ECSCW CONTRIBUTION

Cultivating Data Practices Across Boundaries: How Organizations Become Data-driven

Asbjørn Malte Pedersen*[1] & Claus Bossen*[1]

*[1]*Aarhus University, Helsingforsgade 14, 8200 Aarhus N, Denmark (E-mail: ampedersen@
cc.au.dk; E-mail: clausbossen@cc.au.dk)*

Abstract.   In this paper, we analyze the efforts of a public healthcare business intelligence unit to implement and disseminate their data products and thus make the healthcare organization more data-driven. The paper is based on ethnographic fieldwork in a healthcare business intelligence unit (the BIU) whose mission is to improve healthcare efficiency and quality by making data and data analyses available to healthcare managers and staff. Their primary products consist of a data warehouse and Data Reports, both providing curated and daily updated data for healthcare staff to analyze and visualize. We conceptualize these Data Reports and the data warehouse as boundary objects through which cooperation around data between various users is achieved. Our focus is on the BIU's efforts to introduce and promote the use of boundary objects to healthcare staff while providing them with the competencies to use them in practice. Efforts that we conceptualize as collaborative boundary work through which a new joint field of working with data is created between the BIU and healthcare staff. Based on the analysis of the ethnographic fieldwork, we point to three important aspects in creating this new joint field: Mobilizing interest, building local capabilities, and propagating data locally. The paper makes three contributions: It adds to our understanding of how new joint fields can be cultivated through collaborative boundary work to make healthcare data-driven; it contributes to the emergent field of data work studies; and finally, it adds to the largely normative literature on business intelligence and self-service business intelligence through an ethnographic analysis of its efforts to make healthcare data-driven.

Keywords: Boundary objects, Business intelligence, Self-service business intelligence, Collaborative boundary work, Ethnography, Data-driven, Data work, Healthcare

1 Introduction

Digitization of healthcare has been ongoing for decades and the process has intensified in scope and depth, especially in the last decade (Marent and Henwood 2021; Ruckenstein and Schüll 2017). The availability of massive amounts of data in the wake of digitization has spurred interest in making healthcare organizations data-driven (Madsen 2014; Hogle 2016). With these efforts, Business Intelligence (BI) has emerged as an approach that aims to

exploit the vast amount of data produced in healthcare to improve the efficiency and quality of services (Annapurani et al. 2021). BI encompasses technologies such as data warehouses, dashboards, and self-service reporting tools, and research in the field has heralded that BI can support clinical decision-making (Basile et al. 2023), optimize performance (Ratia et al. 2019), and cut costs.

Yet, despite the importance of BI in efforts to make healthcare data-driven, the work practices at BI units have received little attention beyond conceptual frameworks and maturity models. In fact, there is a dearth of ethnographic studies of BI (Talaoui and Kohtamäki 2020) which leaves us with an impoverished understanding of the related practices. While studies on BI tend to emphasize the potentials and benefits, other researchers stress the importance and lack of research highlighting the various – but often hidden - skillful data work necessary to make healthcare data-driven and the people conducting it (Bossen et al. 2019a, 2019b, 2019c, McVey et al. 2021). This emerging field of data work has described the endeavors of physicians (Bjørnstad and Ellingsen 2019), nurses (Grisot et al. 2019), medical secretaries (Knudsen and Bertelsen 2022, 2021), and other healthcare staff in producing, integrating, analyzing, and re-using data.

In line with this work, we conducted an ethnographic study of the collaborative work at a BI unit that is part of a regional healthcare system. The non-profit BI unit's (BIU) mission is to repurpose data to make the healthcare organization more efficient and improve the quality of healthcare services. Besides maintaining the regional data warehouse, the BIU's main products are Data Reports that provide curated and daily updated data that can be further analyzed and visualized by healthcare staff. In this paper, we focus on the work of the BIU staff members and their efforts to disseminate these Data Reports and data use in general as well as teaching healthcare staff to understand, work with, and implement the Data Reports in their practices. To understand this (data) work and the BIU's role in making healthcare data-driven, we ask the following question:

How is data work cultivated and encouraged by a healthcare BI unit in order to make healthcare data-driven? How can this be conceptualized?

Based on the analysis of our ethnographic data, we identify three aspects of this work at the BI unit: Mobilizing interest, building local capabilities, and propagating data locally. Drawing on the notions of 'boundary objects' and 'collaborative boundary work' (Star and Griesemer 1989; Langley et al. 2019), we conceptualize these efforts as the cultivation of a new 'joint field' (Levina and Vaast 2005) around data work practices. Overall, we label these

efforts 'cultivating data practices across boundaries' which we suggest could point to factors furthering organizations to become data-driven.

The paper is structured as follows: Section 2 presents the background literature on data work, healthcare BI, and the sub-field of Self-Service BI; Section 3 presents the theoretical framework drawing on literature on boundary objects and boundary work; Section 4 presents the research context as well as methods of data generation and analysis; Section 5 presents the findings of the analysis; Section 6 discusses the findings in the context of the theoretical and the background literature; and, finally, Section 7 concludes on the study. The paper makes three contributions: It adds to our understanding of how new joint fields can be cultivated through collaborative boundary work; it contributes to the emerging field of data work studies; and, finally, it adds to our understanding of how organizations can become data-driven. Finally, it adds to the largely normative literature on BI and self-service BI.

2 Background: Data Work and BI in Healthcare

As 'data' has emerged as a central notion in our times, ambitions for healthcare to become data-driven (Grossglauser and Saner 2014) have arisen across different healthcare domains (Marent and Henwood 2021; Ruckenstein and Schüll 2017). Being data-driven means, according to Madsen (2014), transitioning from decision-making-by-instinct to decision-making-by-data. Discussing three different definitions of 'data-driven', Berntsson Svensson and Taghavianfar (2020) identify a common process: '... collect data, use analytics to derive insights, and make decisions based on the derived insights' (ibid, p. 4). While calls and efforts to become data-driven in the last decades are often set in the context of Big Data (e.g., Madsen 2014; Power 2015; Wamba et al. 2015), they, in essence, mean to base actions on insights from data, which may or may not involve machine learning and Big Data analyses. We use the term in this broad sense. In healthcare, calls to become data-driven have gained traction as organizations increasingly implemented IT systems and, often as a side-effect, gained access to large amounts of data, though not all strictly in volumes of Big Data.

However, where much attention has been put on the larger processes of Big Data and the purported benefits hereof (Hogle 2016), data also requires work by people. Data is not 'found' and 'collected', but must be generated, shaped, and presented – also known as data work (Bossen et al. 2019a, b, c). The emerging field of data work emphasizes how this work is often invisible and hidden (e.g., Foster et al. 2018; Rothschild et al. 2022), although the group of 'data scientists' has received some attention as a new, emerging 'data work profession' (e.g., Mao et al. 2019; Muller et al. 2019). Within the healthcare domain, studies on data work groups or occupations such as physicians, laboratorians, nurses, and medical secretaries conducting data work have started to emerge (Bossen et al. 2019a, b, c; Møller et al. 2017; Knudsen and Bertelsen 2022; McVey et al. 2021; Møller

et al. 2020). Moreover, studies have been made of new data work occupations within healthcare such as 'medical scribes' and 'clinical documentation specialists' (Bossen et al. 2019a, b, c; Bryan and Lammers 2020; Pine and Bossen 2020), demonstrating how new roles emerge due to digitization and datafication of healthcare. Other studies have analyzed the data work that patients conduct to understand, provide, or act upon data (e.g., Figueiredo and Chen 2021; Fiske et al., 2019; Torenholt et al. 2020). These studies make visible the work invested in generating, shaping, and putting data into use as well as the skills and competencies necessary to understand, interpret, contextualize, and make data meaningful. Whereas the above studies concern healthcare staff and patients who do data work as part of their job and efforts to treat illness and become healthier, there are few studies of people in healthcare for whom working with data is their main concern, what we could call 'the data professionals'. Exceptions are Choroszewicz's study of a knowledge team of experts and the 'emotional labor' involved in producing data including caring for, getting excited and frustrated about, and developing a sense of data (Choroszewicz 2022); Bonde et al. who highlighted trust as a key aspect of cooperation between technical personnel and clinicians collaborating to develop new data-supported indicators for quality (Bossen et al. 2019a, b, c); Thakkar et al. who described how machine learning (ML) developers remove noise from and contextualize data to make it "good" for ML models (Thakkar et al. 2022); and Sambasivan et al. who studied the model and data work of AI practitioners (Sambasivan et al. 2021).

Despite these studies, we still lack knowledge of the work conducted by data professionals. Hence, we contribute to this body of literature on data work through a detailed ethnography of a BI unit and their collaborative work with healthcare staff to make them understand and apply their data products.

2.1 Healthcare Business Intelligence

To become data-driven, it is necessary to generate, acquire, filter, validate, store, and visualize data as well as ensure that data is put into use. In this, BIUs play an important role. The field of BI gained traction during the 1990s within the business and IT communities as a reaction to information and data requirements in organizations. Even though there is no consensus on a definition, the term is often referred to as '… the techniques, technologies, systems, practices, methodologies, and applications that analyze critical business data to help an enterprise better understand its business and market and make timely business decisions.' (Chen et al. 2012, p. 1166). BI is deeply linked to data warehouses which are used to extract, structure, and uniform data from various organizational sources and then divide it into subject-oriented subsets called data marts (Negash 2004). The processes, methods, and technologies to transform data into information are often related to extract-transform-load processes (ETL) which extract data from data sources into the data warehouse, data mining, online analytical processing,

data visualization, dashboards, and reports (Chen et al. 2012; Negash and Gray 2004; Wixom and Watson 2010).

Within healthcare, BI has gained interest due to the widespread digitization and implementation of EHRs as well as other healthcare IT systems. Around the 2010s, BI was proposed as a solution to healthcare challenges with a promise to improve clinical care, diagnostics, hospital processes, and workflows as well as reduce costs (Madsen 2012; Mettler and Vimarlund 2009; Wixom and Watson 2010). Since then, several streams of research on healthcare BI have come to light. Some early work focused on BI frameworks to develop healthcare domain-specific BI maturity models (Brooks et al. 2015, 2013) which stressed the need to not only focus on technology but also on people and organization (e.g., knowledge management and staff skill levels), as well as domain-specific complexities such as cross-departmental information needs. Other research has focused on how BI can support patient-centeredness (Zheng et al. 2018), the development of dashboards for management and clinicians (Buttigieg et al. 2017; Ghazisaeidi et al. 2015; Helminski et al. 2022; Pestana et al. 2020), as well as factors contributing to BI implementation success and value creation in healthcare (Gaardboe et al. 2018; Gaardboe et al. 2017).

In general, studies on BI tend to approach the development and implementation of BI from a prescriptive research perspective rather than a descriptive one. In general, there is a lack of ethnographic and qualitative studies of BI according to Talaoui and Kohtamäki (2020). This leaves us with an impoverished understanding of BI in practice, how it impacts existing organizational structures (Ibid, p. 1382), and of BI's role in shaping interactions and interpretations of reality (Ibid, p. 1384-1385). Studies taking a descriptive perspective often emphasize the importance of socio-technical and collaborative aspects of the development, implementation, and use of BI. For example, Bygstad et al. (2019), while investigating the requirements of an analytic capability for a hospital as well as how to organize it, found that '… the analytics capability is much more than the technology; it is the network of analytics technology, an analytics team and the medical, administrative and clinical decision makers' (Bygstad et al. 2019, p. 4). In their ethnographic study, Choroszewicz and Alastalo described the laborious cooperation between hospital knowledge team members and an external IT company when developing a data management system to improve healthcare processes (Choroszewicz and Alastalo 2021). As mentioned, Choroszewicz (2022) also studied the mundane, but invisible 'emotional labor' conducted by experts managing data (Choroszewicz 2022).

However, whereas studies on data work and BI point to how users work with data and the socio-technical and cooperative aspects of BI, they do not analyze how data products are implemented and disseminated in practice, or how capabilities to become data-driven emerge within organizations. As we will demonstrate in our findings, this involves a new kind of collaborative boundary work around data.

2.2 Self-Service BI

Recently, a new and in the context of this paper relevant line of interest has emerged in the general field of BI research focusing on self-service business intelligence (SSBI). SSBI aims to simplify the processes of BI and enable users to access data and perform custom analytics themselves (Alpar and Schulz 2016). The notion of SSBI was first introduced by Imhoff and White (Imhoff and White 2011) in the wake of new user-centered technologies like Tableau (visualization software) but has later gained traction within academia. Some of the objectives of SSBI are to provide easier access to data for analysis and reporting; features for supported data analysis; and simple, customizable, and collaborative BI tools (Imhoff and White 2011, p. 5). In comparison, conventional BI is built upon a request-response relationship between the user and power-users (IT and data professionals who can set up BI), which creates a bottleneck due to a lack of time and resources. SSBI aims to make end-users more self-reliant and thus decrease the pressure on the BI department (Alpar and Schulz 2016; Lennerholt et al. 2022).

Several challenges have been identified in relation to SSBI. Thus, a range of studies has highlighted the different users' lack of BI-related skills as a key challenge to implementation. Several SSBI studies have identified that users would find it difficult to use SSBI tools, to access and use data, as well as to create, change, and interpret content due to a lack of skills and training, and further emphasize the advantage of 'champions' (experienced users) who can promote the benefits of SSBI and support other users (Lennerholt et al. 2022; Lennerholt et al. 2020; Lennerholt et al. 2018; Berndtsson et al. 2019). Other research found that users in some situations simply lack knowledge of how to navigate and use these tools while also being skeptical towards SSBI's importance to their workflows (Weiler et al. 2019). Moreover, the perception of SSBI benefits can influence the intention to use SSBI tools (Passlick et al. 2020). While most of these studies tend to emphasize the need for user education as a solution to these challenges, literature on how to approach the training of users is scarce. Yet, there is a dearth of studies on how SSBI is implemented, how its benefits are communicated, and how training of users is conducted in practice.

