Evolution of IT Use: A Case of Business Intelligence System Transition

Completed Research Paper

Paul Glowalla
University of Cologne
Albertus-Magnus-Platz 50923 Cologne
glowalla@wiso.uni-koeln.de

Christoph Rosenkranz
University of Cologne
Albertus-Magnus-Platz 50923 Cologne
rosenkranz@wiso.uni-koeln.de

Ali Sunyaev
University of Cologne
Albertus-Magnus-Platz 50923 Cologne
sunyaev@wiso.uni-koeln.de

Abstract

Business intelligence (BI) becomes increasingly important and is an evolving topic in research and practice. The evolvement of BI, the flexibility of BI systems, and their context-dependency entail diverse and partially contradicting results on BI system use and outcomes. This study examines how and why BI systems are used differently and what the entailing outcomes are. With the theoretical lens of affordances, we account for non-deterministic BI results. We conceptualize constraints, complementary to affordances, for a more holistic picture of the appropriation process. For this, we conduct an in-depth case study to explore different user perceptions and appropriations of a successfully implemented BI system. We inform affordance theory, advancing research on the (mis-)perception of affordances and constraints by applying an extended model of the appropriation process. For practitioners, we present potential paths for BI systems development and provide a visual representation of affordances and constraints supporting intended affordance developments.

Keywords: Affordances, Constraints, Appropriation, Technical object, Business intelligence (BI), Case study
Introduction

Various analytical applications — for example, executive information, online analytical processing, and predictive analytics and data mining — have emerged over the recent decade, and allow users to access and to use data to support decision-making, in practice often described as “business intelligence” (Wixom and Watson 2010). Even though use of business intelligence (BI) systems continuously gains importance across sectors and in academia (Chen et al. 2012; Tamm et al. 2013; Wieder et al. 2012; Wixom et al. 2014), organizations implementing BI still struggle to achieve expected benefits from BI initiatives (İşık et al. 2013; Malladi and Krishnan 2013). BI systems are designed to “provide knowledge workers timely access, effective analysis and intuitive presentation of the right information, enabling them to take the right actions or make the right decisions” (Popović et al. 2012, p. 729). BI is an umbrella term that has been coined in practice to describe several heterogeneous applications, processes, and technologies (Wixom and Watson 2010). This leads to different perspectives, understandings, and viewpoints of what BI is and what it should do as well as what can be considered a successful BI initiative. As a result, there is not ‘the one BI system’ that just needs to be configured to a specific context, which makes comparing and contrasting different BI system implementations and their outcomes difficult. Instead, detailed analyses are necessary to account for the use of BI systems in specific contexts and by different users (e.g., Deng and Chi 2012).

In this context, we apply the theoretical lens of affordances (Leonardi 2011, 2013; Markus and Silver 2008; Robey et al. 2013; Strong et al. 2014; Volkoff and Strong 2013). The affordance concept, with its relational understanding of human-technology interaction, acknowledges the relation between information technology (IT) and human users and that their interplay leads to different uses and outcomes in a specific context. Therefore, these relations are not determined solely by the IT system; instead, what the IT system affords to a potential user and what the user has made of it is an open negotiation between the IT system and user (see Hutchby 2001). Thus, the concept of affordances allows accounting for such non-deterministic outcomes (Markus and Silver 2008). Moreover, since a new IT system is often not developed from scratch in an organization, the implementation of new IT also brings the challenge to transfer former affordances between users and legacy IT systems to a partially new IT system. Especially BI systems have to build on existing applications to integrate various source systems (Hevner and March 2004).

To sum up, it remains an open question how individuals use particular IT artifacts in specific contexts, and to what effect they use it. To our knowledge, the transition from a legacy to a new IT system has been neither examined within an affordance context nor for the domain of BI. With this study we address this research gap. By doing so, we first investigate the role of the transition before turning to the underlying reasons for diverging outcomes of BI use across different users: (RQ1) What role does the transition from a legacy IT system to a BI system play in an organizational context and (RQ2) how and why do specific users use an introduced BI system the way they do?

In order to answer these two research questions, we conduct an in-depth case study, aiming to explore and understand the non-deterministic use and outcomes in the case of a BI system implementation. Moreover, in the case study, we examine the impact of the transition of affordances and constraints from a legacy IT system to a new BI system. Acknowledging existing research on affordances, we develop and apply an appropriation process model to understand existence and perception of affordances and subsequent appropriation of an IT artifact. With this study, we mainly inform affordance research. Our exploratory single case study provides an adequate grounding to examine different appropriations of an alleged ‘common’ BI system. Our study addresses current research gaps in literature by conducting empirical, affordance-based research (Seidel et al. 2013; Volkoff and Strong 2013), informing and facilitating future affordance-based studies. In this respect, we add to the body of knowledge by developing and applying an extended, novel conceptual model for understanding the role of affordances and, additionally as a novel concept, applying constraints in the appropriation process. Moreover, we build upon but also extend the contributions of Markus and Silver (2008) with the developed appropriation process model, bridging the gap from existing affordances and constraints to their perception and their actual appropriation. By showing how the BI system use develops across users, providing paths for BI system development, we provide a visual representation to support planning of
affordance development, to identify affordances as well as constraints, and to steer the emergence of intended IT use and outcomes.

The remainder of the paper is structured as follows. The next section provides an overview of research on BI and affordances, explaining how and why non-deterministic outcomes of BI system use can be adequately addressed with the theoretical lens of affordances. Subsequently, we describe the case setting and the research design. The following section presents the identified affordances and constraints and their appropriation. Finally, the paper concludes with a discussion of the results.

**Related Work and Theoretical Background**

**Business Intelligence**

BI is an ongoing and increasingly important key issue for organizations (Luftman and Ben-Zvi 2011; Malladi and Krishnan 2013; Tamm et al. 2013). Throughout the last decade, BI emerged as an umbrella term (Watson 2010; Wieder et al. 2012) that encompasses several potential technologies, methodologies, and applications for data analysis and decision-making (Chen et al. 2012; Deng and Chi 2012; Popović et al. 2012; Wixom and Watson 2010). Different capabilities and factors are relevant for BI system use and its outcomes than for operational, transaction-oriented application systems (e.g., Popović et al. 2012; Wixom and Watson 2001). Existing studies, however, arrive at counterintuitive or even contradictory results (e.g., Işık et al. 2013; Popović et al. 2012; Wieder et al. 2012). For example, data quality is commonly considered a success factor for BI use and success (Popović et al. 2012; Wixom and Watson 2001; Yeoh and Koronios 2010), whereas, in contrast, more recent research finds data quality negatively correlated with BI success, potentially depending on the data quality level (Işık et al. 2013).

