The Path Biography Methodology: Analyzing Self-Reinforcing Mechanisms on Technical and Organizational Levels

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Abstract

While studies on self-reinforcing mechanisms in information systems (IS) research rely on methodologies that focus on the technical level without fully accounting for such effects on the organizational level, management research relies on methodologies that concentrate researchers' efforts on the organizational level. The purpose of this paper is to introduce the Path Biography Methodology, a qualitative approach that helps researchers capture and analyze self-reinforcing mechanisms on and between technical and organizational levels. By synthesizing insights from IS and management research, we develop four principles that researchers should consider when applying the Path Biography Methodology. Using a path biography study of a university and its information system, we illustrate how researchers may apply this methodology to analyze self-reinforcing mechanisms. Overall, this paper lays the groundwork for a research methodology that enables researchers to capture and analyze self-reinforcing mechanisms on and between technical and organizational levels.

Keywords: Qualitative research, path biography, self-reinforcing mechanisms, path dependence
Introduction

“Modern complex technologies often display increasing returns to adoption in that the more they are adopted, the more experience is gained with them, and the more they are improved” (Arthur 1989, p. 116).

Since Arthur’s (1989, 1994) introduction of self-reinforcing mechanisms in technology contexts, i.e., positive feedback loops that increase the value of selecting a certain option, the analysis of self-reinforcing mechanisms has also entered information systems (IS) research (e.g., Beck et al. 2008; Weitzel et al. 2006; Zhou and Zhu 2006). Self-reinforcing mechanisms constitute the essential foundation of battles among information technology (IT) platforms about which (potentially inferior) IT platform may become prevalent over time (Zhou and Zhu 2006). As such IT platform battles continue—e.g., between Microsoft Windows and Mac OS or Android and iOS—the analysis of self-reinforcing mechanisms that play out in these technology contests remains an important topic in IS research (Henfridsson and Bygstad 2013; Singh et al. 2015). By devoting attention to and analyzing self-reinforcing mechanisms, prior works have provided a better understanding of important IS phenomena, such as IT platform adoption (Fichman 2004), standard diffusion (Cheng et al. 2010; Weitzel et al. 2006), and platform ecosystems (Tiwana et al. 2010).

While prior works in the IS literature have demonstrated the fruitfulness of analyzing self-reinforcing mechanisms, they largely rely on formal or quantitative-empirical methodologies and simulations to explain related IS phenomena (cf. Henfridsson and Bygstad 2013). These methodologies draw researchers’ attention to analyses on the technical level, i.e., the immediate effects of self-reinforcing mechanisms that directly concern the development of the information systems architecture (Fuerstenau and Kliewer 2015; Oates and Fitzgerald 2007). Yet, as the quote by Arthur (1989) at the beginning of this section suggests, self-reinforcing mechanisms not only play out on the technical level (e.g., technological information systems improvements) but may also be prevalent in social processes (e.g., accumulation of user experience). Thus, by methodologically capturing self-reinforcing mechanisms mainly on the technical level, researchers do not fully account for potential effects on the organizational level, i.e., social processes in organizations that are also affected by self-reinforcing mechanisms (Henfridsson and Bygstad 2013).

While the IS literature has shed light on the effects of self-reinforcing dynamics on the technical level, a vibrant stream of management research on self-reinforcing mechanisms has simultaneously developed (e.g., Dobusch and Schüßler 2013; Sydow et al. 2009; Vergne and Durand 2010). Management research predominantly examines self-reinforcing mechanisms as an essential part of “organizational path dependence” (Sydow et al. 2009), a complex social process on the organizational level in which managerial scope of action is reduced over time (Koch 2008, 2011). Accordingly, management researchers mostly rely on research methodologies such as case studies (Sydow et al. 2012) that can capture the social aspects of self-reinforcing mechanisms on the organizational level (Eisenhardt 1989; Yin 2014). While these case studies have provided fruitful insights into self-reinforcing dynamics on the organizational level, they tend to treat the technical level as unexamined organizational context (Drnevic and Croson 2013) and, thus, hardly capture self-reinforcing mechanisms and their effects on the technical level.

While neither the methodologies used in IS research nor those used in management research seem to be able to fully capture self-reinforcing mechanisms on both the technical and organizational levels, a broader understanding of self-reinforcing mechanisms that spans these levels appears to be important for at least four reasons. First, a research focus on the technical level neglects the broader social conditions in which information systems are embedded. As self-reinforcing mechanisms on the organizational level can lead to tremendous social change and, therefore, evoke changes in the information systems architecture, methodologies that capture self-reinforcing mechanisms only on the technical level may explain only part of the story (Dobusch and Schüßler 2013). Second, a research focus on the organizational level does not fully consider the potential emergence of new options that arise from the evolution of information systems. As information systems may infuse new “digital options” (Sambamurthy et al. 2003) on the organizational level when they are shaped and re-shaped by self-reinforcing mechanisms, these self-reinforcing mechanisms may not lead to a lock-in on the organizational level in all cases (Sydow et al. 2012). Third, while self-reinforcing mechanisms may separately unfold their effects on technical and organizational levels, they may also span these levels (Dobusch and Schüßler 2013). Researchers that rely
on single-level methodologies may be inclined to miss those self-reinforcing mechanisms in their analyses. Fourth, information systems within organizations may develop in interaction with self-reinforcing mechanisms on supra-organizational levels (Maielli 2015; Schmidt and Braun forthcoming). Therefore, analyses of self-reinforcing dynamics need to have an eye on how global self-reinforcing mechanisms, such as industry standards, influence local information systems and how local specifications are generified to global standards (Williams and Pollock 2012). In all, these issues highlight the need for a research methodology that can capture and analyze self-reinforcing mechanisms on both technical and organizational levels (Chang et al. 2014; Dobusch and Schüßler 2013; Guillemette and Paré 2012; Henfridsson and Bygstad 2013; Marsan et al. 2012; Oates and Fitzgerald 2007; Sydow et al. 2012).

