' input on the artefact; three members of the core team. One who was developing implementors guidelines, a functional designer and one who was creating impact stories for DHIS2; A member from the DHIS2 Academy.

However, I also included a new group of participants, students from the course IN5320 - Development in platform ecosystems (UiO, 2022d). The students in this course have a practical part where they are creating a web application by using REST API's and web technologies such as HTML, JavaScript and React within the DHIS2 environment. The case is derived from the end-users needs to solve a problem. It can be relevant for the students to use methods related to design and development to organise the

teamwork and develop concepts for the project. In this project, the artefact was purposed as a tool for the students to use for this exact purpose. It is important to note that the students are fundamentally different from members in the HISP groups concerning culture and experience and cannot answer to the complexity faced in real projects with multiple actors. However, they can be represented in the form that they have endured a custom application project within DHIS2. So the focus of the evaluation sessions with this group relates to how the artefact could support their project, rather than how they could support implementation projects the HISP groups endure. An overview of the different groups included in the evaluation workshops can be seen in Table 5.6.

Participant	**Role**	**Reason to include**
HISP Groups	Partner organisation within the DHIS2 ecosystem	The main target group for the artefact
Core team	Platform owner	Can bring insights for what such a resource should include and how design and development methods are used in colloboration with HISP Groups
DHIS2 Academy	Part of platform owner. Creates and distributes knowledge-boundary resources for capacity building within DHIS2.	Can give feedback on the artefact and how it fits in with current knowledge-boundary resources within DHIS2
IN5320 Students	Acts as a partner in the practical part of their course	Can bring insights on how such a resource could support their project

Table 5.6: Participants for the evaluations

Additionally, I wanted to know how the prototype could fit in with the other DHIS2 resources which are available for the ecosystem from the DHIS2 core team and to know from DHIS2 Academy what is needed for the prototype to be used in the capacity building courses. The IN5320 students are fundamentally different from the HISP group members' limited knowledge of DHIS2. However, they have been in a project where they are implementing a custom application on top of DHIS2. Some of them may also have used the prototype during their project. They were asked about how the prototype supported or supported their project and how it could have supported their project better.

5.4.2 Feedback session

A feedback session on three different prototypes was conducted during the formative evaluation session to find a suitable prototype to further evaluate with a usability test. This feedback session was concerned with finding which of the three proposed standardised processes was most applicable to the HISP group. In this case, we only had a feedback session with HISP Malawi. After the three prototypes were presented, a discussion of which of the three was most applicable began with the participants from HISP Malawi in terms of how they used their process and how well the ones presented fitted their case. Trilla was the one who conducted the feedback session. Sometime after the feedback session was conducted, Leia and I joined to discuss the results of the feedback session. This led us to choose one of the prototypes to further work on and conduct a usability test.

5.4.3 Usability testing

Usability testing is a method where the goal is to see if "[...] the product being developed is usable by the intended user population to achieve the tasks for which it was designed" (Preece et al., 2015, p. 475). We tested the prototype which was chosen after the feedback session. Again, HISP Malawi was the one who was the participant in the usability test. The usability test was conducted to see if the practitioner understood where they could get information about methods and if they understood the standardised process model presented. After the usability test, they were asked follow-up questions relating to how the tasks were, if they would like to use such a resource in their projects and if they had something to say about the resource.

5.4.4 Evaluation workshop

For the final evaluation phase of the project, I conducted what I call evaluation workshops. There were 11 evaluation workshops with 14 participants in total. An overview of these workshops can be seen in Table 5.5. The evaluation workshop had three parts, and a complete example of one can be seen in Appendix F. First, I presented myself to the participant(s). I gave a short introduction to the DMT and a use case of how it could be used to support implementation projects at various stages. The second part was concerned with a practical assignment where the participant was given a case to think about how they would use the DMT to support a project. This assignment was meant to make the participant familiar with the prototype. The HISP groups, core team and DHIS2 got a practical assignment where they imagined that a user organisation hired them to investigate their DHIS2 implementation and develop a custom application on top of the implementation. This practical assignment can be found in Appendix F. For the IN5320 students, the practical example was related to how they could have used the DMT in their project and can be found in Appendix J. It first meant that the participants would do the assignment at the evaluation workshop, but as I conducted the workshops, I got feedback from some of the participants. They wished that they could go through it on their own

before the workshop, as they may have had more thought beforehand. So I sent the assignment beforehand via email so that they could choose to do it beforehand. The last part of the evaluation workshop concerned some discussion assignments and can be seen as a semi-structured interview. The questions asked depended on whom the participants were, as described in Section 5.4.1.

The HISP groups got questions related to what was needed for the DMT to support their projects and who was going to help add content to the resource. The questions for the HISP groups can be seen in Appendix G. For the core team, I asked questions relating to how the DMT could support the HISP groups as well as how it can fit in with the existing resources of DHIS2. The questions for the core team can be seen in Appendix H. The DHIS2 Academy was also asked questions related to how the DMT could support the HISP groups but was also asked what was needed for the prototype to become a part of DHIS2 Academy. By being part, I mean used in the courses they provide in some way or another. The questions asked to DHIS2 Academy can be seen in Appendix I.

The IN5320 students got questions about why they did or did not use the DMT during their project and afterwards on what it would need to change to support their project adequately. The questions for the IN5320 students can be seen in Appendix J. These sessions were conducted digitally with the participants. This was working fine for the most part, but during the evaluation session with HISP Malawi, I experienced connection issues with the participant. This resulted in us not being able to hear each other as the audio got cut off. Therefore a lot of repetition was needed. To reduce the latency, we decided to not have cameras and limit screen sharing from my side to what was necessary. The data from the evaluation sessions were not recorded. Instead, I wrote notes during the sessions, which were immediately written into summary documents while it was fresh in my memory.

5.5 Research approach

In this section, I will describe how I applied the DSR methodology of Peffers et al. (2007) to my research project. I will go through what happened from January 2021 to April in Section 5.5.1, May to July in Section 5.5.2, August to November in Section 5.5.3 and finally December to January in Section5.5.4. An overview of the research project and the DSR phases can be seen in Figure 5.5.

5.5.1 January 2021 to April 2021

The problem identification and motivation phase started in late January 2021. We were introduced to a former master's student, and he introduced his prototype for us, called "DHIS2 Design Method Toolkit", which was to support and promote user-centred design during implementation projects within generic software (Kroken, 2021). During the presentation,

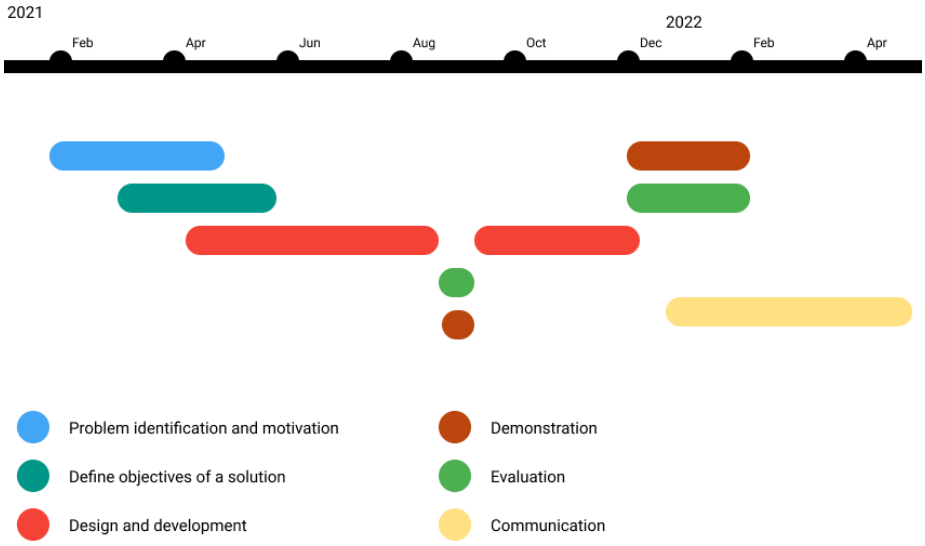

Figure 5.2: The DSR proscess of Peffers et al.(2007) applied to my research project

we learned the process that led to the creation of the prototype and what the prototype contained. This provided us with information to create interview guides to start investigating the use of software design methods in implementation projects within DHIS2 and the challenges of conducting them. After the presentation, we conducted a document analysis session on the prototype to understand it more thoroughly. The prototype of Kroken (2021) had a landing site and two elements: methods and challenges. The landing site introduced the resource and provided links to the elements. Methods showed what it was, why it was used, steps for executing the methods, and what you can expect after doing the method. The method also provided some stats, which could be suggested use of time, materials needed, the difficulty of conducting the method, participants for the method and other methods which could be paired with the said method. An example of a method in the prototype of Kroken (2021) can be viewed in Figure 5.3. Challenges were common challenges found in the DHIS2 ecosystem, as well as some thought of solutions for the challenge. An example of a challenge can be seen in Figure 5.4. Since the prototype already had a structure and some content, it was a good starting point to compare it with other resources of a similar kind and the prototype we were going to design and develop. We analysed other similar digital resources which had goals to support design and development activities outside the DHIS2 ecosystem. This was also done to determine what a resource could look like and what it could contain.

I started being very involved in Reva's project in February 2021. The project seemed relevant initially, as it seemed they were going to utilise methods

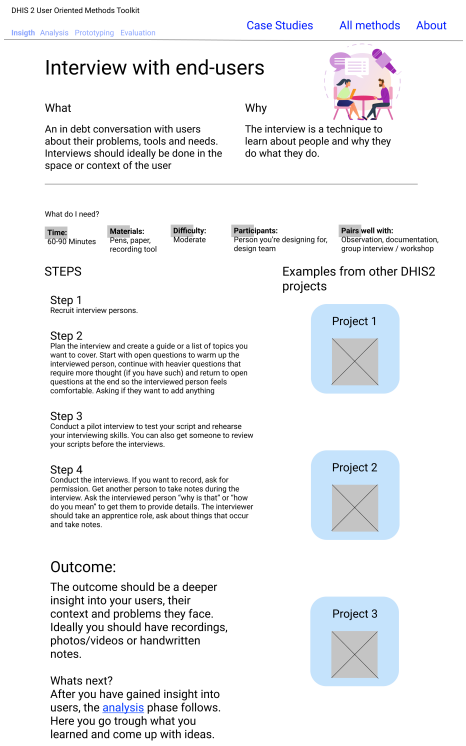

Figure 5.3: Example from a method in the prototype of Kroken (2021)

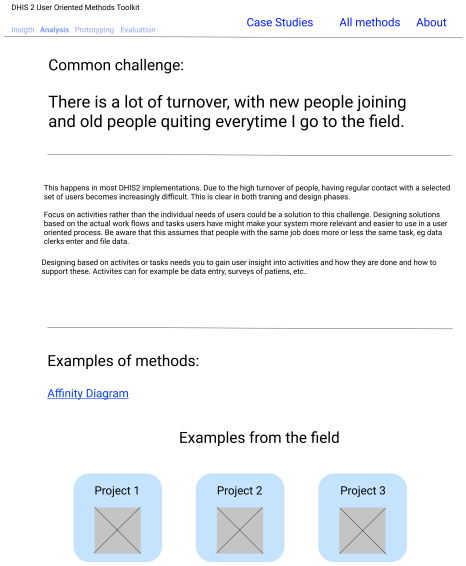

Figure 5.4: Example from a challenge in the prototype of Kroken (2021)

related to software design to develop a solution for immunisation and nutrition in Rwanda. Unfortunately, this project was not that relevant for me, as they had already decided on the solution to the problem. It made me question if they would use methods to develop a solution, and the said design process was not scheduled until fall 2021. Due to the time frame of my project and the uncertainties of this project, I decided to drop it altogether in April 2021. This made me unable to be part of most of the data collection activities of Leia and Trilla's project, which in hindsight, were more relevant and in line with my research interests. During February, Leia and Trilla conducted two interviews with two HISP groups: HISP Malawi and HISP Tanzania. Through these interviews, we learned about how the HISP groups conducted implementation projects and noticed some differences in their approaches as well as different projects and how they used different software design methods with end-users in implementation projects. They also interviewed two members of the DHIS2 core team to learn about how they collaborated with the HISP groups and what they were working on. In March, we had an interview with DHIS2 Academy to learn about the process of creating courses and how they worked with HISP groups to improve them. The interviews were recorded, transcribed, and analysed in the problem identification and motivation phase. The data from these data collection sessions were used to define the objectives of a prototype. We can see in Figure 5.5 that the defined objectives of a solution started to unfold as we learned more about the problem we were investigating.

In April, we started with the process's first design and development activity. Some paper sketches were created on paper to brainstorm the possibilities of how the prototype could support the implementation processes of partners to conduct more software design methods (Figure 5.5). I started the development of the prototype in this period, and it was named the "Design Method Toolkit" after the prototype of Kroken (2021). We discussed these prototypes in the group and continued to iterate upon them. The idea of grouping methods into activities was born to accommodate different practices conducted by implementers. However, there were discussions about whether the methods and activities would be tightly coupled to a traditional user-centred design process. For the time being, the methods were tightly coupled to an iterative design process consisting of insight, analysis, prototyping and evaluation and followed the structure previously set by Kroken (2021). A picture of what a method looked like can be seen in Figure 5.6. The concept of stories was also created to contextualise methods by telling a story of how participants in a project conducted different design and development methods to achieve their project. This could be seen as an extension of the challenges which were created by Kroken (2021).

In the middle of April, we held a digital workshop with a member of DHIS2 Academy. The workshop could be seen as a part of both the problem identification and motivation phase and defining problems of a solution. This is due to it being split up into two parts. The first part mainly was an interview about the use of methods in DHIS2 Academies and user involvement. While the second part was a showcase of the DMT as it was at the time going

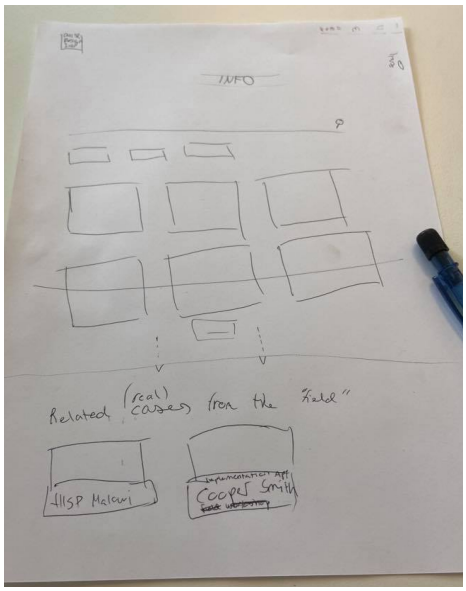

Figure 5.5: Paper sketched prototype

through the benefits of introducing such a resource, the challenges it may bring and what opportunities there are for such a resource.

5.5.2 May 2021 to July 2021

The first design and development phase continued from May to July. In this time frame, a lot of content was developed for the prototype, as it was planned to be a supporting tool for the student's practical part of the course IN5320 - Development in Platform Ecosystems. In this course, the students have a practical project where they are supposed to design a custom application within the DHIS2 ecosystem (UiO, 2022d). They are given a project description where the end-users needs are described, and from this description, they are supposed to come up with a solution. Reva got a summer job to create content for this course, and Trilla got a summer job to create stories related to their specific master's project. Thus a lot of content was generated over the summer. Until the beginning of June, I worked on the prototype, mainly on visual improvements and technical aspects. Some low-fidelity prototypes were also developed in the prototyping tool Figma by Reva and Trilla who had summer jobs. A collection of these can be seen in Figure 5.7.

