Managing digital infrastructures: negotiating control and drift in service provisioning

Nils-Petter Augustsson*

Swedish Center for Digital Innovation,
Department of Informatics,
Industrial Doctorate School,
Umea University,
SE-901 87 Umea, Sweden
Email: nils-petter.augustsson@umu.se
*Corresponding author

Agneta Nilsson

University of Gothenburg,
SE-412 96 Gothenburg, Sweden
and
Chalmers University of Technology,
Box 100, SE-405 30 Gothenburg, Sweden
Email: agneta.nilsson@chalmers.se

Jonny Holmström

Swedish Center for Digital Innovation,
Department of Informatics,
Umea University,
SE-901 87 Umea, Sweden
Email: jonny.holmstrom@umu.se

Lars Mathiassen

Computer Information Systems,
J. Mack Robinson College of Business,
Georgia State University,
33 Gilmer Street SE Atlanta, GA 30302, USA
Email: lmathiassen@ceprin.org

Abstract: The digital infrastructure literature provides important perspectives on the intrinsic relations between information systems in today's organisations. However, little attention has been paid to the challenges involved in providing requisite digital infrastructure services to organisations. In this paper, we argue digital infrastructure service providers operate in highly complex and uncertain environments. Rather than adopting a traditional approach to control, providers must therefore continuously negotiate a balance between control and drift as two complementary strategies. Our argument is based on a retrospective longitudinal case study of a Swedish infrastructure service team within a large

international firm. Using the encounter-episode process model as structuring principle and focusing on the tension between control and drift, we analyse the evolution of the provider's efforts to manage a portfolio of digital infrastructure services over a period of ten years. Based on these analyses, we uncover the involved complexities and dynamics, how control efforts and drift were constituted and how the infrastructure services were managed by continuously balancing control and drift. In conclusion, we relate the findings to extant literature to discuss new insights into provider management of digital infrastructure services.

Keywords: digital infrastructures; services; management; control and drift.

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Biographical notes: Nils-Petter Augustsson is a PhD student within the Industrial Doctoral School at Umeå University. In parallel, he is working as a consultant within the information technology area with service delivery and solution management as his special areas. Prior to these positions, he has been working as a Junior Lecturer at the Department of Informatics, Umea University and as a Junior Researcher at the Interactive Institute Tools studio in Umea. He has presented his research at international conferences such as the International Conference of Information Systems, American Conference on Information Systems, Hawaii International Conference on System Sciences, Information Systems Research Seminar in Scandinavia, the Nordic Conference of Business Studies, International Conference on Design and Emotion, and the International Conference on Work with Computing Systems.

Agneta Nilsson is a Senior Lecturer at the Department of Computer Science and Engineering at Chalmers University of Gothenburg. She holds a PhD in Informatics from the University of Gothenburg. Her general research interest is IT-enabled change focusing on how to arrange and manage such processes in organisations in order to realise intended changes.

Jonny Holmström is a Professor of Informatics at the Umeå University and the Director and co-Founder of Swedish Center for Digital Innovation. He writes, consults and speaks on topics such as IT management, IT innovation, and strategies for leveraging IT-based value for firms. His work has appeared in journals such as *Communications of the AIS*, *Convergence*, *Design Issues*, *European Journal of Information Systems*, *Industrial Management and Data Systems*, *Information and Organization*, *Information Resources Management Journal*, *Information Systems Journal*, *Information Technology and People*, *Journal of the AIS*, *Journal of Strategic Information Systems*, *Research Policy*, and *The Information Society*.

Lars Mathiassen is a Georgia Research Alliance Eminent Scholar, Professor at the Computer Information Systems Department, and cofounder of The Center for Process Innovation at Georgia State University. His research focuses on development of software and information services, on IT-enabled innovation of business processes, and on management and facilitation of organisational change processes. He approaches innovation and improvement initiatives with a strong focus on people skills and collaborative processes while at the same time emphasising adoption of state-of-the-art technologies and methods. He has published extensively in major information systems and software engineering journals and has co-authored several books on the subject including

Professional Systems Development, *Computers in Context: The Philosophy and Practice of Systems Design*, *Object Oriented Analysis & Design*, and *Improving Software Organisations: From Principles to Practice*. He has served as a Senior Editor for *MIS Quarterly* and is currently serving in that capacity for *Journal of Information Technology* and *Information and Organisation*.

1 Introduction

Complex digital infrastructures have become increasingly important enablers of organisational operation and change. Although notable advances have been made towards conceptualising digital infrastructures as part of the structural fabric of organisations (e.g., Weill and Broadbent, 1998; Weill and Vitale, 2002; Bygstad, 2010; Henfridsson and Bygstad, 2013), the need for agility and flexibility in digital infrastructure have driven organisations to evolve their infrastructure over time in response to changing business needs (Baskerville and Pries-Heje, 2004; Bygstad, 2010; Henfridsson and Bygstad, 2013). As a result, digital infrastructures are often characterised as complex ensembles of heterogeneous artefacts, increasingly connected with and dependent upon one another (Hanseth and Lyytinen, 2010).

The evolution of digital infrastructures poses considerable management challenges for the hosting organisation and experiences have demonstrated how difficult it can be to impose managerial control over something that is in such constant flux (e.g. Ciborra, 1997). Hence, Ciborra and Failla (2000) accentuate how the strive for management control over infrastructures is commonly accompanied by drift due to turbulent environments, implementation tactics, complexity, the installed base, side-effects and surprises in contexts and user perceptions. While attempts to control are based on traditional, top-down management approaches, drift manifests itself as "plasticity in response to the re-inventions carried out by users and specialists, who gradually learns to discover and exploit features, affordances and potentials of systems" [Ciborra, (2002), p.87]. While extant research is full of accounts of the complex relationships between elements that make up digital infrastructures (Braa et al., 2007, Ciborra et al., 2000, Hanseth et al., 2006; Henfridsson and Bygstad, 2013), we know little about the challenges and practices involved in providing these services to organisations.

Based on a retrospective longitudinal case study, we investigate how control efforts and drift manifested over a ten-year period as a team managed digital infrastructure services within a firm that provides and maintains administrative portals for their customers. The complexity and the dynamics of the infrastructure and related business opportunities were overwhelming for the team. Based on rich data from this context, we address the research question: *How do control efforts and drift manifest in a provider's management of digital infrastructure services?*

We use several data-collection techniques and sources, covering both documentation and interviews, to investigate control and drift as complementary and intrinsically related opposites in a dialectical relationship (Tjornehoj and Mathiassen, 2008). We analyse how the team addressed these tensions and we make use of the related constructs to discuss management of complex digital infrastructure services. We apply the encounter-episode model (Newman and Robey, 1992; Lyytinen and Newman, 2008) to present a detailed account of the efforts to control the observed infrastructure, of the nature and constitution

of drifts that occurred, and of how the team engaged in ongoing negotiation of an appropriate balance between control and drift. In conclusion, we discuss new insights into providers' management of digital infrastructure services.

2 Background

As theoretical background, we review literature on digital infrastructure, digital infrastructure services, and managing between control and drift.

2.1 Digital infrastructures

Edwards et al. (2009) highlight how the term 'infrastructure' is used with great variation, often related to large, stable systems and services ranging from railroads and highways to telephone systems, electric power and the internet. Multiple terms are used for similar references, e.g., 'cyberinfrastructure' in the USA and 'e-science' in the Europe refer to new infrastructure to support data sharing and interdisciplinary approaches in science and 'e-infrastructure' encompasses emerging forms of e-commerce (Edwards et al., 2009). Frequently used terms include 'digital infrastructure' (e.g., Henfridsson and Bygstad, 2013; Tilson et al., 2010), 'information infrastructure' (e.g., Aanestad and Jensen, 2011; Braa et al., 2007; Ciborra et al., 2000; Hanseth et al., 1996; Star and Ruhleder, 1996) and 'IT infrastructure' (e.g., Armstrong and Sambamurthy, 1999; Bhatt and Grover, 2005; Broadbent et al., 1999).

While terms differ, Edwards et al. (2009, p.365–366) suggest there is a shared core notion about what characterises digital infrastructures that make them different from information systems:

1 the shift from individual computers and local networks to more distributed grid or cloud paradigms

2 integration of different media, e.g., text, audio, video and images

3 the extensive use of the world wide web for commerce, government and social life.

As the authors point out, "These phenomena mark the beginning of a transition to genuine infrastructure: robust, reliable, widely accessible systems and services that are beginning to look in form and centrality like the digital equivalents of the canonical infrastructures of telephony, electricity and the rail network". As such, digital infrastructures are heterogeneous socio-technical ensembles of IT artefacts, standards, patterns of action and capabilities in their social contexts that are layered, historically-determined, comprised of and for diverse communities and enacted in practice (Hanseth et al., 1996; Hanseth and Monteiro, 1997; Tilson et al., 2010; Hanseth and Braa, 2001; Iannacci, 2010; Hanseth and Lyytinen, 2010).