The purpose of this paper is to synthesize the ideas from IS and management research on self-reinforcing mechanisms to develop a methodology that can account for self-reinforcing mechanisms on both technical and organizational levels: the “Path Biography Methodology”. The Path Biography Methodology is a qualitative approach explicitly designed to draw researchers’ attention to self-reinforcing mechanisms on and between the technical and the organizational levels. It does so by using a fine-grained grid of global–organizational, local–organizational, local–technical, and global–technical levels and explicating the potential spots for self-reinforcing mechanisms to which researchers must pay attention. In a path biography study of a university and its information systems architecture, we empirically illustrate how researchers may apply the Path Biography Methodology and in which ways the methodology can provide added value over conventional methods currently in use in IS and management research.

By introducing the Path Biography Methodology, the contributions of this paper are threefold. First, by explicating the four principles on which this methodology is based, we lay the groundwork for a research methodology that enables researchers to capture and analyze self-reinforcing mechanisms on both the technical and organizational levels. Second, by providing a research methodology that encompasses both the technical and organizational levels, researchers may now apply analyses of self-reinforcing mechanisms to research problems that extend beyond a single level (Chang et al. 2014; Dobusch and Schüßler 2013; Guillemette and Paré 2012; Henfridsson and Bygstad 2013; Marsan et al. 2012; Oates and Fitzgerald 2007; Sydow et al. 2012). By synthesizing insights from IS and management research to develop a methodology that researchers from both disciplines may use, we hope that the Path Biography Methodology stimulates future research that leads to a desperately needed exchange between research disciplines (Yoo 2013). Third, the Path Biography Methodology constitutes a useful tool for practitioners (Oates 2004) that facilitates continuous reflections on and diagnoses of self-reinforcing mechanisms on and between technical and organizational levels before they lead to fruitful or harmful outcomes (Guillemette and Paré 2012; Schreyögg and Kliesch-Eberl 2007).

The remainder of the paper is organized as follows. First, we provide an overview of prior literature on self-reinforcing mechanisms in IS and management research as well as the methodologies applied in these disciplines for this purpose. Second, we develop the Path Biography Methodology by explicating the four key principles that researchers should consider when analyzing self-reinforcing mechanisms with the Path Biography Methodology. Third, we illustrate the application of the Path Biography Methodology in practice and its outcomes by providing two illustrative examples from a path biography study of a university and its information system. Fourth, we discuss the added value and challenges of using the Path Biography Methodology and provide concluding remarks.

**Background Literature**

**Self-Reinforcing Mechanisms in IS Research**

**Arthur-Related Research**

Arthur’s (1989) observation that technology markets often face increasing returns to adoption initiated many IS studies on technological and, later, organizational path dependence. Arthur’s (1989, 1994) formal modeling of network effects transformed the notion of increasing value from a growing network, an idea prevalent in many economic texts of that time (e.g. Katz and Shapiro 1985), into an actionable concept. While being conceptualized as a critique to neoclassical economics and its assumption of “efficient” markets, the notion of self-reinforcing mechanisms faced considerable resistance to adoption within the economic community (Liebowitz and Margolis 1990, 1995, 2013). Major areas of criticism on Arthur’s
From the early work of Arthur (1989) to recent developments in the literature, network effects have been a central concept in the study of technology adoption and platform competition. The analysis of network effects has been extensively studied in the context of economic theory, particularly in the field of industrial organization, where the concept was initially developed. However, the broader management literature has also contributed to the understanding of network effects, particularly in the context of software and information technology (IT) adoption, where the term “network effects” is widely used.

The concept of network effects is central to understanding the dynamics of IT adoption and platform competition. Network effects refer to the positive or negative influences that arise when one user's adoption of a product or service increases the value of that product or service for other users. This concept has been applied in various contexts, including software markets, telecommunications, and social networks.

Within the IS community, Arthur’s notion of network effects has been adopted most profoundly in the Economics of IS stream of the literature. In this research stream, Arthur’s economic foundation has influenced many studies of important IS phenomena, such as IT platform adoption (Fichman 2004; Zhou and Zhu 2006), standard diffusion (Cheng et al. 2010; Liu et al. 2011; Weitzel et al. 2006; Zhou and Zhu 2006), and, most recently, platform ecosystems (Tiwana et al. 2010). For instance, Zhou and Zhu (2006) studied platform battles with lock-ins for open source versus proprietary platforms. Niculescu et al. (2012) explored the underlying consumer heterogeneity in competitive markets for subscription-based IT services that exhibit network effects. As another example, Beck et al. (2008) studied the adoption of telecommunication services in the face of network effects.

Concerning the chosen unit of analysis, there is a broad variety of employed perspectives. This is not surprising, given the diverse spectrum of objects under study, such as IT platforms; mobile and telecommunication services; communication standards; and video game platforms, to name a few. Nevertheless, the most prominent perspective is that of individual users or consumers adopting a particular technology or service (cf. Draisbach et al. 2013). Relatively few studies have provided a more complex, multi-level characterization of different actors, such as intermediaries and brokers, organizational sub-units, or networks consisting of technical and non-technical elements (Henfridsson and Bygstad 2013).