Due to the history and broad meaning of the term BI (Wixom and Watson 2010), we consider it helpful to differentiate between BI as a process or methodology and BI as an underlying IT system (Popović et al. 2012; Wieder et al. 2012). We build on the conceptualization of Wieder et al. (2012) and understand “BI as an analytical process which transforms fragmented data of enterprises and markets into action-oriented information or knowledge about objectives, opportunities and positions of an organization” (p. 7). In addition, this definition mitigates narrowing BI down to (managerial) decision-making, which is closely related to decision support systems and executive information systems (Watson 2010). Consequently, we posit that BI systems include, but are not limited to, software products primarily designed to support this analytical process which are deployed within an organization (Wieder et al. 2012) and “that provide knowledge workers timely access, effective analysis and intuitive presentation of the right information, enabling them to take the right actions or make the right decisions” (Popović et al. 2012, p. 729). Our definition is intentionally broad since it aims to account for non-deterministic results found in existing BI research. BI initiatives may also pursue different organizational goals (Wixom and Watson 2010). Accordingly, BI success can be defined “as the positive benefits organizations achieve through their use of BI” (p. 14), but will be more specifically defined based on the organizational goals as well as expected and resulting tangible or intangible benefits (Işık et al. 2013). Spanning different decision and task environments, BI systems need to be tailored to specific decision environments and users, resulting in the need for high flexibility (Işık et al. 2013; Popović et al. 2012) and, thus, in diverse BI instantiations and goals. Accordingly, there are different types of BI users (e.g., Deng and Chi 2012), BI use (e.g., Li et al. 2013), and paths that may lead to business value from BI (Seddon et al. 2012; Tamm et al. 2013). As a consequence, the plethora of application possibilities and contexts, and the dependency on the users’ skill and creativity, become evident only in in-depth analyses (e.g., Deng and Chi 2012; Wixom and Watson 2010).

To recap, existing research so far generates diverse and partially contradicting findings, lacking coherent explanations for BI outcomes and factors, and failing to take into account the diversity and non-deterministic nature of BI systems. Therefore, we aim to inform BI research by examining how and why BI systems are used in different ways and result in different outcomes.

**Affordances, Constraints, and their Appropriation**

In a recent effort to advance the study of human-technology relationships, Markus and Silver (2008) introduced a new conceptualization for the study of IT effects and proposed three concepts in order to
describe the relation between IT artifacts and individual human agents: “technical objects”, “functional affordances”, and “symbolic expressions”. We build on Markus and Silver’s (2008) conceptualization while developing an extended perspective. Table 1 summarizes our main theoretical concepts.

*Technical objects* (TOs) are IT artifacts and their component parts (Markus and Silver 2008), which form an IT system. TOs are real objects, material or abstract, that are made by humans as the outcomes of intentional design and manufacturing processes (Faulkner et al. 2010; Faulkner and Runde 2009), with properties that may have causal potential (Markus and Silver 2008). Previous TOs limit and enable future IT use through the material constraints and through experiences from previous IT systems that shape users’ approaches to using new IT systems (see Chae and Poole 2005).

The concepts of functional affordances and symbolic expressions are bridging concepts that tie together users and TO. Within this paper we specifically focus on the concept of affordances since it has proven to be very fruitful in information systems (IS) research. *Functional affordances*, or just affordances, are potentials or possibilities for goal-oriented action afforded to a specified user or groups of users (Markus and Silver 2008; Volkoff and Strong 2013). Therefore, affordances are a unique relationship between the TO and a specific user or user group (Leonardi 2011; Markus and Silver 2008; Robey et al. 2013; Volkoff and Strong 2013). In other words “it is the capabilities of the technology, just as much as the choices people make about how to use those capabilities, which explain the ultimate effects that technologies have on social structures. They are two sides of the same coin” (Leonardi 2013, p. 751). Moreover, affordances can both enable and constrain (Volkoff and Strong 2013). For example, provision of standardized reports by a BI system may enable some users to access comparable data for decision-making, but may constrain other users that hitherto have been used to access other report formats, customized reports, or spreadsheets. Moreover, the same property of a TO can be both enabling and constraining, even for the same user. In contrast, a user only being constraint by a property might not perceive an affordance at all. Therefore, we argue that enabling and constraining properties of affordances should also be differentiated analytically and empirically, which we do with the concept of constraints.

Existing IS research focuses on the actualization of affordances, that is, the realization of goal-oriented potential (e.g., Bernhard et al. 2013; Leonardi 2013; Strong et al. 2014). However, we argue that negligence of constraints in IS research poses a serious gap because negative side-effects of affordances or even ‘pure’ constraints and their consequences might be downplayed or even ignored. Mirroring the conceptualization of affordances, we consider a *constraint* as a relational concept between a TO and a specified user or groups of users that limits goal-oriented action. For example, in an insurance company, a standardized report might present concluded contracts based on the date where they come into effect. Users who need concluded contracts based on their acquisition date for calculating provisions are limited in their goal fulfillment. Such a constraint may apply to all users and stakeholders of an organization or it may only limit specific users, for instance, due to their abilities, goals, or their particular situation. The latter case includes the situation that an affordance for one or more individuals can be a constraint to other individuals. Moreover, constraints are indicators for potentials of future IS development because new affordances might reshape individuals’ goals, leading to new requirements and therefore new constraints (see Leonardi 2011).

In contrast to an affordance, a constraint of a TO cannot be actualized but will rather lead to ceasing use or change of the TO or task at hand. To describe the use of a TO in order to either actualize affordances or avoid constraints, we rely on the term of *appropriation*. The term appropriation also describes the “application of a specific technology-based rule or resource within a specific context and at a specific point in time” (DeSanctis and Poole 1994, p. 128). We consider an appropriation to be at least one cycle through the appropriation process model (Figure 1), that is, a user’s perception of affordances and constraints, their use or non-use, and the resulting outcome. More specifically, *appropriation moves* (DeSanctis and Poole 1994) refer to actual use of the TO, that is, the actions conducted to put the TO into use (Markus and Silver 2008). Specifically, distinguishing appropriation from actualization accounts for the non-deterministic outcomes of IT use. Appropriation moves can lead to unintended outcomes (see Leonardi 2011; Markus and Silver 2008), whereas actualization of affordances implies successful appropriation, for example, achieving expected outcomes useful for realizing overarching organizational goals (Strong et al. 2014). In this context, we add to Markus and Silver’s (2008) contributions providing “a more complete explanation of IT effects, in which users may appropriate the functional affordances of technical objects” (p. 624). It must be noted that in the context of our study we do not aim to assess if an appropriation is
faithful or ironic based on the developers’ intentions (see DeSanctis and Poole 1994) since we focus on the users’ perspective of appropriation based on their perceptions and goals.

Another reason for distinguishing between appropriation and actualization is the potential (mis-)perception of affordances (Bernhard et al. 2013; Gaver 1991; Shaw et al. 1982). Distinguishing existing affordances from the information perceived by users allows distinguishing misperceived affordances; either affordances that are perceived, but do not exist, or affordances that do exist, but are not perceived (Gaver 1991). A not perceived but existing affordance will usually not be acted upon at all, whereas acting upon a perceived, but not existing, affordance will lead to unsuccessful appropriation. In such a case, the misperceived affordance is not actualized, despite appropriation moves conducted to achieve intended outcomes. However, several appropriation moves might lead to actualization of affordances. Thus, appropriation moves link (mis-)perceived affordances and constraints and the resulting outcome.