Any new infrastructure needs to be integrated with an installed base (Hanseth et al., 1996) that includes not only artefacts, but also human habits, norms and roles that may be the most difficult elements to manage (Edwards et al., 2009). Infrastructures are inherently path dependent, referring to how previous technology paths influence the adoption of new technology (Arthur, 1989; Cohen and Levinthal, 1990; Edwards et al., 2009), and they are therefore not so much designed as they are cultivated over time by multiple actors (Ciborra et al., 2000; Edwards et al., 2009). Moreover, they are critical to

a diverse range of economic and social phenomena, and many organisations adopt an active and intentional role in bringing appropriate infrastructures into existence (Henfridsson and Bygstad, 2013). Such an undertaking involves contradictory forces that drive infrastructural development, including the tensions between short- and long-term interests across a variety of stakeholders (Ribes and Finholt, 2009; Edwards et al., 2009). For the purposes of this paper, we use the term digital infrastructure following Tilson et al.'s (2010, p.748) recent research commentary pointing at the urgent need to theorise the evolution of digital infrastructures as our "field's attention moves beyond administrative systems and individual tools".

2.2 Service provisioning

Services can be narrowly defined as intangible events that are consumed by the end user and do not require any further processing (Grönroos, 1990, 2001; Quinn, 1992). This traditional definition focuses on the distinction between products and services and has later been challenged due to technological developments in which IT has fundamentally changed the way services are developed, delivered and conceived (Rai and Sambamurthy, 2006). As such, IT has become not only an enabler of new services, but also a scope changer for existing ones (Alter, 2010; Lyytinen and Rose, 2003; Chesbrough and Spohrer, 2006).

Vargo and Lusch (2004, 2008) coined the term service-dominant logic, as opposed to product-dominant logic and defined a service as "the application of resources for the benefit of another". The co-creation of value is the central part of a service (Maglio and Spohrer, 2008) and the co-creation and customer-determined benefit of services make them inherently customer oriented and relational (Vargo and Lusch, 2008). The combination of resources that constitute a service can be fairly complex and it is not always apparent what a particular service actually is (Vargo and Lusch, 2008). Maglio and Spohrer (2008) use the term service system to address the compositional aspects of services. Hence, a service system "represents any value–co-creation configuration of people, technology, value propositions connecting internal and external service systems and shared information (e.g., language, laws and measures)" [Maglio and Spohrer, (2008), p.18].

Recent developments suggest IT-based services span boundaries of business function, enterprise and geography. This has taken the complexity involved in evaluating, implementing, and not least managing them to another level, presenting a challenge to both research and practice (Bardhan et al., 2010). In their presentation of the new discipline of service science, management and engineering (SSME), Bardhan et al. (2010) present several areas where the managerial challenges have increased because of advances in technology. The process of understanding and dealing with the connection between technology and organisation is the foundation for managing digital infrastructures. While some scholars use terms like 'enterprise architecture' when describing the relationship between technology and business in organisations (Ross et al., 2006; Weill and Ross, 2004), we use the term 'digital infrastructure' to capture the continuously evolving technology under study as well as the events, people and processes that all together constitute the managerial challenge.

Table 1 Levels of analysis in digital infrastructure research

Context	*Description*	*Example*	*Key citations*
Industrial field	How field-level infrastructures come into being	Telecommunications industry and diffusion of broadband	Aanestad and Jensen (2011), Braa et al. (2007), Damsgaard and Lyytinen (2001), Hanseth et al. (1996), Hanseth et al. (2006), Hanseth and Monteiro (1997), Sahay et al. (2009), Sahay and Walsham (2006), Star and Ruhleder (1996), Tilson et al. (2010), Ure et al. (2009), Vaast and Walsham (2009)
Inter-organisational	How infrastructures between organisation impact organisational activity	Computer-aided design and architecture, engineering, and construction projects	Boland et al. (2007), Bygstad (2010), Bygstad (2008), Carlo et al. (2012), Gal et al. (2008), Hanseth and Lyytinen (2010), Henfridsson and Bygstad (2013), Ribes and Finholt (2009), Rolland and Monteiro (2002)
Intra-organisational	How organisational infrastructures are appropriated in organisational practices	Sociotechnical analysis of organisational change through organisational infrastructures	Armstrong and Sambamurthy (1999), Bhatt and Grover (2005), Broadbent and Weill (1997), Broadbent et al. (1999), Chatterjee et al. (2002), Chung et al. (2003), Duncan (1995), Broadbent et al. (1999), Byrd and Turner (2000), Ciborra and Failla (2000), Dahlbom et al. (2000), Fink and Neumann (2009), Hanseth and Braa (2000), Hanseth and Lundberg (2001), Khan et al. (2013), Lewis and Byrd (2003), Henderson and Venkatraman (1993), Henningsson and Hanseth (2011), Henningsson and Henriksen (2011), Hepsø et al. (2009), Zhu (2004), Pavlou and El Sawy (2006), Pipek and Wulf (2009), Weill (1993)

2.3 Levels of analysis

Extant research has portrayed the evolution of digital infrastructure as a complex process beyond rational managerial control. At least three streams of infrastructure research have emerged – complexity, network and relational – each of them embodying a distinctive view of the nature of this complexity (Henfridsson and Bygstad, 2013). Moreover, extant research covers different settings (e.g., health, telecom, natural resources, government and manufacturing), technologies (e.g., standards, platforms and the internet) and levels of analysis (e.g., industrial field, inter-organisational and intra-organisational). Table 1

provides an overview of extant research on three levels of analysis – industry, inter-organisational and intra-organisational – in which scholars have explored emergent phenomena associated with digital infrastructures.

At the industry level, researchers examine the complex and layered network of relationships and systems that aid in the development and transformation of digital infrastructures. For instance, the development of electronic data interchange (EDI) systems showed that such infrastructures are the result of complex interplay between organisational, industrial and institutional factors (Damsgaard and Lyytinen, 2001). This interplay is a reflection of both the inherent complexity of the underlying networked technologies and the heterogeneity of the stakeholders involved. At the inter-organisational level, extant research has examined how digital infrastructures are developed within and across inter-organisational networks. Recent research has specifically examined design technologies in the architecture, engineering and construction industry and project work using design technologies that penetrates organisational boundaries and serves as infrastructure to the project (Boland et al., 2007, Carlo et al., 2012, Gal et al., 2008). Research at the intra-organisational level highlights the role of material artefacts and organisational routines as carriers of organisational logics. Such material artefacts include ERP systems as infrastructures that get appropriated in the performance of organisational practice (Lyytinen and Newman, 2008).

Table 2 highlights three different perspectives – use, implement and provide – from which scholars have investigated digital infrastructures. The use perspective focuses on challenges and opportunities for an organisation to leverage digital infrastructures in their ways of working. For example Broadbent et al. (1999) study how digital infrastructures condition and impact implementation of BPR in four different organisations. Another example is Bansler and Kensing (2010) who study how infrastructures not only influence and change existing practices, but also connect existing practices as well as create entirely new practices within the area of health care work. Vaast and Walsham (2009) study the implementation of a Web-based information system used by people working in the field of environmental health and the transformations of local practices. The implement perspective highlights the challenges involved in bringing digital infrastructures to use. For example, Bygstad (2010) investigates how existing infrastructures enables innovation of ICT-based services and Ciborra and Failla (2000) study the deployment of CRM at IBM focused on the inner dynamics of conception, launch, deployment, use and ongoing modification. The provide perspective has examined design and development of digital infrastructures solutions. For example, Broadbent and Weill (1997) focus on the creation of an infrastructure in a company based on the view that these efforts can be managed through control and without any focus on the emergent nature of the phenomena. Ciborra (2000) focuses on diffusion, emphasising the need for diverse approaches in different contexts similar to Damsgaard and Lyytinen (2001). The study by Grisot et al. (2014) is the only study we found with an explicit provider perspective. It focuses on design and development of an infrastructure solution in Norwegian healthcare with an emphasis on how to survive by keeping the activity ‘under the radar’ a highly complex and troubled environment.

Table 2 Perspectives in digital infrastructure research

Perspective	*Key citations*
Use	Bossen and Markussen (2010), Byrd and Turner (2000), Broadbent et al. (1999), Bhatt and Grover (2005), Chatterjee et al. (2002), Chung et al. (2003), Cordella (2010), Dahlbom et al. (2000), Duncan (1995), Henningsson and Hanseth (2011), Henningsson and Henriksen (2011); Khan et al. (2013), Henderson and Venkatraman (1993), Henfridsson and Bygstad (2013), Lewis and Byrd (2003), Star and Ruhleder (1996), Steiner van der Kruk and Schellhammer (2014), Vaast and Walsham (2009)
Implement	Aanestad and Jensen (2011), Bansler and Kensing (2010), Bossen and Markussen (2010), Bygstad (2010), Ciborra and Failla (2000), Ellingsen and Røed (2010), Hanseth et al. (1996), Hepsø et al. (2009), Khanna and Venters (2013), Pipek and Wulf (2009), Ribes and Finholt (2009), Rodon and Silva (2015), Sahay and Walsham (2006), Monteiro et al. (2013)
Provide	Braa et al. (2007), Broadbent and Weill (1997), Ciborra (2000), Damsgaard and Lyytinen (2001), Grisot et al. (2014), Piras and Zanutto (2010)

In this research, we take the position that understanding infrastructures-in-use involves addressing the political, social and technical choices that were made throughout their development. Such efforts involve "going backstage" (Star, 1999), practicing "infrastructural inversion" (Bowker, 1994) that shifts the emphasis from changes in infrastructural components to changes in infrastructural relations. Extant research has to a large extent focused attention on the organisations in which infrastructures are used, and according to Pollock and Williams (2010) "the separation between studies of technology design/development and of technology implementation/use is reflected in the circulation within many implementation studies of stereotypical accounts of technology suppliers from the perspective of the organisational user often in the early stages of implementation (e.g., stories of supplier offerings 'thrown over the wall' to unhappy organisational users)". Although there are studies from a provider perspective (Table 2), there is still a tendency to focus more on the receiving than the provider organisation (Williams and Pollock, 2012) and researchers have called for a better understanding of the role of the provider organisation (Henningsson and Henriksen, 2011). This has become increasingly important as ubiquitous computing, increased emphasis on inter-organisational applications and demands for shorter project life-cycles have introduced new types of services and changed the risk profile of digital infrastructure projects. As such, digital infrastructure providers are often challenged to co-create value with would-be users who are outside organisational reach and do not know their precise needs and how to articulate them.