A key explanation for the observed constraint to one or very few actor types and non-hierarchical settings can be found by scrutinizing the chosen methodologies. Most empirical works have used formal approaches—i.e., analytic or game-theoretic models, formal logic, and mathematical proofs—to build or extend theory related to network effects or platform competition. Quantitative-empirical approaches are another prominent methodology among IS scholars, who have employed these to estimate the strength of network effects or transition probabilities in empirical markets, e.g., for Microsoft Windows and Linux operating systems (Economides and Katsamakas 2006), the pre-packaged software industry (Lee et al. 2010), interorganizational standards (Zhu et al. 2006), or the telecommunications industry (Fuentelsaz et al. 2012). A few contributions are based on simulation methods, for instance, to study standardization problems (Weitzel et al. 2006), search engine markets (Cheng et al. 2010), the adoption of social network platforms (Draisbach et al. 2013), or telecommunication services (Beck et al. 2008). Studies referring to the term “network effects” that apply network-analytic methods (e.g., Peng and Dey 2013; Singh et al. 2011) have recently gained momentum. Other approaches, such as case studies, ethnographic studies, and biographical methods, also in combination with alternative quantitative approaches, such as experiments, are comparatively rare in studies in the Economics of IS stream (Henfridsson and Bygstad 2013).

Table 1 gives a brief overview of recent work concerning network effects, path dependence, and lock-in from an economics of IS perspective. We grouped studies in major IS journals (e.g. MISQ, ISR, JMIS) and top-tier conference proceedings (e.g. ICIS, ECIS, PACIS, HICSS, AMCIS) by their methodological approach. The table is representative for a wide array of similar papers.

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1 Our database search included the strings “network effects” and “network externalities”. Thereupon, we followed Webster and Watson’s (2002) advice to perform a backward search. The backward search started from the “previous work” section and the list of references. The resulting papers in the working set were used for a subsequent forward search using Google scholar, Scopus and ebscoHost. Articles from the broader management literature (e.g. SMJ, AMJ, MS) were included only if they made clear reference to either the software industry or to IT/IS in general. Articles that relied exclusively on social network analysis without further reference to Arthur’s original conception of “network effects” where excluded from the analysis.
Table 1. Exemplary References in IS Research Drawing on Arthur's Economic Foundations

While the Economics of IS research stream has relied heavily on formal, quantitative-empirical, or simulation-based methodologies to provide insights into self-reinforcing dynamics, other streams of IS research have made more intensive use of qualitative methods to portray self-reinforcing mechanisms. As the Path Biography Methodology aims to integrate different methodological and theoretical positions, the next section is devoted to these other, more grounded, qualitative, social, and organizational IS research streams rooted in Arthur’s work on self-reinforcing mechanisms.

Other IS Research Streams

Recently, Arthur’s work on path dependence and self-reinforcing mechanisms has received new attention in IS research through a collection of articles on the evolution of digital infrastructures. As a common starting point, Hanseth (2000) and Hanseth and Lyytinen (2005) advocated for the crucial role of self-

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2 In their study, the authors apply a simulation as a complementary method.
reinforcing mechanisms for gaining a better understanding of infrastructure evolution outcomes, such as success or failure. Similarly, Henfridsson and Bygstadt (2013), in their article on determinants of infrastructure evolution success, started by assuming that infrastructure evolution is predominantly driven by self-reinforcing mechanisms, i.e., adoption (or network effects), innovation, and scaling.

The main difference between the digital infrastructure stream of the IS literature and classical studies of technological path dependence (e.g., Arthur 1989, 1994; David 1985) relates to the emphasis on the social dimension of infrastructure and agency. Digital infrastructures are assumed to be socio-technical systems (Pipek and Wulf 2009). Therefore, the organizational context becomes an active component in which self-reinforcing mechanisms nest and unfold. Henfridsson and Bygstadt (2013), for instance, advocated a configurational perspective in which self-reinforcing mechanisms are not limited to the technical level but are nested on different levels and evoke and require each other. Therefore, changes in IT infrastructures can be caused by external shocks, as perceived by many path dependence researchers (Vergne and Durand 2010), but also by many small and incremental changes that lead to a constant “drift” (Ciborra et al. 2000). Nevertheless, the literature also provides pertinent accounts that a “drift”—e.g., by the means of bricolage, workarounds, or shadow IT—can stabilize an infrastructure. The rationale for this observation is that such drifting may continuously reinforce an infrastructure’s architectural foundation (Henningsson and Hanseth 2011; Grisot et al. 2014) or that coordination problems and switching costs arise later from a grown installed base embedded in settings with a large number of actors and locations as well as technical and non-technical elements (Hanseth 2000, 2002).

Methodologically, works studying self-reinforcing dynamics in digital infrastructures rely almost exclusively on qualitative methods, such as case studies (Yin 2014) or ethnography (Van Maanen 2015). For instance, almost all cases Ciborra et al. (2000) collected for their foundational book on information infrastructures use such a case method. For example, Ciborra and Failla (2000) studied CRM at IBM and found a huge influence of self-reinforcing mechanisms on the success of the initiative. Similarly, Hanseth and Aanestad (2003) presented three cases that show the role of self-reinforcing mechanisms in the implementation of successful health care infrastructures. As one of the few exceptions, Henfridsson and Bygstad’s (2013) study drew on qualitative comparative analysis (QCA), a set-theoretic approach, to identify necessary and sufficient conditions for infrastructure evolution success. By uncovering generative mechanisms of infrastructure evolution that quantitative-empirical studies have overlooked, the authors outline and emphasize the importance of research methodologies that can capture such mechanisms on multiple levels.

**Organizational Path Dependence: New Insights for IS Research**

Simultaneous to the growing attention to self-reinforcing mechanisms in IS research, Arthur’s (1989, 1994) insights have also gained track in the management literature. While the body of literature on incumbents’ challenges to conduct strategic change does not specify how these inertial behaviors emerge, self-reinforcing mechanisms have become a powerful explanation for this phenomenon (Koch 2008). With self-reinforcing mechanisms “at the heart” (Sydow et al. 2009, p. 698), management scholars have consolidated these insights into a theory of organizational path dependence (Dobusch and Kapeller 2013; Dobusch and Schüßler 2013; Koch 2011; Rothmann and Koch 2014; Schmidt and Braun forthcoming; Schreyögg and Sydow 2011; Sydow et al. 2009; Vergne and Durand 2010, 2011; Wenzel forthcoming).