Table 1. Definition of Underlying Theoretical Concepts

<table>
<thead>
<tr>
<th>Concept</th>
<th>Definition</th>
<th>Example</th>
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<tbody>
<tr>
<td>Technical objects</td>
<td>IT artifacts and their component parts, which form a technical system. Technical objects are real objects, material or abstract with properties that may have causal potential. Their existence does not depend on people’s perception of them. (Markus and Silver 2008)</td>
<td>An implemented BI system, including components such as documentation and spreadsheet plugins.</td>
</tr>
<tr>
<td>Functional affordances</td>
<td>Functional affordances, or just affordances, are potentials or possibilities for goal-oriented action afforded to a specified user or groups of users. Affordances are relations between technical objects and users. (Markus and Silver 2008)</td>
<td>A BI system affords users of one department with direct presentation of provisions. This affordance exists for these specified users, even after they leave their working place. This affordance also exists for other users given their ability and corresponding goals (i.e., access the provisions), even if they do not perceive the affordance.</td>
</tr>
<tr>
<td>Constraint</td>
<td>Constraint are potentials or possibilities to limit goal-oriented action of a specified user or groups of users. Constraints are relations between technical objects and users.</td>
<td>A BI system limits users with the goal to access provision calculations if they do not have any access to this feature or do not have the ability to use the BI system.</td>
</tr>
<tr>
<td>Perceived Affordance/Constraint</td>
<td>Affordances and constraints that are perceived by a user or users. The perceived affordances and constraints are not necessarily a subset of existing affordances and constraints (see Bernhard et al. 2013). Distinguishes existing affordances and constraints from the information perceived and interpreted by users’ (Gaver 1991).</td>
<td>Perceived affordance: A user with the ability to use the corresponding BI feature and the goal to access the provision calculation perceives the affordance, for instance, through the TO itself by reading the TOs documentation. Perceived constraint: A user aiming to access the provision calculation perceives, for instance, through an external source such as a colleague that it is in fact not possible due to missing user rights.</td>
</tr>
<tr>
<td>Misperceived affordance/</td>
<td>Affordances and constraints that are either perceived by a user or users although they do not exist, or not perceived by a user or users although they do exist (see Gaver 1991).</td>
<td>A user may use the standard report of concluded contracts for calculating provisions, misperceiving that the report is based on the wrong date for his goal, which in turn leads to a wrong provision calculation and thus an unsuccessful appropriation.</td>
</tr>
<tr>
<td>Constraint move</td>
<td>A user may use a TO in different ways, “invoking one or more of many possible appropriation moves.” (DeSanctis and Poole 1994, p. 129) Actual use of a TO, that is, the actions conducted to put a TO into use (Markus and Silver 2008) based on the user perceptions of affordances and constraints.</td>
<td>A user may choose not to use a system, not perceiving any affordance. A user may choose to manipulate or combine different TOs or TO artifacts perceiving that an affordance is missing.</td>
</tr>
<tr>
<td>Appropriation</td>
<td>“A[pplication of a specific technology-based rule or resource within a specific context and at a specific point in time” (DeSanctis and Poole 1994, p. 128). An appropriation encompasses users’ perception of affordances and constraints, their appropriation moves and the respective outcomes.</td>
<td>The BI system use, for instance, affordances used and neglected, can be described for a specified user or groups of users within the examined organization for a specific point in time.</td>
</tr>
</tbody>
</table>
An Extended Model of the Appropriation Process

In order to examine perception and appropriation, we build on the concepts described in Table 1 and on a process model proposed by Bernhard et al. (2013). The model distinguishes between existing and perceived affordances, focusing on the actualization of affordances. By extending the model with our two novel concepts of 'existing constraint' and '(mis-)perceived constraint', we also enable the investigation of appropriation instead of only actualization (Figure 1). The model supports visualizing important implications arising from consolidating the concepts of affordances and constraints, their perception, and appropriation moves. The process view and the cycle show that affordance and constraint perception as well as development is an ongoing, emergent process (Bloomfield et al. 2010). Since affordances and constraints are relational concepts, each user or user group have a specific instantiation of the appropriation process model for a given TO.

One central implication is that an appropriation move leads to specific outcomes and may again lead to new affordances and constraints that can be subsequently perceived or may directly lead to a (mis-)perception of affordances and constraints. Therefore, multiple cycles through the appropriation process might be conducted before actualizing an affordance or even abandoning the TO due to ceasing use. Consequently, the existence of affordances or constraints does not depend on their perception. “Affordances do not disappear when there is no local animal to perceive and take advantage of them”; affordances, and therefore also constraints, are relations that are “perfectly real entities that can be objectively studied” but depend “on the existence of some animal that could perceive them, if the right conditions were met” (Chemero 2003, p. 193).

Existing affordances and constraints can be directly perceived and put into use by a specified user or users. However, Bloomfield et al. (2010) criticize the limited view of affordances just being “picked-up” (p. 424) instead of focusing on the how and when affordances are (un-)available and even “made real” to actors in particular settings. We build upon this view of Bloomfield et al. (2010), arguing that distinguishing affordances and constraints and their perception has another implication. Perceiving that affordances are missing or that constraints exist, appropriation moves can be conducted to change the environment (e.g., the TO) or, if possible, the individual’s abilities (e.g., computer literacy) to arrive at new affordances (see Chemero 2003). Therefore, developers of a TO and users themselves do not only depend on or, respectively, are limited by existing affordances and constraints, but they can take actions to arrive at affordances that are available to them – or even to other humans able to perceive them – if the right conditions are met (see Figure 1). The appropriation moves represent such actions as well. Although it is beyond the scope of this paper to categorize the appropriation moves into the categories suggested by DeSanctis and Poole (1994), it needs to be noted that they already consider, for instance, a combination or correction of structures (i.e., rules and resources) available besides the choice of just directly appropriating a structure. Therefore, we see the inclusion of appropriation moves supporting the broader and more active affordance and constraint perspective, thus also meaningfully extending Markus and Silver’s (2008) work and realigning it with DeSanctis and Poole’s (1994) conceptualization.

By coping with (mis-)perception of both affordances and constraints, we are interested in potential causes in the form of so-called information sources. Following Bernhard et al. (2013), these sources are internal or external. The internal source is the TO itself and external sources encompass further sources other than the TO (Markus and Silver 2008). For example, external sources might include colleagues, consultants, and trainers. As regards the internal sources, TOs are continuously replaced, extended, or updated because most IS projects are not developed from scratch. Therefore, past actualized affordances and

Figure 1. Process Model of Affordance and Constraint Perception and Appropriation

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resolved constraints of existing TOs need to be examined in the context of new TOs. We argue that what we call *legacy TOs* may be a primary information source for (mis-)perception of affordances and constraints. In this context, existing IS research has until now only focused on affordances resulting from novel or currently implemented TOs (e.g., Leonardi 2011, 2013; Strong et al. 2014).

**Research Design and Method**

**Case Study Overview and Data Collection**

Case studies are well-accepted in IS research (Dubé and Paré 2003; Lee 1989). Affordances and constraints, being relationships between a TO and specified users can be best studied applying case study research since the boundaries between the phenomenon and context are not clearly evident (see Yin 2009). We selected a single case study design since it is appropriate (a) to explore the extended appropriation process model – our unit of analysis – of a TO (b) by different users embedded in an organizational context (see Myers 2013; Orlikowski and Iacono 2001; Yin 2009). Therefore, the selection of one case company allows examining different affordances and constraints resulting from different perception of the same TO due to different goals, skills, and so forth. We selected the case company based on preliminary interviews with a supporting consulting company that specializes on BI systems, where the case company is a client of the consulting company. Moreover, we have been able to observe parts of a BI project in the case company in the past and, at the time of the main investigation, the BI project was considered completed successfully. The success of the examined BI project at an organizational level can best be described as having satisfactory achieved the overall goal to provide a BI infrastructure as an organization-wide resource at the country level (see Wixom and Watson 2010).