2.4 Managing between control and drift

Mintzberg (1989) eloquently argued:

a strategies need not be deliberate – they can also emerge largely unplanned

b effective strategies develop in all kinds of strange ways

c strategic reorientation happens in brief, quantum leaps

d to manage strategy, then, is to craft thought and action, control and learning, stability and change.

The notion of management strategies as emergent, rather than based on rational choice, can also be found in organisation studies. For instance, the garbage can model of organisational choice – proposed by Cohen et al. (1972) – describes decision-making in situations that do not meet the conditions of more classical models of decision-making; i.e., situations in which preferences are seen as problematic, technology as unclear and participation fluid. In the garbage can model, decisions are seen as the results of arbitrary streams of solutions, problems, participants and choices, temporarily coinciding in 'choice opportunities'.

Similar to Mintzberg's idea of strategy as emergent, Ciborra (1997) argues management as rational planning is no longer valid since technology tends to drift once it comes into use, emphasising changes in the role and function of a technology in the actual use-situation as opposed to the planned one (Ciborra, 1996). Hence, information system strategies and structures cannot simply be aligned with business suggested by strategy scholars (Sabherwal and King, 1991; Henderson and Venkatraman, 1992, 1993; Fiedler et al., 1996; Chan et al., 1997). Striving for control as a means to deal with complexity and turbulence is often thwarted by unforeseeable events and changing environments. Hence, the view that technology and business are somewhat static components that can be aligned in order to create a perfect fit (Sabherwal et al., 2001) is no longer valid and the complex nature of digital infrastructure services has substantially changed the challenges managers face (Maglio and Spohrer, 2008).

It has been recognised that people respond to technology through improvisation and bricolage, and digital infrastructures are therefore shaped by people's interpretations of and interactions with them along with the already installed base (Ciborra and Lanzara, 1994; Ciborra and Hanseth, 1998). As such, the strive for management control of digital infrastructures is commonly accompanied by drift due to turbulent environments, implementation tactics, complexity, the installed base, side-effects and surprises in contexts and users' perceptions (Ciborra et al., 2000). Hence, Ciborra (2002) promotes a management approach based on the idea of 'cultivation' where the digital infrastructure is not understood as a planned activity, but rather as an organic process in which technology is allowed to drift. Despite being framed as an opposite to control, drift is not characterised as negative, but as an inherent phenomenon of complex systems that, if managed in an adequate way, can leverage an organisation.

Extending the work by Ciborra et al. (2000) explore a middle ground between the extremes of control and drift, advocating control and drift should be handled as complementary and intrinsically related opposites in an ongoing dialectical relationship. Adopting this perspective in our analysis of a ten-year period, we uncovered the nature and constitution of the efforts from a provider company to manage the digital infrastructure, the nature and constitution of the drifts that occurred, and how digital infrastructure services were managed through an ongoing negotiation of an appropriate balance between control and drift. This research contributes to the articulated gap of understanding the provider perspective of digital infrastructure by focusing on how control efforts and drift manifest in a provider's management of digital infrastructure services.

3 Method

3.1 Research approach

Our research is based on an interpretive longitudinal retrospective case study (Yin, 1994; Walsham, 1993; Benbasat et al, 1987), covering a ten-year period from 2001 to 2010. The complexity and intertwined nature of digital infrastructure services suggest that such a case-study approach is appropriate (Yin, 1994; Walsham, 1993, Benbasat et al., 1987), helping to recognise context as a fundamental dimension of technology innovation and social change (Pettigrew, 1997; Pettigrew et al., 2001). We applied the encounter-episode process model (Newman and Robey, 1992; Lyytinen and Newman, 2008) to analyse the dynamics between control and drift in the observed team's efforts to manage a portfolio of digital infrastructure services. Lyytinen and Newman (2008) argue that IT-related changes primarily follow such a punctuated equilibrium perspective from evolutionary biology in which "lineages exist in essentially static form (equilibrium) over most of their histories, and new species arise abruptly, through sudden revolutionary 'punctuations' of rapid change" [Gersick, (1991), p.11]. As contemporary turbulent organisational environments and conditions generate such abrupt and sudden changes, it poses particular managerial challenges. Hence, the punctuated equilibrium perspective allowed us to pay attention to revolutionary, episodic punctuations that challenged planned trajectories. As such, it helped us uncover the complexities and dynamics involved in managing digital infrastructure services.

4 Research site

The research site is a large IT firm, called Weilgo, which provides a variety of products and services, such as consulting, system integration and outsourcing to an international market. Our study focuses on a team in the Swedish part of the company, whose key activity is to provide by technically construct and maintain administrative portals for their customers. The team (hereafter called The Team) originates within the consulting part of Weilgo, but has over the years also become integrated with other parts of the organisation. During the later years of the observed period, the surrounding organisation was structured as a classical service-process matrix where each business unit collaborates with all vertical sectors. As part of a consultancy operation, almost all of the work done by the team is within the scope of projects, be they management, maintenance, or development projects, and as such charged per person per hour basis. This means that team members always have to contribute to the project at hand, which make long-term, cross-project issues difficult to manage.

Over the considered ten-year period, The Team grew from two consultants initially, to three, to four, and eventually to 15 consultants. The consultants were trained as engineers and software developers and organised into temporary groups based on the solution they worked on. As Weilgo is organised around their clients with customer teams that in the main communicate with the end customer, The Team communicated and managed relationships with its customers via the customer teams.

5 Data collection and analysis

To support this retrospective longitudinal study (Barley, 1990; Van de Ven and Huber, 1990), we combined different data collection techniques and sources. The first author's role as insider researcher (Coghlan and Brannick, 2001) and project manager for The Team provided unlimited access to relevant data sources. In the initial phase, we conducted interviews to identify key events during the ten-year period. We focused on the circumstances of The Team during the study period: activities and events that triggered changes, control efforts and their outcomes, emerging opportunities and challenges involved. Iteratively, we organised the data into an overarching timeline of key events, which we then revised as we gained further knowledge and understanding of the process. Eventually, we presented the revised timeline to the other members of The Team for feedback and validation (Miles and Huberman, 1994; Patton, 2003). To address insider bias and consolidate our analyses, we also relied on archives of project proposals, project contracts, meeting minutes, e-mail conversations and focus groups. Table 3 provides an overview of all data sources and the time period for each source. The insider researcher started in The Team in year 2009.

The focus-group session allowed us "to interact directly with respondents which provides opportunities for clarification of responses, for follow-up questions and for the probing of responses" [Stewart and Shamdasani, (1990), p.42]. The insider researcher participated in the focus-group session and one of the outsider researchers acted as moderator. We conducted eight interviews with key individuals from The Team and internal customer sites at Weilgo. Without access to key individuals from external customer sites, we investigated the outer context through interviews with The Team's members, internal customers and through formal documents such as project contracts, e-mails and meeting minutes.

We used the qualitative data analysis tool Atlas.TI©. As a first step, we entered all empirical data into Atlas.TI© and organised them based on source type. We then structured the material according to temporal affinity and importance, as factors for change. To verify the plausibility of the resulting temporal bracketing, we reviewed the data set for confirmation and used data from different sources to triangulate and ensure validity (Miles and Huberman, 1994; Patton, 2003). To analyse the dynamics involved in the case, we focused on dynamics between control and drift (Ciborra et al., 2000; Tjornehoj and Mathiassen, 2008). This theoretical lens served as a coding scheme to uncover how The Team and the larger organisation addressed the dynamics and made use of them in their management approach.

As organising principle, we used Newman and Robey's process model (1992) of antecedent conditions, encounters and episodes. Antecedent conditions are situations that existed before the observed change process. Encounters are events that challenge the equilibrium of the process and mark the beginnings and ends of episodes. Episodes are longer periods wherein the pattern set during an earlier encounter plays out. To identify the encounters that occurred during the study period, we focused on all events that had an effect on the team. We then plotted these events on a timeline and analysed what caused each event and what the consequences were in relation to plans. As an example, The Team engaged in packaging the Gamma solution (plan), but owing to prior financial commitments in the unit's other projects, the financing was lost (event), and The Team ended up not having a complete solution when entering subsequent projects (outcome).