5.5.3 August 2021 to November 2021

In August, we discussed the prototypes created during the summer (Figure 5.7). There were ongoing discussions about whether the prototype would be tightly coupled to a process to accommodate different practices. Some new higher fidelity prototypes were designed, which coupled the methods and activities more tightly with a standardised process. This was done to evaluate with some implementers to see if they would find it useful and

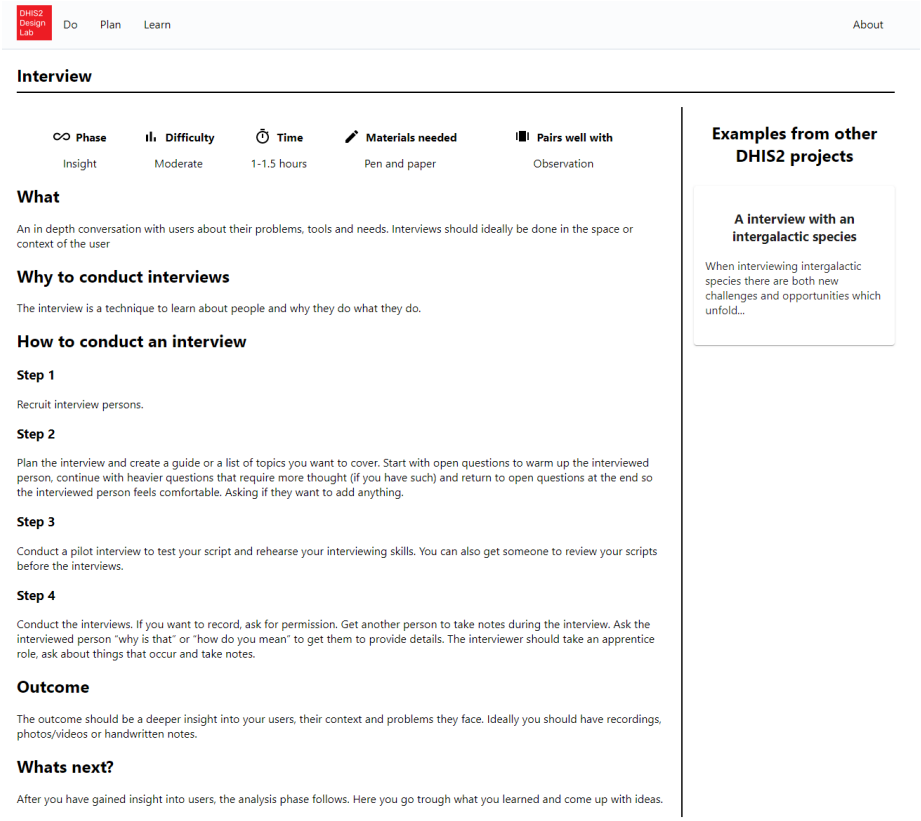

Figure 5.6: Previous design of a method

relevant. This effort concluded the first design and development phase. From late August to September, we conducted a feedback session and a usability test on the prototype with two implementers from HISP Group in Malawi to discuss the phases of the proposed prototype to see if it made sense. The first demonstration and evaluation phase started with these activities and was a type of formative evaluation. I view the demonstration and evaluation as two interconnected activities in this project. The feedback session was conducted as we could not decide which standardised process to test out and what fitted best with the implementer's practices. Three alternatives for the process were presented, and the different process parts were discussed. Two of the prototypes included the same phases with slight variation in the terminology and layout, where Figure 5.8 was one of them. The last prototype was also similar, but was missing the maintenance phase. Figure 5.8 showed a picture of the most preferred prototype and was the one we decided to conduct the usability test on. For the usability test, both set the participants into a context of finding information related to different parts of their process and afterwards discussing the prototype. There was confusion about the different process elements from the feedback session and the usability test. Implementers did not necessarily conduct all of the

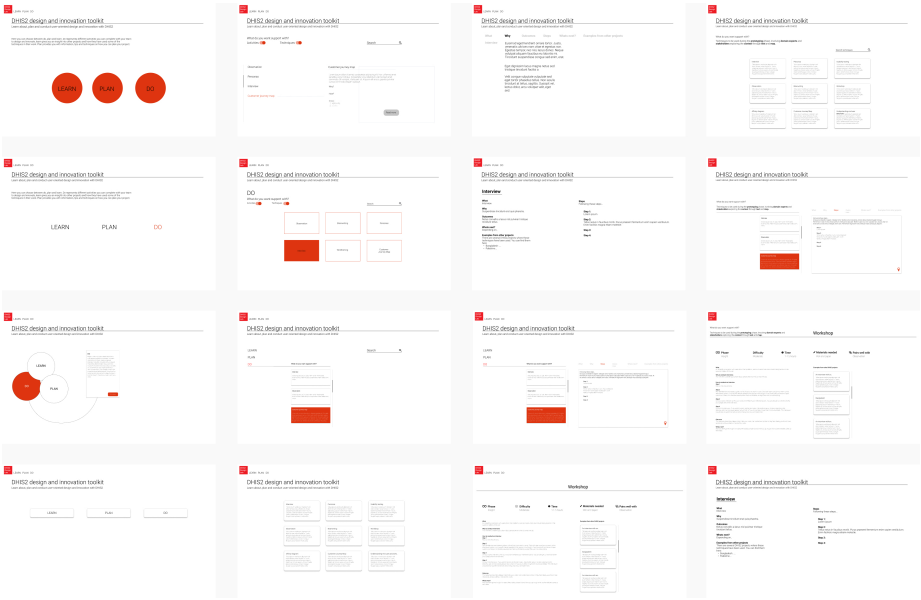

Figure 5.7: Collection of low fidelity prototypes in Figma

different process elements in every project and used different terminology for the different phases. This led me to decide to go forward with the idea of loosely coupled activities and methods that were not directly coupled to a specific process model.

The implementers could pick out activities and methods and create their processes. This idea was inspired by the Method Tailoring theory described in Section 3.1. As our research interests differed, the team decided to work more independently from there on out as we wanted to evaluate different aspects of the prototype. I wanted to focus more on the use of methods and activities, while Leia and Trilla wanted to focus more on the Story element. We still collaborated with the prototype and data collection sessions, which benefited all parties. Reva had a change of focus in her project and thus was less involved in the involvement of the joint project from the fall of 2021. In September, a design and development phase was initiated to make the prototype ready for the IN5320 project and the summative evaluation sessions. This mainly involved fixing the visual profile of the prototype to be more in line with the prototypes created in Figma. The final design and development phase lasted until November, as it was time for the final demonstration and evaluation phase.

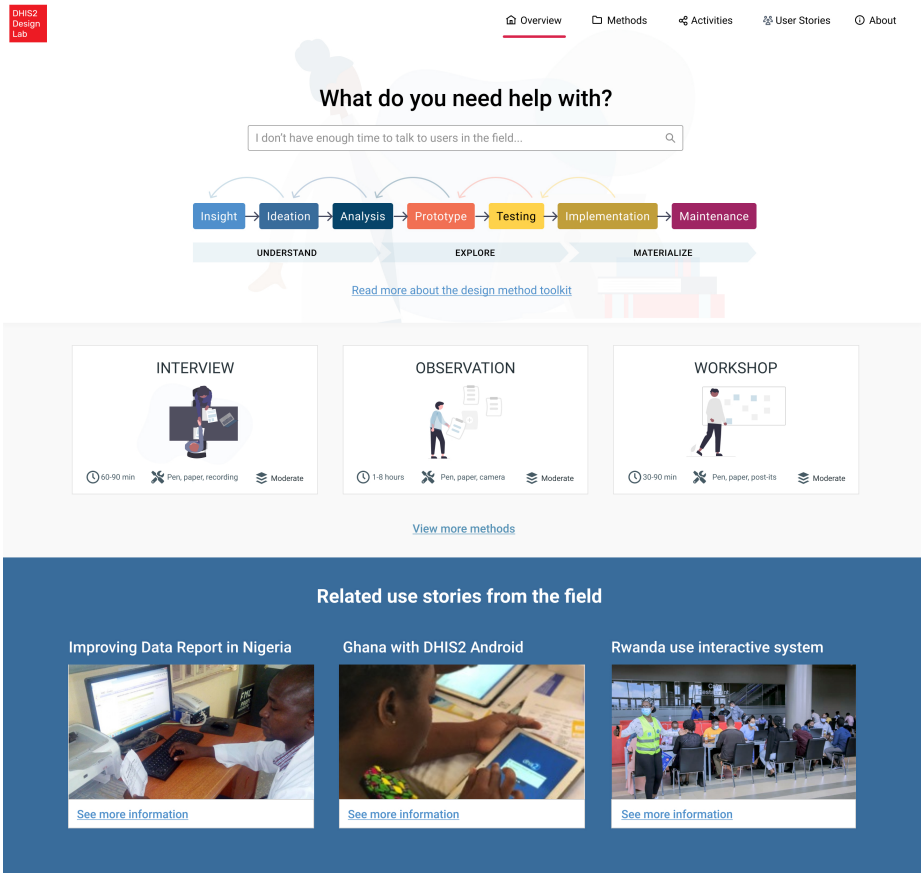

Figure 5.8: The chosen prototype alternative from the feedback session with a standardised process

5.5.4 December 2021 to January 2022

The demonstration and summative evaluation phase started in early December 2021 and lasted until late January 2022. I consider this part of the phase as both a demonstration of the prototype and an evaluation. This is due to how the evaluation session was structured. It was concerned with showcasing a case where it could help an implementer within the DHIS2 ecosystem at various parts of their process, as well as an interview at the end where we were discussing how it could support the HISP groups and fit into DHIS2 after they had explored the prototype themselves.

5.6 Data analysis

In this section, I will present the methods I used for analysing the qualitative data for this research, which have been in the form of thematic analysis and co-analysis. Thematic analysis was used to analyse the data from the problem identification and motivation step and the summative evaluations. At the same time, co-analysis, which is analysis done with other people, was done during problem identification and motivation and for the data coming from the formative and summative evaluations. Crang and Cook (2007) argues that the data collection and data analysis activities should happen continuously during the research process, which is something I have done to make sense of the data to inform the artefact being created.

5.6.1 Thematic analysis

Thematic analysis can guide the researcher through a large set of qualitative data (Nowell et al., 2017) and is defined as ”[...] a method for identifying, analysing and reporting patterns (themes) within data” (Braun & Clarke, 2006, p. 79). The analysis method allows me to learn from the data as I work with it, creating codes and themes. In my case, the analysis was inductive, as all the codes and themes that appeared in the data came from the empirical data gathered during the data collection sessions. The analysis started with me going over and familiarising myself with the data. This involved reading through the summary document or transcript, which is referred to as ”document” in this section. After familiarising myself with the data, I code the document. At this stage, I am not considering the redundancy concerning other codes I had already used. An example of coding a summary document can be seen in Figure 5.9.

After the document was coded, it was time to visualise the codes. To visualise and structure the coded data, I used Miro to create mind maps. The codes were put into their own space in Miro. Each code occurrence was given a post-it note tagged with the alias for the participant or which group they belonged to. This was done to see who stated what and if there were similarities or disagreements between groups. An example of the arrangements of codes and data points in Miro can be seen in Figure 5.10.

One of the key goals of the analysis was to identify challenges a platform owner could meet when creating a resource to support design and develop-

Codes:
Use of toolkit
Course
Awareness
Improvement
Beginner

Why did you (or did not) use the toolkit?
The participant started off saying that they wished they used the toolkit as there was a lot more than just checking it out as there was a lot of good material there. However, the participant also stated that due to the time of the project being so short it became less of a priority. Even though the course was not that focused on the exploration of requirements and needs, they could have used it more on the text based project description the participant stated.

It was also noted that the value of the toolkit was not exemplified when it was shown, which could have helped their group seeing what the toolkit could have offered them. This is interesting as it has a parallel to other data I've gathered from both HISP groups and the core team that if no one knows of the tool it doesn't matter how great it is as it won't be used. Like a great treasure buried under the sea has no value until it's found, the toolkit needs to be shared in some way or another.

Imagine that this toolkit was to be redesigned. What would have been needed to support your project even better?
Inside Activities it was noted to be somewhat hard to navigate when going into a method as finding the way back is not intuitive. Having some sort of breadcrumbs in order to see where one came from would have been beneficial. User stories were noted to have very much information on the cards and finding a certain one could be hard if one were to read through

Figure 5.9: Example of coding of summary document

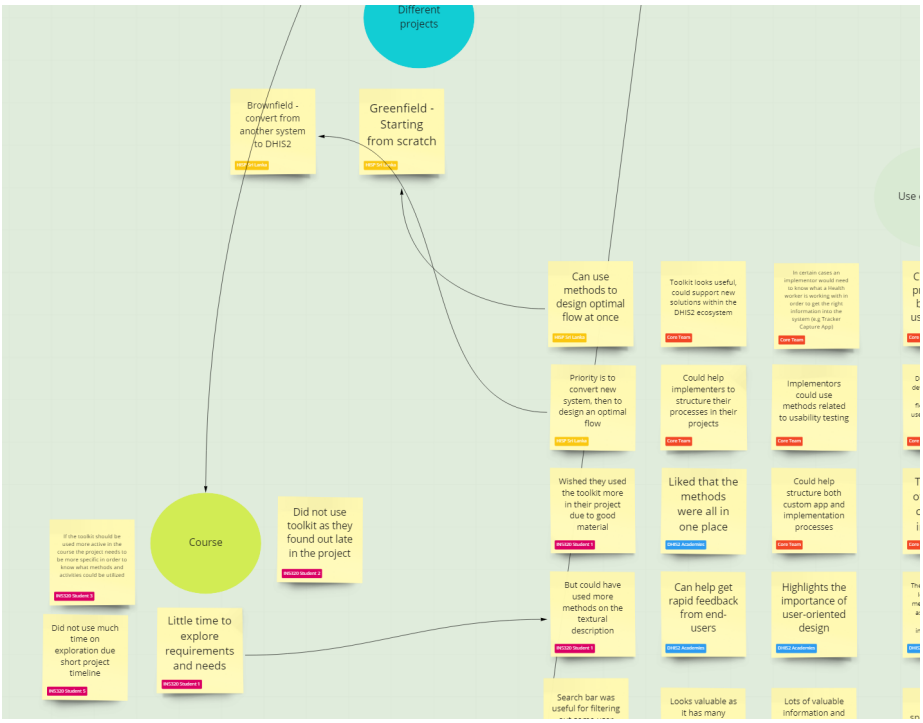

Figure 5.10: Example of codes in Miro

ment to address them in the artefact. During the coding process, I started to see patterns of challenges in the data and grouped these data points. Another goal was to form the design considerations which could be formed in the light of the evaluations, which showed how well the artefact addressed the challenges. All of this was done in a table in Miro. As I already had all of the data points in the Miro board, I could easily copy the data points into the table to show the relevance of the challenge, assessment and evaluation data to the design consideration. This allowed me to see the relationships between the identified challenges and how well the DMT addressed these challenges. Through the process of working with the data in this way, I was able to form six design considerations, which are presented in Section 6.5. Part of the table used for the formations of the design considerations can be seen in Figure 5.11 and Figure 5.12.

5.6.2 Co-analysis

As the research project was organised as teamwork for a large portion of the project, I also collaborated with the three other master's students with analysing. This allowed us to better understand the data by asking questions like "what challenges do the partners have during their project?" and "what challenges do the partners face when they include end-users in the implementation process?". This also helped me when I was analysing transcripts from interviews I was not present, as I could discuss the findings with the other master's students who held the interview. During the master

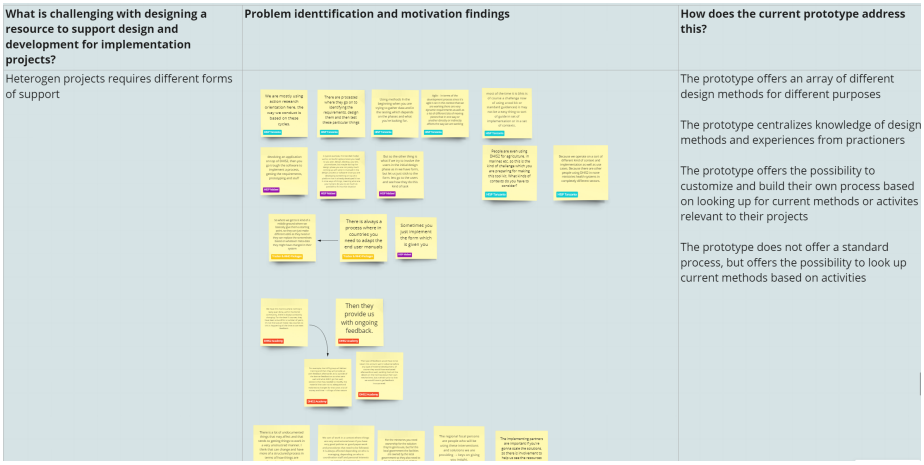

Figure 5.11: First part of the Miro table used to form design considerations

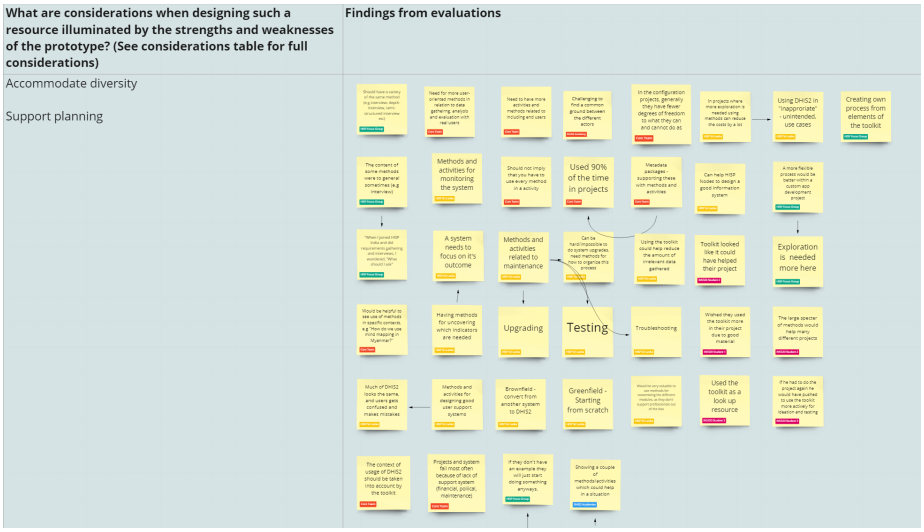

Figure 5.12: Second part of the Miro table used to form design considerations

seminars, I also presented my findings and analysis with the other master students in the DHIS2 Design Lab, where we discussed the results. I also discussed my findings with my supervisors. An example of an outcome from co-analysis was identifying the design consideration and challenge of contributions from partners. I had not initially thought of this as something a platform owner may be challenged by and consider, as there was no data from the problem identification and motivation phase. Co-analysis led me to refine the challenges and design considerations as I got multiple inputs from the other students and my supervisors with different understandings and experiences.