3 Theoretical Framing

In this paper, we draw on two theoretical strands. One is that of 'boundary objects' originally crafted by Susan Leigh Star (Star 2010, 1989; Star and Griesemer 1989). In their seminal study of The Museum of Vertebrate Zoology, Star and Griesemer analyze how the museum director Grinnell was able to create the museum and its collection of samples with detailed information through collaboration by a heterogeneous network of parties; The sponsor, the hosting university, nature lovers, amateur collectors, administrators, trappers, hunters, and

others. They extend the 'model of interessement' (Callon 1984; Latour 1987) that describes how actors' goals are redirected to serve a common goal and argue that such redirection is not always necessary and that cooperation without consensus is possible and can succeed through partial co-optation. In the case of the museum, they point to two major activities: 'Standardization of methods' and the development of 'boundary objects'. Standardization of methods concerns the establishment of simple and structured ways of documenting information, whereas boundary objects involve the creation of objects that can travel across different social worlds. They define boundary objects as:

> … objects which are both plastic enough to adapt to local needs and the constraints of the several parties employing them, yet robust enough to maintain a common identity across sites. They are weakly structured in common use, and become strongly structured in individual-site use. (Star and Griesemer 1989, p. 393).

Boundary objects inhabit the intersection of different social worlds and have different meanings to different actors but satisfy the informational requirements of each social world. In Star and Griesemer's case, standardized methods of data generation were implemented to secure the quality and integrity of data collected by actors from multiple social worlds (e.g., hunters, amateur collectors, and nature preservationists), and several boundary objects were created to enable cooperation between these social worlds. Since the original 1989 article, the notion of boundary objects has proven to be a fruitful and generative concept through which to analyze cooperation in multiple domains, including information science (for a review, see Huvila et al. 2017), education (for a review, see Akkerman and Bakker 2011), and healthcare (e.g., Berg and Bowker 1997; Islind et al. 2022; Østerlund 2008; Zhou et al. 2011). Several studies have since elaborated upon our understanding of the concept, analyzing, for example, how the creation of boundary objects in itself can be a process that creates boundaries (Lee 2007). Also, within the BI literature, the concept has proven productive, and several studies argue that BI methods, tools, and technologies can function as boundary objects, for example data warehouses (Massa and Testa 2005), visual stories to empower users to develop exploration skills (Marjanovic 2016), visualizations to support knowledge sharing on analytics (Marjanovic et al. 2022), and dashboards (Meesters et al. 2022; Rattray et al. 2020). Recently, the link between SSBI and boundary objects has been made as well in a study that analyses how a dashboard for lay users is a boundary object due to its ability to change visualizations, filter data, integrate various kinds of data, and hence is adjustable to the local user needs (Arnaboldi et al. 2021).

In this paper, we are particularly interested in how boundary objects are implemented and disseminated since it is one thing to create something one wants to be used across multiple social worlds, and another thing to achieve this cross-cutting

use. Star & Griesemer (1989) did go into some detail on this. The standardization of methods was simple and stringent and could be '… learned by amateurs who might have little understanding of taxonomic, ecological or evolutionary theory. … At the same time, they rendered the information collected amenable to analysis by professionals.' (Ibid, p. 406). Thus, the methods could be propagated across multiple social worlds and put into use without training. Enrolling actors into using the methods was done by various means: Whereas nature preservationists became allies through the mutual interest in preserving nature, trappers had to be coaxed into providing animal specimens, and amateur collectors had to trade other animals, provide information on hunting, or be paid to ensure their cooperation.

This brings us to the second strand of work that we draw upon. Enrolling actors into the use of a boundary object does not necessarily happen by itself. Even nature lovers have to be made aware of the information sheet, and not all boundary objects are self-explanatory. Actors from different social worlds must be enticed and learn to use a boundary object. Cooperation across boundaries may have to take place. This effort to achieve collaboration across boundaries can be conceptualized as an aspect of 'boundary work', originally proposed by Gieryn (1983) to describe the effort of scientists to demarcate science from non-science. Just as the notion of 'boundary object', the notion of 'boundary work' has proliferated within social and management sciences as a concept through which to analyze differences, conflicts, collaboration, and integration across boundaries in organizations. In their comprehensive review, Langley et al. (2019) define boundary work as "… purposeful individual and collective effort to influence the social, symbolic, material or temporal boundaries, demarcations and distinctions affecting groups, occupations and organizations" (Langley et al. 2019, p. 3). They further point to three different broad categories of boundary work: Competitive, collaborative, and configurational. In competitive boundary work, actors invoke boundaries to achieve an advantage over others. In collaborative boundary work, actors maintain but collaborate across boundaries which can be downplayed, negotiated, and embodied. Finally, in configurational boundary work, differences and hence boundaries between groups are changed, most often top-down, to redesign divisions of work and activities (ibid). Hospitals and their organizational units can be seen as different social worlds, constituted by different primary activities, sites, and technologies (Strauss, 1988) between which there are various boundaries due to different purposes (e.g., administration, IT support, treatment, and care), different practices (e.g., medical specializations such as surgery, dermatology, and hematology), and different vocabularies and knowledge areas (medical specializations, policies and regulations, data analysis). These demarcations or boundaries will be maintained and perpetuated as long as the different purposes, practices, and knowledge areas continue to exist, which they most likely will do due to the need for division of work in healthcare. Collaborative boundary work is of particular interest in this paper since we see the BIU's

efforts to disseminate Data Reports and data to further data practices at the hospital wards as an instance of this.

Even though the concepts of boundary objects and boundary work come from two different strands of theory, several authors have combined them in analyses of organizations and collaboration across boundaries (e.g., Bracci et al. 2020). Here, Levina and Vaast (2005) are of particular interest because they address the issue of how boundary objects are put into use. They provide an interesting comparative study of how boundary objects go from being 'designated boundary objects' (but not used) to becoming boundary objects-in-use. Crucial agents in that process are 'boundary spanners' who are (human) actors that cross different social worlds and can have the status of being 'nominated' and becoming 'boundary spanners-in-practice'. In their two case studies, Levina and Vaast argue that the processes from designated/nominated to in-use/in-practice involve the creation of a new joint field of interest by boundary spanners in between the social worlds. Their main focus is on how individuals become boundary spanners in practice, and they point at legitimacy in both fields and as negotiators, as well as the inclination to span boundaries as important personal characteristics of those actors who succeed in going from nominated to boundary spanners-in-practice. Our focus differs in that we are interested in the organizational processes through which the BIU furthers new data practices and cultivates a new joint field.

4 Research Setting and Methods

The analysis is based on an ethnographic study of a healthcare BIU and the employees' efforts to make healthcare organizations data-driven through the development, implementation, and dissemination of data products. The public, non-profit BIU is part of the regional healthcare system – one of five regions in Denmark, which has universal free healthcare. The BIU was established in 2015 to provide a central data hive for the region and as part of the regional digitalization strategy to become data-driven with the overall aims of improving performance and efficiency to the benefit of patients, citizens, and employees (Regional strategy document 2019). The BIU's mission statement is to support the region '... in delivering more welfare, better quality, higher impact, and greater sustainability for less money.' (Internal BI strategy document).

Since its beginning, the BIU has grown rapidly from 16 employees and 290 users to about 50 employees and 4,000 users. The BIU's staff members often hold the generic title of BI developer with a few exceptions like BI architect, BI specialist, BI project manager, and analyst. Their core task is to repurpose and deliver data to the region's five hospital units to support decision-making and data work tasks of healthcare staff (clinicians, nurses, medical secretaries, etc.), administrative workers, and management.

A central part of the BIU's work is to maintain a data warehouse and to construct and make Data Reports available to management and healthcare staff through a portal. They extract data from various regional data sources, such as the EHR, which includes data on patients, radiology, medicine, booking, etc., as well as data from financial and administrative IT systems. Data is loaded into a data warehouse, where BI staff transforms and structures the data in tables. The data is then further curated in data subject-oriented subsets of the data warehouse (e.g., 'Booking', 'Contacts', 'Diagnose Guarantee', etc.) – also called 'data marts' in technical terms. Based on these data subjects, the BIU staff develops standardized Data Reports - the main product of the BIU – and visualizations in Tableau in collaboration with management at various levels or local healthcare staff. Data Reports can provide the end-user with outputs such as numbers, overviews, lists, and different kinds of visualizations (e.g., bar charts, time series, heat maps, etc.) to do analysis. These can be accessed by all regional healthcare staff members through the 'BI Portal'.

Developing reports of high quality (e.g., valid data sets) and of relevance to the end-user requires not only technical skills but also close collaboration with end-users and domain knowledge. Hence, BIU staff cooperates ongoingly with healthcare staff (Pedersen and Bossen 2021). However, the work of the BIU goes beyond just delivering relevant quality reports. They also actively work to ensure that healthcare staff and administrative workers use the Data Reports, which is the focus of this paper.

4.1 Organizational Context

The BIU's activities are situated in a dynamic interplay of interests among national, regional, and local actors. At the national level, data is regarded as an essential governance tool for accountable and efficient management of public healthcare (Hoeyer 2023). This perspective is evident in the national goals for the healthcare system, where "better use of data" is a specific objective, and Danish regions and hospitals are assessed based on quality indicators, such as 'Acute somatic readmissions within 30 days' (Nationale mål for sundheds-væsenet 2021). These goals and indicators are expected to be integrated into hospitals, requiring awareness and efforts from local departments and staff to register data on goals and monitor levels of compliance. For the government, digitalization and data are considered inevitable solutions to address the challenges of a strained healthcare system, an aging population, and a shortage of healthcare professionals. National and regional strategies for digital healthcare emphasize the ambitions of data-driven workflows, utilizing digital tools for collaboration, coordination, and communication, and fostering digital competency development among healthcare staff (Ét sikkert og sammenhængende sundhedsnetværk for alle - Strategi for digital sundhed 2018-2022 2018; Trygt, nært og nemt - Regionernes strategi for fremtidens sundhedsvæsen 2018).

At the regional level, there is a strategic drive to digitally transform healthcare to achieve a financially sustainable system and enhance cohesion, productivity, efficiency, and quality across all aspects of the organizations. The region´s strategy emphasizes the role of digital tools and data in optimizing workflows, enabling the completion of more tasks with improved speed and quality for the same resources, and enhancing the experiences of patients, citizens, and employees. Key elements include data-driven decision-making, automation, and predictive capabilities, as well as the efficient utilization and sharing of data to ensure interoperable digital solutions and reduce redundant work. However, the regional strategy for digital transformation extends beyond 'electrifying paper' (Regional strategy document) and calls for a 'cultural shift'. This involves recognizing the interplay between technology and culture, fostering digital literacy among management and employees, and promoting the digitalization of workflows and patient communication (Regional Strategy document).

These visions support actors in pursuing the technology- and data-driven initiatives aligned with the regional strategy, including those related to the BIU. This has been exemplified in regional investment budgets, where the BIU was granted several full-time equivalents to be able to hire more employees to sustain both existing and new projects. Moreover, hospital department managers and clinicians may seek funding and expertise to establish clinical quality databases, request data for quality assurance work, and use data to optimize treatment, workflows, and costs (Regional Investment Budget; Field Notes 2022).

Within the region, the BIU is seen as a strategic component for establishing a shared and reliable data repository (a data warehouse) and utilizing healthcare data for clinical and management purposes. While the BIU is self-governing to some extent, it is partly governed by a BI management board which includes managers of the region's hospitals and local departments that sets the framework for the BI projects. However, while there is a context of promoting efforts to become data-driven at many levels, this discourse competes with other national and regional discourses such as more patient involvement, better quality of care, and treatment, and alleviating inequality in healthcare. Healthcare staff may lean into different discourses or focus only on their core tasks around patient treatment and care.

4.2 Data Collection and Analysis

The study was carried out between January 2021 and February 2022. During this time, the first author conducted 21 semi-structured interviews (Brinkmann 2013), 53 hours of participant observation (Hammersley and Atkinson 2019), in-situ interviews, and document research.

Throughout the period of research, the first author also attended monthly 2-hour online staff meetings (13.5 hours in total. These were online due to

COVID-19 - see Table 1). Subsequently, as COVID restrictions were lifted, he conducted onsite ethnographic fieldwork starting within the bounded space of the BIU. The BI staff's daily data work was shadowed to get a better understanding of their practices. However, this soon led to multiple sites of interest such as regional hospital wards, training courses, workshops, and conference halls. For instance, the first author participated in an educational seminar for three days taught by the BI staff. This provided a chance to get first-hand experience with Data Reports and training as well as an opportunity to interact with other participants learning how to use these tools (e.g., medical secretaries and administrative staff). Whenever something interesting occurred during a session, relevant participants were contacted during a break to have an unstructured conversation to get a better understanding of it. On-site fieldwork amounted to approx. 39.5 hours (see Table 1). Verbal consent was obtained from all the participants before any field work, and field notes and pictures were taken during observations and afterward extended into detailed accounts for later analysis.

To substantiate the fieldwork, the first author conducted 21 semi-structured interviews lasting from 30 to 90 minutes (approx. 45 minutes on average) with three BI managers (1.5 hours) and 19 BI staff members (approx. 14.5 hours in total – see Table 2). The interviews revolved around their educational background and work experience as well as their work practices, competencies, and challenges. All interviewees were asked if they wanted to participate, and written consent was obtained before each interview with an option to opt out. All interviews were recorded and transcribed for later analysis.

Moreover, we have analyzed a wide range of documents (see Table 3) including regional policy documents and various internal BIU documents describing strategies and work processes. Further, we were provided with a sheet of data on all course participants (2018-2021) by the BIU. This data only provides job titles, areas of work, and workplaces, and hence, does not hold any personal information that can identify the participants. The list provided us with valuable insight into which occupations attend these courses as well as some insights into participants' data, knowledge, and competence needs.