Table 3 Data sources

Data source	*Description*	*Time period*
Focus group	One focus-group session was conducted with three team members plus the insider researcher and one of the outsider researchers. The session was recorded and transcribed.	2010
Formal interviews	Eight formal interviews were conducted. Each interview lasted approximately one hour. The interviews were recorded and transcribed.	2010–2012
Open-ended, semi-structured interviews	Daily informal discussions that the insider researcher held regarding the digital infrastructure services. These informal discussions provided insight into everyday practices at the company. These discussions were documented in field notes by the insider researcher.	2010–2012
Proposals	Through the insider researcher, access was available to all proposals that the team made. Ten of the proposals made during the study period were collected, including both approved and rejected proposals, which all contributed important information to the study.	2001–2011
Contracts	The six contracts made during the study period were collected.	2001–2011
Meeting minutes	The formal minutes of monthly and weekly meetings between the management group and the internal team groups were collected, in total 200 sets of minutes	2001–2011
E-mail conversations	E-mail conversations between the project manager (the insider researcher) and internal and external stakeholders during the study period were collected and amounted to approximately 1,150 e-mails.	2001–2011
Presentations	The various presentations used to describe the digital infrastructure services to internal and external stakeholders during study period were collected, in total 40 presentations.	2001–2011

The dual role of being a researcher and working in the studied organisation triggers a methodological challenge very similar to the one present for anthropologists performing participatory observation (Patton, 2003), which makes it crucial to take on an open-minded selection. The opportunity to have an insider-researcher brings with it a responsibility when it comes to the ethical aspects (Labaree, 2002). In the setup, we have been transparent in our communication with the team as well as the surroundings. Adopting such a strategy has not only been a way to handle the relations between the research project and the studied organisation, but also the duality, i.e., to balance the insider role and the researcher role (DeLyser, 2001; Gerrish, 1997).

6 Results

During the decade this study reports from, The Team provided digital infrastructure services and developed new solutions in terms of underlying technology as summarised in Table 4. The following sections describe the encounters and episodes that The Team experienced from year 2001–2010 as summarised in Table 5.

Table 4 Key solutions in digital infrastructure services

Solution	*Description*
Alpha	An application targeting the administration of MS active directory. Alpha started out as an address book, but then expanded to AD and exchange administration.
Beta	A centralised functional service that only used some of the functionality present in Alpha, as interface and workflow engine. Beta used Microsoft identity integration server (MIIS) as the underlying connection technology.
Gamma	Second generation of Alpha, with similar but more powerful functions than Beta. Gamma was built to provide a user-friendly interface for administrators, managers, and end-users involved in user administration. Inspired by Beta when in terms of integration and connectivity.
Delta	End-user self-service portal built on SharePoint portal services (SPS). Delta was a development of Gamma's end-user interface and was configured and administrated via Gamma, which functioned as Delta's back-end.

6.1 Antecedent conditions

In year 2000, The Team was not yet formed, but the people that shortly became The Team belonged to a unit. This unit was part of one of Sweden's largest IT service providers (hereon called 'Zethro'), which had changed because of various acquisitions so the consultants came from many different companies. When the unit was at its largest it consisted of approximately 20 consultants. Following the IT crash at the millennium the number of consultants was decreased to ten due to layoffs.

Table 5 Overview of the observed encounters (en) and episodes (ep) at Weilgo

	Time	*Solution*	*Explanation*	*Context*
en1	2001	Alpha	Provide new technology	Inter – Zethro
ep1	2002	Alpha	Product packaging demanded	Intra – Zethro
en2	2004	Alpha	Selected as internal platform	Intra – Zethro
ep2	2004	Beta	Provide new technology	Intra – Zethro
en3	2005	Beta	Added maintenance responsibility	Intra – Zethro
ep3	2005	Beta	Recruitment, sales and development	Inter – Zethro
en4	2006	Gamma	IT alignment across companies	Inter – Weilgo
ep4a	2006	Gamma	Project terminated	Intra – Weilgo
ep4b	2006	Gamma	Sales and development	Inter – Weilgo
en5	2007	Gamma	Contract to complete Gamma	Inter – Weilgo
ep5	2008	Gamma	Upgrade and increase market share	Intra – Weilgo
en6	2009	Gamma	Project terminated	Intra – Weilgo
ep6	2010	Delta	Provide new technology	Intra – Weilgo

The unit had its business focus on resource consulting, and hence the work was all about delivering competence and people to customer assignments. The assignments were small – not only in numbers, but also in hours and value – so the unit struggled to keep chargeable hours on a reasonable level.

Encounter 1: the first large customer

In early 2001, the unit was contacted by a rapidly growing company, who as a result of acquisitions was faced with an urgent need to find efficient ways to keep track of inventory and to manage access to information, systems and processes. They had chosen MS active directory for identity storage and needed their IT solution developed on top of this.

Episode 1

The technology was new on the market and required substantial learning and exploring during the adoption process by both the customer and the unit. While the new technology provided some functionality, additional functionality and improved user interface was requested by the customer. One of the resources from Zethro involved in the project described the collaboration as: "… [The customer representative] stood for much of the ideas, which was good. He was from the business side and understood the benefits and potential of a tool like Alpha." A main requirement was to enable decentralised administration, which was one of the functionalities added into the solution by the unit. One of the project participants described it as: "Back then, focus was on administration of users in AD, and he [customer representative] wanted to delegate the administration through the organisation to the various heads of departments to shorten lead times. […] With the managers using Alpha, they could fill in the user details, address information, the user was not created in AD at once, but it was sent like a case or whatever you called it to the IT department who with a touch of a button could approve the user if everything looked okay. It [adding a new employee] was now a matter of hours instead of two weeks."

The two consultants from the unit worked with the development in close collaboration with the customer at the customer site. The work was a time- and material-based assignment and posed no financial risk to the unit. However, the assignment grew (in person months) much larger than estimated and the customer eventually ran into financial problems. At this point they had a close-to-complete product, and Zethro decided to jointly with the customer finance the completion of the product (the Alpha solution), in exchange for ownership of the code. At the same time, the unit had other highly prioritised projects, leaving this large project to the two consultants to manage mainly on their own, which led to the creation of "The Team".

This ability of self-management became important for the survival of The Team over the subsequent years. The environment at the unit provided little support in terms of product strategies or marketing strategies. Therefore, The Team actively promoted their solution, both internally and externally, in various efforts to build a solid customer base. They managed to significantly increase their customer base by adjusting the solution for each customer implementation. As one of the team members put it: "[…] we worked in really close collaboration with the customers and tried to solve their problems and help them work effectively." As a result, each implementation was in some way unique for each customer.

Encounter 2: widened scope

In 2004 the Alpha solution was selected as the platform for the infrastructure management department at Zethro. The competition included both internal and external

solutions, and the one promoted by The Team was selected thanks to its ability to make administration of users and access rights easier and more effective. In addition, The Team could now harvest the benefits from the internal network of contacts that they had established during the promotion of their solution.

Episode 2

The infrastructure management department had explicit demands in terms of connectivity and integration, so The Team's architect concluded that "The need to move away from hard coded configuration was evident since this central solution was supposed to handle 15–20 customers. For us [The Team] it was the first solution that made this platform customer generic, but it was also the first for Microsoft." This required additional functionality, and connections to additional data sources, so in this assignment The Team developed the solution Beta. The infrastructure management department had decided to use a new technology, a meta-catalogue product from Microsoft, as the foundation of their platform. This required exploration of the new technology and further learning by the team. During the work on Beta, The Team worked in close collaboration with architects from the infrastructure management department. During the project, The Team was enlarged with one person taking on the role of development and testing manager for the ongoing work with the new solution.

The infrastructure management department demanded a one-to-one functional mapping between their old and the new solution. This necessitated extended functionality and configuration of the new solution, which increased the work load of The Team. By the time the project was completed, it had by far exceeded its budget. Therefore, there was an urgent need to deploy the new solution and to become more effective in order to get a return on the investment.

In parallel with the above project, in the spring of 2005, The Team was selected to be the provider of a new solution for the administration of users and of access authorisation at Zethro, using the Alpha solution. One of the team members noted that "There were competing solutions, Iswa, which was already established at our service desk, was one. It [Iswa] was more of a console tool that lacked the connection to the business, administration, and delegation of administrative tasks."

The new assignment was added to the workload of the three consultants, who struggled to cope with the two large assignments. The original assignment to implement Alpha was found to be infeasible due to complicated dependencies between the already existing systems. For part of the assignment, The Team started to implement Beta instead, which was based on Alpha but also provided a needed test environment and a potential technical solution for the identified integration problem.

Encounter 3: expanded roles

Key technical resources in the infrastructure management department unexpectedly left the company. These were the only two at the infrastructure management department who were knowledgeable about the Beta solution, hence the department was left without the competence to configure new customers (which hindered the deployment) or to deal with the maintenance. As a result The Team was assigned to the configuration of new customers and was required to take on increased responsibility for the maintenance work.

Episode 3

The deployment of the Beta solution was strategically important. However, for the team, still consisting of only three consultants, this additional responsibility came on top of an already heavy workload and made time for strategic measures scarce. The Team was in desperate need of strengthening, and the manager of the unit eventually recognised this need and recruited an additional developer. This additional resource contributed to the projects at hand and enabled The Team to put more emphasis on strategic work, as well as on sales activities.

During the deployment of Beta, customer demands for additional functionality kept furthering the development. The Team developed several new features and also activated features from Alpha that were not initially included in the Beta solution. These development activities made Beta more complete, but also delayed the deployment project.