5.7 Artefact description

During this thesis, I was the one who was responsible for developing and hosting the DMT using web technologies. The requirements for the DMT came from the data collected during the problem identification and motivation phase. While I have not been tracking my time while developing the DMT, a rough estimate would be around 100 working hours. This work has involved finding suitable technologies for the DMT to make it work with the different elements of the prototypes being created. Then I needed to learn and use these technologies to develop the DMT. As the DMT needed to be hosted somewhere, I needed to find a suitable option for it and host it.

The artefact I have created is called the Design Method Toolkit (DMT) and is a website composed of activities, methods and stories related to design and development to support implementation projects within the DHIS2 ecosystem. The source code of the DMT can be in the following GitHub repositories: The React application for the DMT: https://github.com/dhis2designlab/method-toolkit-frontend; and the Strapi application for the DMT: https://github.com/dhis2designlab/method-toolkit-backend. The prototype can be accessed through the following URL: https://methodtoolkit.herokuapp.com/. During the evaluation phase of the project, the applications were hosted on a paid instance of the cloud-hosting platform Heroku (further described in Section 5.7.2) to have good performance during the evaluation. The initial plan was to host the DMT on UiO's servers, but due to low resources in the operations department at UiO, this was not carried out. I was troubleshooting some problems my contact person at the operation department at UiO was experiencing while trying to host the Strapi application. When I asked follow up questions my contact person stopped responding to me, which led to me hosting the project on Heroku instead. The hosting on Heroku has been downgraded to a free version since the summative evaluations. It requires both applications to be started up from scratch if the application has not had any activity for a while. Thus it can take some time before the website is up and running. As the project is in the hands of the DHIS2 Design Lab and further projects, I cannot guarantee that the project will be running at the current URL indefinitely after submitting this thesis.

5.7.1 Application of the Design Method Toolkit

This section will provide a short use case for the DMT. A visualised example can be seen in Figure 5.13. The DMT is designed to support the use of software design methods in implementation projects within the DHIS2 ecosystem. During the implementation process, here dubbed a design process, there are many steps the partner organisation has to go through before the project can be completed. At these steps, there could be a need to gather requirements for the system through contact with end-users and stakeholders of the system, analysing data, creating prototypes of the proposed systems, and evaluating either prototypes or the system's performance concerning the end-user of usability. Varying on the partners' knowledge of software design methods, they may or may not know what methods can be conducted at the particular step. The DMT includes elements that support the project's

design process by informing the different steps with methods, activities, and stories, further described in the following section. By doing this, the partners can support the various steps of their process with different elements from the DMT, thereby customising their process. If there is missing content or elements in the DMT, the partners can contact the DHIS2 Design Lab. Thereby informing the DMT and thus making it better. There is, therefore, a two-way process of informing. The DMT informs the partner organisation's design process, and the partner's design process can inform the DMT.

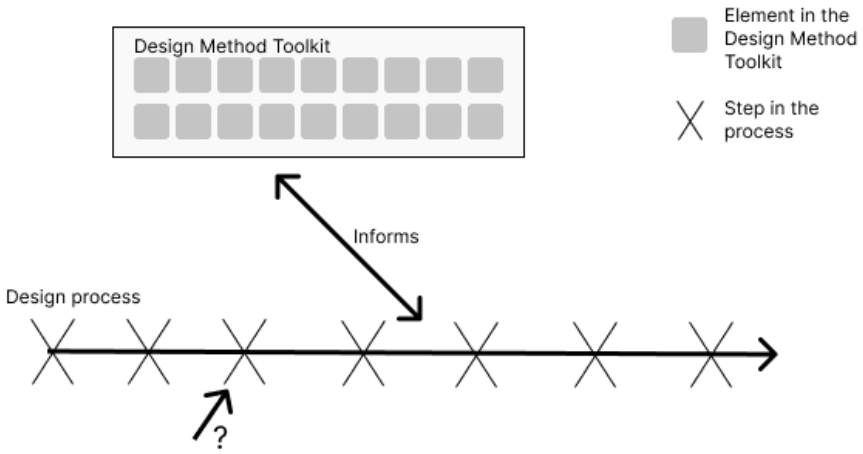

Figure 5.13: Application of the Design Method Toolkit

5.7.2 Technologies used

I needed to use and learn multiple different technologies to create the prototype. In this sub-section, I will describe the different technologies used to create the artefact.

React
React is "a JavaScript library for building user interfaces" (React, 2022). It was chosen as it is already the used front-end library for DHIS2 and one of the most used front-end libraries in the world. This has resulted in many available packages for React that can be utilised.

Strapi
Strapi is an open-source headless Content Management System (CMS) which is fully customizable (Strapi, 2022). The CMS allows users to create data models and create content for these data models through its bundled website. These data models can have relations to each other, which allows for a relation between different data models. It serves its functionality through a REST API, which makes data from Strapi able to be consumed by any client. Strapi was chosen due to its flexibility in creating data models.

It also had an interface where users could easily create, update or delete data from the artefact without touching the code.

TypeScript
TypeScript is a superset of the programming language JavaScript which is strongly typed (Microsoft, 2022). Being strongly typed allows you to catch errors early in your code editor, which may not have been noticed until the application was in production, which again may cause system crashes. TypeScript compiles down to JavaScript, making it possible to use it everywhere JavaScript may be used.

MongoDB
MongoDB is a document-oriented database platform (MongoDB, 2022a). I have used the free version of MongoDB Atlas, which is a Database-As-A-Service, meaning that deployment, set-up and maintenance are taken care of by the cloud provider (MongoDB, 2022b). This has allowed me to spend more time developing the front end of the artefact, and its integration with Strapi made it a natural choice.

React Query
React Query is a library for fetching, caching and updating your data in React applications (Lindsay, 2022). React has no built-in libraries for caching data which we receive through APIs, so I have decided to use React Query for this purpose. This makes helps optimise the performance of the application and lessens the strain on the API as we do not need to retrieve data from the API every time we need it.

Material UI
Material UI is a UI component library for React (Material-UI, 2022), and have been used to create many of the UI components used in the artefact. It was chosen due to its large array of customisable components and that it could speed up my development process, as I did not have to create all the components from scratch.

GitHub
When building software, it is wise to use a version control system to see the history of your project. For this project, I choose GitHub as the version control system for my applications (GitHub, 2022). This was natural as I was familiar with GitHub, and the DHIS2 Design Lab already had a GitHub organisation in which I could house the applications during the time of my thesis and in the future.

Heroku
To host the applications, I used the application hosting platform Heroku (Heroku, 2022). To focus more on developing the prototype rather than spending time on setting up a local web server, I chose Heroku as it had seamless integration with GitHub. This made releasing new versions of the prototype easier.

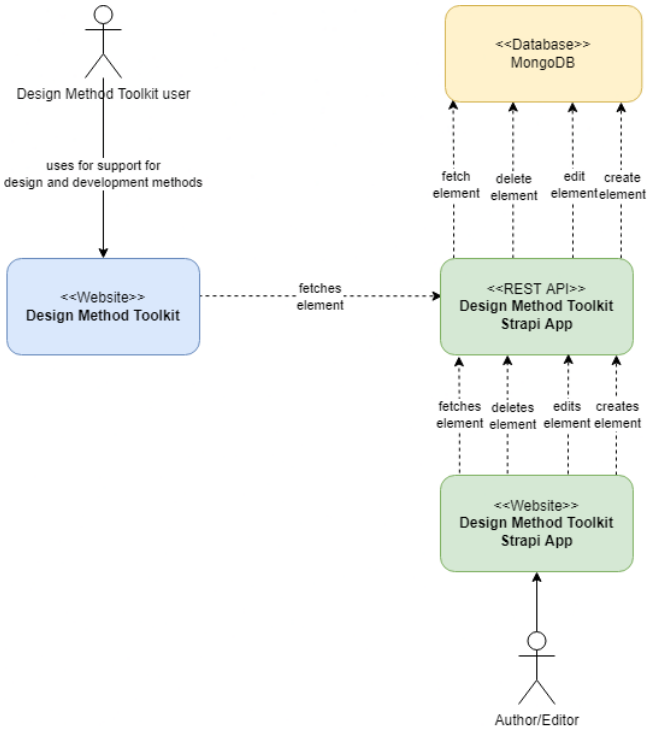

Figure 5.14: Context diagram of the Design Method Toolkit artefact

5.7.3 Architecture

In this section, I will explain the architecture of the prototype. The overall architecture consists of four elements: Design Method Toolkit, Design Method Toolkit Strapi App, which has both a website and a REST API, and a MongoDB database. The Design Method Toolkit is the interface of the end-user of the artefact. The Design Method Toolkit Strapi App REST API serves elements of the artefact to the Design Method Toolkit and fetches, deletes, edits and creates elements in the database. The Design Method Toolkit Strapi App website is used by the author or editor of the content of the elements. The MongoDB database stores the saved content of the author or editor and sends this to the Design Method Toolkit Strapi REST API. The architecture is visualised in Figure 5.14. I will now describe the Design Method Toolkit and the Design Method Toolkit Strapi App.

Design Method Toolkit
The Design Method Toolkit serves as the interface for end-users. It allows end-users to browse the main elements of the prototype, activities, methods and stories (further explained in Section 5.7.4), which is aimed at supporting the use of design and development methods during implementation projects. The Design Method Toolkitt is created using React with TypeScript as the programming language. Many of the components used on the website are created using Material UI. To retrieve the elements of the artefact, the Design Method Toolkit sends requests to the Design Method Toolkit Strapi

App REST API. For these network requests, the Design Method Toolkit utilised React Query.

Design Method Toolkit Strapi App
The Design Method Toolkit Strapi App is two-folded. It has both a website and a REST API. The website is used by the author or editors of the content in the artefact. The author or editors can, from here, create new instances of the elements, edit instances of the elements or delete instances of an element. An instance of an element here refers to, e.g. activity in the activity data model. The REST API is used by the Design Method Toolkit and the website of the Strapi App. The Design Method Toolkit Strapi API sends content when it is requested. For the website, it is used to create, edit, delete or fetch data from the database based on the requests from the user.

5.7.4 Elements of the DMT

In this section, I will provide a short description of each of the different elements of the artefact. There are two common components found throughout the artefact: the header and the footer. These provide links to the different elements of the artefact regardless of where you may find yourself within the artefact.

The overview page
The overview page introduces the prototype, when it can be used, and whom it is currently meant for. It is also here where the main elements of the artefact are introduced, Activities, Methods and Stories. The textual description provides links to go to the other elements. An image of the overview page can be seen in Figure 5.15.

Overview pages for the different elements
The different elements have an overview page for the different elements of the artefact. It provides the title of the element as well as a short description. An element here will refer to either an Activity, a Method or a Story. The elements are shown as cards with a title and a short description of what the element is about, e.g. the method interview will have the title ”Interview” and a short description of the method. If the end-user is pressing the ”READ MORE”-button, he or she will be taken to the element page for that specific element. There is also a search bar to filter out different elements based on the text provided by the end-user. The search bar also has a filter button. However, the search bar does not provide filters as it is uncertain what elements to filter on. An example of an overview page of an element can be seen in Figure 5.16, which shows the overview page for Activities.

Activity
An activity has a header and a short description, also present on the activity card. The activity explains why we conduct certain activities and the benefits. There can be relations to other sub-activities and methods to achieve the activity. For example, for the activity ”prototyping”, we can relate the methods of ”concept sketch”, ”paper prototyping”, ”wireframing”, and ”wiz-

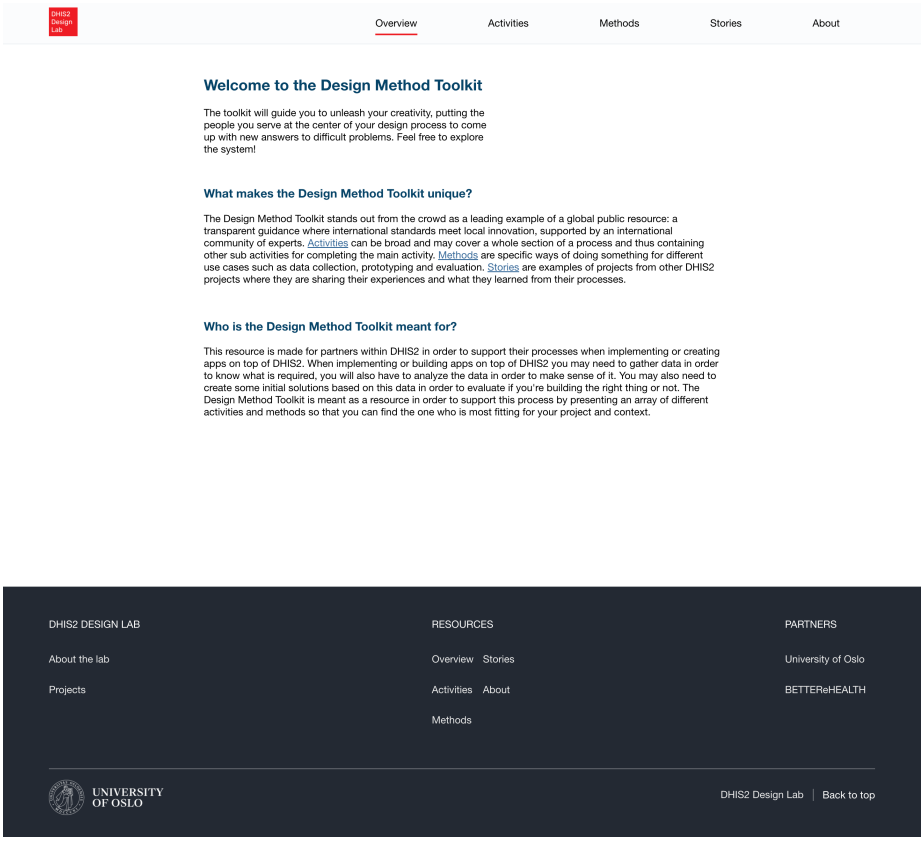

Figure 5.15: Overview of the prototype

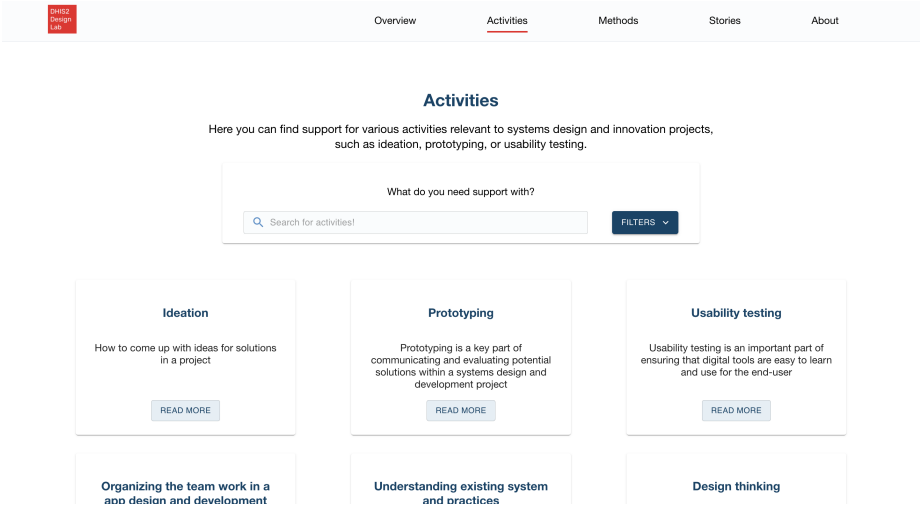

Figure 5.16: Overview page for the activity element

ard of oz" as methods for conducting the prototyping activity. The end-user does not have to follow every method suggested but can get an idea of what methods to use to do the method. There is also a relation to the story element, presenting examples of real-life cases where the activity was utilised. However, as none of the stories has empirical cases of how certain activities were utilised in the projects, this relation is currently unused in any of the activities. An example of what activity looks like can be seen in Figure 5.17.