The examined company is the ERGO Austria International AG (from here ERGO), one of the largest insurance providers in Austria. Its core IT system already held insurance data from several other partner organizations. Due to a merger at the country level, the database of the acquired insurance company had to be migrated and integrated into the existing IT landscape. The BI project under investigation (starting in February 2011 and ending in August 2013) started almost two years afterwards and ran in parallel to the integration project because the BI system should support operational business processes as well. Therefore, the acquired company, being completely cut off from their former IT systems, was integrated into the core IT system and heavily involved into the BI project, for example, to rebuild their necessary former reports. Additionally, aiming at parts of the already previously existing company, a web portal was set up for sales management and external reporting. Packaged software BI systems, including a data warehouse (DWH) for standard as well as ad-hoc reporting, were implemented. With the implementation of a daily updated DWH and online analytical processing, the project is typical for contemporary BI initiatives (Popović et al. 2012).

In conducting the case study, we followed established guidelines for case study research (Dubé and Paré 2003; Miles and Hubberman 1994; Myers 2013; Yin 2009). Our research draws on existing literature and is informed by the collected empirical data from different sources as described below. We aim to elaborate and flesh out relevant affordances, constraints, and related mechanisms using the collected empirical data, because how affordances work in detail is still very unclear. Therefore, our research design is essentially exploratory in nature while being informed by prior literature, as reported in *Related Work and Theoretical Background*. Consequently, we do not test an existing model or theory within our case study.

Overall, we conducted 13 formal interviews. First, we conducted two semi-structured interviews in September 2011 with the CIO at the respective country level and with a head of international IT architecture. Although the BI project started in the same year, these preliminary interviews focused on strategic trends of several companies and not particularly on the BI project. Second, we conducted further semi-structured interviews in May 2013 with three consultants from the supporting consulting company. Since external consultants have a broader overview of the implemented TO than end-users and might perceive the TO differently, the interviews aimed to examine characteristics of data analysis tasks and the TOs that are used for their execution and processing. One of the consultants, being responsible for the BI project in the case company as a project manager, continued to accompany our study as a key informant. He continued to inform our research and was available to answer emerging case-related questions. Moreover, beyond publicly available data (e.g., press releases, business reports), he provided project...
documents (e.g., requirements specifications, project schedules, internal presentations) and demonstrations of the implemented BI system. Third, we conducted eight semi-structured interviews directly after the completion of the BI project in February 2014, solely focusing on the BI project. The informants were chosen in order to provide diverse perspectives on the BI system. We interviewed key users, which provided the requirement specifications for different areas, and analytic professionals (see Appendix). Moreover, the guideline for these eight interviews (see Appendix) was exclusively based on our theoretical lens of affordances and the appropriation process (see Figure 1), including recommendations from affordance literature from the IS domain (e.g., Seidel et al. 2013; Volkoff and Strong 2013). We conducted seven of the eight interviews on-site to also observe the daily use of the BI system that the users work with to be able to refer to features of the BI system in the interviews. Therefore, we could observe the use of artifacts the individual users consider being ‘the BI system’ (e.g., their specific frontend) or artifacts the users even might not be aware of belonging to the TO (e.g., print-outs summarizing available reports, additional spreadsheets).

To facilitate reliable interviews, we ensured informants’ anonymity. The interviews took 35 minutes to 142 minutes, with an average of 63 minutes. All formal 13 interviews were audio recorded and transcribed for analysis, resulting in over 200 pages of interview transcripts. In addition, field notes were taken by the first author to gain new insights and impressions not captured on record. The different data sources assured data triangulation (Myers 2013; Yin 2009). Especially the interviews and the additional observations were insightful regarding the perceived and communicated use in contrast to the actual use of the BI system. To assure researcher triangulation (Myers 2013; Yin 2009), we discussed the collected data and their interpretation in accordance with our theoretical view of the appropriation process (see Figure 1).

**Data Analysis**

Our main analysis intended to explore the causal links of how and why users use BI systems (Yin 2009). We created a provisional start list of codes based on our conceptual framework (Miles and Huberman 1994). We started with descriptive coding of interviewees’ statements (Myers 2013) and, if possible, assigned the descriptive codes to the concepts from our framework. This coding approach allowed us, for example, to describe different outcomes grounded in the empirical data. We used NVivo (QSR 2012) for coding, allowing convenient comparison of coded statements within the concepts and to keep the relation of users, outcomes, and so forth to identified affordances and constraints. The preliminary categorization was followed by iterative descriptive and interpretive coding (Myers 2013) in order to saturate the codes while allowing for context-specific interpretation of findings. Further codes were introduced, for example, to capture information about the organizational and BI project context.

In order to distinguish perceived from existing affordances and constraints, we relied on users’ statements. Misperceptions became visible after failed appropriation, after receiving additional (external) information, or due to contradictions in the statements across users. Although we relied on informants with high project involvement and knowledge of the BI system, we cannot exclude that a key user misperceives a constraint, resulting in non-actualization of a potentially existing affordance. Being aware of this issue, we provide rich exemplary data for high comprehensibility of our interpretations.

**Results**

**Affordance and Constraint Transition in Context of Changing Technical Objects**

As regards different transition scenarios, the interviewees constantly and consistently referred to the legacy IT system, comparing affordances and constraints between both TOs (i.e., the legacy IT system and the new BI system). Instead of abstracting from this comparison and describing affordances and constraints in an isolated manner only related to the new BI system, we decided to incorporate this transition perspective because the legacy system apparently has a decisive impact on the (mis-)perception of affordances and constraints. Figure 2 describes the transition perspective as a Venn diagram.
The transition scenarios are described in detail and augmented with example quotes from the case study in Table 2. Based on the conventions of Strong et al. (2014), we use a triangle symbol for depicting an affordance (pointing to the right) and the mirrored version for a constraint (pointing to the left). For example, the scenario “Aff6\textsubscript{leg} \rightarrow \text{n.a.} \rightarrow \text{Con6\textsubscript{new}}” describes the case where a former affordance of the legacy IT system is not transferred to the new BI system, leading to a missing affordance. The missing affordance, and accordingly the missing potential for goal-oriented action, limit goal-oriented action and thus result in a constraint. Therefore, this perspective might be considered as a new constraint as well. Even if an affordance is transferred (as in scenario “Aff1\textsubscript{leg} \rightarrow \text{Aff1\textsubscript{new}}”), it is necessary for users to perceive the existing affordance based on the new BI system and new functional features before it can be actualized and lead to planned outcomes. In contrast, transferred constraints might be perceived more negatively since users might expect improvements due to the new BI system.