Taking on a grounded theory approach (Charmaz 2014) to guide our analysis, we first conducted open coding, using NVivo. Interviews and field notes were analyzed inductively to understand the work of the BI staff members. Through this analysis, 151 initial codes were produced which were reorganized into 60 axial codes (e.g., introducing the BI setup, learning how to fish, educating users, and realizing the data potential). We iteratively discussed and revised our codes while analyzing the remainder of the field notes, interviews, and documents while still being attentive to new codes. These codes were then used to conduct focused coding where we selected which codes to move forward with. We studied and assessed our initial codes to identify interesting themes and draw comparisons. Here, we identified a pattern of central notions, tasks, and practices related to the

Table 1. Interviews.

Title of informant(s)	Method	Online/Personal	Duration
BI Manager and BI Assistant Manager	Unstructured introductory interview/ Notes	Online via Skype	1:04:00
BI Developer	Semi-structured interview / Verbatim transcription	Online via Skype	0:41:56
BI Developer	Semi-structured interview/ Verbatim transcription	Online via Skype	0:50:20
BI Developer	Semi-structured interview/ Verbatim transcription	Online via Skype	0:32:25
BI Assistant Manager	Semi-structured interview/ Verbatim transcription	Online via Skype	0:33:28
BI Specialist	Semi-structured interview/ Verbatim transcription	Online via Skype	0:55:32
BI Developer	Semi-structured interview/ Verbatim transcription	Online via Skype	0:39:00
BI Developer	Semi-structured interview/ Verbatim transcription	Online via Skype	0:48:39
UX/Communication employee	Semi-structured interview/Notes	Online via Skype	0:43:35
BI Administrator	Semi-structured interview/ Verbatim transcription	Online via Skype	1:37:58
BI Developer	Semi-structured interview/ Verbatim transcription	Online via Skype	0:41:32
BI Developer	Semi-structured interview/ Verbatim transcription	Online via Skype	0:48:03
BI Developer	Semi-structured interview/ Verbatim transcription	Personal in an office at the BIU	1:05:05
BI Administrator	Semi-structured interview /Transcription and notes	Personal in an office at the BIU	0:37:43
Junior BI Developer	Semi-structured interview/ Verbatim transcription	Online via Skype	0:26:58
BI Administrator	Semi-structured interview/ Verbatim transcription	Online via Skype	0:26:27
BI Developer	Semi-structured interview/ Verbatim transcription	Online via Skype	1:08:00
BI Developer	Semi-structured interview/ Verbatim transcription	Online via Skype	0:24:53
BI Developer	Semi-structured interview/ Verbatim transcription	Online via Skype	0:30:03
BI Architect	Semi-structured interview/ Verbatim transcription	Online via Skype	0:32:57
BI Developer	Semi-structured interview/ Verbatim transcription	Online via Skype	0:45:21
Total:			**15:53:55**

Table 2. Observations.

Method	Occasion	Online/On-site	Attending	Duration
Observation	Staff meeting	Online, Regional video platform	BIU management and employees	2:00:00
Observation	Staff meeting	Online, Regional video platform	BIU management and employees	2:00:00
Observation/In situ interviews	BI Setup/Office	The BIU, onsite	BI employees	2:00:00
Observation	Staff meeting	Online, Regional video platform	BIU management and employees	2:00:00
Observation	Staff meeting	Online, Regional video olatform	BIU management and emplovees	2:00:00
Observation	Staff meeting	Online, Regional video platform	BIU management and employees	1:30:00
Observation/In situ interviews	Work at the BI	The BIU, onsite	BI employees	4:45:00
Observation/In situ interviews	BI Cafe	Hospital meeting rooms	BI employees + healthcare and administrative staff attending or dropping by	4:30:00
Observation/In situ interviews	Work at the BI	The BIU, onsite	BI employees	4:00:00
Observation/In situ interviews	BI Ninja Education	Hotel conference room	BI employees and 18 attendees	6:00:00
Observation/Insitu interviews	BI NinjaEducation	Hotel conferenceroom	BI employees and 18attendees	6:45:00
Observation/In situ interviews	BI Ninja Education	Hotel conference room	BI employees and 18 attendees	6:15:00
Observation	Staff meeting	Online, Regionalvideo platform	BiII management and employees	1:00:00
Observation	Staff meeting	Online, Regional video platform	BiII management and employees	2:00:00
Observation/In situ interviews	BI Cafe	Hospital areas, room at surgical department	BI employees + healthcare staff attending or dropping by	2:30:00
Observation/In situ interviews	BI Day	Hospital conference hall and area	Approx. 180 attendees from various departments (Bill, management, clinicians, medical secretaries, administration, etc.)	4:00:00
Total:				**53:15:00**

Table 3. Documents.

Description	Type	Pages/Other
Regional Digitalization Strategy	Report	11 pages
Regional Digitalization Strategy	Report	12 pages
Organization Chart/Description	Report	1 page
Internal BI strategy document	Document	21 pages
Internal BI strategy document	Document	20 pages
Internal BI/Organizational chart/description	Document	21 pages
BI assignment outline	Document	21 pages
Presentation of the BIU and its tasks	Slideshow	18 pages
Internal report of BI board meeting	Report	10 pages
BI document on user education	Document	9 pages
Description of BI activities at data hero course	Document	1 page
Illustration of BI user personas	Document	2 pages
Newspaper article on the BIU	Article	4 pages
Information on the BI Ninja course	Document	1 page
Overview of activities at the BI day	Document	1 page
BI Ninja course assignment/survey	Survey/Document	1 page
Overview of BI Ninja course attendees	Spreadsheet	1 page
BI setup introduction videos (1 to 4 minutes each)	Website/Videos	34 videos

implementation and dissemination of Data Reports as core aspects of the BIU's work. At this point, we focused on the work that pertains to the efforts of teaching and disseminating the use of Data Reports that is the externally directed aspects of the BIU's work. With this focus in mind, we selected ten codes - corresponding to the ten sub-subsections in the analysis - to become focused codes for further analysis of the empirical material, as suggested by Charmaz (2014). Subsequent analysis in conjunction with reading about boundary objects, boundary spanning, and boundary work led to the refinement and development of three main categories: Mobilizing interest, building local capabilities, and propagating data locally. We were especially theoretically sensitized to how our codes could reflect work arrangements revolving around boundary objects, boundary spanners, and boundary work in relation to implementation and dissemination while iteratively moving between the concepts and empirical data. On the one hand, the theories helped us to move beyond our inductive analysis, on the other hand, we found an aspect in the empirical data that had not been fully described conceptually within the literature. The three main categories that emerged are reflected in our subheadings of Section 5, just as the ten codes are reflected in the sub-subheadings.

We have anonymized all informants to the extent it is possible: We do not mention the region or organization by name, and informants have been given pseudonyms or are only mentioned by title. All quotes have been translated from Danish.

5 Findings

In the following sections, we will present the central technology, the Data Report, and then the findings of our analysis. The concern the efforts of the BIU to make themselves visible and introduce the BI Setup to healthcare staff (mobilizing interest), teaching healthcare staff how to use Data Reports and the data warehouse (building local capabilities), as well as how healthcare staff implement and disseminate BI products in their local practices (propagating data locally).

As Data Reports facilitate data work across the various social worlds of healthcare wards and administrative units, they can adequately be conceptualized as boundary objects in terms of their flexibility and ability to support collaboration across various boundaries. The Data Reports produced by the BIU are self-service tools that can be used to do data analysis and gain actionable insights about a specific subject. While reports are standardized and follow specific templates, they can be somewhat customized to each department by the individual users to become useful: All reports can be found via the BI Portal which is an overview of the different report subjects (e.g., 'contacts' or 'booking') with links to each report. Each report consists of a front page and a dashboard with pre-defined visualizations. The front-page acts as a tool through which the user can filter and choose the data they need (e.g., according to place, timespan, diagnosis, etc.). When data is filtered, the user is presented with a dashboard through which they can sort the data according to different variables (e.g., days, gender, place, etc.) and choose which kind of visualizations suit the task at hand (e.g., time series, heatmaps, bar chart, lists, etc.). An example of this can be seen in Figure 1 which illustrates different visualizations of admissions and discharges at a local department. While data on these matters is produced by local clinical and non-clinical staff, it can be used by management to coordinate departmental activities when repurposed and visualized in a report like this. Similarly, the reports can be used in everyday data work practices. For instance, medical secretaries use Data Reports to produce documentation error lists to correct coding errors in collaboration with clinicians. All the reports are dynamic and updated daily. The customized reports can be saved by the user and shared with others.

Likewise, the data warehouse can just as well be characterized as a boundary object (a repository) that is used to order and uniform the heterogeneous regional data, so it can be accessed and used by others to work with data locally. In fact, there are many other types of boundary objects at stake as well. However, it is not the boundary objects as such that concern us, but instead, the BIU's work arrangements that revolve around the implementation and dissemination of the very same artifacts.

Over the years, the BIU has worked to create a solid foundation of quality data and Data Reports, collaborating closely with healthcare staff, administration, and management to make them relevant and user-friendly. Yet, according to the BI management, the regional healthcare system has a huge data potential that has
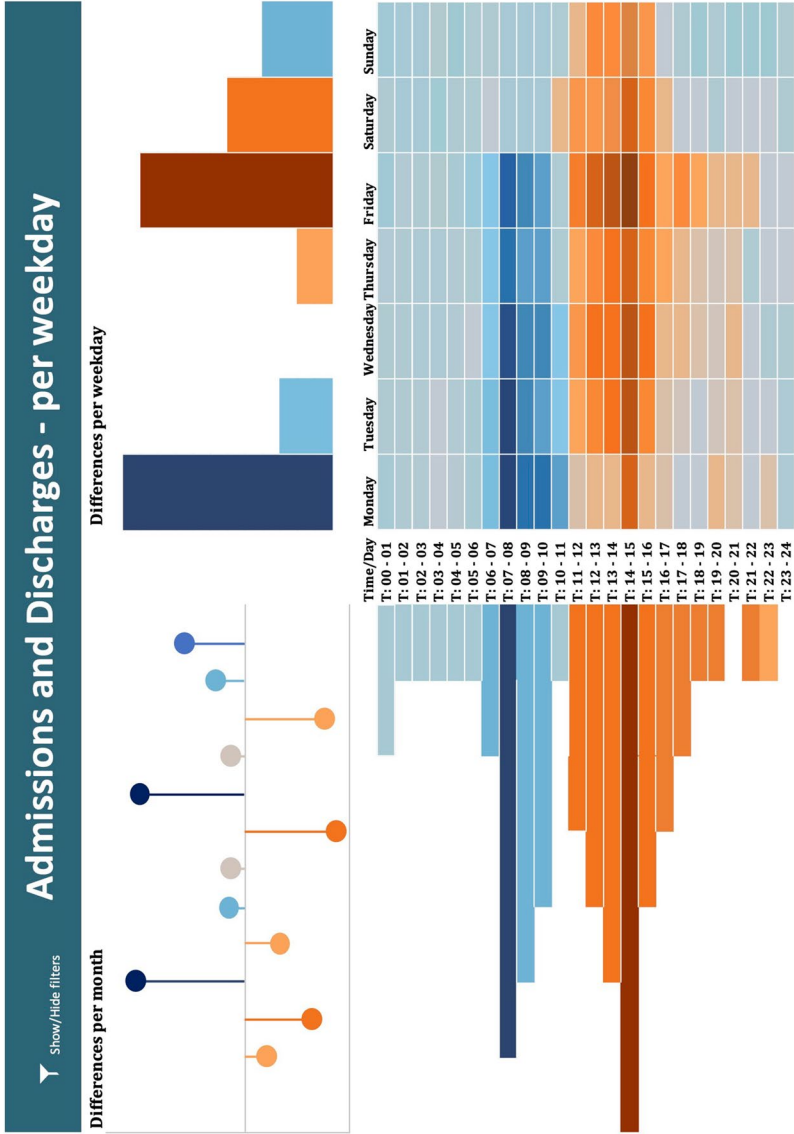
Figure 1. Graphic illustration of a Data Report visualization.

not been realized yet, since more data is produced and accumulated than what is possible for the BIU to repurpose into Data Reports. Hence, they operate with a strategy called the 'open BI setup' which entails users being granted permission to work on data in the data warehouse, developing Data Reports themselves in Tableau, or applying the self-service Data Reports in their everyday data work. All these tasks require that the users know how to either work on a data warehouse or how to customize and work with data in a Data Report. This leads to another challenge: The successful implementation of Data Reports in daily practice relies on end-users who realize their benefits *and* have the capabilities to use them. Both issues prompt a bottleneck situation that constrains the BIU from achieving its aims. Hence, they work to overcome these challenges and make healthcare data-driven. As we will show, the BIU does this by engaging in considerable collaborative boundary work where BIU staff themselves act as boundary spanners-in-practice and try to mobilize staff from wards to become boundary spanners-in-practice too. In the process, a new joint field around data work practices is created and cultivated, in which Data Reports and the data warehouse become boundary objects-in-use.

5.1 Mobilizing Interest: 'Data Saves Lives'

To arouse the interest of healthcare staff, the BIU has developed different activities and artifacts through which they promote themselves and their setup. These among other things include introductory events and support workshops at the local hospitals as well as merchandise and quizzes. While some of these activities also aim to support the users when they need help or show them how to use the BI Portal and Data Reports, the point is that it is also about being close to the healthcare staff to build relations as well as communicating benefits of the BI setup to mobilize interest. In the following, we will present three subcategories of how the BIU works to mobilize the interest of healthcare staff.