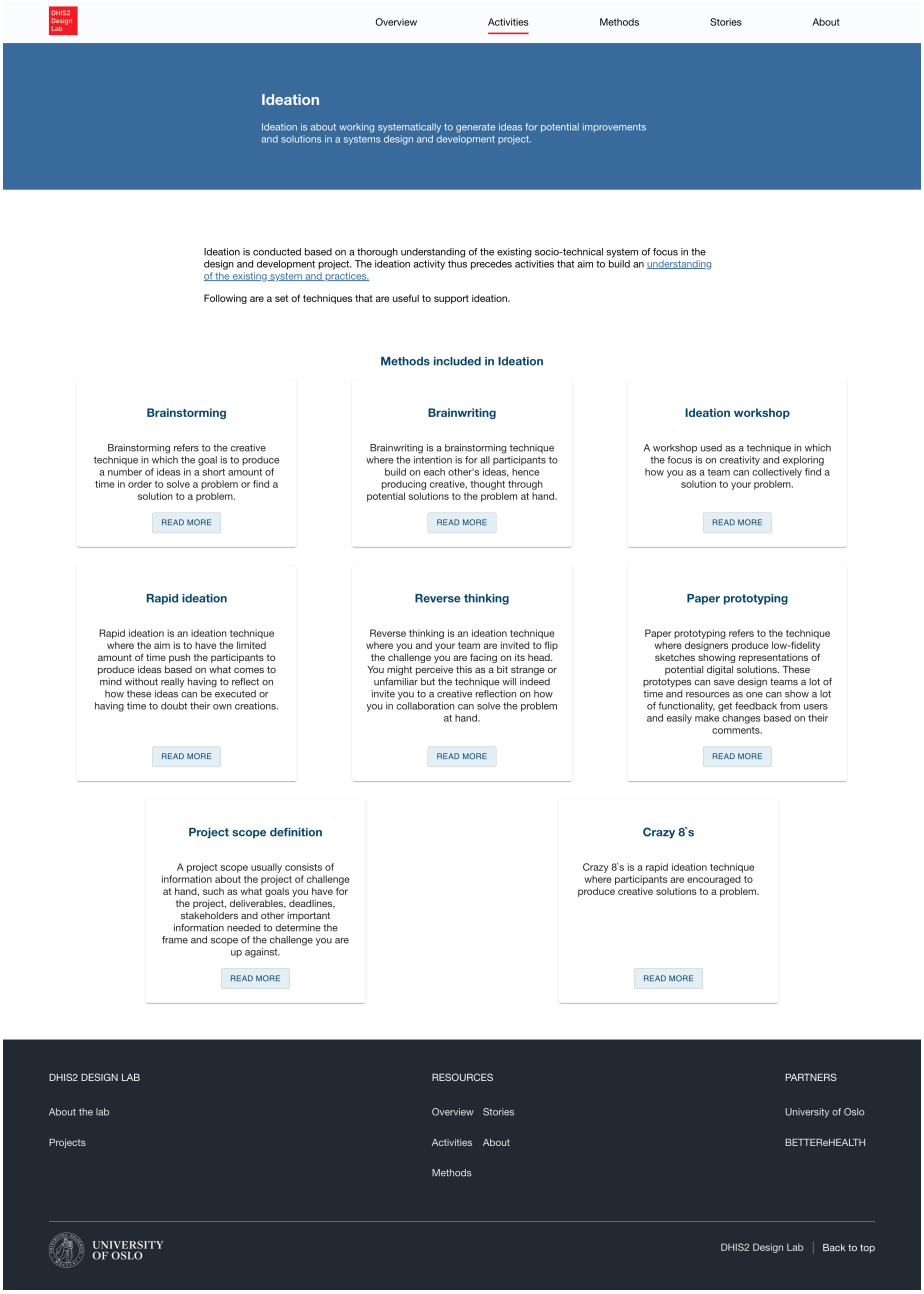

Figure 5.17: Example of an activity

Method

A method has a header and a short description, which is also present on the card of the method. The method explains when you would want to use a certain method and how you would execute the method. There are usually steps presented to the end-user on how the method could be done. It also provides tips and notes on what you may want to think about during the conduction of the method, such as what materials you may need, complementary tools for the method and permissions from the participants, e.g. documentation in terms of photographs. The method also describes what the end-user can assume regarding the method's outcomes and suggested next steps. There is a relation for story elements to see how the method was used in an empirical case. However, as mentioned for an activity, since no storey emphasises the use of methods in their story, this relation is not utilised. An example of a method can be seen in Figure 5.19. The "interview" method was set up with a sidebar for "stats", including the difficulty of conducting the method, suggested time, materials you would need and whom the participants were going to be. This was done to test if the stats would give the end-user value if the evaluation participant went into the method. An example of how the stat bar looks on the interview method can be seen in Figure 5.18.

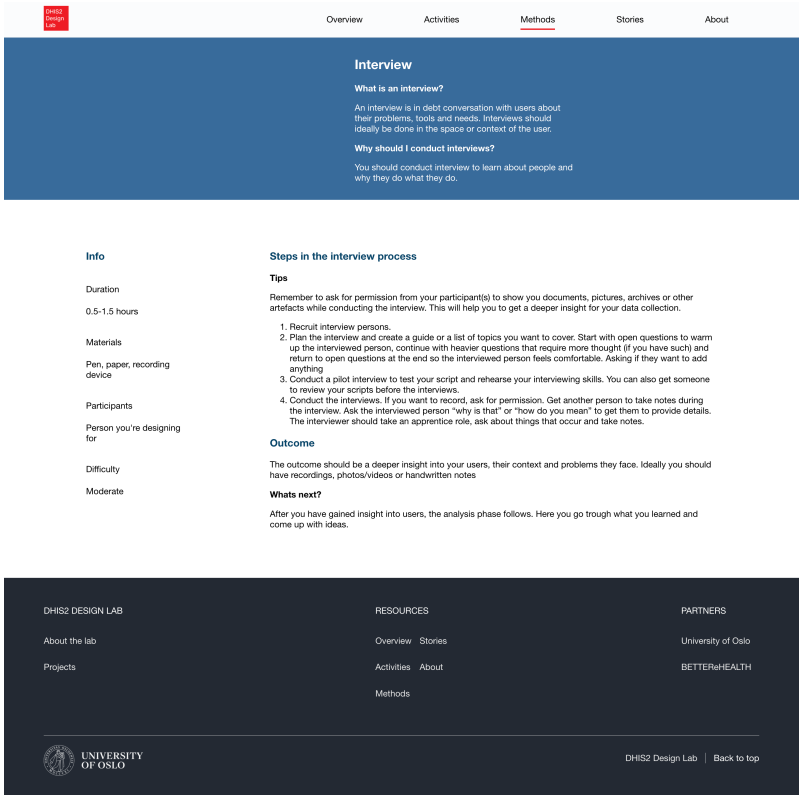

Figure 5.18: Example of a method with stats

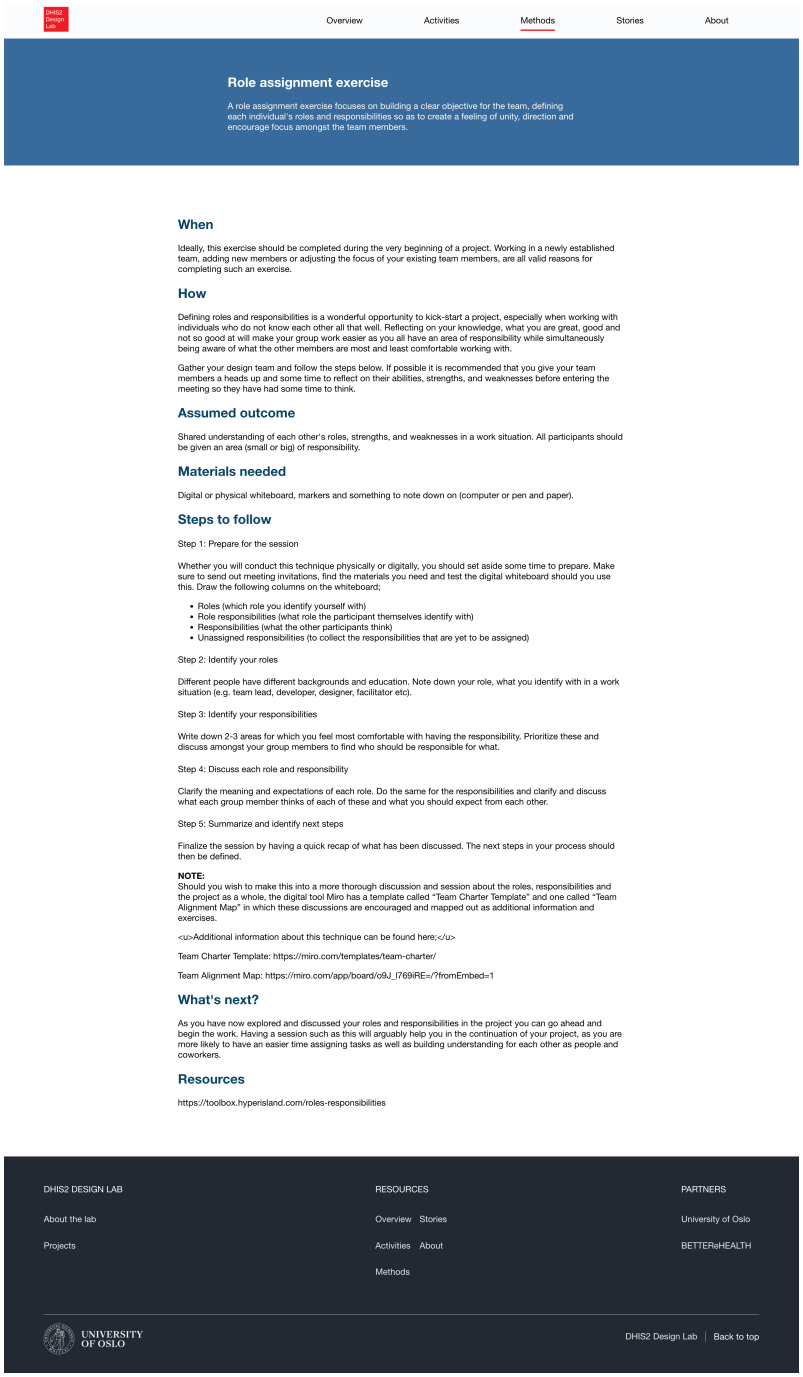

Figure 5.19: Example of a method

Story

Stories are meant to showcase projects which have happened within the DHIS2 ecosystem. The meaning behind them is to share knowledge between HISP groups on how they have conducted projects, what kinds of activities and methods have been used and how their experiences with using them, as well as what the project outcome was. In a story, you can find storytelling of this kind of project. The partner's contact information also shared the story so that the end-user may contact them for more information. There is a relationship with both activities and methods to showcase this. As mentioned before, there is, unfortunately, no content generated to showcase this relationship. An example of a story can be seen in Figure 5.20.

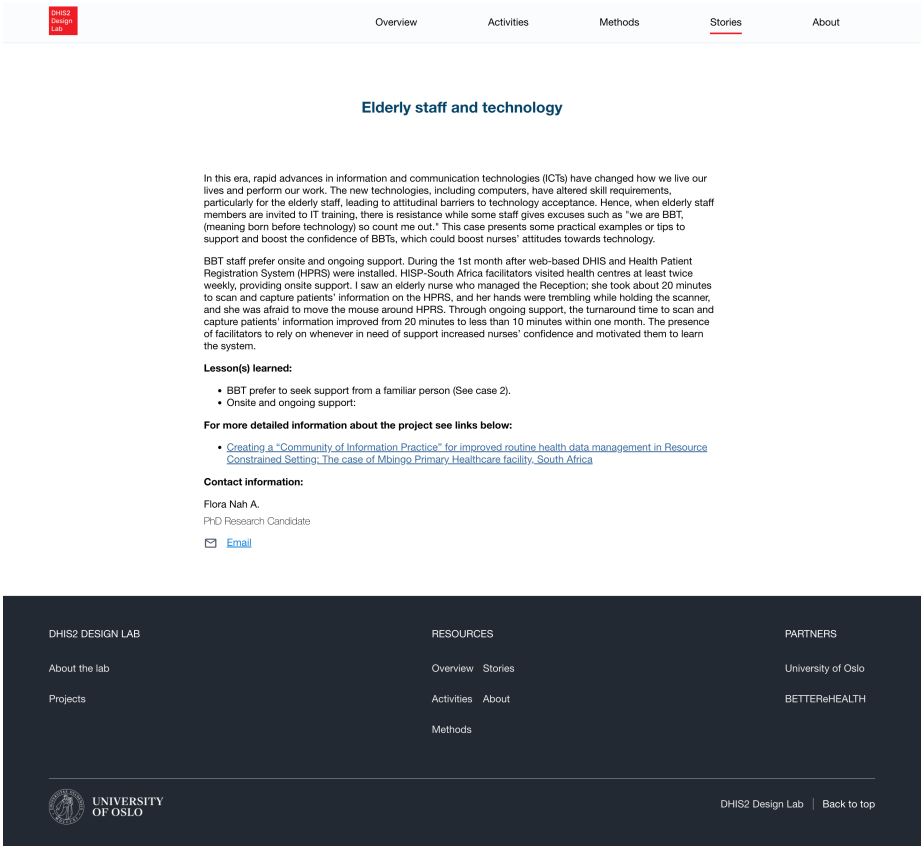

Figure 5.20: Example of a story

5.8 Ethical considerations

When doing interpretive research, there are ethical considerations the researcher must have in mind and do something about. The participants share their personal opinions and views on themes, and they may face unwanted exposure if identified. Therefore, an informed consent describing the nature of the project, what the data will be used for, and the participants' rights were given to the participants before the data collection session started. The informed consent can be viewed in Appendix A. The participant was required to read and agree to the informed consent contents before the data collection started. This was done for the participant to ensure that they wanted to participate, be collected data from and be informed that they could withdraw at any time and contact me to get their data erased. The project was also reported to the Norwegian Center for Research Data (NSD) (NSD, 2022) for the processing of the participant's data.

The collected data was stored in UiOs G Suite (UiO, 2022c). This goes for raw data collected during the problem identification and motivation phase as well as the summative and formative evaluation phases of the project. Additionally, personal information of the participants, which was the names and email addresses of said participants, were also collected. Shared access to data was given between the data collected by the other team members and me together, which was primarily during the diagnostic phase and prototype evaluation sessions in the spring and early autumn of 2021. For the data regarding the summative evaluation sessions, I was primarily the only one who had access to data. There were two data collection sessions where data was shared: One was my co-supervisor was present during an evaluation workshop with multiple HISP partners. The other was with Leia and Trilla during an evaluation workshop with two members of the DHIS2 core team. To connect what the different participants said to the analysis, I used pseudonyms to protect their identities from being identified in the analysed material. This is, however, not an entirely bulletproof way of concealing the identity of the participant as "[...] a little detective work on the part of the reader may enable them to make a good guess as to who is being discussed" (Walsham, 2006, p. 327).

6 Findings

During the research process, I have identified four challenges a platform owner may endure when building a resource to support methods related to design and development for partners within ES ecosystems. These challenges are 1) Heterogeneous practices require different forms of support; 2) Partner's knowledge of software design methods varies; 3) Time and resource constraints affect partners' ability for process improvements; 4) Resource constraints and quality concerns affect partners' ability to contribute to the resource.

I will be going through the three first challenges, where the following is presented: Describing the challenge based on the empirical findings, going through how the DMT has attempted to address the challenge and finally, in the light of the evaluations, showcasing how the DMT addresses the challenges. The last challenge was identified during the summative evaluations of the DMT. Therefore it has not been addressed in the current version of the DMT's design. I will describe the challenge and go through how a platform owner can address this challenge with both pros and cons from the empirical findings. To end this chapter, I will be going through the design considerations for designing a resource like the DMT illuminated by the strengths and weaknesses of the DMT and showing how they can respond to the challenges.

6.1 Heterogeneous practices require different forms of support

The findings from the problem identification and motivation phase show that HISP groups work on similar projects, but the way they approach them can be fundamentally different. The most common projects related to the implementation of DHIS2 for national use in the health sectors of a country by configuration. However, other projects can relate to doing custom development on top of the local DHIS2 implementation using the different boundary resources offered by the DHIS2 ecosystem. The latter type of project is usually done in a context where DHIS2 has not been traditionally aimed at supporting, e.g. agricultural, so more insights and exploration is usually needed in these kinds of projects. In projects where the HISP partners were building applications on top of DHIS2, it was said that they needed to have a more extensive process. This is needed as there is more uncertainty about what requirements and needs need to be addressed. So they need to identify the requirements for the system, design possible solutions and test out these solutions in these projects. The process they refer to working in is a kind of agile inspired process or a blended process as they referred to it.

Although both of the HISP groups worked on implementation and custom application projects, the HISP groups have different practices for working on the various projects. For example, in projects related to the implementation of DHIS2, HISP, Tanzania stated that when they are doing projects, they

usually follow an Action Research (AR) described as ”There are processes where they go on to identifying the requirements, design them and then test these particular things” and ”Using methods in the beginning when you are trying to gather data and in the testing which depends on the phases and what you’re looking for” (Implementer from HISP Tanzania). In contrast, HISP Malawi stated that ”sometimes you just implement the form which is given you” (Implementer from HISP Malawi). On the one hand, you have a more inductive approach where the partner has to identify the requirements for the system themselves, and on the other hand, the partner may be given the form they are supposed to implement. These two approaches require different forms of support. Concerning identifying requirements, HISP Tanzania could, for instance, be supported with more methods and activities related to identifying needs through various ways, e.g. observation and interviews. While HISP Malawi could, for instance, have methods associated with identifying requirements through existing artefacts to help their process of implementing the forms.

Different stakeholders also need to be included in the process, affecting how the partners work. Some stakeholders the partners can work with are the ministries of health, local government, implementing partners, domain experts, district health managers, program managers, and data entry clerks. Many different stakeholders have their motivations, which indicates that projects are often influenced by various opinions. Some of these stakeholders will be the ones who give the requirements to projects, like the case from HISP Tanzania stated that the health workers who will be using the systems could provide you insight on requirements. HISP Malawi would often evaluate with the ones who gave them the form and consult themselves with domain experts when implementing DHIS2, which could, for instance, be the ministries of health. DHIS2 Academy also involved a range of different stakeholders when developing course material. The ones who may fund the projects would often be heavily involved in the process. External stakeholders would suggest incorporating certain key concepts into the course material without having a say in the course curriculum.