Encounter 4: company merger

During the autumn of 2006, Zethro announced a merger with a large global IS provider (here called Weilgo). The merger was a way for Weilgo to strengthen their Nordic presence, which implied that Zethro's organisation was to a large extent maintained. However, IT alignment across the companies was conducted.

Episode 4

All of the projects running at Zethro were halted, and their relevance was evaluated in the light of the merger. Two members of The Team got involved in the evaluation and took part in the process of comparing the existing solution within Weilgo with the solution that The Team was intending to implement at Zethro. After an intense period of analysis of IT alignment, it became clear to The Team that their solution did not fit well into the Weilgo platform. Similarly, it did not fit well with the administrative approach within Weilgo, which was centralised as opposed to the decentralised approach promoted at Zethro. One of The Team members described it as: "It looked good and we were basically performing rollout at Zethro when Weilgo came in and bought Zethro and it was no discussion because they had a diametrically different administrative approach!". As a consequence, the ongoing work at Zethro, i.e., the development of Gamma based on the previous solution, Beta, was terminated.

The termination of the Gamma project was a significant customer loss. To secure financing, The Team had to engage in sales activities. Since The Team had not been marketing their solutions for several years, this implied putting a lot of effort into the production of new sales materials, reactivation of old sales channels and identification of new sales channels. These activities had just begun when The Team received a request from an external customer that was in need of an administrative system. The Team viewed this as an opportunity to get the Gamma solution out into the market, and initiated a dialog with the potential customer. One of The Team members said "[…] we began to aim for a product direction, even if we never said it was going to become a product, but we had a common core instead of customer unique solutions. So it's been a long term strategy to have a common core."

At the same time, the unit experienced economic difficulties owing to several projects finished at the same time and new orders did not fill the gap. Hence there were

consultants within the unit that had little or nothing to do. The unit engaged in sales activities targeting areas outside their core businesses, which payed off and the unit signed three contracts to build custom-made systems within the area of statistics and pharmaceuticals. The Team was heavily involved in these development projects, hence their available time for development, marketing, and maintenance of their administrative portals was reduced.

Encounter 5: first customer contract for gamma

Despite being involved in several development projects, The Team managed to follow through their sales activities, which resulted in the first customer contract for their administrative portal Gamma in 2007. As the solution was not yet finished (terminated due to IT alignment in the company merger), the selection of customers was done with care and The Team was upfront about the situation. Hence, the customer was fully aware of the fact that the offered solution was at beta stage and that they were pilot customer.

Episode 5

The Team began developing Gamma for the pilot customer. With the completion of Gamma within reach, The Team also intensified the strategic dialog with their large internal customer, i.e., the infrastructure management department regarding an upgrade of Beta. Since Gamma offered more powerful functionality, an upgrade could potentially solve many of the challenges and problems that had been encountered during the maintenance of Beta.

The dialog continued and at the beginning of 2008 the infrastructure management department formulated a strategic objective to increase their market share in the area of outsourcing. The sales department sent the demands of the solution to the service manager responsible for Beta. However, it became clear that Gamma was more suitable given the demands articulated in the customer's requests. Hence Gamma was selected as the solution to be offered. The functionality in Gamma mapped very well onto the demands. The selection of Gamma became a confirmation for the team's architectural approach and accelerated the platform shift.

The functionality in Gamma was potentially useful in many different customer projects. Most of the projects initiated during this time were initiated by the infrastructure management department, the key actor in large-scale infrastructure projects. The Team's involvement in sales activities also changed; and according to The Team's architect: "Focus during the last couple of years have been on the central delivery and that organisation, i.e. the delivery organisation. They perform sales activities in large projects and hence our [The Team's] role has changed in terms of who we communicate with […] We seldom only speak to the IT department, but we speak with decision makers […] The reason is partly because we are part of a larger offer and [our solutions] function as icing on the cake that make Weilgo in a unique way stands out in relations to other suppliers."

In June 2008 the infrastructure management department landed an outsourcing agreement. This was not only the largest outsourcing agreement that the Nordic part of Weilgo had ever signed, it was also the first delivery in an outsourcing setting for The Team. This new delivery setting meant that The Team had to meet requirements not only from the external customer, but also from their internal customer.

With the infrastructure management department landing several contracts there was a growing demand for Gamma and The Team, still only four members, struggled to manage the new projects. Due to the general economic situation, which had led to internal cost-cutting programs within the company, the unit was reluctant to hiring more resources. The result being that The Team was under extreme pressure with the three parallel deliveries.

Working with the third project, it became evident that the internal customer had shifted focus from a limited number of users, they now targeted all end users at the customer site. This created a need for heavy investment and The Team was appointed to build a completely new solution (from here on called Delta) to meet the customer demands.

After the analysis phase it looked as if the funding for the necessary investments was secured. However, a large deviation between the budget for the project and the estimated cost from the analysis phase, forced the management to demand a 30% decrease in budget throughout the project. This led to a redesign of both deliveries The Team was responsible for. Instead of building a generic multi-customer portal, the portal was built as a standalone customer-specific solution. Despite the decrease, the delivery was still so large that The Team was not able to handle it. The Team got more members from a unit in a nearby city. However, increasing the workforce was not an easy endeavour. One of the team members described the situation as: "When we were few it was a lot of action and it worked fine, but when we became so many, I think it was chaotic and the quality decreased considerably. […] It was full speed ahead, sales, and then try to transfer this [work descriptions] to us [The Team]. It was not an easy situation." Another member of The Team described this problematic situation as "[…] we have tried to take in more people, but we have failed […] or at least we have failed in transferring our knowledge or rather our way of working." Since the new members lacked the specific competence required, The Team had to attend to significant knowledge transfer activities before they could engage in the implementation project at full speed.

Encounter 6: external competition

Just before the end of the implementation, management decided to terminate the Gamma project. This decision originated from a strategic decision within one of the central services inside Weilgo, which had chosen another tool to support their services. Hence the steering committee saw no possibility to deliver Gamma and a main component in the installed base was terminated.

Episode 6

Despite the turbulence around Gamma, the new portal project of developing Delta continued unaffected. Due to dependencies between the two projects, parts of Gamma's activities and functions had to be incorporated into the Delta project.

Although not yet launched, news about the upcoming new portal had spread. Both Weilgo and external customers had waited a long time for a solution of that kind and a huge demand had built up. In addition to new customers, existing customers were candidates for migration to Delta, which created an even higher workload.

In June 2010 the first version of Delta was finally launched. The Team was already working on implementing Delta for customer number two. Despite being raised as an

issue to management already during the first project, the Delta solution lacked governance. This uncertainty had negative effects as there was nothing to fall back on when customer demands regarding platform functionality were raised.

Despite these difficulties, the launch of Delta for the first customer and the roadmap ahead gave The Team good hope for the future, but this changed when gaps in platform functionality were revealed already during the initial phases of the second implementation. The gaps were due to the reduced budget during first implementation, and called for further development. This delayed the implementation of Delta for the second customer and postponed the project for all customers waiting for Delta to be implemented.

7 Discussion

Asking how control efforts and drift manifest in providers' management of digital infrastructure services, we have presented a longitudinal case study spanning a period of ten years at Weilgo. Drawing on Tjornehoj and Mathiassen's (2008) view of control and drift as complementary and intrinsically related opposites in a dialectical relationship, we uncovered how The Team continuously negotiated an appropriate balance between control and drift to manage the development of its digital infrastructure services. Our study contributes to the IS literature by highlighting the challenges involved in a provider's efforts to manage its portfolio of complex digital infrastructure services with particular focus on the involved dynamics between control efforts and drift.

Table 6 provides an overview of our analyses. Here, 'control' indicates The Team exercised controlling activities in order to realise planned strategies and to ensure its continuation; 'equivocation' represents some kind of wait-and-see, a transitional stance; and, 'drift' indicates a deviation from The Team's plans caused by external or internal forces, such as a top management decision to terminate a project. Similarly, the summary shows how a customer was either external, i.e. a company buying the digital infrastructure service from Weilgo, or internal meaning the service was appropriated by units or departments within the provider. As such, the context alternated between an inter-organisational and an intra-organisational focus.

Table 6 demonstrates how The Team continuously shifted between different contexts to manage its digital infrastructure services. Maneuvering the complex and changing circumstances (Damsgaard and Lyytinen, 2001), the efforts took different directions towards intra- and inter-organisational relationships as The Team continuously adapted and developed new strategies to cope and survive in highly fluctuating contexts. This fundamental condition shaped the unfolding of the digital infrastructure services and the challenges faced by The Team. Tracing the contradictory forces that served as drivers for digital infrastructure development, including the tensions between short- and long-term interests across the stakeholders involved (Ribes and Finholt, 2009) our findings showed how digital infrastructures are not static structures; instead, they are constantly enacted and (re)created.

The control efforts and drift manifested in terms of ongoing resource challenges. From the very start The Team members had to cater for themselves which created a self-management culture within The Team. As the small and highly specialised team built up an informal and effective way of organising work and communicating, the need for

additional resources became evident repeatedly over the studied period. A common effort to control the situation was to add resources and attempt to determine the technology, either by making a decision to build a certain solution, or by seeking to influence decisions about the technology by making a team member a representative in steering committees, or through maintenance agreements that helped The Team formalise the service they provided and define their relationships with customers (Maglio and Spohrer, 2008; Vargo and Lusch, 2008). In these maintenance agreements, the customer presented additional work opportunities as a reflection of The Team's dependence on customers for chargeable hours.