5.1.1 Promoting the Data Potential: The BI Day

The entrance of a local hospital building is filled with people: BI developers running around in 'BI Day' T-shirts, welcoming guests, and handing out 'BI Day' water bottles; physicians, clinicians, and administrative workers are mingling with each other while helping themselves to breakfast and coffee from the buffet next to the entrance. At the other end of the room, tables have been set up in front of partitions with small posters describing different BI-related success stories and projects. At each table, two BI developers are waiting to answer questions from the participants and tell them more about the BI unit. In the neighboring room, a large auditorium, the BIU manager is getting ready to present the first speaker of the day, one of the regional group managing

directors. I spot a poster with today's program which has a subtitle in capital letters stating: "BECAUSE DATA SAVES LIVES!" - (Field Note, 2021)

The BIU organizes the annual event 'The BI Day' to, in their own words, 'inspire valuable data use and celebrate gains achieved with data' by healthcare staff. The event has between 150-200 participants who are mainly healthcare and administrative staff members from the regional hospitals. Throughout the day, healthcare staff presents stories of how they successfully have applied data and BI products in their practices: A physiotherapist shares examples of different models he has developed for his department and shows a video of a coworker who uses data visualizations in consultations with her patients; a professor from a psychiatric department talks about predicting clinical outcomes with support from machine learning; and a medical secretary, who is there to talk about how she works with Data Reports at her ward, is announced as the landslide winner of an advent calendar quiz - she gets a cup and a BI developer for a day. Meanwhile, the BI developers present the BI setup, answer questions, and mingle with the participants. One of the BI developers does a presentation called 'Tableau Brag'. Another BI developer conducts two workshops called 'Build-Your-Own Reports' in which the participant gets a crash course and basic understanding of how they can customize reports in their local departments. The last event of the day is 'Speed Date a Data Doctor' where all the BI developers are placed at separate tables, ready to consult curious participants.

Events like the BI Day are an important part of the BI developers' work to promote success stories and the BI setup while also showcasing the potential through real-life examples from clinical practice. This helps to make new potential users interested, and the number of participants indicates that there is some interest among ward staff.

5.1.2 Nurturing a Data Culture: T-shirts, Competitions, and Big Screens

"Data Rocks", states one of their many different data-related merchandise T-shirts on the wall of the staircase leading to the offices of the BIU. They are crazy about data. - (Field Note, 2021)

In- and outside of the offices of the BIU, the BI developers work on their relations with the local wards and employees. This takes place on an everyday basis when introducing healthcare staff to their setup or rendering support for their products. Beyond that, the BIU also does data-related activities and artifacts to entertain and make the BIU visible. Some of these activities are quizzes and competitions - for instance, an advent calendar quiz – where employees from local departments can solve data-related questions, sometimes with the assistance of a Data Report. Occasionally the prize is a visit from a BI developer, other

times it is a bottle of wine - for instance, one of the BI developers keeps a couple of boxes of wine, just in case he needs a reward in one of the competitions he conducts or when he visits a ward. Annually, the BIU lends a winner a big screen for a year to display real-time data from the BI setup. Other times, prizes are merchandise T-shirts with data-related slogans such as 'Insights you want – Use data you must', or mugs and fake tattoos with the BIU logo. All these smaller activities are part of their work of creating and maintaining relations with healthcare staff, as well as nurturing a data culture where other staff start to think of data as relevant and important to their everyday practice.

5.1.3 Introducing the BI Setup: Introduction Workshop and The BI Café

The 'BI Café' is a workshop taking place at different hospitals in the region two times a month. The BI Café has two core activities: Introducing and demonstrating the BI setup – both the BI Portal and Data Reports - and providing support to healthcare and administration staff on challenges related to data and the BI setup. As such, the BI Café has two overlapping sections: A two-hour introduction workshop called 'Introduction to the BI Portal' and a four-to-six-hour support workshop. A BI team consisting of a BI developer named Liam and three to four other BI developers travel to different hospitals to conduct this work of servicing healthcare and administration staff. The BI Café is free and open to all employees in the region and the idea is that they can drop by whenever they see fit. A key point here is that the workshop takes place close to the end-users and at different sites, in local wards among clinicians, physicians, medical secretaries, administration staff, and patients.

The workshop's purpose is to create interest in the BIU's services by introducing them to local employees. Here, the participants get acquainted with the content of the BI Portal and the structure of Data Reports; how to navigate in reports; how to filter, sort, and visualize data; and how to save and share visualizations with others. It is a light introduction that demonstrates how to operate the BI portal but also illustrates the possibilities of the BI setup and some of the most popular products.

Parallel to the Introduction of the BI setup, the support side of the BI Café takes place in a nearby room. Here, healthcare and administrative staff members stop by to ask BI developers BI-related questions and ask for support. These could be questions about how to set up Data Reports. For example, a medical secretary would drop by, asking for reassurance on how to set up the report properly. The BI developer would then help her set up the report and, meanwhile, try to explain to her why it needs to be done like that. Additionally, healthcare staff would drop by with short questions on where to find certain data; ask for help with problems that require simple solutions, to be assured they set up the reports correctly; or get a BI developer to set up the report for them. At other times, chief physicians, clinicians, and even staff members from technical and environmental

services drop in asking for help. One example of this happened during our observations when a clinician attended the BI Café:

> A man in blue scrubs appears in the doorway: Fred, a Ph.D. student belonging to the Department of Nephrology. He asks for help to search in a Data Report for all patients who are affiliated with the nephrology department and have a known diabetes diagnosis - but he would also like to include patients from other departments if they are also affiliated with the nephrology department in some way. His idea is to search 'contacts' in his departments and apply a broad diabetes diagnostic code as a parameter to filter the data. Fred expects that the result will show all his department's patients with a diabetes diagnosis no matter where at the hospital the diagnosis was registered. But that is not quite the case. The BI developer, Kenny, explains that this query only returns the contacts [patients] his department has registered with the diagnosis. If the patients are registered as contacts with diabetes in e.g., the diabetes department, but not at his department, they do not show up in the report, even though they also have registered a contact on them.
>
> Fred wants to include more contacts to ensure that he has all patient cases in his data set, regardless of whether the nephrology department has registered that the patient has diabetes or not. Kenny says that it could be the case that his department registers that the patients have diabetes - regardless of whether it is relevant or not. Fred doubts it: "But do we register it? And who does it? It must be the medical secretaries. They probably do not", he answers himself. "Well, at least they did in 516 cases", Kenny replies, pointing to the screen where the Data Report result is. "But that is a low number," Fred replies. "It's only for this year," says Kenneth. "Yes, for the last year", Fred says. "No, since January, or since January 1st" (Note: This situation takes place in February 2022). Kenny changes the filters in the report so that it instead shows the number of cases for all of 2021. There are more than 5000. "Oh, that's more realistic", Fred immediately exclaims much more delighted. He decides that he will go back and talk to the medical secretaries to find out if they always apply the diagnosis code, whether it is relevant to the department or not. – (Field Notes, 2022)

As this rather long vignette illustrates, the BI setup is rather complex and requires knowledge of infrastructure, registration practices, diagnosis codes, time logic, and data models. It also shows that there is local interest in working with data, but knowledge about possibilities and technical capabilities can be limited. The problems encountered above by Fred include the following: How to search for diagnoses across departments; a year can be filtered as 'present year' or 'the last 12 months'; and knowing how diagnoses are registered by medical secretaries. Therefore, the BIU needs to be available and help staff understand the

complexities of data and Data Reports. Besides, the fact that the BI Café makes it easier for healthcare staff to get help and support where it is needed when they visit the local departments, this work also helps the BIU to make themselves visible in the local wards and to the healthcare staff. Further, it helps them to make the potential of the system visible when helping healthcare staff.

All these events organized by the BIU – the BI Day, promotion through merchandise and quizzes as well as the BI Café - also demonstrate that it is not enough to make designated boundary objects available to healthcare and administration staff. The BIU must make themselves visible, create interest in their setup, communicate the benefits and potential, and nurture relations to ensure that Data Reports become boundary objects-in-use. This of course requires a great deal of work from the BI staff. Further, these examples also illuminate the complexities of Data Reports as boundary objects. Even though the BIU has put a great effort into making user-friendly and standardized Data Reports, it still requires specific knowledge and skills to make use of them.

In summary, the BIU strives to mobilize interest in data and its potential through various initiatives such as introductory workshops, BI Cafés, gadgets, and competitions as well as through BI Days. In the next section, we turn to another aspect of the BIU's efforts: Building local capabilities.

5.2 Building Local Capabilities: 'Teaching Users How to Fish'

Despite the BIU's attempt to create a good foundation of user-friendly Data Reports and a high-quality BI setup, it has still been a challenge to integrate these into daily practices of the healthcare staff. This is because the Data Reports and the BI setup do not necessarily lend themselves as self-explanatory boundary objects that are easy to use and fit seamlessly into everyday practice. One BI developer reflected on this challenge, stating:

> 'In general, the entire training function is super important too, because that is how we teach the users how to fish themselves… we know that you do not wake up one morning and think, "Yes, now I enter the BI Portal and extract all data that is relevant to me because it is easy and intuitive, and I just know exactly where to look".' - (Interview 7, 2021)

The metaphor 'teach the users how to fish' stresses the complexity of the BI setup: Without the users' proficiency, the BIU is compelled to set up the reports or help the users. To make healthcare staff more self-reliant, the BIU works to build local capabilities by training staff through two key courses: The 'Data Hero' and the 'BI Portal Ninja' programs. These educational initiatives exemplify the BI developers' strategy and work to implement BI products in healthcare practices.

The Data Hero program involves a three-week technical crash course attended by six to seven participants at a time. It equips the participants with the skills to utilize the data warehouse. This encompasses proficiency in SQL programming language and using Tableau, a front-end software for data analysis and visualization. The BI developers teach the participants various data processes, including data access and integration, data warehousing, report generation, and different calculations. The aim is to provide the participants with an understanding of the data analysis process (but not necessarily becoming experts), cultivating a level of comfort with data, and enabling them to continue independently. The participants are a mix of IT professionals, data professionals, administrative staff, and some healthcare staff members. Furthermore, the BIU occasionally hires new employees to become Data Heroes who can be contracted by other healthcare departments, assisting with data-related questions and challenges.

The BI Portal Ninja program is less technically oriented and focuses on navigating the BI Portal, setting up Data Reports, and applying them in practice. Since the BI Portal Ninja education is a central element of the BIU's efforts to make the healthcare organization data-driven, we will go a bit more into detail with this. In the following subsections, we provide some background on the course and describe four training elements. These elements both serve as examples of the BI developers' work put into teaching others how to become data-driven as well as examples of the demands placed on the participants and the challenges they encounter.

5.2.1 The BI Portal Ninja Program: Background

During a break, I talk to a head medical secretary who is affiliated with the Department of Anesthesia and Surgery. Answering my question on why she is attending the course, she tells me that others at her ward ask her for data, so she is already a bit familiar with the BI Portal. But she gets frustrated and angry with the system, so she always ends up calling the BI unit and asking them to do it. "And then others say it is good [the course]. The rumor spreads", she says laughingly. "Everybody talks to BI, but nobody knows what it is. Except that it is something with numbers". – (Field Note, 2021)

The BIU introduced the BI Portal Ninja program (BI Ninja in short) to train medical secretaries and administrative staff in BI Portal usage. Despite their awareness of the BIU and BI setup, as the above situation illustrates, some potential users lack practical utilization skills. Hence, the BIU offers quarterly courses at different regional locations, spanning four days with a two-week midpoint break. Each course has around 20 participants and currently 302 people have attended the course (some more than once) while 254 people have passed it. Participants

hold various titles which we have grouped into four categories: Healthcare Professionals; IT Professionals; Administrative Staff; and Other/Unknown (see Table 4).

As can be seen from Table 4, healthcare professionals (154) make up the majority of attendees who have finished the course, and the subcategories of medical secretaries, nurses, and midwives are most prevalent. The administrative staff is the second largest category (60) with administrative officers (16) being the most prevalent. The Other/Unknown category includes one job title that fell outside of the other categories and 16 participants who did not state their job title or work affiliation.

As mentioned, the course was originally aimed at medical secretaries and administrative workers because their everyday work involves data work tasks supported by the Data Reports. Many participants already handle EHR or similar data and have a strong interest in learning new skills that benefit their work and department. As one medical secretary told us, she had not learned these skills during her education. However, while participation might be driven by self-interest and volunteering in some cases, attendance hinges on the approval of the department management. In other cases, participants are asked - or nominated - by their supervisors due to their involvement in data work, but more importantly, in recognition of the potential for enhancing the departmental data-driven initiatives. For example, a head medical secretary mentioned that she expects her medical secretaries to use the BI reports as a quality assurance tool in their work. Other BI Ninjas mentioned that they were asked because the management expected the medical secretaries to be able to start delivering reports and visualizations to the department.

Over time, other types of healthcare occupations, particularly nurses and midwives, have joined the course. Only a few physicians and clinicians have attended which, according to a BI developer, may result from their time being more challenging to buy out or because '… they get so engulfed in it [the BI setup] that they figure out how to use the reports by themselves' - (Field Note, 2021). Across the four overall categories, employee attendance outweighs managers, though some managers like functional managers, chief physicians, head nurses, and chief midwives also engage. For instance, a head physician told us that she attended with her head nurse as she perceives data as an imperative in department management, optimizing departmental procedures, and ensuring quality. Notably, Table 4 indicates the BIU's success in extending to healthcare employees beyond management and administration.

At the course, the BI developers provide knowledge on BI and teach the participants on the Data Report setup. The curriculum includes lessons on the BI Portal, the data sources and infrastructure, the technical terminology, the data classification systems, as well as different reports and how they work. This also includes lessons called 'The BI Ninja's Dojo' where the participants work on exercises that help them practice navigating the Data Reports and applying their new knowledge. To ensure relevance, several lessons called 'The Class Decides' are allotted to subjects that most of the participants want to learn more about.