Having different projects, practices that vary from partner to partner, and an extensive array of diverse stakeholders, which may affect the process differently, surfaces a challenge when designing a resource for partners to support software design methods in their implementation projects. With these practices in mind, it would be challenging to support a standard design process, promoting the steps one by one to have a successful project. It may also entail that such a resource should support a large array of different methods and activities, to support different ways of working on these projects.

6.1.1 Addressment in the prototype

Since different practices require different forms of support, there needs to be a variety of different software design methods within the DMT for it to be relevant for partners. To address this challenge, I have provided a large

array of different methods and activities which partners may use in their processes. As the DMT can house many elements, a partner may be able to use the information about the methods and activities it contains to support the usage of different software design methods which they may use in their process. They may also use the methods and activities in the DMT to create and customise their process from the DMT's content. As stated earlier in this thesis, I decided that the DMT should not follow a standard process model due to the challenges of fitting partners' practices. This belief was strengthened by the feedback session and usability test conducted during the formative evaluation phase. A prototype of the DMT was presented with a standardised process model to two implementers from HISP Malawi. They disagreed that the process model was something you followed each time. The implementer did not necessarily follow some parts of the presented process.

Due to this, the DMT is designed so that you can look up methods after which activity they are part of. An activity can be of varying sizes. You could have an activity that has methods for performing certain activities. This may also include a further description of using the methods in certain situations. You could have an extensive activity that houses more sub-activities that could, for example, represent an entire process. They are designed so the partner may pick and mix activities and methods that can fit into their context and processes. Thus, the process of using the DMT to incorporate methods and activities in their process can be seen as a form of method tailoring. Method tailoring requires some form of fragment repository, which is a collection of method fragments (Campanelli & Parreiras, 2015). The DMT can be seen as a fragment repository which is available to the DHIS2 ecosystem. The activities and methods can be seen as method fragments the partners may choose to include in their processes. As activities can vary in size, the partners may only include certain sub-activities or methods based on their criteria. Some criteria the partners may set for choosing an activity or method in their process may be limited time or access to end-users. Further, the description of the method and activities can also be seen as practice patterns, which need to be adopted and adapted to the context in which they are to be used (Dittrich, 2016). Therefore, the partner needs to adapt the activity or method to their context and project to make it applicable to them.

6.1.2 Evaluation

In the summative evaluation phase, it was apparent that the resource did not support every phase that the participants from the HISP groups would deem as necessary. Some examples of these unsupported process phases were maintenance and user training. This implies that various methods and activities will be relevant to partners as their projects require different methods and activities to support them. There was also a lack of variety of other methods. An example came from the interview method, where there was a wish for more versions of the methods such as unstructured, semi-structured and structured interviews. There was also a wish for more contextual methods, meaning that the HISP partners wanted examples of how different methods and activities were carried out in a real-life project. One of the participants during the evaluation workshop with HISP Sri Lanka,

HISP India and HISP Mozambique stated that:

> *The elements in the toolkit should have a tighter relationship to each other. Methods and activities should showcase examples of use, and [stories] should show how they used certain methods and activities*.

This was thought to give the partners inspiration and an example of adapting the method to their context. Some of the students stated that they used the DMT as a look-up resource for quick information on methods and activities to support their project. This was mainly information on exploring their project to see what was possible. They wished they would have used the DMT more in their project, as it could help them gather more requirements from the textual description of the case they were given, which could have led to a better system.

As partners' processes vary greatly, it would be relevant to support different processes that can house different elements. However, there was a concern for beginners who were not familiar with the process to have something to latch onto. For instance, in the DMT, the methods or activities are not labelled to phases of a standard design process or another process, for that matter, and this could make it harder for beginners to see where the methods would fit. Some examples of the use of the methods in a particular part of a process or an example of a process that could be customised were thought to help beginners understand how the methods could be utilised.

It could also be relevant here for the partners to have a module to create their process from the elements of the toolkit, as the projects and practices vary a lot. This would also allow them to structure their process, which would help them identify where they are in the process quickly. To support many different partners, the DMT will need an extensive array of various activities and methods to support many projects illustrated prior in this subsection. Another possibility with allowing the end-user to customise their process in the DMT was thought to be able to present it to the user organisation as they could "sell themselves", as it is much competition in the field. Since these projects require different processes, a tension between flexibility and structured processes has been seen as some users would like to have the methods be more linked to certain process parts. In contrast, others want to have them more loosely structured, as the DMT is currently doing. A customisable example process could potentially help with this tension, as you, on the one hand, get to see a standardised process, and on the other, you can customise it to your needs.

6.2 Partner's knowledge of software design methods varies

The partners think that the inclusion of end-users in the process of a project is consequential. However, they do not always include end-users of the system in their implementation projects. Sometimes the HISP partners receive their requirements from the ministries of health, which requires the partner to implement the system from those requirements. Other times, including end-users in the process is time-consuming, and they do not always have the resources to include them. A member from HISP Tanzania stated that "Engaging [the end-users] means that we need to have workshops. Visiting them also requires resources and time". Thus it becomes more practical not to include them in the process sometimes, even though they are aware of the benefits user involvement brings.

The partners also name a handful of methods when gathering data for requirements or evaluating the system they have made. The methods which could be used in the process were: interviews, observations, user testing, acceptance testing and workshops. The findings also indicate that the partners usually test out the system when it is a working system, not prototypes. This may suggest that they do not have an extensive overview of what methods for design practices may exist. Also, the workshop method sometimes has inconsistent meaning, as it may be hard to know exactly how it is done. Sometimes the workshop is described as a user testing session, where they are also using observation to see if the users are doing the task right, and other times it is described as a user training session.

The partners were often facing challenges regarding time to include end-users in the process, as it could be a time-consuming endeavour to travel across the country and conduct workshops with them. They may not be aware of methods that could help them include end-users and still be time-efficient such as personas. Another misconception noted was that the partners were often trying to get hold of computer-savvy individuals or people with the proper knowledge when they wanted to test with end-users. These individuals could be seen as a sort of expert user, which some stated could give them requirements directly as they knew what they needed. In contrast to the computer-savvy end-user, the partners would sometimes have to teach the end-user how to work a computer before evaluating with them. While it can be time-efficient to get requirements from the expert users, it may result in a system that is more in line with the wishes of the expert user rather than the average user.

6.2.1 Addressment in the prototype

As shown in the problem identification and motivation phase, the partners only tell us a handful of software design methods they use in their process. Since the partner's knowledge of software design methods may vary, the DMT addresses this challenge by having various methods and activities. The partners may choose what methods and activities they want to learn about and utilise in their projects. If the partners see other software design

methods, they could utilise them in their projects. They may learn how they can conduct other types of software design methods that may be more suitable for their situation and particular context. There is a relationship to stories for these elements to showcase how activities and methods can be utilised in practice. The idea is that the stories could show how a different partner had conducted an activity or method in their project, thus giving a practical example for the one wanting to learn more about that method or activity. A partner may, for example, read about how another partner used personas or conducted a design sprint in their implementation project to support their implementation phase. This is currently only an idea, as it has not been able to test this in practice. There is no content for such stories yet. However, it is thought that this linkage may contextualise the methods and activities in the DMT as it can show how these elements were used in different projects and contexts.

6.2.2 Evaluation

Many of the participants, including HISP participants and IN5320 students, stated during the evaluations that they would like to see examples of how the methods and activities were carried out in practice. This was seen as vital as it could showcase how the methods and activities were utilised in a project and inspire other partners to use the same methods and activities in their context. The participants from evaluation workshop with HISP Sri Lanka, HISP India and HISP Mozambique also wished explicitly for a tighter relationship between the different elements of the DMT. This was also stated by the participant from HISP Malawi, who further said, ”Wants a link between the different elements of the toolkit to see that they are connected and not isolated modules”. By this, they meant that the Stories should show how the methods and activities were used, and the methods and examples should show examples of use (e.g. a link to the relevant story). This indicates that the relationship between the stories, methods, and activities in the DMT would be helpful for the partners if it were utilised and contained relevant content.

The arguments for showing an example process and what methods and activities are typically used are also related to the varying knowledge in design practices. This was due to not everyone knowing where the different methods and activities could be used. There were also wishes to read more about the specific process phases, indicating that information about a standard process was favourable. This could also help beginners learn about the process from start to finish if coupled with relevant examples. One of the IN5320 students stated, ”Wished I had a toolkit the first time I started learning about methods within interaction-design”.

Another student saw it as an excellent resource to learn about software design methods as he had little experience with them beforehand. The participant from DHIS2 Academy in the evaluation workshop also stated that he ”Liked that the methods were all in one place” and that ”The content is good for learning about the methods and activities as well as helping to un-

derstand the importance of them". This may indicate that the centralisation of information is valuable in the DMT as the end-user can find information within a single source.

An IN5320 student stated that "The toolkit could help to use other methods you've not tried or thought of". The participant from DHIS2 Academy also noted this and further elaborated that it could be even further enhanced with a decision-maker tool. During the discussion about the decision-maker tool, it was described as a wizard in which you could state what you needed, and it would "show a couple of methods which could help in a situation" (Participant from DHIS2 Academies during evaluation session). For example, you could say that you would want evaluation methods, but you do not have access to end-users, and you would get methods and activities related to this. By having such a decision-making tool, the participant from DHIS2 Academies stated that it "Could help "break the pattern" of choosing the same method by suggesting new methods". This could indicate that for such a resource to accommodate the varying knowledge levels of design practices, it should have a way to find suitable methods and activities for the end-user.

6.3 Time and resource constraints affect partners' ability for process improvements

Partners are often short on resources to conduct design practices, as seen earlier. This may also indicate that they may not have a lot of time and opportunities in their daily work to improve their implementation processes. When presenting an alternative prototype for DHIS2 academy, the participant stated that: ”Need to show that the toolkit is an ”add-on” which can support”. If this is not taken into consideration, the platform owner could ”[...] end up creating a tool which either helps or creates an extra layer of burden” (DHIS2 Academy). As the partners are already short on time, they could become resistant to changing their processes, both from a human point of view regarding how they work and from introducing such a resource in their processes. A resource to support the use of software design methods should not make the partner need to restructure their entire process but should be seen as an optional tool to help their process when conducting these practices. The partners seem to be on the lookout for helpful tools which can support their process, as stated by a participant from the interview with HISP Tanzania ”We are always in search of new resources and new opportunities in helping us to implement these kinds of projects”.

6.3.1 Addressment in the prototype

The relationship between the Stories, Activities, and Methods may inspire the partners to look at how they can incorporate more software design methods into their process. As partners are short on time, it may be necessary to show the benefits of conducting these methods in similar partner organisations and how they have incorporated them, as they may experience the same challenges. The resource is also designed as a look-up tool rather than a book. This means that a partner does not have to read everything in the DMT from A-Z. Instead, they are supposed to look up what they need for the situation they may be in. A search bar is added in which the partner can search for relevant content by searching for words or sentences.

6.3.2 Evaluation

For partners using the DMT, it needs to be showcased as a valuable tool that can support their projects. DMT was seen as more of an information page at first glance than a tool from the evaluations. An implementer from HISP Malawi said, ”The Design Method Toolkit as it now looks more like an information page than a tool”, and an IN5320 student said that the ”Overview page looked like an info page”. This was the case until most participants started exploring the DMT and saw the methods and activities. Some participants even stated that if they were in a real-life setting and did not have any prerequisite knowledge of the DMT, they would most likely have closed the page and gone on with their day. Therefore, the participants have wished to exemplify how the DMT could support their project and ”capture them”. Some examples have been stated as showing a story example of a process from A-Z, where you show how the resource could support the

process at the different phases. This is needed to make the end-user want to use the resource, the point that the resource can ”sell itself”.

Another part of making clear who and how the resource could support the partners is to build awareness around it. One of the informants from the DHIS2 Core Team stated that for the resource to be relevant, it has first to be known. This relates to building awareness around the resource through the owner of the platform's communication channels with the partners. In the case of DHIS2, the DMT could, for instance, be presented and promoted through HISP seminars and HISP webinars, where they often share new information in the ecosystem. There was also the possibility of making partners use the DMT during DHIS2 Academy courses, where they could get first-hand experience with the resource.

For a partner to see the resource as valuable and therefore want to spend time using it to improve their process, it needs to have the ability to find relevant information quickly. This is something almost all of the participants have mentioned in the evaluation. Even though the DMT had a search bar for filtering out information based on titles and descriptions of the methods and activities, it would still pose a challenge if you did not beforehand know the name of the method or activity. This was all you could filter out. Most of the cards for the methods, activities and stories have much information, and it would be cumbersome to read through them all to find relevant information. The ability to filter out information on specific attributes such as the process phase from a traditional design process or the activities and methods is sorted logically were some suggestions for filtering out information. As of now, the DMT presented the activities and methods in a seemingly random order, as they are now being presented from oldest added element to newest. This was a concern from the workshop with HISP Sri Lanka, HISP India and HISP Mozambique. As one of the participants stated, ”Beginners could potentially start in the ”wrong” end”. If the activities were ordered in a random series, it could set up a fake sequence the partner should follow. This was especially problematic for beginners who were not knowledgeable about the partner organisation's process. An example could be that the partner goes directly from collecting data to prototyping. This comes from the need to find relevant information for the right situation, and this has implications for how useful the resource appears for the partner and, ultimately if they will use the resource or not.

6.4 Resource constraints and quality concerns affect partners' ability to contribute to the resource

This last challenge was identified during the summative evaluations. Therefore, the data for the challenge is only from the summative evaluations, as it was not thought of during the defining objectives of a solution phase or came up during the problem identification and motivation phase. Therefore it is not addressed in the design of the DMT. All the participants from DHIS2 Core Team,DHIS2 Academy and the HISP groups were in agreement that the HISP groups could provide content for such a resource. However, there was diversity in how this would be done. The participant from HISP Sri Lanka from the evaluation workshop with HISP Sri Lanka, HISP India and HISP Mozambique said that the HISP groups would be glad to share what they know and their stories and experiences, but if you ask them to write it down it will probably not be done as they do not have the time for that as the "HISP groups tend to be busy, but will gladly share their stories" (Participant from HISP Sri Lanka).

On the other hand, the participant from HISP Malawi stated that she would love to contribute to the resource, not only with stories of projects but also with activities and methods. She also said that to kickstart this collection, you could have someone use the DMT in their project and then ask them to make a story. Another possibility was to hire students for part-time jobs to collect and write these stories if the partners did not have the time to write themselves.

The participant from HISP Sri Lanka stated that "The content should be a "multi-stake cooperation" between practitioners of DHIS2, information system champions and the DHIS2 Core Team". By this, the participant expressed that more actors outside of the initial DHIS2 ecosystem should contribute to the resource to get a broader appeal. However, even though the partners could contribute to the resource, it would "Need to have a moderation process for content created by third parties", said the participant from HISP Malawi. This was to meet a certain level of quality in the content that came into the toolkit and protects the resource's reputation and the contributing partner organisation. There are several ways this could be done. For instance, you could give access to the partner organisations and have a review process before the content could be published to see that the content is within the guidelines of the resource. However, as seen earlier in this Section, partners have already limited time to focus on process improvements for themselves. So a question which may arise is how can a platform owner encourage partners to contribute with content for the DMT if they have to go through a moderation process of some sort? Additionally, members from the DHIS2 core team stated that "someone has to "own" the toolkit", implying that someone has to govern content that comes into the toolkit and the future direction of the DMT.

6.5 Design Considerations

As mentioned in Section 5.6, I have created six design considerations by analysing how well the DMT have addressed the identified challenges. The design considerations are meant to guide platform owners in creating a resource to support the use of software design methods in ES ecosystems for partners conducting implementation projects. Through the process of creating and evaluating the DMT, I provide these considerations for platform owners as factors they need to consider based on empirical data. The titles of the considerations are: 1) Accommodate diversity; 2) Encourage and maintain partners' contributions; 3) Indication of usefulness; 4) Navigability; 5) Relatability for partners; 6) Support planning. I will go through considerations and come up with possible solutions based on the findings.

6.5.1 Accommodate diversity

During the summative evaluations, most of the participants from the HISP groups felt that the DMT was not supporting most of the process. This was because some of the activities they did in their process were missing, or some activities which were presented in the DMT were not relevant to them. The platform owner needs to consider the needs of the partners to handle the diversity in their practices for the resource to provide support for them. In the current version of the DMT, it would not be a problem to add methods and activities related to these activities. For example, the platform owner could create an activity for maintenance that would house all potential sub-activities or methods related to it. This could potentially be done for all of those phases which was deemed missing.

However, not all the activities and methods within an activity may be relevant for all the partners in that phase due to their existing practices. So the resource also needs to clarify that the methods and activities within the activities are suggestions that they can either follow or partially follow as partners' practices vary. Therefore I propose that *the platform owner must consider how to deal with diversity in terms of existing practices among the partners* to handle the challenge of heterogeneous practices requiring different forms of support. This could, for instance, be done by structuring the resource as a fragment repository with a diverse set of method fragments the partner could use in their processes.