Table 6 Summary of observed encounters (en) and episodes (ep) at Weilgo

	Time	*Solution*	*Customer*	*Classification*	*Explanation*	*Context*
en1	2001	Alpha	External	Control	Provide new technology	Inter – Zethro
ep1	2002	Alpha	Internal	Control	Product packaging demanded	Intra – Zethro
en2	2004	Alpha	Internal	Control	Selected as internal platform	Intra – Zethro
ep2	2004	Beta	Internal	Control	Provide new technology	Intra – Zethro
en3	2005	Beta	Internal	Drift	Added maintenance responsibility	Intra – Zethro
ep3	2005	Beta	External	Control	Recruitment, sales and development	Inter – Zethro
en4	2006	Gamma	Internal	Drift	IT alignment across companies	Inter – Weilgo
ep4a	2006	Gamma	Internal	Drift	Project terminated	Intra – Weilgo
ep4b	2006	Gamma	External	Control	Sales and development	Inter – Weilgo
en5	2007	Gamma	External	Control	Contract to complete Gamma	Inter – Weilgo
ep5	2008	Gamma	Internal	Control	Upgrade and increase market share	Intra – Weilgo
en6	2009	Gamma	Internal	Drift	Project terminated	Intra – Weilgo
ep6	2010	Delta	Internal	Control	Provide new technology	Intra – Weilgo

Control efforts and drift also manifested in terms of ongoing technology challenges. The Team's technology evolved from an administrative perspective as it increasingly focused on integrating underlying systems. During this journey, The Team had the ability to manage and leverage technologies that enabled services (Bardhan et al., 2010) by means of a good overview of the general technological development, the determination to keep up with technological development and the persistence to promote their solutions. During the early years, The Team worked in close collaboration with the customers and the dialog on the operational as well as the strategic level was direct. The Team's contact with customers changed when they began orienting their work towards internal customers

at Weilgo, which created some distance between The Team and its external customers. The Team was placed in an unfortunate situation where their internal customer was a middleman between them and the external customers. Although The Team's delivery focus changed from external customers to mainly internal ones, it continued to work in close collaboration with their customers. In doing so, The Team established connections with key people internally at Weilgo, creating a network which it leveraged to promote solutions and capabilities. This highlights the important customer orientation and relational characteristics and the co-creation of value with customers (Maglio and Spohrer, 2008; Vargo and Lusch, 2008). Despite operating in a consulting organisation and having to finance the main part of new developments, The Team managed to provide several successful solutions. As is evident from these findings, infrastructure evolution cannot be separated from changes related to customers and resources. During the studied period, we have seen how the team developed the technology that went under various epithets such as application, solution, functional service and platform. This variation in the definition of the technology at hand depicts a journey where the Team's delivery has gone from an application to an infrastructure.

Our study also gave insights into specific digital infrastructure challenges as The Team manoeuvred between control and drift to cope with continuous change (Tjornehoj and Mathiassen, 2008). One specific set of challenges related to the intrinsic multi-level nature of digital infrastructure services (Table 1). Shifting between intra- and inter-organisational levels, the observed services required different management strategies as part of existing infrastructural organisational arrangements. On a higher industry level, the observed services were also part of larger structures such as the Internet or diffusion of standards within and across industrial fields (Damsgaard and Lyytinen, 2001), which could not be managed in the same way since nobody or no constellation of actors control these large and complex structures. To this end, our efforts to be specific about the context in which digital infrastructure were managed showed how digital infrastructure management on different levels of analysis (e.g., industrial field, inter-organisational level and intra-organisational level) must be seen as different from each other.

Moreover, the highly turbulent environment often affected The Team abruptly. As Lyytinen and Newman (2008) state, contemporary turbulent organisational environments and conditions tend to generate sudden changes. Hence, our analysis revealed repeated occasions where plans had to be changed due to unforeseen events. The Team demonstrated the importance of seizing business opportunities, and they learned that while you cannot control everything that happens, you can control how you react to what happens. Borrowing from Glucksberg and McCloskey (1981), The Team realised unforeseen things will happen when managing digital infrastructure services, and they therefore developed the ability to 'know that you do not know and be humble'.

8 Conclusions

The presented research advances our understanding of management of digital infrastructure services from a provider perspective by demonstrating how ongoing negotiation between control and drift as two complementary strategies is a useful way to deal with the involved complexities and uncertainties. The provision of digital

infrastructure services requires continual handling of unintended consequences and surprises on a strategic as well as operational level. Providers need to acknowledge this and organise to create the flexible space needed to handle unforeseen consequences, surprises and side effects.

Like any research, this study has limitations. The inclusion of the inside researcher made it possible to gain access to the research site in a way that would not be possible otherwise. However, this approach also brought with it the risk of biased results, which we mitigated by applying data-source triangulation with several different sources and data-analysis triangulation in which tentative analysis were discussed and confirmed both with colleagues at Weilgo and outside researchers over several iterations. Considering possible transfer of insights to other settings, it is also important to emphasise The Team's specific conditions. The context changed rather drastically over the studied period, not only in terms of their business, but also because Zethro and Weilgo underwent several reorganisations, which changed the situation for The Team and for the internal customers.

Finally, the research revealed interesting aspects, which we did not cover in this paper. Hence, future research into provision of digital infrastructure services may ask: What does a company's internal service orientation mean for the co-creation of value? How do various technologies affect its managerial approach? What are the contextual factors affecting the implementation of a management approach based on negotiating a balance between control and drift? What are the challenges in providing industry level digital infrastructures?

References

Aanestad, M. and Jensen, T.B. (2011) 'Building nation-wide information infrastructures in healthcare through modular implementation strategies', *The Journal of Strategic Information Systems*, Vol. 20, No. 2, pp.161–176.

Alter, S. (2010) 'Does Service-dominant logic provide insight about operational IT service systems?', *AMCIS 2010 Proceedings*, Paper 138.

Armstrong, C.P. and Sambamurthy, V. (1999) 'Information technology assimilation in firms: the influence of senior leadership and IT infrastructures', *Information Systems Research*, Vol. 10, No. 4, pp.304–327.

Arthur, W.B. (1989) 'Competing technologies, increasing returns and lock-in by historical events', *The Economic Journal*, Vol. 99, No. 394, pp.116–131.

Bansler, J.P. and Kensing, F. (2010) 'Information infrastructures for health care: connecting practices across institutional and professional boundaries', *Computer Supported Cooperative Work (CSCW)*, Vol. 19, No. 6, pp.519–520.

Bardhan, I.R., Demirkan, H., Kannan, P.K., Kauffman, R. and Sougstad, R. (2010) 'An interdisciplinary perspective on IT Services management and service science', *Journal of Management Information Systems*, Vol. 26, No. 4, pp.13–64.

Barley, S.R. (1990) 'Longitudinal field research methods', *Organization Science*, Vol. 1, No. 3, pp.220–247.

Baskerville, R. and Pries-Heje, J. (2004) 'Short cycle time systems development', *Information Systems Journal*, Vol. 14, No. 2, pp.237–264.

Benbasat, I., Goldstein, D.K. and Mead, M. (1987) 'The case research strategy in studies of information systems', *MIS Quarterly*, Vol. 11, No. 3, pp.369–386.

Bhatt, G.D. and Grover, V. (2005) 'Types of information technology capabilities and their role in competitive advantage: an empirical study', *Journal of Management Information Systems*, Vol. 22, No. 2, pp.253–277.

Boland, R.J., Lyytinen, K. and Yoo, Y. (2007) 'Wakes of innovation in project networks: the case of digital 3-D representations in architecture, engineering, and construction', *Organization Science*, Vol. 18, No. 4, pp.631–647.

Bossen, C. and Markussen, R. (2010) 'Infrastructuring and ordering devices in health care: medication plans and practices on a hospital ward', *Computer Supported Cooperative Work (CSCW)*, Vol. 19, No. 6, pp.615–637.

Bowker, G.C. (1994) *Science on the Run: Information Management and Industrial Geophysics at Schlumberger*, pp.1920–1940, MIT Press, Cambridge, MA.

Braa, J., Hanseth, O., Heywood, A., Mohammed, W. and Shaw, V. (2007) 'developing health information systems in developing countries: the flexible standards strategy', *MIS Quarterly*, Vol. 31, No. 2, pp.381–402.

Broadbent, M. and Weill, P. (1997) 'Management by maxim: how business and IT managers can create IT infrastructures', *Sloan Management Review*, Vol. 38, No. 3, pp.77–92.

Broadbent, M., Weill, P. and St. Clair, D. (1999) 'The implications of information technology infrastructure for business process redesign', *MIS Quarterly*, Vol. 23, No. 2, pp.159–182.

Bygstad, B. (2008) 'Information infastructure as organization: a critical realist view', *ICIS 2008 Proceedings*, p.190.

Bygstad, B. (2010) 'Generative mechanisms for innovation in information infrastructures', *Information and Organization*, Vol. 20, No. 3, pp.156–168.

Byrd, T.A. and Turner, D.E. (2000) 'Measuring the flexibility of information technology infrastructure: exploratory analysis of a construct', *Journal of Management Information Systems*, Vol. 17, No. 1, pp.167–208.