Table 4. BI ninja course participants categorized by professions and occupations.

Cate-gories	Healthcare Professionals	Administrative Staff	IT Professionals	Other/Unknown
	Medical Secretaries (90)	Administrative Officers (16)	Health IT Consultants (14)	Kitchen Manager (1)
	Nurses (34)	Office Assistants (3)	IT Developer (1)	Unknown (16)
	Midwives (15)	Strategy and Plan Consultants (4)	Health System Coordinator (1)	
	Physicians (6)	Specialists (3)	Project Manager (1)	
	Clinicians (4)	Quality Consultants (3)	Special Consultant (1)	
	Biomedical Laboratory technicians (2)	Special consultants (2)	Professional Coordinator (1)	
	Pharmacist (1)	Economists (2)	Health IT Responsible (2)	
	Physio- and Occupational therapist (1)	Student Helpers (2)	Functional Manager (1)	
	Functional Manager (1)	Secretaries (1)	IT Administrator (1)	
		Quality Coordinator (1)		
		Consultant (1)		
		Administrative Coordinator (1)		
		Development and Quality Coordinator (1)		
		Process Optimization Consultant (1)		
		Organization Consultant (1)		
		Knowledge Worker (1)		
		Unknown Title (16)		
Total: 254	154	60	23	17

Those uninterested can access alternate exercises in 'The Eagle's Nest' – a neighboring room – with the assistance of a BI developer. At the end of the course, the participants are examined on their BI knowledge and competencies, with successful participants designated as BI Portal Ninjas, receiving certificates, BI Ninja mugs, and fake tattoos. In the following subsections, we present two examples from the course that demonstrate how the BI developers attempt to empower the participants with new knowledge and skills as well as some of the challenges that they encounter, emphasizing the intricacies of the BI setup and Data Reports.

5.2.2 Breaking Down Complexities: Filtering and Sorting

Two of the participants call John for help during an exercise session on how to filter data. "Why does this happen?", one of them says while pointing at her screen. "I have entered a date and I have chosen February 2019. Why is it so sensitive?", she says a bit frustrated. John looks at the screen for a second. "All right, what you are saying is that you want everybody from February 2019. That is not many. You have everybody who started [a care trajectory] in February and nobody else. You do not have to set a time limit. When you pick February, you only get those who start in February – and not after. 'Start date' does not indicate the beginning of the period. It indicates the beginning of the care trajectory. Ergo you do not get those after February". - (Field Note, 2021)

The vignette demonstrates BI developers instructing participants in fundamental skills for customizing Data Reports and working with data: Filtering and sorting. The reports offer diverse filters like 'period', 'start date', and 'location' which are taught through both plenary instructions and class exercises where the participants practice these skills. Nonetheless, the complexity of data filtering and sorting logic, as highlighted in the scenario, presents challenges; while some grasp it swiftly, others need more time. Consequently, these tasks require concerted efforts from both participants and BI developers.

To break down the complexity of filtering and sorting to the participants – and teach them the difference – the BI developers introduce activities and physical artifacts to make the logic more comprehensible. For instance, cubes that each represent a patient with different specific data like name (instead of a CRS number), gender, patient type, start time of care trajectory, hospital, and department (incl. the hospital-department classification (HCD) codes) (See Figure 2). Each participant is handed a different cube representing an individual patient with its own specific data set. Meanwhile, around 30 colored cubes without any writing are piled on the floor (see Figure 3). This pile of cubes represents the whole data set. The first part of the exercise imitates a filtering process, where relevant data is identified by asking the participants in plenum about their cubes, e.g., how many of the participants have a

Figure 2. Picture of a cube representing patient data. Here, the top of the cube represents patient type (outpatient), and the front represents the individual by name (Mogens).

Figure 3. The BIDs imitate data filtering and sorting with homemade cubes.

cube with an outpatient? Or how many are located at a specific hospital? Depending on the number of participants raising their hands, the BI developer piles up cubes on top of each other, creating a designated data set. This data set can now answer different questions by sorting them into categories. For example, how many of the outpatients are women? Or which hospital has the most patients? For each question, the cubes representing the data set can be divided into pillars like a bar chart. By introducing physical artifacts to visualize what is happening in these processes and involving the participants in the exercise, the BI developers attempt to break down the complexities of filtering and sorting. These kinds of exercises might seem trivial but are necessary activities to teach certain subjects that the participants struggle to understand.

5.2.3 Teaching Sense-Making and Interpretation: Being 'Critically Attentive'

After doing a few exercises from the exercise pamphlet, they follow up in plenary. John asks if anybody encountered any challenges. "Yes!", a participant exclaims, "It is easy to set up and adjust the report, but not making it show something that makes sense. To know when you use a bar chart or something else. What is best?". Liam explains that "there is rarely a 'best answer', but this is when you need to be critically attentive when your colleagues ask for data: What is it you need?" Another participant asks: "How am I sure that it is the right numbers, I have found?". Another one asks if it is possible to find a key indicator definition and adds: "In the old times there was one". Liam shows them a list on the BI Portal of all the key indicators. He also shows them how every report has a question mark that, when clicked, explains the specific report's key indicator and what it answers. "Perhaps this list will make me feel more confident that what I have chosen is correct", a participant reflects. - (Field Note, 2021)

As depicted in the vignette, some participants struggle to make sense of the result they get and lack confidence in their own choices. This is because choosing the right visualization and making sense of the numbers on screen is not self-evident. To address this, the BI developers teach the participants how to be 'critically attentive' toward data and Data Report requests. This entails several activities: Breaking down and analyzing the data request at hand; identifying the correct report that can provide an answer; and figuring out which visualization will support the analysis and help provide an answer. Importantly, it also entails questioning data work tasks at hand ('What is it you need?') to determine if a task could be done smarter or more correctly by choosing different data, Data Reports, or visualizations. To support the activity of choosing the right Data Report and data, the BIU provides supportive tools such as a documentation list of accessible key indicators and comprehensive documentation for each Data Report and key indicator. These tools support the users in understanding utilized data, identifying key indicators' relevance, and making sense of a result or visualization. As one of the participants mentioned, these tools can help foster the users' confidence in report setup and outcomes.

Further, to teach the participants how to be 'critically attentive', the BI developers make them practice these different activities several times during the course. They, for example, practice how to create an overview of a ward's diagnoses and procedures (see Figure 4). The exercises resemble real-live data work tasks that the participants themselves must figure out how to solve by setting up the Data Report and getting the correct result. Even though the description provides hints or explains certain things specifically (e.g., which codes to

---

Exercise 6 – Combined Coding List

Exercise description: Orthopedic surgical department HEV (665037) wants to gain insight into their knee and foot operations.

Special considerations: Combined Coding List is a focus report that allows you to look for combinations of diagnosis and procedure codes across patients, contacts, and procedure groups.
1. You must create a patient list with those patients who in the period 01-03-2021 to 31-03-2021 had a knee or foot surgery (KNG or KNH) as a primary procedure, and at the same time did not get a TUL Additional Procedure.
   Hint: Use 'Short List – Procedure Group' as you then search within the procedure group. Remember, several subgroups of KNG- and KNH-operations exist.
   a. Set up the above-mentioned view and insert spaces in the columns, for example, an action diagnoses and date of surgery.
   b. Click on a patient and go to the detailed view.

2. You are now asked to create an overview of how many KNG-operations that has been conducted within the same period that can also show which action diagnosis the patients had under the contact.
   a. Find the answer for the above-mentioned. Is Combined Coding List the smartest report for this or could you set up a view easier in another report?

Figure 4. An exercise description from the Exercise Pamphlet for the BI Portal (Own translation).

apply – see Figure 4, Exercise 1), some participants can still find it challenging to solve the problems. For example, if the exercise or Data Report does not relate to their practice and they do not know the workflow, procedures, or diagnoses the exercise calls for. However, the exercises do allow the participants to apply their newly acquired knowledge (e.g., on classification codes, diagnosis codes, etc.) as well as to practice navigating the functionalities of the Data Report. To become a more competent user and able to guide others who request Data Reports, the participant must reflect on the exercise's report suggestion and if it could have been done 'smarter' (see Figure 4, Exercise 2a).

In summary, it is not necessarily self-evident to the participants how to ensure that a Data Report has been properly set up, choose an adequate visualization, or make sense of visualizations. Hence, it is important for the BIU to teach the participants how to deconstruct data work tasks through practice-based exercises; provide insights into data visualization techniques; and further introduce documentation lists and accessible information on the underlying calculations and definitions, as data and Data Reports are highly contextual.

Through these educational activities, the BIU build local capabilities in healthcare and administrative staff to further the use of data and Data Reports. While the courses are attended by different healthcare occupations – either

self-motivated or nominated by management - these courses underscore the challenge of integrating BI tools into healthcare practices and the complexity of the BI setup; they are not self-explanatory and require specific skills to utilize. To overcome this knowledge barrier, the BIU engages in education of healthcare staff to provide them with the expertise to understand the terminology and logic embedded in Data Reports as well as how to make sense of the data they work on. In the following section, we turn to the last aspect of implementing and disseminating the BI products in local practices: Propagating data locally.

5.3 Propagating Data Locally: 'Like Ripples in the Water'

Liam asks the participants, how things have worked out since they last saw each other 14 days ago: "Have you used what you have learned?". A participant raises her hand: "Yes, we would like to report back", she says on behalf of herself and her coworker sitting next to her. "We actually got a task immediately after, and she [coworker] was like YES! Then I can use some of these ninja skills. So, we spent some time together to look at the task. And then we actually 'hash tagged' someone, so the report appeared on their front page. And they were pretty ecstatic about it. It is really smart!", she tells Liam excitedly. "She asked if it could be converted, but she didn't need to do anything else than open it". Liam is excited too. "Then it is beginning to work which is also the plan we have had. This thing about distributing it. At the BIU, we cannot necessarily distribute to everybody, but we can help you to distribute it to somebody, as you have an example of here", he tells the participants. "We actually have two examples", the woman begins again. She and her coworker also made a report for her manager – one she had not asked for, but they thought she would find it useful – and showed her how to find it. "Now she knows it too, so now it is spreading. Like ripples in the water". - (Field Note, 2021)

Halfway through the BI Ninja course, some of the participants started to realize the benefits of the BI setup when utilizing their newly acquired skills in their everyday work. Many of these participants are already data workers who extract data from systems and databases, make lists and overviews, etc., and might be servicing others by request such as delivering reports to other healthcare staff members and management. As the above situation illuminates, the BI setup can support these daily tasks and make them more effective. Interestingly, the BI Ninjas also started to introduce the BI products to others, help them set up reports, and distribute them. As Liam mentions – and as interviews with the BI management also confirm – this is in line with their overall strategy for these educational initiatives. So, the main purpose of

the BI developers' work is not only to make the participants self-reliant and 'smarter data workers' that work more effectively with data and BI but also to enable them to propagate Data Reports and data use to other healthcare staff members and managers as well as supporting other coworkers. The medical secretary's metaphor of 'ripples in the water' conveys too smooth a process and disregards the learning efforts invested by the BIU and local staff. However, the gist is to have data work propagate locally. In the following sections, we provide two examples of how Data Heroes and BI Ninjas work in their respective departments.

5.3.1 A Hybrid Data Hero: The Physiotherapist

Ryan, a physiotherapist at a neurological department, is an auto-didact Data Hero. He became interested in BI after a presentation of the BI setup at his hospital. Before this, the hospital where he works had tried to establish its own clinical database but had to give up. In general, they were challenged by slow and demanding data work processes such as double registrations in multiple systems, data extraction, and data processing in Excel sheets. This was too exhausting and time-consuming and additionally, the clinicians generally perceived the data as unreliable because of differences in registration practices and understandings of definitions.

Since then, he and a team of healthcare and data professionals gained access to their own corner of the data warehouse where they reorganized data, so it fitted their local context better. Ryan calls this approach the 'BI data cycle': Clinical data is registered locally through various healthcare systems and automatically loaded into the data warehouse, then repurposed and used at the hospital for the benefit of both the clinicians and the patients. Hence, they now make their reports, projection models, prediction models, as well as local knowledge and evidence models. Progressively, this work helped to change other clinicians' perceptions of data and how they worked. For instance, they now have organizational and historical knowledge of a patient's continuity of care with the characteristics that apply to their specific hospital, and they use visualizations and projection models in their consultations with patients, e.g., showing when a patient can expect to eat properly again. According to Ryan, this work had several other practical and organizational implications: They eliminated double registrations as the data warehouse already gathers data from all the regional healthcare systems; they enhanced the local data quality through work with deficiency lists; they have a better overview of their resources; they continuously adjust registration practices if their data needs change.

According to Ryan, they have achieved great results because they work with data on a departmental level. This involves asking questions and solving data-related challenges relevant to the local departments so that data becomes

valuable in a local context. For example, clinical questions such as: Are patients in the right beds concerning regional specializations? How are the personnel strained and how much? These kinds of questions can prompt organizational changes about how resources are prioritized and at the same time inform hospital management of workloads at the different departments. Additionally, they continuously work to make more clinicians interested in working with data through weekly BI postings with insights from their data (e.g., visualization of patients' infection rate concerning their body temperature).

5.3.2 A BI Ninja: The Medical Secretary

The BI Ninja Judith works as a medical secretary at a psychiatric department and has a crucial role in implementing reports developed by the BIU into clinical and non-clinical practices. She sets up and distributes reports for coworkers and trains and supports them.