6.5.2 Encourage and maintain partners' contributions

There was a clear wish that the partners within the ecosystem could contribute with content to the DMT. This would spark the possibility of gathering much content from different partners, which could be a driver for accommodating diversity within the resource. However, there would need to be a moderation process, as stated prior. A moderation process ensures that a certain level of quality is met to protect the resource's reputation and the contributing partner. These processes could be achieved in multiple ways, and I will provide the following example: A partner could be given a template of what an activity, method, or story should contain and

fill it out. After that, it would review the platform owner to see that it met specific criteria. If it meets the requirements, it will be published. If it is not meeting the requirements, it will be sent back to the partner with feedback guiding them to meet the requirements. However, the platform owner needs to find a way to encourage the partners to contribute content to the resource if they need to go through a moderation process. Partners are already busy, so there should be some incentives or rewards for contributing content. This could, for instance, be closer collaboration with the platform owner in various projects or getting acknowledgements for their contributions which could be used as a form of advertisement. Therefore I propose that *the platform owner must consider how to encourage partners to contribute with content for such a resource and how to handle these contributions*. This can help them address the challenge of encouraging partners to contribute to the resource and how to handle these contributions.

6.5.3 Indication of usefulness

Many participants thought the DMT was more like an information page than a tool. This undermined the value of the DMT at first, as they thought it could provide limited support for them. The reason for this was that the overview page did not present any practical examples of the DMT's intended purpose, when it could provide support, and how it could support in these time frames. If you have an overview of your resource, you could, for instance, have a simplified example process to showcase how the resource could support the different phases of a typical process. This was felt as needed for the participant to be "captured" by the DMT, as a feeling of something they wanted to use as it could help them. The example case also needs to capture the ones for whom the resource is intended to make it seem relevant to them. In other words, it needs to indicate that the resource is helpful for the partner and that it is a worthwhile effort to use it to conduct their projects. The resource will need to show how it could support the partner's current process as well as the ability to improve their process. I propose that *the platform owner must consider how the resource is supposed to clarify who, when and how the resource is to be utilised by the partner*.

6.5.4 Navigability

The need to find relevant information quickly was evident during the evaluations. This was seen as a weakness in the current version of the DMT as this was not satisfied with only a search bar for searching on clear text. Other attributes which would be nice to search up methods and activities were seen as traditional process phases. The need for a logical structure of the elements was also evident, as it could lead the end-user to think it was structured and follow it. Some ways the DMT could address this issue were discussed with the participants: addition of filtering on labels, sorting the cards of the elements on traditional process phases or labels, labelling the cards of the elements and having a wizard to suggest possible methods and activities based on your needs. Quickly finding relevant information may also make beginners figure out how and when to use specific methods and activities for the right situation. Some participants even stated that

if they could not find relevant information quickly, they would most likely not continue to use the DMT and go on about their project. The need to find relevant information swiftly will also continue to grow as the content of such a resource continues to increase.

With the knowledge of finding relevant information being an essential factor for such resources, I propose that *the platform owner must consider how to let the partner find relevant information for their situation*. This consideration could help handle the varying knowledge levels of design practices by quickly finding the correct information at the right time. It could also help with the challenge of time constraints for the partner's to focus on process improvements. If it takes less time to find relevant information on the particular process phase you may want to improve, there may be a higher likely hood that the partner will actually use the resource.

6.5.5 Relatability to partners

Exemplifying how different methods and activities were conducted in practice was thought to be a helpful way of contextualising the methods and activities. This was missing in the DMT as no content in the stories described an actual project and how they used the different methods and activities in their project. However, the link between the activities and methods with the stories was a good way of inspiring the partners. This was thought to help the partners to see how they could adapt the methods and activities to their context based on the story they were reading. Suppose a partner reads about how another partner was conducting, e.g. interviews in their context, which has similar challenges. It may be easier to adapt the method as the story is relatable for the partner. This would be an arena for partners to share their stories and experiences with the activities and methods usually done in the field. It may also be possible for them to share their experiences of newly tried methods and activities and spark inspiration for another partner to conduct the same method in their project. Therefore I propose that *the platform owner must consider including practical knowledge on how different partners have conducted various software design methods*.

6.5.6 Support planning

When the practices of partner's vary, it is hard to be tied to a standard process. A solution for this is to provide a set of activities and methods for the partner to choose what is relevant to include in their process. The current version of DMT houses many methods and activities that could let the end-user mix and match methods to their own needs. This allows the end-user to create a process or support their ongoing process with the elements of the DMT. This could, for instance, be done on a piece of paper or an external digital tool. The IN5320 students who used the DMT during their project mostly used it as a look-up resource. However, some of the students did not know about the DMT and said that they would have liked to design a ”lightweight” process to have more structure to their project.

There were also suggestions regarding creating your process within the

DMT itself with the different elements. In this scenario, you could, for instance, create your activity with other sub-activities and methods which would result in your process. The participant from DHIS2 Academy also proposed that this process making module could have a grading system to see if you have covered the typical essential phases. This could allow the resource to teach beginners about standard processes and what they should include. Another suggestion was to have an example process filled out with different activities and methods, but the process is customisable. This would allow for a process template that a beginner could follow. The same template could serve as a starting point for an experienced partner to customise his or her process. This would also allow the partner to ”sell” themselves to a user organisation with such a tool. As the aspect of supporting the planning of processes was seen as necessary, I propose that *the platform owner must consider how to support partners in customising their process with the elements of the resource*.

6.6 Summarizing of findings

Table 6.1 summarises the considerations a platform owner may think about when designing a resource to support the use of software design methods.

Consideration	Specification	Example of implementation
Accommodate diversity	The platform owner must consider how to deal with diversity in terms of existing practices among the partners.	Offer a wide range of methods and activities for the partners to include in their processes.
Encourage and maintain partners' contributions	The platform owner must consider how to encourage partners to contribute with content for such a resource and how to handle these contributions.	Have guidelines for partners' contributions, and review the content before publication. Give incentives to contributing partners.
Indication of usefulness	The platform owner must consider how the resource is supposed to clarify who, when and how the resource is to be utilised by the partner.	Specify who, when and how partners could utilise the resource by providing example cases of implementation projects the partners may find themselves in and show how the resource could help them.
Navigability	The platform owner must consider how to let the partners find relevant information for their situation.	Include ways to filter out information in the resource on attributes such as typical phase the method is used. Sort information in a logical sequence. Have a wizard module to suggest methods based on needs.
Relatability to partners	The platform owner must consider including practical knowledge on how different partners have conducted various software design methods.	Have real-life cases of use of methods in the resource readily available. Show the benefits, challenges and adaptation of these methods.
Support planning	The platform owner must consider how to support partners in customising their process with the elements of the resource.	Have a customisable process template that the partners could customise using the methods which are present in the resource.

Table 6.1: Considerations for platform owners building a resource supporting the use of software design methods for partners within an ES Ecosystem

7 Discussion

This section will discuss my findings in light of the related literature. In this thesis, I have two kinds of contributions: research and practice. First, I contribute by extending the body of knowledge on knowledge boundary resources and their implications on governance in the following sections. Second, I contribute with six design considerations for platform owners creating a knowledge boundary resource for supporting the use of software design methods within ES ecosystems as well as such a resource for the DHIS2 ecosystem. The following section is structured as follows: First, I discuss the DMT as a knowledge boundary resource. Second, I discuss the DMT's effect on governance. Third, I discuss the generification of contributions of partners to the DMT. Fourth, I discuss the practical contributions of this thesis. Finally, I discuss the limitations of my contributions.

7.1 DMT as a knowledge boundary resource

Prior research on boundary resources has mainly focused on the technical abilities to leverage the capabilities of the platform (Ghazawneh & Henfridsson, 2013; Tiwana, 2013). The research on knowledge boundary resources has mainly focused on supporting technical boundary resources in direct documentation, courses, help desks, and online forums. An examples such a knowledge boundary resource in the DHIS2 ecosystem is the documentation of DHIS2 which covers everything from the usage of DHIS2 to developing applications using the DHIS2 core API (DHIS2, 2021). This research project has been concerned with creating a resource to support the use of software design methods for partners, which have resulted in the DMT. The resource itself is different from the traditionally researched knowledge boundary resource as it does not provide direct support to the platform's technical capabilities. Instead, DMT provides knowledge on how the partners in an ES ecosystem can use different software design methods which can be utilised in their projects. The use of software design methods contributes to the social aspect of implementation projects. With the social aspect of implementation projects, I refer to activities which are not directly related to the technical implementation of the system. It is concerned with how the development of these projects is carried out regarding requirement gathering, prototyping, and evaluating with end-users. This is a relatively unexplored area in the literature on knowledge boundary resources. This is because knowledge boundary resources have mainly been seen as enablers for the technical boundary resources of the platform.

The DMT is a resource which does not require the partner to interact with the platform owner, as it is an open website on the internet. In line with the description of a broadcasting knowledge boundary resource from Foerderer et al. (2019), the DMT can be categorised as this kind of knowledge boundary resource. However, traditional broadcasting resources are usually bound to some technical boundary resource or build capacity to use them. Therefore, their utility can often be evident as they directly support other platform resources. In the case of supporting the use of methods, it is not often as

clear for partners who, when and how a resource such as DMT should be utilised. This is the case if it is not explicitly stated in the resource, indicated by the results from the summative evaluation. Thus, the consideration of indication of usefulness addresses the challenge of unclear utilisation of knowledge boundary resources, which are not created to support a technical boundary resource. Therefore, such resources need to exemplify their utility with cases and examples to convince partners that such resources would provide utility in their projects.

The consideration of accommodating diversity between partners relates to how different partners have different practices that must be considered when a partner creates a resource for supporting software design methods for their platform. Earlier research on knowledge boundary resources has not considered the diversity in practices. This comes from the history of knowledge boundary resources being focused on enabling the technical boundary resources. When researching the social side of implementation and creating resources for them, the different practices are highlighted. By offering an extensive array of different ways of conducting practices (activities and methods), we can support this diversity within the ecosystem, thus creating a fragment repository which can be utilised for method tailoring endeavours (Campanelli & Parreiras, 2015) by the partner organisation. This also allows partners to be able to customise their processes. From the summative evaluations of the DMT, it was seen that a standardised process would have been beneficial to have as an example, but that it could be customised would help to tailor the process to their needs. This takes into account the consideration of support planning.

The consideration of accommodating diversity and support planning for partners can, in one way, be comparable to the process of implementing an ES into a user organisation. When implementing an ES into an organisation, there are usually misfits between the purposed processes of the ES and the local practices of the user organisation (Light, 2005). In order to handle this, the vendor can support implementation-level design to customise the ES (Li, 2019a). Having a standardised process in the DMT would likely result in misfits between the local practices of the partners and the purposed process of DMT. An example of this would be if the DMT were structured around a traditional iterative design process, covering phases such as insight, analysis, prototyping and evaluation. As the different HISP group's practices are different, it would be most likely more applicable to a few partners who were more familiar with software design methods rather than those who were not. We saw with the purposed standardised model presented to the HISP group in the formative evaluation that customisation of standardised processes may have been a good middle-ground. The customisation of such a standardised process could support the implementation-level design. It would help with the tension of the local relevance for the partner and the standardised process of the resource. The partner organisation would also benefit by treating the methods and activities in the DMT as practice patterns, which means that the method should be adopted and adapted to the specific context to be effective (Dittrich, 2016).

The effort of creating the DMT could be seen as a self-resourcing effort. This is due to the DHIS2 Design Lab can be considered a third-party of the DHIS2 ecosystem. The DHIS2 ecosystem does not offer an official resource for supporting the use of software design methods as of yet. Therefore the effort of creating DMT can be seen as self-resourcing, as there are no boundary resources to support this within the platform ecosystem (Ghazawneh & Henfridsson, 2013). This brings implications for the platform owner, as they are not directly controlling what kind of content goes into the toolkit.

7.2 Governance implications for DMT

The DMT can be seen as a way of a soft governing mechanism for the platform ecosystem and can be used to give partners a shared vision and goals (Benlian et al., 2015). Through the summative evaluations, it was believed by some of the participants that partners would implicitly start to think more about using software design methods when using such a tool. Thus, such tools may shape the partners to think and utilise software design methods more in their process. It was also suggested the DMT must be seen as an optional tool for partners and not be enforced upon them, meaning a way of soft governing mechanism. This was due to the enforcement of the DMT could imply that the implementers do not know what they are doing in terms of conducting software design methods in the implementation process. This enforcement could be seen as a form a hard form of governing mechanism, as the implementor would not have a choice to use it. Therefore, the DMT should be presented as an optional tool which could help implementers with the use of software design methods. Through the process of using the DMT, the partner could be shaped to have more focus on using software design methods through their process. While more research is needed on soft governing mechanisms (Halckenhaeusser et al., 2020), a challenge which may come from soft governing mechanisms is that they are optional. Due to this, there is no guarantee for the platform owner to make the partner use these resources. This has implications for platform owners as they need to find ways to encourage partners to use these resources and change their behaviour, which may be done through incentives and rewards (Halckenhaeusser et al., 2020).

From the empirical data of the study, there have been positive indications of the partner's willingness to contribute with content for the DMT. However, it was clear that the content from partners could not be directly published to the resource without the overseeing of the owner of the DMT. This is in line with the tension between openness and control in a platform ecosystem (Ghazawneh & Henfridsson, 2013), where too much control may hinder innovation, and too much openness may result in the platform owner losing control over their platform. However, the difference here is that openness and control are now within the boundary resource, in contrast to the existing literature, which focuses on the boundary resource's effect on openness and control on the platform ecosystem itself. The focus of openness will relate to the ability of partners to share their stories, activities and methods with the entire community. On the other hand, control will relate to the governance mechanisms which the partner may place for content to be ”accepted” into

the resource.

Some ways in which partners' content may be governed were discussed during the summative evaluations. One way was to have a review process, where the platform owner reviews the resource's content to see if it is up to the criteria or standards set for such content. Thereby, the platform owner can control the partner's content and give feedback on how the partner may get on par with the criteria of the resource. This is comparable to Apple's App Store review process described by Ghazawneh and Henfridsson (2013). To help partners in the process of creating content to be up to standards with the resource, the platform owner can create guidelines for partners to follow. Therefore, encouraging and maintaining partners' contributions is given, as this is something the platform owner needs to think about for knowledge boundary resources of this kind. One question to ask oneself is the motivation for partners to go through a review process and create content for such a resource? Should the partners be compensated for their efforts, what compensation would be applicable? Therefore, partners need to be encouraged to contribute to the resource while at the same time having to go through these moderation processes. One way of doing this may be to give incentives, such as a tighter relationship between the platform owner and contributing partner in collaboration projects and publicity.

7.3 Generification of partners contributions

When considering how to handle a partner's contributions to such a resource, the platform owner also needs to consider how to make content from the contributing partners relatable to other partners with other backgrounds and experiences in the ecosystem. One could see the process of getting the content from partners into the DMT as a form of generification process. Generification has mainly been concerned with the process of making a specific technical application into a generic application applicable for all (Gizaw et al., 2017). In this case, generification involves taking specific textual information from partners and making it into something relevant for the entire ecosystem instead. Content, in this case, could be a method, activity or story. So when the partners are creating content for the DMT, they may need to go through some form of the review process, as discussed in the previous section. They may get feedback from the platform owner within this process, who may shape the content to apply to the resource. Guidelines to create content for the DMT would also be a supporting part of the process, as they may help reduce the number of times the partner has to get feedback from the platform owner. This shaping process of the content can be seen as a generification process. This has implications for considering relatability for partners, as the content needs to be relatable thought the entire ecosystem. In the case of DMT, this concerns relatability for the entire DHIS2 ecosystem, which is on a global scale.

To make sure the content is understood throughout the ecosystem, there needs to be some form of process that takes out the particularities of the content and generalises it somehow. The process of disembedding takes local

particulars from one context and makes it applicable to a generic one (Gizaw et al., 2017). Implementing governing mechanisms on partners' contributions may start a disembedding process as the platform owner gives feedback on what is relevant to the ecosystem and what is too specific. Another solution could be for the platform owner to do this disembedding process themselves if the contributing partner is not willing or cannot make the content relevant for the ecosystems themselves. This is seen in the literature on disembedding software where the DHIS2 core team had to rewrite a local module from scratch to make it applicable for the DHIS2 ecosystem, as the quality of the software created by the partner was poor (Gizaw et al., 2017). At the same time, as the platform owner needs to ensure the disembedding of content, they also need to ensure that the other partners in the ecosystem are able to embed the content of contributing partners to their local setting. If another partner can use a disembedded story to their advantage, they may also be able to create a story of a similar kind, which may add to the diversity of the resource.