Organizational path dependence is, first and foremost, a process (Schreyögg and Sydow 2011). It explains how a managerial scope of action, i.e., the perceived range of strategic options, is reduced over time (Sydow et al. 2009). Although competing conceptualizations of path dependence vary in their details, they share an understanding that the reduction of managerial scope of action is a three-stage process (Dobusch and Kapeller 2013; see also Figure 1).
In the first phase, organizations have a broad scope of action available. Although the scope of action is always limited to a certain degree (as represented by the shaded area in Figure 1), for instance, because of historical “imprints” (Stinchcombe 1965), organizations can choose between a large number of strategic options. At this stage, the outcome of the process is not predictable and the strategic choice is reversible (Sydow et al. 2009). Due to this lack of predictability, organizations may—either consciously or unwittingly (Sydow et al. 2012)—initiate the second phase: they may trigger self-reinforcing mechanisms, i.e., positive feedback on selecting this strategic option (Schreyögg et al. 2011). The positive feedback increases the attractiveness of re-selecting this strategic option over time and simultaneously renders strategic alternatives increasingly unattractive (Dobusch and Schüßler 2013). In principle, strategic choice is still reversible at this stage (Sydow et al. 2009), but a reversal becomes increasingly difficult toward the end of this phase (Koch et al. 2009). When self-reinforcing mechanisms have narrowed the scope of action to a limited range of strategic options, organizations enter the third phase, the “lock-in” stage. In this phase, organizations reliably reproduce their strategic choice over time. Even if new strategic alternatives emerge along the way, affected organizations stick with their established choice pattern for cognitive, normative, or resource-based reasons (Koch 2008; Rothmann et al. 2014; Sydow et al. 2009). Thus, strategic choice becomes irreversible at this stage (Sydow et al. 2009).

Given that the management literature emphasizes the self-reinforcing dynamics of path dependence as an organizational phenomenon, it predominantly conceives self-reinforcing dynamics as a complex social process on the organizational level in which routines, institutions, organizational structures, and competencies rigidify over time (Koch 2008; Sydow et al. 2009; Sydow et al. 2012). As in-depth analyses of qualitative data from a small number of cases are particularly well-suited to gaining a better understanding of complex social phenomena (Eisenhardt 1989), prior empirical studies in the management literature that examine self-reinforcing dynamics mostly rely on the case study method (see Dobusch and Kapeller 2013, Dobusch and Schüßler 2013, and Sydow et al. 2012 for overviews of empirical studies on self-reinforcing dynamics). Accordingly, these case studies have provided fruitful insights into the social processes of how paths emerge (Koch 2008), how they are reproduced (Rothmann and Koch 2014), and how they are disrupted (Wenzel et al. 2015). While case studies continue to dominate the landscape of path research in the management literature, a few studies have begun to examine these social processes in simulation-based setups (Fuerstenau 2014; Meyer 2012; Obschonka 2014) or experiments (Koch et al. 2009).

In line with the emergent awareness of the strategic importance of information systems on the organizational level (Bharadwaj et al. 2013; Guillemette and Paré 2012), first case studies on the social aspects of self-reinforcing dynamics have also informed IS research. For instance, in their case study of path dependence in the funeral industry, Wenzel et al. (2015) shed further light on the disruptive nature of information systems (e.g., Lytinen and Rose 2003). In particular, by comparing and contrasting critical change events in the environment, they showed that emerging information systems can disrupt strategic paths by destabilizing self-reinforcing mechanisms. Furthermore, although developments in information systems entail promising strategic opportunities (Drnevich and Croson 2013), Rothmann et al. (2014) revealed that path-dependent organizations have fairly limited outlooks for exploiting these...
strategic opportunities. In their case study of the newspaper industry, they showed that path-dependent organizations are either unwilling or unable to exploit emerging strategic opportunities that emerging information systems provide and that the reasons for sticking with the established choice pattern—cognitive, normative, or resource-based (Koch 2008; Sydow et al. 2009)—alternate over time.

Although the management literature on self-reinforcing dynamics bears promising contributions to the IS literature (cf. Henningsson and Henriksen 2011), it largely reflects the social dimension of the process that appears on the organizational level. By focusing on the organizational level, path researchers largely treat technical aspects as the context in which self-reinforcing mechanisms are at work (Drnevich and Croson 2013). Therefore, an overly narrow focus on self-reinforcing mechanisms on the organizational level does not fully consider self-reinforcing dynamics on the technical level that the IS literature has explored.

The simultaneous consideration of self-reinforcing mechanisms on the technical and organizational levels would help researchers integrate the theoretical insights into self-reinforcing mechanisms that the management literature and IS research have developed (Dobusch and Schüßler 2013). However, too empirically consider self-reinforcing mechanisms on both the technical and organizational levels, researchers require a methodology capable of capturing self-reinforcing mechanisms on both levels. Based on the insights and methodological approaches that have simultaneously developed and evolved (see Figure 2 for a summary), we propose the Path Biography Methodology as a methodological approach that is well-suited for this purpose. By doing so, this methodology surpasses various other multi-level approaches to organizational path constitution (e.g., Dobusch and Schüßler 2013; Meyer and Schubert 2007; Singh et al. 2015; Sydow et al. 2012) that have typically tilted either toward the technical or the organizational side and have not yet fully integrated both levels of analysis into a coherent framework.