Carlo, J.L., Lyytinen, K. and Boland Jr., R.J. (2012) 'Dialectics of collective minding: contradictory appropriations of information technology in a high-risk project', *MIS Quarterly*, Vol. 36, No. 4, pp.1081–1108.

Chan, Y.E., Huff, S.L., Barclay, D.W. and Copeland, D.G. (1997) 'Business strategic orientation, information systems strategic orientation, and strategic alignment', *Information Systems Research*, Vol. 8, No. 2, pp.125–150.

Chatterjee, D., Pacini, C. and Sambamurthy, V. (2002) 'The shareholder-wealth and trading-volume effects of information-technology infrastructure investments', *Journal of Management Information Systems*, Vol. 19, No. 2, pp.7–42.

Chesbrough, H. and Spohrer, J. (2006) 'A research manifesto for services science', *Communications of the ACM*, Vol. 49, No. 7, pp.35–40.

Chung, S.H., Rainer Jr., R.K. and Lewis, B.R. (2003) 'The impact of information technology infrastructure flexibility on strategic alignment and application implementations', *The Communications of the Association for Information Systems*, Vol. 11, No. 1, p.44.

Ciborra, C. (2000) *From Control to Drift: The Dynamics of Corporate Information Infrastructures*, Oxford University Press on Demand.

Ciborra, C. (2002) *The Labyrinths of Information: Challenging the Wisdom of Systems*, Oxford University Press, NY, USA.

Ciborra, C. and Failla, A. (2000) 'Infrastructure as a process: the case of CRM in IBM', in C. Ciborra (Ed.): *From Control to Drift: The Dynamics of Corporate Information Infrastructures*, pp.105–124, Oxford University Press, Oxford.

Ciborra, C. and Hanseth, O. (1998) 'From tool to Gestell – agendas for managing the information infrastructure', *Information Technology & People*, Vol. 11, No. 4, pp.305–327.

Ciborra, C. and Lanzara, G. (1994) 'Formative contexts and information technology: understanding the dynamics of innovation in organizations', *Accounting Management Information Technology*, Vol. 4, No. 2, pp.61–86.

Ciborra, C., Braa, K., Cordella, A., Dahlbom, B., Failla, A., Hanseth, O., Hepsø, V., Ljungberg, J., Monteiro, E. and Simon, K. (2000) 'From control to drift', *The Dynamics of Corporate Information Infrastructures*, Oxford University Press, NY, USA.

Ciborra, C.U. (1996) 'The platform organization: recombining strategies, structures, and surprises', *Organization Science*, Vol. 7, No. 2, pp.103–118.

Ciborra, C.U. (1997) 'De profundis? Deconstructing the concept of strategic alignment', *Scandinavian Journal of Information Systems*, Vol. 9, No. 1, pp.67–82.

Coghlan, D. and Brannick, T. (2001) *Doing Action Research in Your Own Organization*, Sage Publications, London.

Cohen, M.D., March, J.G. and Olsen, J.P. (1972) 'A garbage can model of organizational choice, *Administrative Science Quarterly*, Vol. 17, No. 1, pp.1–25.

Cohen, W.M. and Levinthal, D.A. (1990) 'Absorptive capacity: a new perspective on learning and innovation', *Administrative Science Quarterly*, Vol. 35, No. 1, pp.128–152.

Cordella, A. (2012) 'Information infrastructure: an actor-network perspective', *Social Influences on Information and Communication Technology Innovations*, p.20.

Dahlbom, B., Hanseth, O. and Ljungberg, J. (2000) 'Conservative success organization and infrastructure evolution at SKF', in C. Ciborra (Ed.): *From Control to Drift: The Dynamics of Corporate Information Infrastructures (2000)*, Oxford University Press, Oxford.

Damsgaard, J. and Lyytinen, K. (2001) 'Building electronic trading infrastructures: a public or private responsibility?', *Journal of Organizational Computing and Electronic Commerce*, Vol. 11, No. 2, pp.131–151.

DeLyser, D. (2001) ''Do you really live here?' Thoughts on insider research', *Geographical Review*, Vol. 91, No. 1, pp.441–453.

Duncan, N.B. (1995) 'Capturing flexibility of information technology infrastructure: a study of resource characteristics and their measure', *Journal of Management Information Systems*, Vol. 12, No. 2, pp.37–57.

Edwards, P.N., Bowker, G.C., Jackson, S.J. and Williams, R. (2009) 'Introduction: an agenda for infrastructure studies', *Journal of the Association for Information Systems*, Vol. 10, No. 5, p.6.

Ellingsen, G. and Røed, K. (2010) 'The role of integration in health-based information infrastructures', *Computer Supported Cooperative Work (CSCW)*, Vol. 19, No. 6, pp.557–584.

Fiedler, K., Grover, V. and Teng, J.T.C. (1996) 'An empirically derived taxonomy of information technology structure and its relationship to organization structure', *Journal of Management Information Systems*, Vol. 13, No. 1, pp.9–34.

Fink, L. and Neumann, S. (2009) 'Exploring the perceived business value of the flexibility enabled by information technology infrastructure', *Information & Management*, Vol. 46, No. 2, pp.90–99.

Gal, U., Lyytinen, K. and Yoo, Y. (2008) 'The dynamics of IT boundary objects, information infrastructures, and organisational identities: the introduction of 3D modelling technologies into the architecture, engineering, and construction industry', *European Journal of Information Systems*, Vol. 17, No. 3, pp.290–304.

Gerrish, K. (1997) 'Being a 'marginal native': dilemmas of the participant observer', *Nurse Researcher*, Vol. 5, No. 1, pp.25–34.

Gersick, C.J.G. (1991) 'Revolutionary change theories: a multilevel exploration of the punctuated equilibrium paradigm', *The Academy of Management Review*, Vol. 16, No. 1, pp.10–36.

Glucksberg, S. and McCloskey, M. (1981) 'Decisions about ignorance: Knowing that you don't know', *Journal of Experimental Psychology: Human Learning and Memory*, Vol. 7, No. 5, pp.311–325.

Grisot, M., Hanseth, O. and Thorseng, A.A. (2014) 'Innovation of, in, on infrastructures: articulating the role of architecture in information infrastructure evolution', *Journal of the Association for Information Systems*, Vol. 15, No. 4, pp.197–219.

Grönroos, C. (1990) *Service Management and Marketing*, Lexington Books, Massachusetts, Toronto.

Grönroos, C. (2001) 'Service management and marketing', *A Customer Relationship Management Approach*, 2nd ed., John Wiley & Sons, Chichester, NY.

Hanseth, O. and Braa, K. (2000) 'Who's in control: designers, managers-or technology? Infrastructures at norsk hydro', from *Control to Drift: The Dynamics of Corporate Information Infrastructure*, pp.125–147.

Hanseth, O. and Braa, K. (2001) 'Hunting for the treasure at the end of the rainbow: standardizing corporate IT infrastructure', *Computer Supported Cooperative Work* Vol. 10, Nos. 3–4, pp.261–292.

Hanseth, O. and Lundberg, N. (2001) 'Designing work oriented infrastructures', *Computer Supported Cooperative Work (CSCW)*, Vol. 10, Nos. 3–4, pp.347–372.

Hanseth, O. and Lyytinen, K. (2010) 'Design theory for dynamic complexity in information infrastructures: the case of building internet', *Journal of Information Technology*, Vol. 25, No. 1, pp.1–19.

Hanseth, O. and Monteiro, E. (1997) 'Inscribing behaviour in information infrastructure standards', *Accounting, Management and Information Technologies*, Vol. 7, No. 4, pp.183–211.

Hanseth, O., Jacucci, E., Grisot, M. and Aanestad, M. (2006) 'Reflexive standardization: side effects and complexity in standard making', *Management Information Science Quarterly*, Vol. 30, No. SI, pp.563–581.

Hanseth, O., Monteiro, E. and Hatling, M. (1996) 'Developing information infrastructure: the tension between standardizations and flexibility', *Science, Technology and Human Values*, Vol. 21, No. 4, pp.407–426.

Henderson, J.C. and Venkatraman, N. (1992) 'Strategic alignment: a model for organizational transformation through information technology', in Kochan, T.A. and Useem, M. (Eds.): *Transforming Organizations*, pp.97–116, Oxford University Press, New York.

Henderson, J.C. and Venkatraman, N. (1993) 'Strategic alignment: leveraging information technology for transforming organisations', *IBM Systems Journal*, Vol. 32, No. 1, pp.4–16.

Henfridsson, O. and Bygstad, B. (2013) 'The generative mechanisms of digital infrastructure evolution', *Mis Quarterly*, Vol. 37, No. 3, pp.907–931.

Henningsson, S. and Hanseth, O. (2011) 'The essential dynamics of information infrastructures', *Proceedings of the 32nd International Conference on Information Systems*, Shanghai, China.

Henningsson, S. and Henriksen, H.Z. (2011) 'Inscription of behaviour and flexible interpretation in information infrastructures: the case of European e-customs', *The Journal of Strategic Information Systems*, Vol. 20, No. 4, pp.355–372.

Hepsø, V., Monteiro, E. and Rolland, K.H. (2009) 'Ecologies of e-Infrastructures', *Journal of the Association for Information Systems*, Vol. 10, No. 5, p.430.