7.4 Practical contributions

My practical contributions to this thesis are two-fold. The first contribution is the design considerations I have created to answer my research question, which was *What are design considerations for a platform owner creating a resource to support the use of software design methods for partners in an ES ecosystem?*. Through creating the DMT and evaluating it, I was able to form these design considerations that may help platform owners guide the design of similar resources for their respective platforms. The second contribution is related to the DMT as an example of a knowledge boundary resource to support the use of software design methods for partners within the DHIS2 ecosystem. DMT includes activities and methods which could help partners with conducting software design methods in their respective HISP groups. By presenting descriptions of how these methods and activities can be conducted in a general setting, they can get ideas on how they can use them in their setting. DMT may also give them new knowledge on software design methods they had not initially thought of. There are also new projects being made with further work on the DMT in the DHIS2 Design Lab. Since the DMT's source code is available through their respective GitHub repositories, other platform owners and third parties can inspect and take the source code for their benefit. This allows them to inspect the source code and potentially create their version of the resource with the source code as inspiration or a foundation.

7.5 Limitations

In this section, I will discuss the limitation of my research.

7.5.1 Limited time

I had limited time to conduct the master thesis, as with any research project. Many of the DSR phases are happening simultaneous during the research process. As discussed earlier in this thesis, I was part of two separate projects. Thus my time was slim, and I could not follow them closely as I wanted to. One of the projects was eventually dropped, but this led me to join in on the other project in the initial parts of the project. The final evaluation phase ended in January 2022, as I needed time to analyse the findings from the evaluations and form design considerations. I had initially planned to have an additional evaluation session but cancelled it due to time constraints. As I only got to evaluate with one member from DHIS2 academy, I may miss the information which could have made influenced the design considerations. However, I noticed that new information came up during each evaluation workshop, indicating that there was still information which further supported or altered my findings. However, since new information came so often, more evaluation workshops could have uncovered even more design considerations and grounded them further in the data.

7.5.2 Limited access to data

Establishing contact with participants was somewhat of a challenge. During the initial phases of the project, we attempted to get in touch with different HISP groups to learn about how they differ from each other. However, we only managed to get in touch with two different HISP Groups. Even though we sent out requests for other HISP groups to join, we did not get an answer from these groups. Therefore, there may be more similarities or differences between partners found in the findings of this study. However, if this was an AR study, I may not have been able to identify the difference in the partners at all if I had only heard and seen what one HISP group was doing. In that case, the DMT may have only been based on one HISP group and possibly not applied to other partners in the DHIS2 ecosystem. This could have been avoided by collaborating with more HISP groups. However, this would also require time and building a good relationship with the HISP groups. I also encountered difficulties trying to reach potential participants for the evaluations. I was initially going to have another evaluation session with another HISP Group and a member from the core team. However, I did not manage to contact them, even though I sent reminders about the evaluation workshop.

Due to the COVID-19 pandemic, I was not able to travel to the location of the HISP groups and see how conducted implementation processes in practice. Therefore, all of my data collection and evaluations were conducted digitally except for one. This brings implications to the research. As the data from the problem identification and motivation has data from what was said by the implementers, we could not observe their work in practice. Therefore,

we cannot be sure if practices have been lost in translation or if something else has happened.

7.5.3 Design considerations limitations

The design considerations were created by studying a ES Ecosystem, which has some unique characteristics. As DHIS2 is an ES Ecosystem and has a global user base with mainly user organisations and partners in low-and-middle-income countries. The design considerations I formed during this process are aimed at being relevant for platform owners, which are going to create resources to support the use of software design methods within ES ecosystems. Taking into account that the design considerations were based on empirical data from the context of DHIS2, they may be more applicable to platforms similar to DHIS2. This will relate to platforms with a global reach, which end up having a lot of different user organisations and partners with vastly different cultures, which may have had implications on the design considerations.

8 Conclusion

During this thesis, I have explored the use of software design methods within the DHIS2 ecosystem. The way I have been able to do this is through a Design Science Research study which was led by the development of a prototype. The prototype was developed by collaborating with three other students. Throughout the project, the practices of the HISP groups were investigated, and the Design Method Toolkit was created as a way of supporting the use of software design methods for partners of DHIS2.

I have two types of contributions in this thesis. The first is theoretical, which contributes to the body of knowledge on knowledge boundary resources with the intent to support the social aspect of innovation in a platform ecosystem. The second contribution is for practice. This contribution is two-fold: The first contribution is the answer to my research question, which was "*What are design considerations for platform owners creating a resource to support the use of software design methods for partners in an ES ecosystem?*", and is in the form of six design considerations. These considerations can be leveraged when designing a resource for supporting the use of software design methods for a ES ecosystem and are summarised in Table 6.1. The design considerations are to 1) consider to accommodate for diversity, 2) consider how to handle contributions from partners, 3) consider the indication of usefulness, 4) consider how to handle navigability, 5) consider the relatability to partners and 6) consider to support the planning of processes. The second contribution is the implemented version of the Design Method Toolkit. This contribution is for use for the DHIS2 ecosystem and its partners, as well as a resource to conduct further research for the DHIS2 Design Lab.

8.1 Future work on the DMT

Earlier in this thesis, I stated that the DMT has not yet been tested in an actual project. Therefore, future work should consider further development on the DMT and putting it into use in an applicable project within the DHIS2 ecosystem. Action Research projects should be considered as the researcher may be able to see changes in work practices after the intervention of the DMT. Incentives for partners contributing with content for the DMT should be further investigated. Many of the HISP groups were interested in collaborating on the content of the prototype, but this takes time from partners, and some form of compensation should be considered. Investigating this with the core team of DHIS2 may be a good entry point. There should also be more work on the refinement of the design considerations. As there was limited time to do more evaluations and new information still came up, future work on the design considerations and the DMT should evaluate further. More HISP groups should be contacted to get a broader view of the diversity in the DHIS2 ecosystem in regards to using software design methods.

Future work on the DMT should also try to accommodate partners' abilities to create their process within the resource. The findings suggest that

a tighter relationship between the different elements would be helpful for partners. One way of incorporating a closer relationship was for the partners to create a custom process from the elements within the prototype as its module. Additionally, future work on the DMT should explore how partners' contributions should be handled and how their contributions should be compensated. This could be explored by making partners create content themselves and exploring different types of governing mechanisms to be used in such a process. Communicating with the partners to see what incentives are needed to encourage partners should also be explored.

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Appendices

A Informed consent

Would you like to join the research project about

"Exploring and promoting methods and approaches to participatory and/or user-oriented design and innovation for DHIS2 implementation"?

This is a request for you to participate in a research project where the purpose is to explore and promote approaches to user-oriented design and innovation for DHIS2 implementation. In this letter, we give you information about the goals of the project and what participation will mean for you.

Purpose
The purpose of this project is to potentially develop material (e.g., guidelines, method toolkits) that can help strengthen awareness, motivation, and competence in user-oriented design and innovation for the DHIS2 community. As DHIS2 is designed as a generic system to work across multiple contexts, it has to be shaped and 'customized' to fit the needs of users when implemented in specific organizations. This is done with the help of DHIS2 experts in various countries, making up a community of implementers and developers around the software.

To better utilize this potential, awareness, motivation, and competence in advocating for and using appropriate approaches and methods to user-oriented design and innovation are needed. For instance, to support developers and implementers in understanding the current practices and needs of users, analyzing their problems and needs, and ideating, prototyping, and evaluating solutions with users.

To address these issues, the research project will also include the implementation of a "method toolkit". The method toolkit can become a resource for the DHIS2 community to being motivated and build capacity to conduct user-oriented methods and analyze their findings and use said findings to localize the applications to the context of the users.

Who is responsible for this research project?
The University of Oslo is responsible for this research project, more precisely, the DHIS2 Design Lab at the Faculty of Informatics within the Information Systems (IS) research group.

Why are you asked to participate?
You are asked to participate because your knowledge about user-oriented design, which is relevant for this research project is more or less relevant.

What does it mean for you to participate?
If you choose to participate in the project, it means that you will provide some information about you in an interview. There will be information on the research project. I will take notes from the interview.

It is voluntary to participate
It is voluntary to participate in the project. If you choose to participate, you can withdraw your consent at any time without giving any reason. All your personal information will then be deleted. 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 described in this article. We treat the information confidentially and in accordance with the privacy regulations. The interviewee will be the only one that treats the data collected.

What happens to your information when we end the research project?
The information is anonymized when the project ends / the assignment is approved, which according to the plan is 16th May 2022.

Your rights
As long as you can be identified in the data material, you have the right to:
- access to which personal information is registered about you, and to receive a copy of the information,
- to have personal information about you corrected,
to have personal information about you deleted, and
- to send a complaint to the Data Inspectorate about the processing of your personal data.

What entitles us to process personal information about you?
We process information about you based on your consent.

Where can I find out more?
If you have questions about the study, or want to exercise your rights, please contact:
• Master student: Steffen Ekeberg Bråten – steffeeb@ifi.uio.no
• Main supervisor: Petter Nielsen - pnielsen@ifi.uio.no
• Co-supervisor: Magnus Li – magl@ifi.uio.no

Supervisor Student

Declaration of consent

I have received and understood information about the project "Exploring and promoting methods and approaches to participatory and/or user-oriented design and innovation for DHIS2 implementation" and have had the opportunity to ask questions. I agree to:

- ☐ to participate in interview
- ☐ that Steffen can provide information about me to the project - if applicable
- ☐ that information about me is published so that I can be recognized the given information - if applicable
- ☐ that my personal information is stored after the end of the project, to take part of this research project - if applicable

I agree that my information will be processed until the project is completed

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(Signed by project participant, date)

B Interview guide for interview with HISP groups

Interview guide

Introduction

- Can you tell me about your work? What do you do?
    - Position / profession For how long?
    - Institution / company
    - What are your daily activities?
- What was your master's project about?
- What parts of DHIS2 did your work on in the master's thesis?
    - What were the main findings during the projects?
- What parts of DHIS2 are you working on now?
- What DHIS2 implementations have you been working on?
    - What kinds of projects are you working with?
    - What is your role in these projects?

Projects and activities

- Who initiates the projects and decides the project scope?
    - Why do they initiate the projects? What knowledge is it based on?
    - Who takes part in negotiating the scope of the project?
    - Can the scope be renegotiated later in the project? If so, how does it happen?
- How is your work related to each other?
- Who do you need to collaborate with?
- What activities do you do related to the projects?

Requirements:

- Who do you collect requirements from?
- What kind of requirements do you collect?
    - Can you give any examples?
- How are the requirements documented?
- What is the purpose of involving users?
- What is the process of requirement gathering like?
    - Who is in charge of the process?
    - How is it done?

Evaluation

- Do you evaluate the projects
    - (if yes) Who do you evaluate the potential solutions and suggestions with related to the course of DHIS2 academies?
    - What kind of evaluation techniques are useful?
- Who do you evaluate the projects with?
- What is the purpose of the evaluations?

    - How do you proceed with potential outcomes?
- What kind of evaluation techniques do you find impractical?
- In what phases do you evaluate with different stakeholder groups?
- How is the evaluation documented?

Involved groups of people

- Which groups of people are involved in the implementation project...
- How are these groups of people involved?
- Do you think it is important to involve those groups of people and why / why not?
    - What is your motivation to involve them?
- To what extent do you want to involve the different groups?
    - In which stages do you want them to be involved in?
- How much do you try to involve the different groups throughout the process?
- What are the challenges to involving them?

Methods

- What are your experiences with different methods? (ex; Interview, workshop, observation, etc)
- In what phases do you make use of such methods?
    - DHIS2 Academies?
    - Tracker Module?
- Which of these did you find useful? Why?
- Which of them did you find impractical? Why?
- What methods would in your opinion be better for making suitable solutions?
    - Tools and techniques?
    - Possibilities?
    - Which group of people would you like to involve (to a further extent)?

Development

- How is your development process structured? For example, do you use an agile process or a waterfall process.
    - How do you go from requirements to deciding what to build?
- Which stages are involved in your developing process?
- Are there any experiences you would like to share regarding your development process?
    - Challenges
    - Limitations
    - Positive outcomes
- Do you have any thoughts on current processes?
    - What could be improved?
    - Do you feel like there is room for changes?
- What is needed for the development to be usable and relevant?

    - Are there any other groups of people that should be involved in this process?
- Are you dependent on other people's work?
- What is your best advice that you would give other DHIS implementers to increase user involvement?
    - What should the implementers not do?

Maintenance

- How do you start the process of making a DHIS2 academies course?
- How is the process structured?
- How is the emphasis on maintenance of the projects?
    - When?
    - Who takes the initiative of maintenance?
- Are there any projects that you would like to start?
- Is there a consistency between the multiple courses of the DHIS2 academies?
    - (if no) Do you have an example of a course which you find especially well developed?
- What do you like the best about the DHIS2 academies courses?
- What could be improved in relation to the DHIS2 academies courses?

Concluding

- We plan to make a method tool kit with resources for DHIS2 implementers to better involve users. What resources do you think this website/course should have?
- How was it to reflect upon these questions?
- Do you have any thoughts on how this interview could be done differently?
- Were there any questions that were challenging to answer?
- Are there any topics we did not talk about today you think are important to investigate?
- Is there anything you would like to know more about when it comes to user approaches in the developing process?
- Are there any other staff members we should contact regarding user-involvement?
- Are there anything else you want to share or add?

C Interview guide for interview with DHIS2 core team

Interview guide

Introduction

- What parts of DHIS2 are you currently working on? What do you do?
    - Position / profession For how long?
    - Institution / company
    - What are your daily activities?
- What other DHIS2 implementations have you been working on?
    - What kinds of projects are these?
    - What is your role in these projects?

Projects and activities

- Who initiates your projects and decides the project scope?
    - Why do they initiate the projects? What knowledge is it based on?
    - Who takes part in negotiating the scope of the project?
    - Can the scope be renegotiated later in the project? If so, how does it happen?
- How is your work related to each other?
- Who do you need to collaborate with? sa alt utenom users
- What activities do you do related to the WHO packages? (Rebecca & Vittoria)
- What activities do you rdo related to the Academy training modules? (Rebecca)
- What activities do you do related to the Tracker module? (Karoline)

Requirements: Related to WHO packages

- Does WHO packages relate to the modules of DHIS2?
    - (If yes) Can you tell us how this relates?
    - (If no) Can you give us a short introduction to the concerns of the WHO packages?
- Who do you collect requirements from? (Data?, individual level vs. completeness? → Metadata)
- What kind of requirements do you collect?
    - Can you give any examples?
- How are the requirements documented?
- What is the process of requirement gathering like?
    - Who is in charge of the process?
    - How is it done?

Requirements: Related to DHIS2 academies

- Which parts of the DHIS2 academies are you working on?
- Who is the primary user of the academies?
- Who is in charge of setting the requirements for each course?
- Do you collect requirements from the users in configuring the courses?
    - (If yes) Can you give any examples?

    - How are the requirements documented?
- What is the process of requirement gathering like?
    - Who is in charge of the process?
    - What is the main purpose of involving users?

Requirements: Related to Tracker Module

- Who do you collect requirements from?
- What kind of requirements do you collect?
    - Can you give any examples?
- How are the requirements documented?
- What is the purpose of involving users?
- What is the process of requirement gathering like?
    - Who is in charge of the process?
    - How is it done?

Evaluation

- Do you evaluate the projects?
    - (if yes) Who do you evaluate the potential solutions and suggestions with?
    - What kind of evaluation techniques do you find useful in doing so?
- What is the purpose of the evaluations?
    - How do you proceed with potential outcomes?
- In what phases do you evaluate with different stakeholder groups?
- How is the evaluation documented?

Involved groups of people

- Which groups of people are involved in the projects?
    - WHO packages?
    - The Academy training modules?
    - Tracker Module?
- How are these groups of people involved?
- What is your motivation to involve them?
- In which stages of the process do you want them to be involved in?
- What are the challenges to involving them?

Methods

- What are your experiences with different methods? (ex; Interview, workshop, observation, etc)
- In what phases do you make use of such methods?
- Which of these did you find useful? Why?
- Which of them did you find impractical? Why?
- What methods would in your opinion be optimal for making suitable solutions?
    - // Tools and techniques?
    - // Possibilities?

    - // Which group of people would you like to involve (to a further extent)?

The process

- How is your work process structured? (iterative, agile?)
- In what stages do you make use of the requirements? How?
- Are there any experiences you would like to share regarding your work process?
    - // Challenges
    - // Limitations
    - // Positive outcomes
- Do you have any thoughts on current processes?
    - What could be improved?
    - Do you feel like there is room for changes?
- What do you consider is needed for the work to be usable and relevant?
- Are you dependent on other people's work?
- What is your best advice that you would give other DHIS implementers to increase user involvement?

Maintenance

- Is there an emphasis on maintenance of your projects?
    - (if yes) How are they maintained?
    - Who takes the initiative of maintenance?
- Do you feel the processes of potential change and maintenance are flexible? (not agile)
- Is there a consistency between the multiple modules of DHIS2 that you are working on?
    - Do you have an example of a course which you find especially well developed?
- What could be improved in relation to the maintenance phase? How?

Concluding

- We plan to make a method tool kit with resources for DHIS implementers to better involve users. What resources do you think this website/course should have?
- How was it to reflect upon these questions?
- Do you have any thoughts on how this interview could be done differently?
- Were there any questions that were challenging to answer?
- Are there any topics we did not talk about today you think are important to investigate?
- Is there anything you would like to know more about when it comes to user approaches in the developing process?
- Are there any other staff members we should contact regarding user-involvement?
- What do you think our research project might contribute to?
- Are there anything else you want to share or add?