**Figure 2. Arthur-Related Research on Self-Reinforcing Mechanisms**

**Toward a Biographic Methodology to Examine Self-Reinforcing Dynamics**

**Developing the Path Biography Methodology**

The analysis of self-reinforcing dynamics requires researchers to “study processes in ‘real time’, i.e., place oneself at the time that events occurred even if one were looking at data gathered in the past” (Garud et al. 2010, p. 770). For this purpose, the “biography” of a particular information system, i.e., a reconstructed account of the development of an information system and the technical and social contexts with which it has interacted over time, constitutes a rich data source that allows “scholars to go beyond the study of
technology at a single locale or moment and, rather, attempt to follow it through space and time” (Williams and Pollock 2012, p. 1). Thus, we propose to analyze self-reinforcing mechanisms using the “Path Biography Methodology”, a methodological approach that relies on qualitative data to reconstruct the biography of an information system and considers self-reinforcing mechanisms on and between technical and organizational levels. The Path Biography Methodology takes Williams and Pollock’s (2012) call for more studies of information systems that take a biographic perspective as a starting point. This connects the Path Biography Methodology with several previous studies on innovation and technology management that viewed biographies as a central tool in understanding the trajectory of technological innovations (Butzin 2013; Butzin et al. 2012; Cooke 2012; Ibert and Müller 2015; Rammert 2002; Strambach 2012).

Whereas our literature review emphasizes the disconnected nature of the previous literature on self-reinforcing dynamics in information systems research and management research, the Path Biography Methodology promotes synthesizing empirical studies by making two major distinctions. The first distinction relates to the difference between the technical and the organizational realm. As previously discussed, the IS literature closely related to Arthur’s (1989, 1994) insights focuses on self-reinforcing mechanisms on the technical level, i.e., the immediate effects of self-reinforcing mechanisms that directly concern the development of the information systems architecture, whereas other streams rather focus on self-reinforcing dynamics on the organizational level, i.e., social processes in organizations that are also affected by self-reinforcing mechanisms. The Path Biography Methodology allows researchers to analyze self-reinforcing mechanisms on both technical and organizational levels (see (a) and (c) in Figure 3). In addition, the proposed methodology also draws researchers’ empirical attention to mutually reinforcing mechanisms between the technical and organizational levels (see (b) in Figure 3).

**Figure 3. Analyzing Self-Reinforcing Mechanisms with the Path Biography Methodology**

The other central distinction we use is the difference between local, i.e., the focal organization and its information system (see (a), (b), and (c) in Figure 3), and global, i.e., broader technical and social developments that interact with the focal organization (see (d1), (d2), (e1), and (e2) in Figure 3). Thus,
building on Williams and Pollock (2012), we argue that positive feedback mechanisms not only unfold within user organizations (e.g., the local adoption of standards) but also on a global level (e.g., industry-wide user base effects). Furthermore, global industry knowledge might be transferred from the global level to the local level, or local knowledge might be generalized from the local level to the global level (Pollock et al. 2007). Thus, following Pollock et al. (2007), two processes with opposing directions might be at work: “localization”, i.e., a process of implementing an application or extension that is available in the market to the local user organization (see (d₁) and (e₁) in Figure 3), or “generification”, i.e., a process of abstraction by which a local IT feature, component, algorithm, or function is generalized and made available to a broader user base (see (d₂) and (e₂) in Figure 3), e.g., by implementing it in a new release of a standard software.

**The Four Principles of the Path Biography Methodology**

To move conceptually from building a methodology for a particular instance or case to applying this methodology to a broader class of problems (cf. Sein et al. 2011), we develop principles that researchers should consider when using the Path Biography Methodology as a methodological tool for analyzing self-reinforcing mechanisms in and around information systems. In particular, based on key readings from IS and management research (see Table 2 for an overview), we suggest the following four principles on which the Path Biography Methodology is based and which may guide researchers in the analysis of self-reinforcing dynamics.

<table>
<thead>
<tr>
<th>Principles of the Path Biography Methodology</th>
<th>Key References</th>
</tr>
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| Principle 1: Focus on self-reinforcing mechanisms. | • Fichman 2004 (ISR)  
• Sydow et al. 2009 (AMR)  
• Dobusch and Schüßler 2013 (ICC)  
• Henfridsson and Bygstad 2013 (MISQ) |
| Principle 2: Focus on the technical level, organizational level, and level-spanning interactions. | • Dobusch and Schüßler 2013 (ICC)  
• Henfridsson and Bygstad 2013 (MISQ)  
• Pipek and Wulf 2009 (JAIS)  
• Sydow et al. 2012 (BR) |
| Principle 3: Consider the interaction between the local information system and the global environment. | • Pollock et al. 2007 (SSS)  
• Williams and Pollock 2012 (MISQ)  
• Sydow et al. 2012 (BR)  
• Dobusch and Schüßler 2013 (ICC) |
| Principle 4: Focus on stabilization and lock-in. | • Hanseth and Lyytinen 2005 (working paper)  
• Zhou and Zhu 2006 (ICIS)  
• Koch 2011 (OS)  
• Sydow et al. 2009 (AMR) |

Table 2. The Principles of the Path Biography Methodology and Key Readings from IS and Management Research

**Principle 1: Focus on Self-Reinforcing Mechanisms**

Self-reinforcing mechanisms can be seen as the drivers of history that amplify taken paths. These mechanisms create cascading “escalation spirals” or snowball effects that can hardly be stopped once they gain momentum (Sydow et al. 2009). The “nature of technology” within organizations makes IT infrastructures most susceptible to network effects, complementarities, and other important sources of self-reinforcement, as there are high initial investments, often as “sunk costs”, and increasing returns for additional users to adopt (Weitzel et al. 2006). To gain a better understanding of these developments, researchers require rich empirical data that uncover and track self-reinforcing mechanisms and their effects over time. As self-reinforcing dynamics continuously unfold in processes over time (Schreyögg and Sydow 2011), researchers must collect and analyze process data (Langley 1999) to gain a better understanding of self-reinforcing dynamics.
Principle 2: Focus on the Technical Level, the Organizational Level, and Level-Spanning Interactions