### Table 2. Explanation of Transition Processes of Affordances and Constraints

<table>
<thead>
<tr>
<th>TO\textsubscript{leg}</th>
<th>TO\textsubscript{new}</th>
<th>Representation</th>
<th>Explanation and Exemplary Quotes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aff1\textsubscript{leg}</td>
<td>Aff1\textsubscript{new}</td>
<td>![Triangle Symbol]</td>
<td>An affordance is transferred from the legacy IT system to the new BI system. Effort to perceive and actualize affordance. Example: “Specific process steps changed because the analyses are built up differently and need to be merged differently [...] The task is still the same with different process steps” (key user #2)</td>
</tr>
<tr>
<td>n.a.</td>
<td>Aff2\textsubscript{new}</td>
<td>![Triangle Mirrored Symbol]</td>
<td>New affordance. Effort to perceive and actualize affordance. Example: “I have more options to look into details, which haven’t been possible before because of the [data] structure [...] The options are necessary and positive, that I am able to analyze things at such a detailed level not available before.” (key user #3)</td>
</tr>
<tr>
<td>Con3\textsubscript{leg}</td>
<td>Con3\textsubscript{new}</td>
<td>![Triangle Mirrored Symbol]</td>
<td>A constraint is transferred from the legacy IT system to the new BI system. Effort to identify constraint and to develop workaround. Example: “[The reason] that some things are not analyzable as hoped for or expected, is certainly not due the DWH, but a great deal due to the [source system] and the administration processes.” (key user #3)</td>
</tr>
<tr>
<td>n.a.</td>
<td>Con4\textsubscript{new}</td>
<td>![Triangle Symbol]</td>
<td>New constraint. Effort to identify constraint and to develop workaround. Example: “[Where we are] still uncertain if the data that are extracted from the [source system] into the DWH [...] as we expect, is the delta extraction logic. [In the legacy system] there was no delta extraction logic.” (key user #4)</td>
</tr>
<tr>
<td>Con5\textsubscript{leg}</td>
<td>n.a. \rightarrow Aff5\textsubscript{new}</td>
<td>![Triangle Mirrored Symbol]</td>
<td>A now missing, but formerly existing constraint is a new affordance. Effort to identify constraint as eliminated or to perceive and actualize affordance before leading to a benefit. Example: See transition scenario for new affordance (n.a. \rightarrow Aff2\textsubscript{new})</td>
</tr>
<tr>
<td>Aff6\textsubscript{leg}</td>
<td>n.a. \rightarrow Con6\textsubscript{new}</td>
<td>![Triangle Symbol]</td>
<td>A now missing, but formerly existing affordance is a new constraint. Effort to identify affordance as missing and to develop workaround. Example: See transition scenario for new constraint (n.a. \rightarrow Con4\textsubscript{new})</td>
</tr>
</tbody>
</table>

### Identified Affordances and Constraints

All identified affordances and constraints are presented within a dependency map (Figure 3, see Strong et al. (2014)). The map allows us to capture affordances and constraints at a specific point in time. Moreover, the combination of both triangles allows showing conflicting affordances and constraints, that is, the situation where an affordance is simultaneously perceived as a constraint. Due to the given limited space, this paper focuses on the affordances and constraints distinguished by a bold triangle and grey shading in detail, which represent different scenarios of affordance and constraints perception as well as appropriation. According to Table 2, there are four distinct scenarios (two for affordances and constraints,
respectively). However, since the dependency map represents affordances and constraints at a collective level, a combination of the scenarios is possible, for instance, if an affordance or constraint is new only to a part of stakeholders and considered transferred for others. To resolve the combination of scenarios, a detailed representation would be necessary, distinguishing (single) stakeholders and respective goals.

![Affordance and Constraint Dependency Map](image)

**Figure 3. Affordance and Constraint Dependency Map**

The new BI system continues to afford **capturing, storing, and accessing basic data**. Users define basic data depending on their respective goals. Data being available in the legacy IT system is expected to be available in the BI system as well, enabling users to continue routinized task-fulfillment.

“That was a requirement […] It is not practicable that afterwards we aren’t able to do certain things. The basic facts, data, just need to be available. […] it is indispensable that the basic data are there.” (Key user #3)

Although this affordance is the only one we categorized as solely transferred from the legacy IT system, it is essential and a requirement for several other affordances. Specifically at the operative level, users are primarily concerned with their basic task fulfillment, before – if at all – exploring new affordances.

“Everything you need for the daily business needs to work or at least what was analyzable in the legacy system should be analyzable in the DWH as well. You want as much as possible additionally, sure. But that is the minimum requirement: that the running business isn’t suffering.” (Key user #4)

The **detailed data analysis** afforded by the new BI system constitutes a major goal of the BI initiative. It builds on several other affordances: whereas the access to additional data allows retrieving data in more breadth and depth as well as considering historical data, the ad-hoc reports allow developing customizable, consistent, but still flexible reports. Finally, the access for a broad stakeholder base allows customized, autonomous access to current reports at any time across organizational levels.

The users often mention access to additional data and the ad-hoc reports in combination, enforcing respective outcomes or leading to new ones, for example, uncovering insurance fraud or increasing trust with partner organizations due to detailed data analysis provided for external stakeholders.
The data analysis features and the inclusion of detailed data allow for sophisticated data provenance. Unexpected results can be crosschecked and root causes for flawed reports can be eliminated. During the course of the project, the new BI system was also used for improving data quality, even resulting in new tasks to provide formalized reports for managing data quality.

“We have the sloppy [workarounds] well under control [now...] The crucial application is the following [opening an analysis labeled ‘quality’]. This is a trivial analysis, but it helped a lot [...] It brought a change of mind last year, because very many employees saw how much payoff they had, which wasn’t displayed.” (Sales PM #7)

In contrast, the flexibility of the new BI system and the possibility to satisfy highly diverging user needs with one consistent database lead to a high data amount and complexity of data analysis. Therefore, key users have broad data access and potential for high flexibility, but are limited by the complexity of the underlying data model. Even if users learn to cope with the complexity for their tasks, some resulting additional efforts are still present.

“I don’t want to write queries, honestly. I must write it, then it needs to be transferred [from the test system], it’s annoying. [...] In the legacy system I worked in the production system. What should go wrong?” (Key user #3)

The data volume and complexity of the queries also lead to decreased performance of the BI system. A main challenge is the definition of the data model and extraction logic upfront. For instance, one user, who relies on aggregated reports, criticizes the complexity and performance of the DWH.

“I expected more performance from the DWH. It all depends on the correct and foresighted design of the cubes and multi provider. Actually, at the beginning of such a project one is completely overburdened to provide a reasonable structure, especially from a functional perspective. [...] As so often if running out of time, we tried to build workarounds with the existing means.” (Key user #4)

However, from an organizational perspective, performance improved due to possibility to directly build and retrieve reports without previously necessary support from the IT department and with current data.

“The colleagues are overall very satisfied from and enthusiastic about the DWH, because it improved and simplified some steps, the performance, cycle time, and simplified analysis.” (DWH #5)

The web frontend is provided for specific internal and external users – currently for sales management – for user-friendly access and customization of standard reports. Some users have no access to the selection-based web frontend. Being aware of the web frontend, users working with the query designer feel additionally limited, perceiving the potential affordances of the web frontend for their tasks.

“I have two basic queries, but I’d like to have the web portal [...] I could make it available for my [custodians and line manager] with predefined parameters, so they can look into things on a daily basis. That would be nice since currently, I make all reports and the pdfs, and put them on a drive.” (Key user #3)

Data quality issues still exist, although by becoming visible with the new BI system, their correction, including underlying workarounds, improved and the DWH impact on data quality is considered positive.

“By loading data into the DWH we realized that we had some inconsistencies. [...] One cannot see [missing data and inconsistencies] directly in a very complex administration system. [...] One can sell it as an expected benefit [of a DWH project]: You will be able to improve data quality.” (Overall PM #8)

However, new data quality issues arise from the complexity of the data logic.