Iannacci, F. (2010) 'When is an information infrastructure? Investigating the emergence of public sector information infrastructures', *European Journal of Information Systems*, Vol. 19, No. 1, pp.35–48.

Khan, S.S., Khouja, M. and Kumar, R.L. (2013) 'Effects of time-inconsistent preferences on information technology infrastructure investments with growth options', *European Journal of Information Systems*, Vol. 22, No. 2, pp.206–220.

Khanna, A. and Venters, W. (2013) 'The role of intermediaries in designing information infrastructures', in *Strategic Niches: The Case Of A Sustainable Mobility Infrastructure Experiment In Berlin*, p.43, in ECIS.

Labaree, R.V. (2002) 'The risk of 'going observationalist': negotiating the hidden dilemmas of being an insider participant observer', *Qualitative Research*, Vol. 2, No. 1, pp.97–122.

Lewis, B.R. and Byrd, T.A. (2003) 'Development of a measure for the information technology infrastructure construct', *European Journal of Information Systems*, Vol. 12, No. 2, pp.93–109.

Lyytinen, K. and Newman, M. (2008) 'Explaining Information system change: a punctuated socio-technical change model', *European Journal of Information Systems*, Vol. 17, No. 6, pp.589–613.

Lyytinen, K. and Rose, G.M. (2003) 'The disruptive nature of information technology innovations: the case of internet computing in systems development organizations', *Mis Quarterly*, Vol. 27, No. 4, pp.557–595.

Maglio, P.P. and Spohrer, J. (2008) 'Fundamentals of service science', *Journal of the Academy of Marketing Science*, Vol. 36, No. 1, pp.18–20.

Miles, M.B. and Huberman, A.M. (1994) *Qualitative Data Analysis: An Expanded Sourcebook*, 2nd ed., Sage, Thousand Oaks, CA.

Mintzberg, H. (1989) *Mintzberg on Management: Inside our Strange World of Organizations*, The Free Press, New York.

Monteiro, E. and Hanseth, O. (1995) 'Social shaping of information infrastructure: on being specific about the technology', in Orlikowski, W., Walsham, G., Jones, M.R. and DeGross J.I. (Eds.): *Information Technology and Changes in Organisational Work*, pp.325–343, Chapman & Hall.

Monteiro, E., Pollock, N., Hanseth, O. and Williams, R. (2013) 'From artefacts to infrastructures', *Computer Supported Cooperative Work (CSCW)*, Vol. 22, Nos. 4–6, pp.575–607.

Newman, M. and Robey, D. (1992) 'A social process model of user-analyst relationships, *MIS Quarterly*, Vol. 16, No. 2, pp.249–266.

Patton, M.Q. (2003) *Qualitative Research and Evaluation Methods*, 3d ed., pp.467–483, Sage Publications, Thousand Oaks, CA, 2002, 4 August 2003.

Pavlou, P.A. and El Sawy, O.A. (2006) 'From IT leveraging competence to competitive advantage in turbulent environments: the case of new product development', *Information Systems Research*, Vol. 17, No. 3, pp.198–227.

Pettigrew, A.M. (1997) 'What is a processual analysis?', *Scandinavian Journal of Management*, Vol. 13, No. 4, pp.337–348.

Pettigrew, A.M., Woodman, R.W. and Cameron, K.S. (2001) 'Studying organizational change and development: challenges for future research', *Academy of Management Journal*, Vol. 44, No. 4, pp.697–713.

Pipek, V. and Wulf, V. (2009) 'Infrastructuring: toward an integrated perspective on the design and use of information technology', *Journal of the Association for Information Systems*, Vol. 10, No. 5, p.1.

Piras, E.M. and Zanutto, A. (2010) 'Prescriptions, x-rays and grocery lists: designing a personal health record to support (the invisible work of) health information management in the household', *Computer Supported Cooperative Work (CSCW)*, Vol. 19, No. 6, pp.585–613.

Pollock, N. and Williams, R. (2010) /E-infrastructures: how do we know and understand them? Strategic ethnography and the biography of artefacts', *Computer Supported Cooperative Work (CSCW)*, Vol. 19, No. 6, pp.521–556.

Quinn, J. (1992) *Intelligent enterprise: A knowledge and service-based paradigm for industry*, The Free Press, New York, NY.

Rai, A. and Sambamurthy, V. (2006) 'Editorial notes – the growth of interest in services management: opportunities for information systems scholars', *Information Systems Research*, Vol. 17, No. 4, pp.327–331.

Ribes, D. and Finholt, T.A. (2009) 'The long now of technology infrastructure: articulating tensions in development', *Journal of the Association for Information Systems*, Vol. 10, No. 5, pp.375–398.

Rodon, J. and Silva, L. (2015) 'Exploring the Formation of a healthcare information infrastructure: hierarchy or meshwork?', *Journal of the Association for Information Systems*, Vol. 16, No. 5, p.1.

Rolland, K.H. and Monteiro, E. (2002) 'Balancing the local and the global in infrastructural information systems', *The Information Society*, Vol. 18, No. 2, pp.87–100.

Ross, J.W., Weill, P. and Robertson, D.C. (2006) *Enterprise Architecture: Creating A Foundation For Business Execution*, Harvard Business School Press, Boston, US.

Sabherwal, R. and King, W.R. (1991) 'Towards a theory of strategic use of information resources: an inductive approach', *Information Management*, Vol. 20, No. 3, pp.191–212.

Sabherwal, R., Hirschheim, R. and Goles, T. (2001) 'The dynamics of alignment: insights from a punctuated equilibrium model', *Organization Science*, Vol. 12, No. 2, pp.179–197.

Sahay, S. and Walsham, G. (2006) 'Scaling of health information systems in India: challenges and approaches', *Information Technology for Development*, Vol. 12, No. 3, pp.185–200.

Sahay, S., Monteiro, E. and Aanestad, M. (2009) 'Configurable politics and asymmetric integration: Health e-infrastructures in India', *Journal of the Association for Information Systems*, Vol. 10, No. 5, p.4.

Star, S.L. (1999) 'The ethnography of infrastructure', *American Behavioral Scientist*, Vol. 43, No. 3, pp.377–391.

Star, S.L. and Ruhleder, K. (1996) 'Steps toward an ecology of infrastructure: design and access for large information spaces', *Information Systems Research*, Vol. 7, No. 1, pp.111–134.

Steiner van der Kruk, S. and Schellhammer, S. (2014) 'A reflexive and interactive approach on novice-based data collection to investigate information infrastructure (II)', in *Proceedings of the European Conference on Information Systems*, Tel Aviv, Israel.

Stewart, D.W. and Shamdasani, P.N. (1990) *Focus Groups: Theory and Practice*, Sage, London.

Tilson, D., Lyytinen, K. and Sorensen, C. (2010) 'Digital infrastructures: the missing is research agenda', *Information Systems Research*, Vol. 21, No. 4, pp.748–759.

Tjornehoj, G. and Mathiassen, L. (2008) 'Between control and drift: negotiating improvement in a small software firm', *Information Technology & People*, Vol. 21, No. 1, pp.69–90.

Ure, J., Procter, R., Lin, Y.W., Hartswood, M., Anderson, S., Lloyd, S. and Ho, K. (2009) 'The development of data infrastructures for ehealth: a socio-technical perspective', *Journal of the Association for Information Systems*, Vol. 10, No. 5, p.3.

Vaast, E. and Walsham, G. (2009) 'Trans-situated learning: supporting a network of practice with an information infrastructure', *Information Systems Research*, Vol. 20, No. 4, pp.547–564.

Van de Ven, A.H. and Huber, G.P. (1990) 'Longitudinal field research methods for studying processes of organizational change', *Organization Science*, Vol. 1, No. 3, pp.213–219.

Vargo, S.L. and Lusch, R.E. (2008) 'Service-dominant logic: continuing the evolution', *Journal of the Academy of Marketing Science*, Vol. 36, No. 1, pp.1–10.

Vargo, S.L. and Lusch, R.F. (2004) 'Evolving to a new dominant logic for marketing', *Journal of Marketing*, Vol. 68, No. 1, pp.1–17.

Walsham, G. (1993) *Interpreting Information Systems in Organizations*, Wiley, Chichester.

Weill, P. (1993) 'The role and value of information technology infrastructure: some empirical observations', in *Strategic Information Technology Management*, pp.547–572, January, IGI Global.

Weill, P. and Broadbent, M. (1998) *Leveraging the New Infrastructure*, Harvard Business School Press, Boston, US.

Weill, P. and Ross, J. (2004) *IT Governance: How Top Performers Manage IT for Superior Results*, Harvard Business School Press, USA.

Weill, P. and Vitale, M (2002) 'What IT infrastructure capabilities are needed to implement e-business models?', *MIS Quarterly Executive*, Vol. 1, No. 1, pp.17–34.

Williams, R. and Pollock, N. (2012) 'Research commentary-moving beyond the single site implementation study: how (and why) we should study the biography of packaged enterprise solutions', *Information Systems Research*, Vol. 23, No. 1, pp.1–22.

Yin, R. (1994) *Case Study Research: Design and Methods*, 2nd ed., Sage Publishing, Beverly Hills, CA.

Zhu, K. (2004) 'The complementarity of information technology infrastructure and e-commerce capability: a resource-based assessment of their business value', *Journal of Management Information Systems*, Vol. 21, No. 1, pp.167–202.