When Judith attended the BI Ninja course, she realized how easy and fast it became to get data herself from the BI Portal, as she no longer needed to wait a day for a report she had requested. Additionally, she realized that not everybody in the department should set up reports because of the complexity. As such, only a few people in her department work directly within the BI Portal and act as the department's point of contact in relation to BI. Consequently, an important part of Judith's work as a BI Ninja is to set up reports for other medical secretaries. For example, she set up a deficiency list that is automatically updated and sent to her colleagues, so they can correct registration errors. Before the department utilized Data Reports, they did this kind of error recovery work for several weeks at the end of the year before the December deadline. Now, they correct errors throughout the year which, according to her, also means the department and management can trust the data they use, as it is validated continuously.

Judith also helps to ensure the quality of the report setup across the department. She sets up the Data Reports and, in collaboration with local IT and data professionals, makes them available as 'validated reports' through the department's intranet portal.

She also keeps herself updated on the performance and knowledge of the BI reports, so she can offer support within her department. She subscribes to newsletters on new features as well as on the operating status of the Data Reports. She joins in on BI meetings with head medical secretaries where she learns about their experiences with BI and gains inspiration from other departments (e.g., the somatic departments and their reports).

Finally, she participates in education for medical secretaries every month, where she presents and goes through different reports. She initially teaches them simple maneuvers in the ready-made Data Reports and progressively

increases the level of complexity. Where a report had to be very specific in the beginning (showing data from their exact ward or a specific disease), this work has prompted the fact that the Data Reports now can be a bit less specific and more complex, as her coworkers know better how to navigate them.

5.3.3 Implementing Locally

Even though the two examples above are different in terms of technical complexity (one makes advanced models, develops Data Reports, and works with backend programming, while the other sets up existing Data Reports), they still bear interesting resemblances. Both people work to adjust and customize parts of the BI setup to their respective contexts such as the reports and 'a corner of the data warehouse', so it fits the objective of their departments. They add new elements to the existing data infrastructure (the BI setup) such as intranet portals where data can be accessed, report updates via emails, and provide support and enhance the quality of the local data work. Lastly, they both attempt to enroll new users through different activities: Setting up Data Reports for others, introducing the setup, establishing potential benefits, and identifying data solutions to healthcare challenges.

Interviews with BI developers confirm that propagating data locally is an important part of the Data Hero work. A BI developer, who formerly acted as a Data Hero at a psychiatry ward and collaborated with the local researchers, told us:

> 'The purpose of my work is also to introduce the medical researchers within psychiatry to this goldmine of data in the BI setup, which they can use and where it is much easier for them to access data both in a legal sense but also practically.'
> - (Interview 6, 2021)

Another BI developer, who told us how they sometimes will hire a Data Hero for a department who are interested in working with data but need help to do the work, also elaborated on this:

> 'We hired an employee, and then we trained that person for over a month. That is, we taught her everything we knew about this [BI], and then afterward, well, the employee had to sit in the department 80-90% of the time. What was the person in question supposed to do? Well, the employee had to figure that out together with the department management: Where did the shoe pinch so to speak? Where can we change something? Where is there something we can change using data?'
> - (Interview 7, 2021)

The Data Heroes help the departments build data products that fit the local contexts, but, as the above quotes indicate, their work also involves introducing the BI setup and establishing the potential to other employees and management. This emphasizes how their work can help to propagate the ideas of data and BI. Thus, the BI Ninjas and Data Heroes' work is an important part of the BIU's work and overall strategy of implementing BI in healthcare practices.

In summary, we understand the educational work that the BIU conducts as a means to enroll new boundary spanners that help span boundaries between the social worlds of the BIU and their department by introducing the Data Reports as effective boundary objects. Three things are at stake here: First, the participants take on new roles as BI Ninjas or Data Heroes and become self-reliant users of the BI setup. Second, they help other staff members set up or share reports between staff members and wards. Third, they work to enroll new users when they introduce BI products to others and share expertise and knowledge with coworkers. This moves some of the BI workload (e.g., setting up reports on request or doing support work) away from the BIU towards the healthcare and administrative staff members as well as translating their products. Hence, the local boundary spanners play an important role in making the organization data-driven.

6 Discussion

In the above, we have analyzed the BIU's efforts to make the region's hospitals become data-driven. We have categorized these efforts under three main labels: Mobilizing interest, building local capabilities, and propagating data locally. Mobilizing interest concerns the various initiatives that the BIU undertakes to make itself and its data visible. The BI Cafés, the BI Day, competitions, and mugs and T-shirts with slogans like 'Data Rocks', all work towards making the BIU, its competencies with data, and most importantly, the potential of data visible. The building of local capabilities is spurred by the realization that the demand for the BIUs' services and support exceeds what the BIU can provide. Hence, they work to enable healthcare staff to set up the reports and work with data themselves through the BI Ninja and Data Hero training courses. Finally, we demonstrated how the learned capabilities are propagated locally when staff begin to work with data and make use of the Data Reports and data warehouse provided and maintained by the BIU. Our analysis makes three contributions which will be discussed in the following sections: It nuances our understanding of boundary objects and especially boundary work in ambitions to become data-driven; adds to the literature on data work; and, finally, provides an empirical study for the largely normative literature on BI and SSBI.

6.1 Boundary Objects and Boundary Work in Healthcare BI

Drawing on Star and Griesemer (1989), we have argued that the Data Reports and data warehouse are boundary objects that cross the social worlds of the BIU and local hospital departments. Data Reports can be created on the initiative of hospital management or request by local departments and, as we have described, the BIU collaborates with departments to agree on which data should be included as well as on the design of the reports (within the overall template's format). Thus, Data Reports will most often be designated boundary objects by both the BIU, management, and local departments. Similarly, the data warehouse is a boundary object – a 'repository' (Star and Griesemer 1989) - created and maintained by the BIU. A repository is defined as being ''piles' of objects which are indexed in a standardized fashion' (ibid, p. 410) to solve challenges of heterogeneity and is characterized by enabling various actors to use – or borrow – the so-called 'piles' (e.g., data or information) for their purposes. In our case, the data warehouse is utilized to gather, store, transform, and curate data to make it available for the entire regional healthcare system for different purposes such as management, research, quality assurance, and patient treatment. The data warehouse connects and lends itself to other social worlds to be used and adapted and, in this manner, works along and across the line of different boundaries such as geographical (5 hospital units placed across the region), departmental (different departments using the same data for different purposes), and professional boundaries. Moreover, the repository can be adapted and drawn upon locally as illustrated in the case of the hybrid data hero (physiotherapist).

This, however, does not mean that the Data Reports and data warehouse automatically become boundary objects-in-use, since local staff might not know of them or have the capabilities to put them into use. In this instance, the BIU case is similar to but also different from the original study of the Museum of Vertebrate Zoology (MVZ) by Star and Griesemer (1989) as well as the two case studies by Levina and Vaast (2005). Like in the case of the MVZ, the challenge for the BIU is to build a network of alliances. The BIU's growth from 16 to 50 employees and 290 to 4,000 users within a short period (2015-2022) testifies to the continued support of its sponsor, the healthcare Region, which strives to make the region's hospitals data-driven. That strategy can be seen as an example of configurational boundary work: The work from management to "... design, organize or rearrange the sets of boundaries influencing others' behaviors" (Langley et al. 2019, p. 8). The BIU's growth, however, also testifies to its success in attracting interested Data Report users and implementing reports into practice. Where 'love of nature' played an important role in enrolling stakeholders in the case of the MVZ, the idea of 'saving lives with data' plays a central role with the BIU. However, the two cases also differ in some respects: The MZV gathered information from lay persons for (science) professionals to do analyses, and for that reason the standardized methods of documenting information were simple.

In the case of the BIU, lay persons (healthcare staff) make use of already existing and curated data in the Reports by analyzing the data and putting those insights into use. The MVZ and the BIU are at opposite ends of the data cycle of creating, analyzing, visualizing, and putting-into-use. Since neither data in itself nor the boundary objects in the form of Data Reports are simple, the BIU needs to engage with and provide the users – local, nominated boundary spanners – with the knowledge and skill to apply them. Hence the importance of the BIU's open approach, training courses, and use of its staff as boundary spanners reaching into local wards. This is where Levina & Vaast's (2005) framework becomes pertinent. All these efforts of mobilizing interest in the BI setup and as well as building local capabilities can be regarded as collaborative boundary work in which the BIU and local staff work across knowledge and practical boundaries around a new joint field of data practices.

6.1.1 Cultivating Data Practices Across Boundaries

Similar to Levina and Vaast's two case studies, the challenge for the BIU is to make both boundary objects and boundary spanners become such in-practice through collaborative boundary work. However, whereas Levina and Vaast focus on what it takes to build individual boundary spanner competencies, we focused on the BIU's efforts on an organizational level to make their data products become implemented and used. In other words, the BIU works to make designated boundary objects and nominated boundary spanners become boundary objects-in-use and boundary spanners-in-practice. We identified three aspects of the work involved in those efforts: Mobilizing interest, building local capabilities, and propagating data locally. We argue that these categories can be understood as dimensions of collaborative boundary work to cultivate new joint fields and local boundary spanners-in-action. Overall, we label this work 'cultivating data practices across boundaries' and suggest that these categories could point to factors furthering organizations to become data-driven.

Mobilizing interest concerns the activities, events, and artifacts to make others interested in using data and demonstrate the potential to cultivate a cultural shift. This happens through collaborative boundary work, where local actors negotiate and downplay knowledge boundaries to further the use of data and BI products in local practices. In our case, this activity is evident in large-scale events where data use is promoted for clinical use, but also in everyday practices of support and relational work between healthcare and BI staff. The BIU engages in this activity because they realize that their boundary objects are complex and do not travel on their own. Hence, the BIU must make themselves visible and promote the potential of data. That advocacy is supported by the region's strategies in general, but also by the fact that some local management and staff are interested in working with data. It should be kept in mind that to the majority of employees in healthcare, data work is secondary to their primary concern of treating and taking care of patients, or whatever other tasks are

at the core of their job. Making employees interested in data and showing them how working with data can contribute to their core work is crucial. Especially, since some healthcare professionals experience data work as work 'for the system' (Håland and Melby 2021) or to the benefit of secondary purposes such as management, research, or budgeting (Hoeyer 2023).

Building local capabilities designates the work of providing local, nominated boundary spanners with capabilities necessary to work with data and apply boundary objects in practice. Hence, to make the healthcare staff more 'self-reliant', the BI and healthcare staff negotiate and reinterpret knowledge boundaries and tasks between their roles. While some participants in the Data Hero and BI Ninja courses are appointed by management, other participants are driven by self-interest. It is the management who must permit their employees to participate and, hence, must see potential in data-driven competency development, and choose to invest in this. Consequently, we understand the participants as self- or management-'nominated' boundary spanners who can take on new tasks and help make the local department data-driven. In our case and as evidenced by the emergence of the field of SSBI, the expertise on how to work with data needs to be spread out into the organization, since demand for support will often easily surpass the capacity of centralized BI units. This is in part because the BIU cannot solely satisfy the demand for data, but also because working with data and the BI setup is challenging and requires knowledge, skills, and training. As our and several other studies have shown, understanding which data to use, knowing which data is relevant, and recontextualizing data into local practices require specific (socio-) technical skills (e.g., filtering and sorting as well as sense-making).

Finally, *propagating data locally* concerns the consolidation and extension of new joint fields through the incorporation of new local boundary spanners-in-practice. These boundary spanners take on new responsibilities to use, implement, and disseminate boundary objects locally, spanning the boundaries between activities and strategies at the local and organizational levels in collaboration with other local actors. Within hospitals and healthcare in general, putting data into use requires an understanding of how to relate data to local practices of management, treatment, and care. We surmise this applies to organizations in other domains as well, since 'all data are local' (Loukissas 2019). These local efforts are evident in the case of BI Ninjas working with Data Reports and supporting their coworkers. In contrast, we also see how boundary spanners may emerge from local wards in the case of the Data Hero physiotherapist: "Getting a corner of the data warehouse" enabled him and his coworkers to make a data model suited for their department, building off the work of the BIU and hence, adapting the boundary object to local circumstances and standards. This work further enabled them to create various other designated boundary objects (reports, projections models, etc.) which potentially can be used by different healthcare professionals to collaborate and

coordinate their work. While management support is important, the category of propagating data locally emphasizes the need for local actors' involvement, interest, and work to implement data in local healthcare practices.

These three dimensions of boundary work characterize the BIU's externally directed work to cultivate data practices across boundaries. We suggest being aware of these to gain a better grasp of how healthcare organizations can become data-driven: Organizations do not become data-driven solely through strategies, data warehouses, and data reports, but need to cultivate new joint fields between data experts and lay users.

6.2 Data Work in Healthcare

This case analysis also contributes to the field of data work studies. First, by describing and analyzing the work going on at a site of intensive data generation, use, and promotion, and by providing one of the first ethnographic analyses of data work practices in a BI site. The analysis has in particular focused on and made visible the work invested by the BIU in promoting the use of data and of the BIU's data products, as well as the efforts to build local capacity for putting data into practice. As with many other inventions and new designs, we cannot assume that these spread and diffuse by themselves but rather that it takes effort and energy to translate between actors and social worlds and make them move (Latour 1984). Hence, the BIU cares for data and invests 'emotional labour' (Choroszewicz 2022) into furthering the use of data.

Second, our case highlights the importance of collaboration when working with and by data. In our case, this was for example prevalent when BI developers and healthcare professionals collaborated to mobilize interest, to establish potential and possibilities, and to share knowledge and expertise. Other data work studies also demonstrate the importance of collaboration and interdisciplinarity in data work: E.g., data science workers collaborate with direct and indirect stakeholders throughout every stage of a data science project (Zhang et al. 2020; Mao et al. 2019), IT-personnel collaborate with clinicians to develop new indicators of quality (Bonde et al. 2019), and audit support staff negotiates queries about data with healthcare staff to gain a deeper understanding of data (McVey et al. 2021). In particular, we point to collaborative boundary work as one important aspect of collaboration around data. Extending this argument, our findings and other data work studies demonstrate how digitalization and data work are not just '[…] imposed from the outside of sites subjected to the technical' (Cruz 2021, p. 2). Whereas national and regional politics regulate the organizational settings and provide the basis for resources, a kind of configurational boundary work, the data-driven healthcare organization emerges in everyday practices through collaboration and co-production between healthcare professionals, data professionals, and

management, translating national, regional, and local interests in various creative ways.