“We need an automatic comparison because the figures need to be correct. I cannot say I’m sorry that the balance sheet is incorrect because the DWH misinterpreted the data.” (Key user #2)

The visibility and demand for high data quality, or the critique of low data quality, respectively, might reshape organizational goals. Following the users’ demands, controls for data quality should be developed.

“Another issue are the so-called consistency checks [...] The DWH continuously raises questions about data quality or consistency issues. Is it an issue of the DWH or the source system?” (DWH #5)

The affordances and constraints addressed above are summarized in Table 3, which is similar to Strong et al. (2014). However, outcomes do not only refer to actualized affordances but also to constraints.
### Table 3. Existing Affordances and Constraints

<table>
<thead>
<tr>
<th>New BI system features</th>
<th>User characteristics</th>
<th>Goal</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>Affordance: Capture, store, and retrieve basic data</td>
<td>Ability to type and/or enter data based on a common standard; ability to retrieve basic data</td>
<td>Continuation of task fulfillment; ensuring operative work</td>
<td>Fulfillment of routine tasks</td>
</tr>
<tr>
<td>Database for storing and accessing data necessary for users’ task fulfillment</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| Affordance: Detailed data analysis | | | |
| Common database for storing and accessing data; structured, standardized data model; rights management; user access to data and query designer | Ability to retrieve additional data; ability to embed additional data within existing tasks and goals or accordingly reshape or define new tasks or goals | Improvement of data quality and trust in data quality; direct access to broad information base | Increased trust with external stakeholders; data quality and compliance improvement; identification of insurance fraud; changes in organizational culture |

| Constraint: Data amount and complexity of data analysis | Complexity of structured, standardized data model; new extraction logic | Need for reports based on query designer, missing skill to master complex queries | Efficient, easy-to-use data analysis | Complex query design and need of specific skills; limited computing performance; workarounds; doubt about report results |

| Constraint: No access to selection-based web frontend | No adequate data base or user access to some users | Awareness of selection based web frontend | Efficient, easy-to-use data analysis | Perception of effort for using BI system increases |

| Constraint: Data quality issues | Complexity of structured, standardized data model; new extraction logic; resolution of routinized workarounds | Awareness of data quality issues | Provision of correct reports | Data quality issues, increased perception of poor data quality by users |

### Diverging Perception of Affordances and Constraints

External resources identified are managers, consultants, colleagues, training, and documentations that are not part of the TO, whereas internal sources are the TO artifacts. Since we examine the transfer of TOs, the legacy system as well as the new BI system are sources of perceived affordances and constraints.

The managers, representing the organization as a whole, are a source for abstract, organizational affordances, linked to overall organizational goals. Subsequently, users are left with their interpretation of affordances at their individual level, which are put to test by the individuals within their tasks and goals, even though organizational affordances might not be simply transferred to the individual level.

“A DWH, as often propagandized – that all data from the whole company, regardless of their origin, are integrated centrally and all departments can analyze everything – that’s not the case.” (Key user #4)

Organizational affordances and benefits are communicated to justify the BI project. However, conflicting or misperceived affordances and constraints may lead to unsuccessful appropriation or missing benefit.

“I always had a hierarchy [...in the current project] I need to restructure my hierarchy to get the same final result I had before.” (Key user #3)

Consultants, actively working with key users, are a primary external source for perceiving affordances closely linked with the users’ individual goals. The consultants are engaged in the appropriation of affordances, learning about users’ goals to arrive at an actualization of affordances.

“Without a real DWH expert by your side helping to develop the queries, it is often a tedious process [...] the [external consultants] did not only examine the whole thing from the technological, but also tried very hard to understand it from a functional perspective.” (Key user #4)

The other way around, users are supported to perceive new affordances, embedding them within their existing or reshaped goals.

“It arose from the development of the specification, that I got the information that specific processes can be automated, that we do not need to intervene manually [...], that I got to know what the [BI] system is able to do and what one can use it for.” (Key user #1)
Colleagues, available ad-hoc, are another external source for perception and appropriation of affordances. Key users seek help from other key users and are an information source for regular users.

“Surely one talks to the colleagues and there are frequent questions, where one calls a colleague, to help on another. The advantage is that, when you analyze something that the colleagues already analyzed similarly, you can build on already existing queries.” (Key user #4)

Scheduled training was provided for key users conveying basic information. However, users are skeptical about the benefit of the training, especially if it did not address their specific needs.

“We had a three-day training presenting how the [analyzer] and query designer work and the data situation was somewhat described. But for the applications we need it’s more learning-by-doing. […] The bottom line is that the data situation is so complex, it only works with much time and preoccupation.” (Key user #2)

In contrast to key users, personal training is provided to managerial staff for the web frontend. Those end users have not necessarily been involved in the project and vary highly in their computer literacy. Additionally, they have more choice if they use the system, thus, needing more persuasion.

“Everybody, without exception, gets a personal training, […] that is, they don’t visit a training center and only see a projection of what’s possible, but they experience it actively. That went insanely well.” (Sales PM #7)

Documentations are considered helpful for providing basic guidance and serve as reminders. For specific tasks or current problems, the interviewees, however, seek other sources of support.

“I’m not a big fan of documentations. [...] you can document] topics you must not forget and so on [...] But generally, if you’re working in a computerized area and we are close to the data: Then one won’t manage system without intensive preoccupation with the system.” (Key user #2)

The TO itself is a source of perception of affordances and constraints. When working with the TO, the perception of affordances and constraints and the subsequent appropriation moves are tightly linked. As pointed out above, perceived affordances and constraints already result from the users’ relation with the legacy IT system. Therefore, legacy affordances are a starting point for the new BI system as well.

“When we built this tool, of course, we collected the reports in the company we could find. We tried to find out, which are actually still required and which aren’t.” (Sales PM #7)

The new BI system brings the challenge to perceive and actualize existing affordances. A transition takes place to replace legacy affordances and resolve constraints (see Figure 2). During the transition of each affordance and constraint, the appropriation process (Figure 1) might be iterated multiple times.

“[I] asked if [my customers] need something more, presented prototypes […] Then you get the feedback “I need also this” […] We deployed it internally and then got the feedback “that’s it and that’s not it.” (Sales PM #7)

The transition context from one TO to another directly shapes users’ expectations since the role-based tasks and IT skills are tightly linked with the legacy TO. For instance, legacy workarounds that are routinized and forgotten over time are sources for misperceptions and application of old routines with the new BI system leads to unsuccessful appropriation. Such misperceptions became evident in the form of flawed data due to workarounds in the legacy IT system complicating analyses with the BI system.

“I get another perspective, which might be even the better and correct one. Perhaps what we did before was just a workaround due to the legacy system. […] Now comes the new system saying: […] that is clearly structured […] and you got bats in the belfry, because this [former approach] doesn’t work.” (Key user #3)

While the transition of legacy affordances is expected, further benefits from the new BI system are expected as well, such as improvements of affordances or new affordances. Beside the individual user type, the necessity for the new BI system at an organizational and individual level impact users’ expectations and their willingness for transition. In the ERGO, due to the merger one part of users had no other choice than try to transfer their affordances to the new BI system.