Analyses of self-reinforcing mechanisms on the technical level do not fully consider self-reinforcing dynamics on the organizational level and vice versa (Dobusch and Schüßler 2013; Drnevic and Croson 2013; Henfridsson and Bygstad 2013; Sydow et al. 2012). Therefore, methodologies that focus merely on a single level potentially neglect important developments on the other level as well as interactions among these levels (Dobusch and Schüßler 2013). Therefore, a broader focus on self-reinforcing mechanisms across levels is an important component of the Path Biography Methodology. Whereas methodologies to examine path constitution processes differentiate between focus levels and surrounding levels that can be located either above or below the focal level of analysis (Sydow et al. 2012), the Path Biography Methodology further specifies the areas to which researchers should devote their empirical attention to gain a better understanding of self-reinforcing dynamics; i.e., the local–technical level, the local–organizational level, and local level-spanning interactions.

Principle 3: Consider the Interaction Between the Local Information System and the Global Environment

The Path Biography Methodology not only takes a differentiated eye to local self-reinforcing dynamics but also focuses on global levels. This is necessary because actors who have an impact on the development of information systems are often distributed across the organization or even globally; i.e., they work in different locations, units, and regions (Arvidsson et al. 2014). Information systems often do not adhere to central surveillance but there are many dispersed agents with heterogeneous demands, diverse intentions, and decentralized decision processes (Schmidt and Braun forthcoming). Furthermore, self-reinforcing mechanisms that are in place in the global environment may be locally installed in organizations’ information systems or, in turn, local settings may diffuse to become widespread global standards (Dobusch and Schüßler 2013; Williams and Pollock 2012). Therefore, devoting empirical attention to the interaction between the local information system and the global environment is crucial to gaining a better understanding of self-reinforcing dynamics.

Principle 4: Focus on Stabilization and Lock-In

Self-reinforcing mechanisms are the drivers of path dependence (Sydow et al. 2009). As several paths and self-reinforcing mechanisms may be involved when studying information systems (Henfridsson and Bygstad 2013), we suggest identifying those self-reinforcing mechanisms that are the main drivers of path dependence, i.e., the most prevalent positive feedback loops that make a certain option become dominant. The analysis of paths that appear to be in the lock-in stage seems to be particularly fruitful (Koch 2008, 2011; Sydow et al. 2012): it enables researchers to reconstruct how these paths were initiated, how they emerged through self-reinforcing mechanisms, and how they became stable. In this way, researchers can determine and better understand stabilization processes driven by self-reinforcing dynamics.

Applying the Path Biography Methodology: An Empirical Illustration

Data

To illustrate possible applications of the developed methodology, we present two path biographies in the remainder of this section. The examples were taken from an empirical study on enterprise resource planning (ERP) systems in higher education conducted by two authors of this paper. In this research project, we applied the methodology with a longitudinal qualitative research design to a large German university that implemented an ERP system based on a new industry-specific standard software package to examine how organizations implement urgently needed functionality into their information systems despite the fact that the vendor of packaged standard software does not yet provide all of these functionalities. Because of the multi-level nature of the studied phenomenon (Sydow et al. 2012), the case seemed suitable for an illustrative application of the Path Biography Methodology.

To reconstruct the biography of the information system, we gathered qualitative data from 2005 to 2015. In particular, we relied on interviews, archival materials, and public documents that provided rich accounts on the evolution of the information system. To capture global mechanisms, we used interview...
data from another research project that particularly focused on self-reinforcing mechanisms on the industry level (Schmidt and Braun forthcoming). These data comprised 40 interviews with consultants and vendors of ERP software. To capture local mechanisms, we conducted four semi-structured, retrospective interviews with five key informants in the user organization: the ERP department manager, the application manager, two ERP platform developers, and a person participating on several projects over the entire implementation and post-implementation phase. These interviews generally lasted one to two hours. We also referred to archival documents, collecting documents for each stage of the information system’s development (including the original project mandate); implementation status and milestones; IT strategy documents; and other communications. We asked all interviewees to provide relevant documents that showed how the information system evolved. For example, we obtained a presentation giving the detailed timeline of the ERP module development. We also obtained information from the campus intranet webpage of the university’s ERP department, such as video recordings of presentations given at the country-specific ERP campus user group forum. From the campus-internal website, we also obtained several training documents for users from different communities (e.g., students using the web modules, lecturers using the grading module, and administrative personnel using related ERP modules), how-to documents, and other information material. Finally, we analyzed more than 40 public documents, including information from the vendor website, product brochures, vendor release management procedures, support site entries, and industry reports. These documents helped us gain a deeper understanding of local and global developments on the technical and organizational levels, but also to validate (or dispute) the information we obtained in the interviews.

In line with the principles of the Path Biography Methodology, we analyzed our data in four steps. First, to identify self-reinforcing mechanisms in our data (Principle 1), we searched for positive feedback that increased the value of certain variables over time (Sydow et al. 2012). For example, the dispersion of specific organizational values (organizational culture) was a process that we could treat as a delimitable unit of analysis, where we could show a self-reinforcing increase in quantity and quality over time by temporally bracketing (Langley 1999) the historical data into different stages.