D Interview guide for interview with DHIS2 Academy

Interview guide

Introduction

- Can you tell me about your work? What do you do?
    - Position / profession For how long?
    - Institution / company
    - What are your daily activities?
- What parts of DHIS2 are you working on now?
- What DHIS2 implementations have you been working on?
    - What kinds of projects are you working with?
        - DHIS2 academies?
        - Tracker Module?
    - What is your role in these projects?

Projects and activities

- Who initiates the projects and decides the project scope?
    - Why do they initiate the projects? What knowledge is it based on?
    - Who takes part in negotiating the scope of the project?
    - Can the scope be renegotiated later in the project? If so, how does it happen?
- How is your work related to each other?
- Who do you need to collaborate with?
- What activities do you do related to the DHIS2 Academies?

Requirements: Related to DHIS2 academies

- Who is the primary user of the academies?
- Who is in charge of setting the requirements for each course?
- Do you collect requirements from the users in configuring the courses?
    - (If yes) Can you give any examples?
    - How are the requirements documented?
- What is the process of requirement gathering like?
    - Who is in charge of the process?
    - What is the main purpose of involving users?

Evaluation

- Do you evaluate the courses of DHIS" academies?
    - (if yes) Who do you evaluate the potential solutions and suggestions with related to the course of DHIS2 academies? ⇒ Who do they get feedback from?
    - What kind of evaluation techniques are useful?
- What is the purpose of the evaluations?
    - How do you proceed with potential outcomes?
- What kind of evaluation techniques do you find impractical?

- In what phases do you evaluate with different stakeholder groups?
- How is the evaluation documented?

Involved groups of people

- Which groups of people are involved in the implementation project...
    - of DHIS2 Academies?
    - of the Tracker Module?
- How are these groups of people involved?
- Why not externally?
- Do you think it is important to involve those groups of people and why / why not?
    - What is your motivation to involve them?
- To what extent do you want to involve the different groups?
    - In which stages do you want them to be involved in?
- How much do you try to involve the different groups throughout the process?
- What are the challenges to involving them?

Methods

- What are your experiences with different methods? (ex; Interview, workshop, observation, etc)
- In what phases do you make use of such methods?
    - DHIS2 Academies?
- Which of these did you find useful? Why?
- Which of them did you find impractical? Why?
- What methods would in your opinion be good for making suitable solutions?
    - Tools and techniques?
    - Possibilities?
    - Which group of people would you like to involve (to a further extent)?

Process (DHIS2 academies)

- How do you start the process of making a DHIS2 academies course?
- How is the process structured?
- Is there an emphasis on maintenance of the course?
    - When?
    - Who takes the initiative of maintenance?
- Are there any courses that you feel like are missing?
- Is there a consistency between the multiple courses of the DHIS2 academies?
    - (if no) Do you have an example of a course which you find especially well developed?
- What do you think the DHIS2 academies provide the best insight to?
- What do you like the best about the DHIS2 academies courses?
- What could be improved in relation to the DHIS2 academies courses?
    - How?

Concluding

- We plan to make a method tool kit with resources for DHIS implementers to better involve users. What resources do you think this website/course should have?
- How was it to reflect upon these questions?
- Do you have any thoughts on how this interview could be done differently?
- Were there any questions that were challenging to answer?
- Are there any topics we did not talk about today you think are important to investigate?
- Is there anything you would like to know more about when it comes to user approaches in the developing process?
- Are there any other staff members we should contact regarding user-involvement?
- What do you think our research project might contribute to?
    - What do you hope we can find out through our project?
- Are there anything else you want to share or add?
- What do you think are the biggest differences in working as a designer and a developer?

E Agenda for workshop with DHIS2 Academy

Agenda

Workshop 19.04.21

Introduction	Hi and welcome to the workshop and thank you for taking the time to join us!
Recording	First of all I wonder if you saw my email, where we asked if we can record this session? The recording will not be shared with anyone, but it is to be used by us to analyse the session. So, if that is okay with you we will start the recording now.
DHIS2 Design Lab	This workshop is arranged by us master students in the DHIS2 Design Lab where we are exploring how we can facilitate and promote more user oriented methods and innovation during DHIS2 implementation.
Presentation	Let's start with a small presentation round.
Master students	We are three master students from the lab today, I can start… [redacted] and Steffen next *(present themselves)*.
Participant	And [redacted] *(Start interview guide)* Introduction ● Can you tell me about your work? What do you do? ○ Position / profession For how long? ○ Institution / company ○ What are your daily activities? ● What parts of DHIS2 are you working on now? ● What DHIS2 implementations have you been working on? ○ What kinds of projects are you working with? ○ What is your role in these projects?
Miro	Have you used Miro before? Any questions about the tool?
Demonstrate (share screen)	Show our Miro board and the sticky notes. (*Steffen shares screen,* [redacted] *demonstrates from her pointer)*
Agenda	Here you can see the agenda for today. We have also given you your own color for the sticky notes, so please give it a try.
Methods	The topic of this workshop is to explore approaches to user involvement during DHIS2 implementation using a design method toolkit, but first we would like to know how you have worked with this topic from an DHIS2 Academic point of view.

	Methods For example, interviews, document review etc. ● When doing implementation projects, how are you guys involving end-users? ○ Which methods are used when involving end-users? ● Which methods did you find impractical? ● Are there any methods you find more useful than others? (Why?)
2-3 min	For this workshop, we would really like you to brainstorm so lets start with the first bubble which is “Methods”. *(Methods interview guide)*
Benefits	Now over to the next bubble We want to motivate this workshop by looking at which benefits we can get from involving end-users in implementation projects. Write down every reason you can think of for why we should involve users more. ● You can also add your inputs on the benefits of involving other stakeholders, but the main focus of this workshop is for example, health workers. ● You can also talk about projects you have been involved in where you have seen the benefits of involving end-users. *(Benefits interview guide)* Benefits (of user-involvement) For example, better fit between technology and health work ● Which benefits can come from involving end-users in implementation projects?
Challenges	So then we know more about why we want to involve users, so let's move on to the challenges. *(Follow [redacted]´s pointer)* What are the challenges of involving users? We will now do a new brainstorming for 2-3 min. *(Challenges interview guide)* Challenges (of user-involvement) For example, resistance to the use of certain technologies ● Have you encountered any challenges when involving users in your projects, if so what kinds of challenges? What challenges does involving end-users add?

Opportunities	Lastly we want to look at what opportunities we have for involving users more during DHIS2 implementation. Again we can brainstorm ideas for 5 minutes. *(Opportunities interview guide)* Opportunities (of user-involvement) For example, more training in user oriented methods ● How would you like to involve the different stakeholders in future projects? ● What is your motivation to involve these users? ● To what extent would you like to involve these users?
Design Method Toolkit	Steffen presents the method toolkit, its aim/goals etc. ● Start design method toolkit interview guide and follow bubbles *(Follow Steffen's pointer)* Design Method Toolkit ● How can a design method toolkit help support including end-users in the implementation process? ○ Do module: ○ Learn module: ■ We're not sure what should be included in this module. Benefits (method toolkit) ● What are some benefits a method toolkit might possibly give? Challenges (method toolkit) ● Are there any challenges related to introducing a method toolkit? Opportunities/ ideas/ solutions (method toolkit) ● What opportunities could a method toolkit give? *(Share screen and show the toolkit - still work in progress)* ● We want to evaluate it together with you and receive feedback.
Summary	[redacted] *follow interview guide of Summary* ● How was it to reflect upon these questions? Were there any questions that were challenging to answer? ● Do you have any thoughts on how this workshop could be done differently?

F Slides from evaluation workshop slides

DHIS2
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Lab

Evaluation of the Design Method Toolkit

Hosted by Steffen E. Bråten

DHIS2 Design Lab

Agenda

- Who am I?
- The Design Method Toolkit
  - Introduction
  - An example of use
- Practical assignment
- Discussion assignments
- Feedback

DHIS2 Design Lab

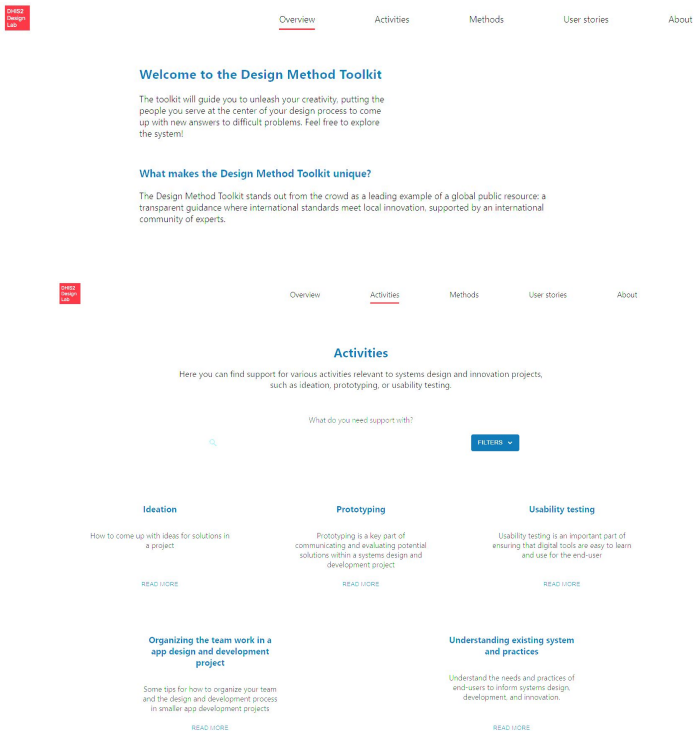
Who Am I?

- Steffen Ekeberg Bråten
- Master student at the DHIS2 Design Lab writing for the information systems (IS) group at Institute for Informatics (ifi)
- Looking at how boundary resources can help partners of an enterprise software ecosystem to utilize methods better in their development processes.
- Developing an artefact to explore what design principles is needed to realize this

The Design Method Toolkit

The Design Method Toolkit

- An artefact developed in order to explore how partners can utilize methods
- Implementers and developers
- Some initial uses could be:
    - A “Look up” resource when conducting a technique (e.g how to conduct an interview)
    - Using elements in order to create a customized process
    - Look at stories from other projects



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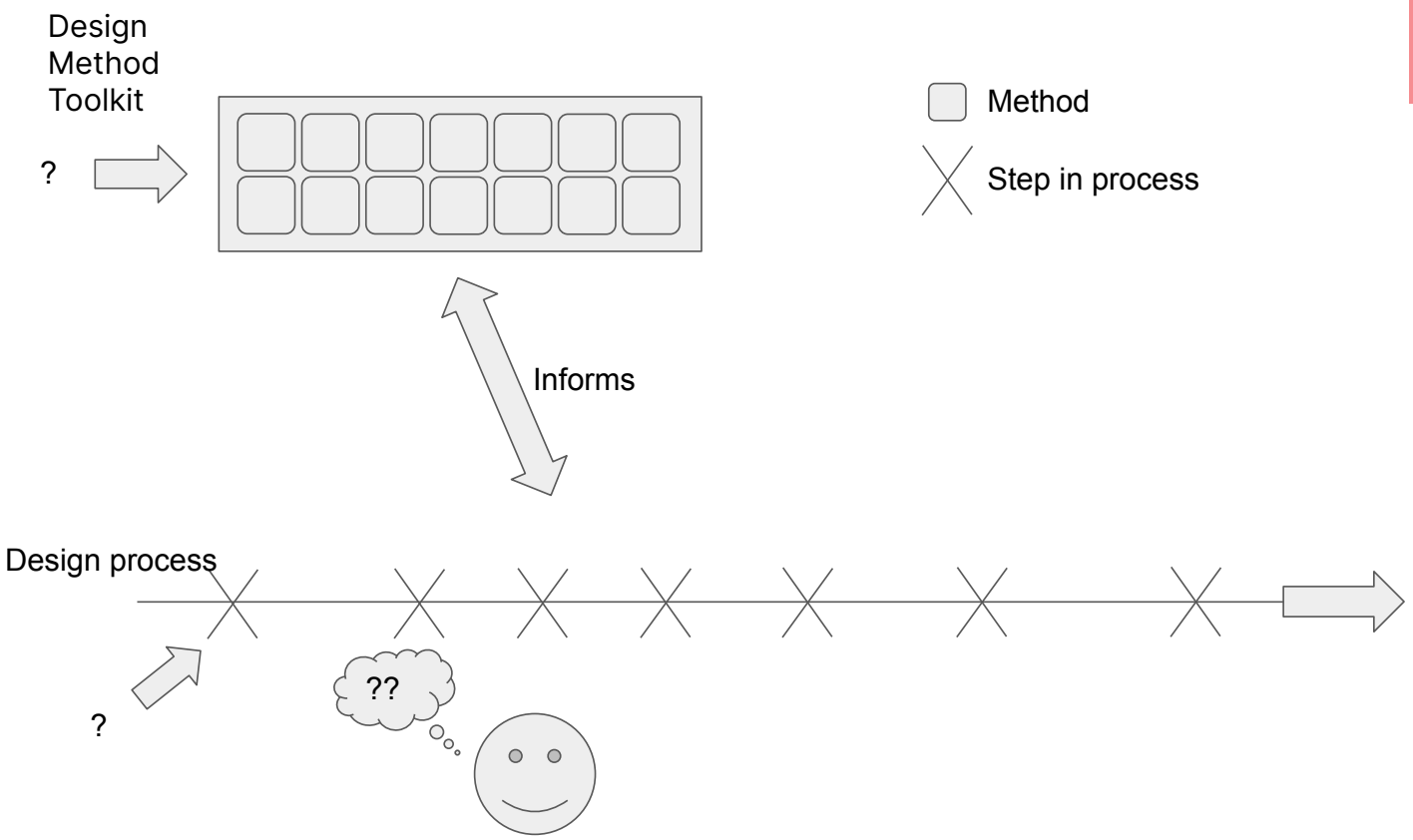

Practical assignment

DHIS2 Design Lab

Practical assignment

- Imagine you're an hired as an consultant by a Ministry of Health to find issues with their DHIS2 implementation based on their needs and requirements. After that you're to develop an application on top of the implementation in order to respond to the identified issues.
- In order to do this have to do some activities:
  - For figuring out what's possible
  - Gathering needs and requirements
  - Evaluating the artefact
  - Facilitating the configuration project
- Use the elements from the Design Method Toolkit to develop a process in order to tackle this assignment
  - Use 10-15 minutes

Link to the Design Method Toolkit: https://methodtoolkit.herokuapp.com/

Discussion assignments

DHIS2 Design Lab

Discussion assignments

- How could the toolkit support implementers and developers in HISP groups in DHIS2 projects?
  - What should the toolkit contain to be valuable?
  - How should it present and structure its content?
- How could the toolkit promote more focus on innovation and user-oriented design?
- Who should provide content and contribute to the toolkit?
  - Should HISP groups contribute?
    - With what?
    - How could this be realized?

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Feedback on the workshop

- How was the workshop?
- What could we have done differently or do better next time?

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Thanks for participating!

Any questions?

If you have any questions afterwards, you can reach me at:
steffeeb@ifi.uio.no

G Questions from evaluation workshop with HISP

DHIS2 Design Lab

Discussion assignments

- How could the toolkit support implementers and developers in HISP groups in DHIS2 projects?
  - What should the toolkit contain to be valuable?
  - How should it present and structure its content?
- How could the toolkit promote more focus on innovation and user-oriented design?
- Who should provide content and contribute to the toolkit?
  - Should HISP groups contribute?
    - With what?
    - How could this be realized?

H Questions from evaluation workshop with Core Team

DHIS2 Design Lab

Discussion assignments

- How could the toolkit support implementers in HISP groups in DHIS2 projects?
  - What should the toolkit contain to be valuable?
  - How should it present and structure its content?
- How could the toolkit promote more focus on innovation and user-oriented design?
- Who should provide content and contribute to the toolkit?
- How could the toolkit complement the already existing resources found within DHIS2?
  - What is needed in order for it to be a valuable resource?

I Questions from evaluation workshop with DHIS2 Academy

DHIS2 Design Lab

Discussion assignments

- How could the toolkit support implementers and developers in HISP groups in DHIS2 projects?
- How could the toolkit promote more focus on innovation and user-oriented design?
- What is needed for the Design Method Toolkit to be used in DHIS2 Academy?
  - Does something have to change?
  - What content should be included?
  - What functionality should it contain?
  - Is the structure of the toolkit understandable?

J Practical assignment and questions from evaluation workshop with IN5320 Students

DHIS2 Design Lab

Practical assignment

- You've all heard about this toolkit and some might have used it in your project
- Use some time to familiarise yourself with the toolkit
- Think of ways it could or could not be used in the project you had this autumn

Link to the Design Method Toolkit: https://methodtoolkit.herokuapp.com/

DHIS2 Design Lab

Discussion assignments

- Why did you (or did not) use the toolkit?
  - If you used the toolkit, what made it useful in your project?
- Imagine that this toolkit was to be redesigned. What would have been needed to support your project even better?
  - New functionality?
  - The content?
  - Structure of the content?
  - Structure of the toolkit?