“The reason for the transfer [was...], that, with the legacy system, we’ve been attached to our former parent company and then we were sold. […] The other reason was that the [legacy] system was very old, any change, any intervention was very complicated.” (Key user #1)

Other users were used to direct reports from the source system. In contrast to users from the acquired company, these users were less willing to conduct the transition.

“Employees, which had analyses in [the source system...] are a little bit sceptic. They want something new,
better, faster. But during the testing phase for [these employees] it was hard to convince them. [...] It was completely different on the side of [the acquired company]." (DWH #6)

**Appropriation Moves**

We consider an appropriation to be at least one cycle through the process model (Figure 1) and an appropriation move as a user action to actualize a perceived affordance or to avoid a perceived constraint. Therefore, a final outcome – planned or unplanned – results from several iterations, including several perceptions of affordances or constraints as well as according appropriation moves.

"There was definitely a certain number of cycles until we put it into production, where we've been always told to test it out again [...] the requirements didn't change at all, rather how they could be realized. (Key user #1)

If an appropriation move does not result in a satisfactory affordance actualization, individuals might cease to use the BI system or parts of it. Alternatively, they might reshape their perception of affordances and constraints and conduct another appropriation move, such as modifying the BI system or their routines. However, considering the numerous appropriation process iterations to arrive at a satisfactory outcome, the appropriation cannot be clearly described being achieved by only changing routines or the BI system.

"There are certainly some subareas not working 100% in the system, where we had to change our requirements a little bit [...] Where possible, we certainly changed the system. If it wasn't possible, perhaps because it was too expensive, than we weighed up: 'is it really necessary or can we live with 98%?'" (Key user #1)

Whereas no transition to a new BI system will be conducted without modification of routines or the BI system, it additionally depends on the level of abstraction how changes are perceived.

"There are some things where we need to work with workarounds, although they've been available more comfortably before. And there are particular reports, which partially work faster and more direct. [...] No, the [basic task structures] have been the exact same before. Therefore, there isn't any change. (Key user #4)

The whole appropriation process, especially when taking place between the user and the BI system, is described by the informants as learning-by-doing or trial and error.

"That's simply learning-by-doing. [...] one needs, on the one hand, the functional know how and, on the other hand, the know how regarding the data situation in [the source system]. (Key user #2)

Repeatingly misperceived affordances and constraints as well as failing to achieve expected or satisfactory outcomes increase the risk of ceasing system usage, diminish perceived benefits, or heighten expectations.

"Much analytical and validating tasks have been necessary and provision of functional know how. The hope is that it decreases considerably in the next years [...] I think, it will be an advantage. That we are faster, overall, due to the flexibility, because the one-time effort will pay off. I am firmly convinced of it." (Key user #2)

**Discussion**

**Affordance Perspective in the BI Context**

The study corroborates the flexibility of BI systems, regarding their broad application area and customizability as well as the diverse and potentially contradicting user perceptions. The flexibility of BI systems increases the potential for divergent appropriation processes, such as trial and error, resulting in non-deterministic outcomes. Assessment of BI systems’ benefit and according root causes across organizations, without being aware of their respective context, is difficult. With respect to variance models that aim to predict BI outcomes, some relevant context factors can be and partially are elicited using surveys, for example, the experience with similar BI systems and if BI systems are used directly or through employees. However, some essential factors cannot be elicited in this way, for example, misperceived affordances and constraints as well as impact of the BI system beyond the informants’ scope. Moreover, in BI system studies, mostly (middle) management is addressed, whereas we argue that the root causes lie at lower organizational levels, where affordances and constraints vary significantly. Our study shows that a main affordance of BI systems, providing ad-hoc and flexible, but consistent data analysis, rests on several requirements and basic affordances. Due to the typically broad data and stakeholder base, a limited focus on the BI system, without considering underlying IT systems and involved users, is infeasible. Individual affordances or constraints may inhibit actualization of collective
affordances at the organizational level (see Leonardi 2013) and entail the need to ‘drill down’ or zoom in on lower levels in order to arrive at the root causes for appropriation moves and their outcomes. In this context, the presented dependency map facilitates zooming in and out based on identified conflicts to understand relations of individual and emerging collective appropriation (see Seidel and Berente 2013).

The data quality issues constraint (see Figure 3) represents different perceptions across users and organizational levels and helps to explain the ambiguous role of data quality addressed in the context of extant BI research. Data quality is justifiably treated as an important factor for BI use and success (e.g., Tamm et al. 2013; Wixom and Watson 2001). The case study shows that data quality plays a critical role. However, we find three potential reasons for unclear or contradicting results regarding data quality in BI. First, due to the need for integration and standardization, data quality will most likely indeed decrease for some stakeholders. Second, even if data quality improves, perception of previously existing data quality problems might lead to a falsely decreased assessment of data quality. Users might judge a BI system based on presented data and functionality, even if data originates from several IT systems (March and Hevner 2007), which impact final data quality (Glowalla and Sunyaev 2013, 2014). Third, precisely because of poor data quality the BI system provided significant benefit in the ERGO and might be considered successful due to the enabled data quality improvement. Consequently, there are several potential explanations for a negative correlation of data quality with BI success (Işık et al. 2013) or inconclusive results regarding factors relevant for data quality in a BI context (Wixom and Watson 2001). An important aspect in the case study is that the improvement of data quality upfront (see Malladi and Krishnan 2013) was not possible, but was enabled due to the BI systems’ analytic capabilities, resulting in a conflict regarding the necessity of high data quality for ‘BI success’.

**Appropriation Processes and the Transition Perspective**

Our extended appropriation process model (Figure 1), conceptualizing constraints complementary to affordances, allows to encompass extant IS research’s perspectives on constraints: Leonardi (2011) considers constraints alternated with affordances where constraints might follow actualized affordances indicating further potential of the TO. However, treating constraints as a consequence of actualized affordances neglects potentially wasted efforts if affordance actualization fails. Volkoff and Strong (2013), not explicitly conceptualizing constraints, find a “more paradoxical result” (p. 831) since one user’s affordances might be constraints to another user. The presented affordance and constraint dependency map allows us to visualize both perspectives on constraints.