6.3 BI and Self-Service BI

Finally, our study contributes to the field of BI, through an ethnographic study of the work practices at a healthcare BIU. We consider their work a socio-technical matter of concern, as opposed to a purely technical one. While the identified activities in our case are not necessarily generalizable, they may be transferable, and we will discuss our analytical contributions to the field of BI and SSBI and the practical implications in the following.

In general, it is recognized that SSBI is not 'self-propelling' (Weiler et al. 2019), but requires training and communication of benefits and expectations – especially with users inexperienced with BI. Our findings also resonate with other SSBI studies in this matter and recognize the need for training (e.g., Lennerholt et al. 2022; Imhoff and White 2011), however, not many have gone into detail on how this could be approached or how training is conducted in practice (See though Berndtsson et al. (2019)). Moreover, the SSBI literature has not sufficiently recognized 'champions' (expert users) as a success factor for SSBI implementation (Lennerholt et al. 2022). In our study, we found that boundary spanners (champions) are needed to cultivate new joint fields to further the use of SSBI reports which could potentially lessen the burden on the BIU (e.g., medical secretaries setting up reports, supporting other users, and maintaining standards). However, all of this, of course, shifts the workload of support, reporting, and analytics from the BIU toward the end-user while the BI staff attends to new kinds of activities such as promotion and teaching.

In line with this, we offer a different analysis. Instead of thinking of SSBI as a push operation from the outside, we suggest thinking of the implementation and dissemination of SSBI in line with collaborative boundary work, new joint fields, and boundary objects: A dynamic interplay between several actors who want different things from each other. These actors move along and across boundaries, not only to break them down but also to negotiate them. In this process, some actors will take on new responsibilities or change their skills, while others will change their strategies and activities to pursue this change. Changes that require the work of all the actors involved which is often overseen in the greater narratives of data-driven organizations, but also in the implementation of SSBI and its success. Our study stresses the importance of such work. While it has been argued that SSBI is a disruptive technology - as it changes the role of the IT organization (e.g., the BIU), its way of working, and its purpose (Schlesinger and Rahman 2016, p. 20) - we suggest extending this focus to include the end-user: When data workloads shift towards the user

and their local departments, it will possibly change their roles and competence needs as well as reorganize work. In a healthcare context, this poses questions regarding resources, skills, and workflows: For example, how do these new data-driven methodologies enter practice and change the daily work of the healthcare department? How do these systems support the cooperative work between different professions? Which new skills are required of healthcare staff members? In general, there is a need for ethnographic studies investigating how BI influences existing organizational practices and sense-making (Talaoui and Kohtamäki 2020, p. 1382). This will be the next step for our future research.

7 Conclusion

Based on an ethnographic case study, we have analyzed the collaborative work of a BI unit aimed at making the healthcare organization data-driven. We point at the three aspects of this work: 1) mobilizing interest, 2) building local capabilities, and 3) propagating data locally. We label this work 'cultivating data practices across boundaries' which signifies the efforts to cultivate a new joint field through collaborative boundary work to implement and disseminate boundary objects and spanners. We hope that this study can contribute to an understanding of what it takes and means in practice to become data-driven and further data-driven efforts pragmatically as well as in research.

Competing Interests The authors declare no competing interests.

References

Akkerman, Sanne F., and Arthur Bakker. 2011. Boundary Crossing and Boundary Objects. *Review of Educational Research* 81 (2): 132–169.

Alpar, Paul, and Michael Schulz. 2016. Self-Service Business Intelligence. *Business & Information Systems Engineering* 58 (2): 151.

Annapurani, K., E. Poovammal, C. Ruvinga, and Ibrahim Venkat. 2021. Healthcare Data Analytics Using Business Intelligence Tool. In *Machine Learning and Analytics in Healthcare Systems*, eds. H. Bansal, B. Balusamy, T. Poongodi, and K. P. Firoz Khan, 191–212. Boca Raton: CRC Press.

Arnaboldi, Michela, Andrea Robbini, and Paola Carlucci. 2021. On the Relevance of Self-Service Business Intelligence to University Management. *Journal of Accounting & Organizational Change* 17 (1): 5–22.

Basile, Luigi Jesus, Nunzia Carbonara, Roberta Pellegrino, and Umberto Panniello. 2023. Business Intelligence in the Healthcare Industry: The Utilization of a Data-Driven Approach to Support Clinical Decision Making. *Technovocation* 120: 102482. https://doi.org/10.1016/j.technovation.2022.102482.

Berg, Marc, and Geoffrey Bowker. 1997. The multiple bodies of the medical record. *The Sociological Quarterly* 38 (3): 513–37.

Berndtsson, Mikael, Christian Lennerholt, Peter Larsson, and Thomas Svahn. 2019. A blueprint for training future users of self-service business intelligence. *Business Intelligence Journal* 24 (1): 30–38.

Richard, Berntsson Svensson, and Maryam Taghavianfar. 2020. Toward Becoming a Data-Driven Organization: Challenges and Benefits. In *Research Challenges in Information Science. Lecture Notes in Business Information Processing*, 385th edn., eds. Fabiano Dalpiaz, Jelena Zdravkovic, and Pericles Loucopoulos, 3–19. Cham: Springer International Publishing.

Bjørnstad, Camilla, and Gunnar Ellingsen. 2019. Data Work: A Condition for Integrations in Health Care. *Health Informatics Journal* 25 (3): 526–535.

Bonde, Morten, Claus Bossen, and Peter Danholt. 2019. Data-Work and Friction: Investigating the Practices of Repurposing Healthcare Data. *Health Informatics Journal* 25 (3): 558–566.

Bossen, Claus, Yunan Chen, and Kathleen H. Pine. 2019a. Information infrastructures in healthcare and emergent data work occupations: The case of medical scribes and CDIS. In *7th International Conference on Infrastructures in Healthcare. European Society for Socially Embedded Technologies (EUSSET)*, 1–10. https://doi.org/10.18420/ihc2019_014.

Bossen, Claus, Yunan Chen, and Kathleen H. Pine. 2019b. The Emergence of New Data Work Occupations in Healthcare: The Case of Medical Scribes. *International Journal of Medical Informatics* 123: 76–83.

Bossen, Claus, Kathleen H. Pine, Federico Cabitza, Gunnar Ellingsen, and Enrico Maria Piras. 2019c. Data Work in Healthcare: An Introduction. *Health Informatics Journal* 25 (3): 465–474.

Bracci, Enrico, Giorgia Gobbo, and Luca Papi. 2020. The Integration of Risk and Performance Management: The Role of Boundary Objects. *Journal of Public Budgeting, Accounting & Financial Management* 34 (1): 139–161. Emerald Publishing Limited.

Brinkmann, Svend. 2013. *Qulitative Interviewing - Understanding Qualitative Research*. New York: Oxford University Press.

Brooks, Patti, Omar El-Gayar, and Surendra Sarnikar. 2013. Towards a Business Intelligence Maturity Model for Healthcare. In *2013 46th Hawaii International Conference on System Sciences*, 3807–3816. Wailea: IEEE.

Brooks, Patti, Omar El-Gayar, and Surendra Sarnikar. 2015. A framework for developing a domain specific business intelligence maturity model: Application to healthcare. *International Journal of Information Management* 35 (3): 337–345.

Bryan, A. L., and J. C. Lammers. 2020. Professional fission in medical routines: Medical scribes and physicians in two us hospital departments. *Journal of Professions and Organization* 3: 265–282.

Buttigieg, Sandra C., Adriana Pace, and Cheryl Rathert. 2017. Hospital performance dashboards: A literature review. *Journal of Health Organization and Management* 31 (3): 385–406.

Bygstad, Bendik, Egil Øvrelid, and Thomas Lie. 2019. Establishing an analytics capability in a hospital. In *Smart Working, Living and Organising. IFIP Advances in Information and Communication Technology*, 533rd edn., eds. Amany Elbanna, Yogeshk Dwivedi, Deborah Bunker, and David Wastell, 3–14. Cham: Springer International Publishing.

Callon, Michel. 1984. Some elements of a sociology of translation: Domestication of the scallops and the fishermen of St Brieuc Bay. *The Sociological Review* 32 (1_suppl, 2005): 196–233.

Charmaz, Kathy. 2014. *Constructing Grounded Theory*, 2nd edn. Sage Publications.

Chen, Hsinchun, Roger H. L. Chiang, and Veda C. Storey. 2012. Business intelligence and analytics: From big data to big impact. *MIS Quarterly* 36 (4): 1165–1188.

Choroszewicz, Marta. 2022. Emotional labour in the collaborative data practices of repurposing healthcare data and building data technologies. *Big Data & Society* 9 (1): 1–12.

Choroszewicz, Marta, and Marja Alastalo. 2021. Organisational and professional hierarchies in a data management system: Public–Private collaborative building of public healthcare and social services in Finland. *Information, Communication & Society*, 1–19. https://doi.org/10.1080/1369118X.2021.1942952.

Cruz, Taylor. 2021. Data politics on the move: Intimate work from the inside of a data-driven health system. *Information, Communication & Society*, 1–16. https://doi.org/10.1080/1369118X.2021.1954972.

Daradkeh, Mohammad, and Radwan Al-dwairi. 2017. Self-service business intelligence adoption in business enterprises: The effects of information quality, system quality, and analysis quality. *International Journal of Enterprise Information Systems* 13 (3): 65–66.

Dash, Sabyasachi, Sushil Kumar Shakyawar, Mohit Sharma, and Sandeep Kaushik. 2019. Big data in healthcare: Management, analysis and future prospects. *Journal of Big Data* 6 (1): 1–25 (Springer).

Deng, Xuefei, and Lei Chi. 2012. Understanding postadoptive behaviors in information systems use: A longitudinal analysis of system use problems in the business intelligence context. *Journal of Management Information Systems* 29 (3): 291–326.

Ét sikkert og sammenhængende sundhedsnetværk for alle - Strategi for digital sundhed 2018-2022. 2018. The Danish Government, KL, and The Danish Regions.

Figueiredo, M. C., and Y. Chen. 2021. Health data in fertility care: An ecological perspective.

Fiske, Amelia, Barbara Prainsack and Alena Buyx. 2019. Data work: Meaning-making in the era of data-rich medicine. *Journal of Medical Internet Research* 21 (7): e11672. https://doi.org/10.2196/11672.

Fosso Wamba, Samuel, Shahriar Akter, Andrew Edwards, Geoffrey Chopin, and Denis Gnanzou. 2015. How 'big data' can make big impact: Findings from a systematic review and a longitudinal case study. *International Journal of Production Economics* 165 (July 2015): 234–246.

Foster, Jonathan, Julie McLeod, Jan Nolin, and Elke Greifeneder. 2018. Data work in context: Value, risks, and governance. *Journal of the Association for Information Science and Technology* 69 (12): 1414–1427.

Gaardboe, Rikke, Niels Sandalgaard, and Tom Nyvang. 2017. An assessment of business intelligence in public hospitals. *International Journal of Information Systems and Project Management* 5 (4): 5–18.

Gaardboe, Rikke, Niels Sandalgaard, and Tanja Svarre. 2018. Which Factors of Business Intelligence Affect Individual Impact in Public Healthcare? In *Proceedings from The 16th Scandinavian Conference on Health Informatics 2018, Aalborg, Denmark August 28–29, 2018*, 151:96–100. Aalborg, Denmark: Linköping University Electronic Press. Linköping Electronic Conference Proceedings. http://www.ep.liu.se/ecp/151/017/ecp18151017.pdf.

Ghazisaeidi, Marjan, Reza Safdari, Mashallah Torabi, Mahboobeh Mirzaee, Jebraeil Farzi, and Azadeh Goodini. 2015. Development of performance dashboards in healthcare sector: Key practical issues. *Acta Informatica Medica* 23 (5): 317.

Gieryn, Thomas F. 1983. Boundary-work and the demarcation of science from non-science: Strains and interests in professional ideologies of scientists. *American Sociological Review* 48 (6): 781–795.

Grisot, Miria, Alexander Moltubakk Kempton, Laila Hagen, and Margunn Aanestad. 2019. Data-work for personalized care: Examining nurses' practices in remote monitoring of chronic patients. *Health Informatics Journal* 25 (3): 608–616.

Grossglauser, Matthias, and Hugo Saner. 2014. Data-Driven healthcare: From patterns to actions. *European Journal of Preventive Cardiology* 21 (25): 14–17.

Håland, Erna, and Line Melby. 2021. Coding for Quality? Accountability Work in Standardised Cancer Patient Pathways (CPPs). *Health: An Interdisciplinary Journal for the Social Study of Health, Illness and Medicine*, 1–18. https://doi.org/10.1177/13634593211013882.

Hammersley, Martyn, and Paul Atkinson. 2019. *Ethnography - Principles in Practice*, 4th edn. London and New York: Routledge - Taylor & Francis Group.

Helminski, Danielle, Jacob E. Kurlander, Anjana Deep Renji, Jeremy B. Sussman, Paul N. Pfeiffer, Marisa L. Conte, Oliver J. Gadabu, Alex N. Kokaly, Rebecca Goldberg, Allison Ranusch, Laura J. Damschroder, and Zach Landis-Lewis. 2022. Dashboards in health care settings: Protocol for a scoping review. *JMIR Research Protocols* 11 (3): 1–9.