Second, the holistic research design of the qualitative study enabled us to capture these dynamics not only on the technical level but also broadened our empirical attention for developments on the organizational level and interactions between these levels (Principle 2); i.e., it allowed us to analyze the “biographic” evolution of the information system (Williams and Pollock 2012). For instance, we identified a point in time in our data when we could not separate the dispersion of organizational culture on the organizational level from the information system on the technical level. This indicated that the organizational culture became indispensably entangled with, and inscribed into, the information system (Koch 2011; Sydow et al. 2012).

Third, the holistic research design also provided the opportunity to give more focused consideration to data from the global industry level (principle 3), which allowed us to more closely examine the interaction between global and local paths (Sydow et al. 2012). By focusing on level-spanning interactions, we recognized, for instance, that the focal organization stabilized the emergence of a global technical path by generifying specific local knowledge to a standardized software package.

Fourth, whereas the previous steps led us to identify an elevated number of self-reinforcing mechanisms, we focused on the key self-reinforcing mechanisms that led to a high degree of stabilization (Principle 4) based on a data reduction process (Strauss and Corbin 1998). In particular, we focused on those paths that were strategically relevant for the organization (Koch 2008), given that their stabilization could have a positive or negative long-term impact for the organization. For example, decision makers in our case study paid high attention to the organizational adaption of a new regulation with the help of information technology because it was clear that these decisions would have a long-term effect on the organization.

Although the proposed Path Biography Methodology provides a fresh perspective on self-reinforcing mechanisms on and across different levels of analysis, it is—more abstractly—a qualitative methodology. Therefore, the same criteria for evaluating qualitative research (e.g., Lincoln and Guba 1985; Tracy 2010; Yin 2014) also apply to studies that adopt the Path Biography Methodology. Following Yin’s (2014) quality criteria for qualitative research and the author’s recommendations for enhancing the quality of qualitative studies, we improved construct validity by collecting and triangulating multiple sources of evidence, improved internal validity by grounding our study in an extended literature review to explicate the key constructs and clarify the causal relationships among the constructs, improved external validity by
providing additional information on the “context” of the study and the rationale for selecting the examined case, and improved reliability by gathering and analyzing all data in a database and using a protocol for our interviews.

In the following sections, we briefly illustrate two path biographies, the first one showing how organizations stabilize global paths and the second one demonstrating how the interaction between global and local paths can lead to a stable branching of the local information system.

**Example 1: When Regulations and Technologies Meet in Organizations**

![Figure 4. When Regulations and Technologies Meet in Organizations](image)

Figure 4 illustrates how the focal university implemented and enforced a new European regulatory rule that required universities to introduce new classification schemes of university degrees. These classification schemes frame how a degree program is structured, how it is decomposed into modules and courses, which academic degrees will be awarded, and so forth. Almost at the same time, the university also implemented a new industry-specific standard software package. It was a major challenge for the organization to integrate a new standard software package that was not ready-made for the new regulation. Therefore, the software vendor and the university agreed upon a lead-user collaboration project. With special help from the software vendor and partners, the user organization localized the software package by implementing the software in a way that met the new regulations. Furthermore, the introduction of the new regulation and the implementation of the new standard software reinforced each other due to “complementarity effects”, i.e., increased value coming from the joint implementation of elements rather than from their separate implementation (Sydow et al. 2009). For example, the university used the implementation of the new standard software to inscribe the new classification schemes into the information system. As a consequence, departments that were supported by the new information system—for instance in their course registration, student enrollment, and grade recording—were more likely to implement the new classification schemes. This, in turn, led to a further distribution of the new classification system on the technical level. Yearly planning cycles, including a budget for customization and new developments, continuously reinforced the chosen solution and made further adaptations

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3 Whereas other studies on path dependence typically focus either on the technical level or organizational level and treat the other as context, the proposed methodology conflates the text/context distinction—without dismissing the difference—and suggests devoting attention to both levels; i.e., to capture self-reinforcing mechanisms on and between these levels, the Path Biography Methodology inherently requires a description of the global environment in which the local information system is embedded.

4 To ensure confidentiality, we disguised year specifications.
possible, as indicated by several self-reinforcement cycles in Figure 4. Furthermore, the functionality that was developed during this process also influenced the global development of the standard software package. Thus, in the case of the German university, the local implementation of the ERP system would have been of little use without the local adaptation of the new regulation and vice versa; only in their joint implementation did these elements become valuable to the university. This complementarity led to a stabilization of a local–organizational as well as a local–technical path (see Figure 4). The global–technical path, the industry-specific standard software package, was also reinforced because locally developed functionality was generified and became part of the standard solution.

**Example 2: The Branching of Information Systems**

Figure 5 illustrates how the “culture of freedom” of the analyzed university, which historically developed because of the self-referential telling of dominant narratives (Geiger and Antonacopoulou 2009), interfered with the implementation of a new packaged industry solution that the university localized. By repeatedly communicating independence as a central value of the university, a contradictory situation occurred: whereas an organizational culture of freedom favors organizational disintegration, the strength of standard software is the technical integration of organizational processes; i.e., the integration of the new software solution led to incompatibilities with a variety of routines, rules, and regulations within the university. Therefore, the university had to develop a lot of functionality necessary to meet its cultural requirements on its own. These developments coincide with “coordination effects” (Sydow et al. 2009), i.e., the more the ERP system complied with the cultural rules of this university, the more value could be derived from this system. Therefore, modules of the information system were increasingly split up (“branched”) into components that allowed variety and into parts that were fully integrated and aligned with the software standard. These branched components became increasingly intertwined with the local organizational practices and routines. In this case, the Path Biography Methodology allows researchers to observe the mechanism-driven stabilization of a local techno-organizational path (self-reinforcing mechanisms between the local–technical and local–organizational level, see Figure 5).