We also find that the potential gap between existing and perceived affordances and constraints facilitates explanation of non-deterministic outcomes. In our case study, we find evidence for misperceiving not existing affordances, such as not fulfilled expectations. The study also shows examples of not perceived affordances, such as the automation of some task parts, where information about the affordance was not available to the users and needed to be inferred from other evidence (see Gaver 1991). A broader perspective results from the inclusion of constraints. In this context, not perceived constraints might be noticed too late, that is, after effort was put into appropriation moves. In contrast, perceived constraints that actually do not exist lead to omission of appropriation moves although an affordance might be actualized. Based on the results, we find the distinction of internal and external information sources (Bernhard et al. 2013) necessary for affordance and constraint perception. Internal information is crucial in guiding users’ to existing affordances during TO use, whereas external information might build (abstract) expectations even before the TO itself is implemented and used. The latter case complements the bottom-up perspective from Strong et al. (2014), where the focus is on the emerging organizational affordances based on individual affordance actualization. From a top-down perspective, planned organizational affordances cannot be easily transferred to an individual level since individuals are putting affordances to test within their own goals. Stakeholders at all organizational levels perceive abstract affordances through external information. Without a specific TO already in place and with potentially missing basic requirements and, additionally, not being aware of the context-specific appropriation, these affordances might be and stay misperceived. Therefore, we strive to facilitate the context-specific identification of affordances and constraints by providing an abstract perspective on collective affordances and constraints as well as a visual representation that guides detailed examination. Coping with root causes for misperceived affordances and constraints is necessary to improve affordance development and sharing across users and organizational levels.
Considering appropriation in contrast to actualization is necessary to embed affordances and constraints and their respective perception within a reasonable process model. The developed process model, acknowledging that affordances and constraints as well as their perception evolves continuously, emphasizes the dynamics of affordances and constraints (see Bloomfield et al. 2010). Especially with flexible TOs, few affordances might be identified and actualized as intended. As our case study shows, ‘trial and error’ seems to be a typical appropriation process, implicating multiple iterations through the appropriation process to finally actualize an affordance. Ignoring these iterations results in ignoring wasted appropriation efforts and their consequences, such as frustration and diminished valuation of affordances (if an affordance is actualized at all after multiple unsuccessful appropriation moves). The developed appropriation process model allows a detailed description and examination of individual appropriation processes. Such a detailed examination is helpful to identify different appropriation strategies and reasons for conflicting perceptions. The affordance and constraint dependency map (Figure 3) may guide such closer structured examination to identify individual appropriations, which, for instance, inhibit actualization of collective or shared affordances (see Leonardi 2013; Strong et al. 2014).

When existing affordances are transferred to a new TO and constraints are disposed of, the routines established between users and the legacy TO will have a strong impact on the appropriation of the new TO. The relevance of the transition perspective is evident through the constant comparison of affordances with the legacy TO. Therefore, the legacy TO is a primary source for (mis-)perception of affordances and constraints, including former workarounds that became reified through practice resulting in accepted routines (Seidel and Berente 2013). We corroborate that legacy TOs are active forces (Chae and Poole 2005) and should be used actively to identify and steer affordances, that is, aim to make (cascades of) affordances real in a given situation and with specified users (see Bloomfield et al. 2010). The advantage of an affordance perspective is the possibility to allow abstraction from concrete features. Affordances might be actualized with different feature sets, and just transferring routines from a legacy to a new TO might not result in the desired outcomes, thus impeding the use and benefit of new TOs. The transition perspective allows identifying affordances that need to be transferred before users turn to the appropriation of new ones.

**Limitations and Further Research**

We are not able to generalize all of our results, such as the paths of affordances and constraints of BI system development, beyond our single case. However, focusing on one organization allowed a rich picture on the transition of affordances and constraints from a legacy to a new IT system in the same organizational context. Moreover, the study design allowed examining different perceptions and conflicts of affordances and constraints of the same TO. Beyond the presented appropriation process, this study does not aim on other factors having an impact on BI system use or outcome, for instance, how users can be motivated to continue from appropriation of basic affordances to innovative use of the BI system (see Li et al. 2013). We interviewed analytic professionals and key users, which differ in their BI system use from regular end-users (see Deng and Chi 2012; Tamm et al. 2013). However, we are confident that the identified affordances are articulated in a way applicable for end-users as well, with the need to resolve potential conflicts with a structured analysis. More research is necessary to examine factors on the valuation of affordances, for example, the necessity for a new TO. Such research might improve managing expectancy across users and prioritization of affordances, in turn leading to improved perception and actualization of affordances. Moreover, our study provides an informed basis to examine potential explanations for inconclusive BI research. Specifically the simplifying assumptions of data quality's impact on BI outcomes need to be examined in detail. In research and in practice, it might be helpful to consider achieving adequate data quality as a major goal since poor data quality needs to be addressed anyway and might not be leapfrogged when aiming for high BI maturity (see Wixom and Watson 2010). Finally, further research is needed to more extensively examine the implications of realigning the affordance and the appropriation perspective (see DeSanctis and Poole 1994; Markus and Silver 2008).

**Conclusion**

The lack of theories about IT artifacts, the ways in which they are developed, emerge, and evolve over time, is still an unresolved key issue (Orlikowski and Iacono 2001). DeSanctis and Poole (1994) with their insightful adaptation of Structuration Theory as well as Markus and Silver’s (2008) extension using the
affordance perspective made important contributions to IS research. Although the concept of affordances has found broad acceptance in the IS research community, the knowledge about the process of affordance generation, perception, and actualization is limited. This gap is especially evident in the context of transitions from legacy to new IT systems. In this paper, we build on the affordance concept and offer a more holistic perspective on the appropriation of affordances as well as constraints, the latter introduced as a new concept. We hope that our appropriation process, integrating the concepts, will be useful for other IS researchers and practitioners.

Appendix

| Overview of Formally Interviewed Informants and Quotation References for 3rd Round Interviews |
|-----------------------------------|---------------------------------|
| 1st round interviews – ERGO       | 3rd round interviews            |
| - CIO (BI project site)           | Key user #1 actuarial services, re-insurance |
| - IT architect (international)    | DWH #5 IT services, DWH team    |
| 2nd round interviews – consulting company | Key user #2 actuarial services, statistical analysis |
| - lead consultant                 | DWH #6 IT employee, DWH team    |
| - project manager                 | Key user #3 sales controlling   |
| - senior consultant               | Sales PM #7 sales controlling sub-project manager |
|                                  | Key user #4 asset management    |
|                                  | Overall PM #8 head of IT services, project manager |

Abstract of Interview Guideline for 3rd round (BI project interviews)

<table>
<thead>
<tr>
<th>Questions on the user and BI system</th>
<th>Questions on perception of affordances and constraints</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Can you describe your job position and job tasks?</td>
<td>- What did you learn by using the system (helpful functions etc.)?</td>
</tr>
<tr>
<td>- Can you describe your project involvement?</td>
<td>- How did you learn it?/How did you get to know of this function?</td>
</tr>
<tr>
<td>- Can you shortly describe the system you are using?</td>
<td>- What other sources you used to learn about the system?</td>
</tr>
<tr>
<td>- What other IT systems, tools or documents support your use of the implemented system?</td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Questions on goal-oriented use of the BI system</th>
<th>Questions on (reasons for) appropriation</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Why do you use the system?</td>
<td>- Did the company or specific users provide guidance for the system use?</td>
</tr>
<tr>
<td>- How often do you use the system for which tasks?</td>
<td>- Do you use workarounds to achieve your goals?</td>
</tr>
<tr>
<td>- What are your role-based goals by using the system?</td>
<td>- Did you have to change your work routines?</td>
</tr>
<tr>
<td></td>
<td>- Did you have to change the system (or ask for changes)?</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Questions on affordances and constraints</th>
<th>Questions on effects of appropriation</th>
</tr>
</thead>
<tbody>
<tr>
<td>- What did the technology enable you to do?</td>
<td>- Are you more satisfied with the system regarding your goal fulfillment?</td>
</tr>
<tr>
<td>- What did it make it more difficult to do?</td>
<td>- Did the system improve your work process or work outcome?</td>
</tr>
<tr>
<td>- What happened once you started to use the technology?</td>
<td>- Did the system fulfill your expectations and have your expectations been managed?</td>
</tr>
<tr>
<td>- Were things you expected to be able to do in fact possible?</td>
<td>- What impact do you think the current system has beyond your (individual) tasks?</td>
</tr>
</tbody>
</table>
References


Yin, R. K. 2009. Case study research: Design and methods, Los Angeles, California: SAGE.