Hoeyer, Klaus. 2023. *Data Paradoxes: The Politics of Intensified Data Sourcing in Contemporary Healthcare*. The MIT Press.

Hogle, Linda F. 2016. Data-Intensive Resourcing in Healthcare. *BioSocieties* 11 (3): 372–393.

Huvila, Isto, Theresa Dirndorfer Anderson, Eva Hourihan Jansen, Pam McKenzie, and Adam Worrall. 2017. Boundary objects in information science. *Journal of the Association for Information Science and Technology* 68 (8): 1807–1822.

Imhoff, Claudia and Colin White. 2011. Self-Service Business Intelligence: Empowering Users to Generate Insights. *TDWI Best Practices Report* 40.

Islind, Anna Sigridur, Helena Vallo Hult, Karin Rydenman and Per Wekell. 2022. Co-creating a digital symptom tracker: An app as a boundary object in the context of pediatric care. In *International Working Conference on Transfer and Diffusion of IT*, 79–93. Springer International Journal.

Kitchin, Rob. 2014. Big data, New epistemologies and paradigm shifts. *Big Data & Society* 1 (1): 1–12.

Knudsen, Casper and Pernille Bertelsen. 2022. Maintaining data quality at the hospital department level – The data work of medical secretaries. In *Proceedings of the 18th Scandinavian Conference on Health Informatics,* 159–65.

Knudsen, Casper and Pernille Scholdan Bertelsen. 2021. Data Work in Health Care: The Case of Medical Secretaries. In *Context Sensitive Health Informatics: The Role of Informatics in Global Pandemics*, 60–64. Studies in Health Technology and Informatics 286. IOS Press. https://doi.org/10.3233/SHTI210638.

Langley, Ann, Kajsa Lindberg, Bjørn Erik Mørk, Davide Nicolini, Elena Raviola, and Lars Walter. 2019. Boundary work among groups, occupations, and organizations: From cartography to process. *Academy of Management Annals* 13 (2): 704–736. Academy of Management.

Latour, Bruno. 1984. The powers of association. *The Sociological Review* 32 (1): 264–280. SAGE Publications Ltd.

Latour, Bruno. 1987. *Science in Action: How to Follow Scientists and Engineers through Society*. Cambridge, Mass: Harvard University Press.

Lee, Charlotte P. 2007. Boundary negotiating artifacts: Unbinding the routine of boundary objects and embracing chaos in collaborative work. *Computer Supported Cooperative Work (CSCW)* 16 (3): 307–339.

Lennerholt, Christian. 2019. Data Access and Data Quality Challenges of Self-Service Business Intelligence. In *Proceedings of the 27th European Conference on Information Systems (ECIS)*, 1–14. Sweden: Stockholm & Uppsala.

Lennerholt, Christian, Joeri van Laere and Eva Söderström. 2018. Implementation challenges of self service business intelligence: A literature review. In *Proceedings of the 51st Hawaii International Conference on System Sciences*, 5055–5063. https://doi.org/10.24251/HICSS.2018.631.

Lennerholt, Christian, Joeri van Laere, and Eva Söderström. 2022. Success factors for managing the SSBI challenges of the AQUIRE Framework. *Journal of Decision Systems* 32 (2): 1–22. https://doi.org/10.1080/12460125.2022.2057006.

Lennerholt, Christian, Joeri Van Laere, and Eva Söderström. 2020. User-Related Challenges of Self-Service Business Intelligence. *Information Systems Management* 38 (4): 1–15.

Levina, Natalia and Emmanuelle Vaast. 2005. The emergence of boundary spanning competence in practice: Implications for implementation and use of information systems. *MIS Quarterly* 29 (2): 335.

Loukissas, Yanni Alexander. 2019. *All Data Are Local: Thinking Critically in a Data-Driven Society*. Cambridge, Massachusetts/London, England: MIT Press.

Madsen, Laura. 2014. *Data-Driven Healthcare: How Analytics and BI Are Transforming the Industry*. Hoboken: John Wiley & Sons Inc.

Madsen, Laura B. 2012. *Healthcare Business Intelligence: A Guide to Empowering Successful Data Reporting and Analytics*. Hoboken, NJ, USA: John Wiley & Sons, Inc.

Mao, Yaoli, Dakuo Wang, Michael Muller, Kush R. Varshney, Ioana Baldini, Casey Dugan, and Aleksandra Mojsilović. 2019. How Data Scientists Work Together With Domain Experts in Scientific Collaborations: To Find The Right Answer Or To Ask The Right Question *Proceedings of the ACM on Human-Computer Interaction*, 3 (GROUP): 1–23. https://doi.org/10.1145/3361118.

Marent, Benjamin, and Flis Henwood. 2021. 21 Digital health. In *Routledge International Handbook of Critical Issues in Health and Illness*, 261–275. Routledge.

Marjanovic, Olivera. 2016. Empowering Business Users to Explore Visual Data Through Boundary Objects and Storytelling. In *2016 49th Hawaii International Conference on System Sciences (HICSS)*, 5032–41. Koloa: IEEE. https://doi.org/10.1109/HICSS.2016.624.

Marjanovic, Olivera, Greg Patmore, and Nikola Balnave. 2022. Visual analytics: Transferring, translating and transforming knowledge from analytics experts to non-technical domain experts in multidisciplinary teams. *Information Systems Frontiers* 25 (4): 1571–88. https://doi.org/10.1007/s10796-022-10310-4.

Massa, Silvia, and Stefania Testa. 2005. Data Warehouse-in-practice: Exploring the function of expectations in organizational outcomes. *Information & Management* 42 (5): 709–718.

McVey, Lynn, Natasha Alvarado, Joanne Greenhalgh, Mai Elshehaly, Chris P. Gale, Julia Lake, Roy A. Ruddle, Dawn Dowding, Mamas Mamas, Richard Feltbower, and Rebecca Randell. 2021. Hidden Labour: The Skilful Work of Clinical Audit Data Collection and Its Implications for Secondary Use of Data via Integrated Health IT. *BMC Health Services Research* 21 (1): 1–11.

Meesters, Kenny, Joris Wijnen, Mats Visser, and Kees Boersma. 2022. The Challenge and Value of Dashboard Development During the COVID-19 Pandemic. In *2022 IEEE Global Humanitarian Technology Conference (GHTC)*, 9–16. Santa Clara: IEEE.

Mettler, Tobias, and Vivian Vimarlund. 2009. Understanding business intelligence in the context of healthcare. *Health Informatics Journal* 15 (3): 254–264.

Møller, NajaHolten, Claus Bossen, Kathleen H. Pine, Trine Rask Nielsen, and Gina Neff. 2020. Who does the work of data? *Interactions* 27 (3): 52–55.

Møller, Naja L., PernilleBjørn Holten, Jonas Christoffer Villumsen, Tine C. Hansen Hancock, Toshimitsu Aritake, and Shigeyuki Tani. 2017. Data Tracking in Search of Workflows. In *Proceedings of the 2017 ACM Conference on Computer Supported Cooperative Work and Social Computing*, 2153–2165. Portland Oregon: ACM.

Muller, Michael, Ingrid Lange, Dakuo Wang, David Piorkowski, Q. Jason Tsay, Vera Liao, Casey Dugan, and Thomas Erickson. 2019. How Data Science Workers Work with Data: Discovery, Capture, Curation, Design, Creation. In *Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems*, 1–15. Scotland: ACM.

Nationale mål for sundhedsvæsenet. 2021. *The Ministry of Health, KL, and The Danish Regions*. https://sum.dk/Media/637697073524473744/Nationale%20M%C3%A5l%20for%20Sundhedsv%C3%A6senet%202021.pdf.

Negash, Solomon. 2004. Business Intelligence. *Communications of the Association for Information Systems* 13 (1): 15. https://doi.org/10.17705/1CAIS.01315.

Negash, Solomon, and Paul Gray. 2004. Business intelligence. In *Handbook on Decision Support Systems*, 2nd edn., eds. F. Burstein and C. W. Holsapple, 175–193. Berlin, Heidelberg: Springer Berlin Heidelberg.

Østerlund, Carsten S. 2008. Documents in Place: Demarcating Places for Collaboration in Healthcare Settings. *Computer Supported Cooperative Work (CSCW)* 17 (2–3): 195–225.

Passlick, Jens, Nadine Guhr, Benedikt Lebek, and Michael H. Breitner. 2020. Encouraging the use of self-service business intelligence – An examination of employee-related influencing factors. *Journal of Decision Systems* 29 (1): 1–26.

Pedersen, Asbjørn Malte, and Claus Bossen. 2021. Data Work in Healthcare: An Ethnography of a BI Unit. In *Infrahealth 2021 - Proceedings of the 8th International Conference on Infrastructures in Healthcare 2019*, 5 (4): 1–11.

Pestana, Miguel, Ruben Pereira, and Sérgio Moro. 2020. Improving health care management in hospitals through a productivity dashboard. *Journal of Medical Systems* 44 (4): 18–19.

Pine, Kathleen H., and Claus Bossen. 2020. Good organizational reasons for better medical records: the data work of clinical documentation integrity specialists. *Big Data & Society* 7 (2): 1–13.

Power, Daniel J. 2015. Creating a Data-Driven Global Society. In *Reshaping Society through Analytics, Collaboration, and Decision Support: Role of Business Intelligence and Social Media. Annals of Information Systems*, eds. Lakshmi S. Lyer and Daniel J. Power, 13–28. Cham: Springer International Publishing.

Ratia, Milla, Jussi Myllärniemi, and Nina Helander. 2019. The potential beyond IC 4.0: The evolution of business intelligence towards advanced business analytics. *Measuring Business Excellence* 23 (4): 396–410.

Rattray, Nicholas A., Teresa M. Damush, Edward J. Miech, Barbara Homoya, Laura J. Myers, Lauren S. Penney, Jared Ferguson, Brenna Giacherio, Meetesh Kumar, and Dawn M. Bravata. 2020. Empowering implementation teams with a learning health system approach: Leveraging data to improve quality of care for transient ischemic attack. *Journal of General Internal Medicine* 35 (S2): 823–831.

Rothschild, Annabel, Amanda Meng, Carl DiSalvo, Britney Johnson, Ben Rydal Shapiro, and Betsy DiSalvo. 2022. Interrogating data work as a community of practice. *Proceedings of the ACM on Human-Computer Interaction* 6 (CSCW2): 1–28.

Ruckenstein, Minna, and Natasha Dow Schüll. 2017. The datafication of health. *Annual Review of Anthropology* 46 (1): 261–278.

Sambasivan, Nithya, Shivani Kapania, Hannah Highfill, Diana Akrong, Praveen Paritosh, and Lora M. Aroyo. 2021. "Everyone Wants to Do the Model Work, Not the Data Work": Data Cascades in High-Stakes AI. In *Proceedings of the 2021 CHI Conference on Human Factors in Computing Systems*, 1–15. Yokohama: ACM.

Schlesinger, Peggy A., and Nayem Rahman. 2016. Self-Service business intelligence resulting in disruptive technology. *Journal of Computer Information Systems* 56 (1): 11–21.

Shilo, Smadar, Hagai Rossman, and Eran Segal. 2020. Axes of a revolution: Challenges and promises of big data in healthcare. *Nature Medicine* 26 (1): 29–38. (Nature Publishing Group).

Star, Susan Leigh. 1989. The structure of ill-structured solutions: Boundary objects and heterogeneous distributed problem solving. In *Distributed Artificial Intelligence*, 37–54. San Francisco (CA): Morgan Kaufmann. https://doi.org/10.1016/B978-1-55860-092-8.50006-X.

Star, Susan Leigh. 2010. This Is Not a Boundary Object: Reflections on the Origin of a Concept. *Science, Technology, & Human Values*, September 2010, 35 (5): 601–617..

Star, Susan Leigh, and James R. Griesemer. 1989. Institutional ecology, translations and boundary objects: Amateurs and professionals in Berkeley's Museum of Vertebrate Zoology, 1907-39. *Social Studies of Science*, August 1989, 19 (3): 387–420.

Talaoui, Yassine, and Marko Kohtamäki. 2020. Of BI research: A tale of two communities. *Management Research Review* 43 (11): 1371–1394.

Thakkar, D., A. Ismail, P. Kumar, A. Hanna, N. Sambasivan, and N. Kumar. 2022. *When Is Machine Learning Data Good?: Valuing in Public Health Datafication*

Torenholt, Rikke, Lena Saltbæk, and Henriette Langstrup. 2020. Patient data work: Filtering and sensing patient-reported outcomes. *Sociology of Health & Illness* 42 (6): 1379–1393.

Trygt, Nært Og Nemt - Regionernes Strategi for Fremtidens Sundhedsvæsen. 2018. The Danish Regions. http://www.e-pages.dk/regioner/148/html5/.

Weiler, Severin, Christian Matt and Thomas Hess. 2019. Understanding User Uncertainty during the Implementation of Self-Service Business Intelligence: A Thematic Analysis. In *Proceedings of the 52nd Hawaii International Conference on System Sciences*, 5878–87. Hawaii. https://hdl.handle.net/10125/60023.

Wixom, Barbara, and Hugh Watson. 2010. The BI-Based Organization. *International Journal of Business Intelligence Research* 1 (1): 13–28.

Zhang, Amy X., Michael Muller, and Dakuo Wang. 2020. How Do Data Science Workers Collaborate? Roles, Workflows, and Tools. *Proceedings of the ACM on Human-Computer Interaction* 4 (CSCW1): 1–23.

Zheng, Wenzhi, Yen-Chun Jim Wu, and Liangyong Chen. 2018. Towards healthcare business intelligence in long-term care. *Telematics and Informatics* 35 (4): 665–676.

Zhou, Xiaomu, Mark Ackerman, and Kai Zheng. 2011. CPOE Workarounds, Boundary Objects, and Assemblages. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, 3353–3362. Vancouver: ACM.