**Discussion and Conclusion**

The purpose of this paper was to introduce the “Path Biography Methodology” as a methodological tool for richer and more complete analyses of self-reinforcing mechanisms in IS and management research. While extant studies on self-reinforcing mechanisms in the IS literature predominantly rely on formal, quantitative-empirical, and simulation-based methodologies that draw researchers’ attention to self-reinforcing mechanisms on the technical level, they cannot fully capture the social processes of self-reinforcement on the organizational level with which the development of information systems may be
The Path Biography Methodology

intertwined (Henfridsson and Bygstad 2013). In contrast, studies on self-reinforcing mechanisms in the management literature rely on research methodologies that capture self-reinforcing mechanisms on the organizational level and do not fully consider the effects of self-reinforcing mechanisms on the technical level (Drneovich and Croson 2013). We synthesized the established insights from IS and management research to develop the Path Biography Methodology. This methodology allows researchers to capture and analyze self-reinforcing mechanisms on both technical and organizational levels and, therefore, provides broader and more complete insights into the driving effects of self-reinforcement. Therefore, the main contribution of this paper is to introduce the Path Biography Methodology that enables researchers to extend the analysis of self-reinforcing mechanisms to a broader class of research problems. By providing a fine-grained grid of global–organizational, local–organizational, local–technical, and global–technical levels and explicating the four principles on which this methodology is based, this paper lays the groundwork for a research methodology that allows researchers to capture and analyze self-reinforcing mechanisms on and between technical and organizational levels.

Our two empirical examples illustrate why it seems important to consider self-reinforcing mechanisms on both technical and organizational levels. In Example 1, without observations of developments on the global–organizational level (change of university regulations) and its impact on the local–organizational level (adaptation of new regulations), researchers may find it difficult to generate suitable and complete explanations for the development of the university’s path on the local–technical level (the localization of lead-user software) and the global–technical level (the generification of lead-user software). The same holds true for Example 2: without giving consideration to the identity of the university on the local–organizational level (culture of freedom), explanations for developments on the local–technical level (information system branching) may address only part of the story. These examples outline and emphasize the need for a more complex methodology that can more fully capture the multi-level aspects of self-reinforcing trajectories (Chang et al. 2014; Dobusch and Schüßler 2013; Guillemette and Paré 2012; Henfridsson and Bygstad 2013; Koch 2011; Marsan et al. 2012; Oates and Fitzgerald 2007; Sydow et al. 2012). We propose the Path Biography Methodology as a suitable candidate that serves exactly that purpose.

Although we grounded the Path Biography Methodology in insights from IS and management research, the methodology is not only applicable to research problems in the respective disciplines but, most importantly, to research problems that span disciplinary boundaries. Using this methodology in future research, management researchers may give more consideration to information systems beyond just regarding them as the context of social processes on the organizational level (Drneovich and Croson 2013) and IS researchers may broaden their attention toward social processes on the organizational level that extend beyond the technical level (Henfridsson and Bygstad 2013). Therefore, we hope that the Path Biography Methodology stimulates future research that leads to a fruitful exchange between research disciplines (Yoo 2013).

We not only hope that researchers will adopt the Path Biography Methodology for inspiring multidisciplinary research, but we also consider the methodology as a valuable tool for practitioners (Oates 2004). As the rigidifying forces of self-reinforcing mechanisms are potentially harmful when a shift toward a new information system architecture is required (Dobusch and Schüßler 2013; Rothmann and Koch 2014; Sydow et al. 2009; Wenzel et al. 2014, 2015), practitioners are interested in diagnosing the harmful effects of self-reinforcing mechanisms as early as possible (Guillemette and Paré 2012; Schreyögg and Kliesch-Eberl 2007). The Path Biography Methodology provides a suitable tool to do so. By continuously tracking the developments on technical and organizational levels as well as their interactions, for instance by keeping a diary (Bolger et al. 2003), organizations may continuously and consciously reflect on self-reinforcing dynamics and their threatening effects. This vigilance enables organizations to take counter-actions as soon as they are required to do so.

Although the Path Biography Methodology provides major opportunities for both research and practice, we also denote that it entails certain challenges. As for all qualitative approaches (e.g., Eisenhardt 1989), the theoretical insights drawn from the Path Biography Methodology are not statistically generalizable. However, the aim of qualitative approaches is not to achieve statistical generalization but analytic generalization (Yin 2014), i.e., the theoretical inferences must be transferrable to different contexts to a certain extent (Lincoln and Guba 1985). Our illustrative example shows that this may also be possible for the Path Biography Methodology: although the empirical study of the university and its information
system is located in a peculiar sector, other studies similarly report on level-spanning self-reinforcing mechanisms, for instance in the semi-conductor industry (Sydow et al. 2012; see also Dobusch and Schüßler 2013 for an extended overview).

Furthermore, the application of the Path Biography Methodology may require researchers to invest more effort in collecting (qualitative) data as compared to more prevalent methodologies in use (Oates 2006). Yet, while this increase in methodological complexity seems necessary to capture self-reinforcing mechanisms on multiple levels (Dobusch and Schüßler 2013; Henfridsson and Bygstad 2013; Koch 2011; Marsan et al. 2012; Oates and Fitzgerald 2007; Sydow et al. 2012), our illustrative example shows that this might not hold true in all cases. To reconstruct the biography of the university’s ERP system, we could extensively rely on documents that were readily available, e.g., publically or on the intranet of the university. As these documents were—as is often the case (Romano et al. 2003)—even richer than interview data, we needed only a few additional narrative interviews with central key informants of the organization to develop a comprehensive picture of the information system’s biography. Therefore, we believe that researchers may overcome this challenge, and we are eager to observe what researchers willing to use the Path Biography Methodology will do with it.

References


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