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CAPABILITIES TO ACHIEVE BUSINESS INTELLIGENCE AGILITY – RESEARCH MODEL AND TENTATIVE RESULTS

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Abstract

The class of business intelligence (BI) systems is used as a basis for decision making in most big organizations. Extensive initiatives have been launched to accomplish adequate and timely decision support as an important factor to achieve and sustain competitive advantage. Within turbulent market environments it is challenging to keep up a distinguishable long-term strategy while quickly reacting to changing circumstances. This area of conflicts holds particularly true for BI as it is originally used to retrospectively reflect an organization's performance and built upon stability and efficiency. Therefore, we investigate how dynamic BI capabilities, i.e. adoption of assets, market understanding and intimacy as well as business operations, impact the agility of BI. We approach our goal from a dynamic capability perspective. Starting from a literature review of dynamic capabilities of information systems (IS) and BI, we propose hypotheses to connect dynamic BI capabilities and BI agility. Derived hypotheses based on existing literature will be tested in our prospective research agenda. A small pre-study showed promising results. In-memory (IM) technology seems to be a technology enabler for agile BI. However, adoption of BI assets and the focus on market orientation and business operations may even intensify the positive effect.

Keywords: Business Intelligence, Agility, Dynamic Capabilities, PLS-SEM

1 INTRODUCTION

Turbulent market environments are key challenges of today's organizations. On the one hand, an organization needs to keep up a distinguishable long-term strategy to position itself in the market. On the other hand, they need to react quickly to changing circumstances in order to be successful. This area of conflict between stability and innovativeness holds especially true for information systems (IS) as they have to be stable and agile at the same time (Mesaglio and Mingay, 2014; Gartner, 2014; Aghina et al., 2016). Business intelligence (BI) systems, a distinct class of IS, have proven its value to support management decision making during the last decades. The fundamental principles of data warehouse (DWH)-based BI, i.e. integration, subject-orientation, time-variance and non-volatility (Inmon, 1996), are designed toward stability, reliability and robustness. Yet, BI is more and more challenged by dynamic business environments. These changing requirements require a flexible use and adaption of information provision as they create a growing amount of data that needs to be incorporated in business decisions (Mendelson and Pillai, 1998). Organizations enlarged the "information bandwidth" with improved technologies to answer the growing amount of information. This turns information processing capacity of human beings to a bottleneck. In other words, bounded rationality (Simon, 1972) forces decision makers to reduce information overload to be able to focus on relevant information (Mendelson and Pillai, 1998). As a basis for decision support, it is crucial for BI to support both ways: the established, stable and reliable retrospective reporting and agile, future-oriented analytics. Consequently, the challenge of rapid and frequent adaption is very present for BI (Sambamurthy et al., 2003; Krawatzeck et al., 2015). While organizational agility is popular in practice and academia for decades, agility in terms of BI is still in its early stage and starting to gain attention (Krawatzeck et al., 2015; Zimmer et al., 2012; Knabke and Olbrich, 2013; Baars and Hütter, 2015; Moss, 2009; Watson and Wixom, 2007a). Attempts for achieving BI agility (BIA) mostly focus on agile project or development approaches like Scrum (Schwaber, 1997) or BI-adapted versions (Hughes, 2008; Collier, 2011). These valuable concepts look at the way how BI systems are developed and not on the agility of the resulting system itself. Nevertheless, there is criticism if such methods are applicable to BI at all (Moss, 2007; Caruso, 2011). We neither focus on these methods nor organizational agility. Instead, we investigate the drivers and further effects on BIA, i.e. the "what" as there is still a lack of research in this area. Hence, we need a perspective to build theory on achieving BIA. After reviewing IS and management literature, we found the concept of dynamic capabilities promising to identify antecedents of BIA. It provides means to further understand the relation between emerging technologies like in-memory databases (IMDB), BI capabilities and their impact to BIA. Thus, the overarching question of this research-in-progress paper is: *"How do dynamic capabilities in the domain of BI impact each other and how can organizations use them to achieve BI agility?"*

The remainder of the paper is structured as follows. First, we provide a theoretical background about dynamic capabilities as well as BI and in-memory (IM) technology. Afterwards, we focus on agility in the field of BI. Thereafter, we introduce the connection between dynamic capabilities and BI based on a literature review. Next, we explain our research model and derive hypotheses based on existing literature. After detailing the future research approach and methodology, we indicate first results of a preliminary study. We conclude this paper with our intended contribution and outlook.

2 THEORETICAL FOUNDATION

2.1 Dynamic Capabilities

Dynamic capabilities (Teece et al., 1997; Winter, 2003; Helfat and Peteraf, 2003; Eisenhardt and Martin, 2000) of an organization describe the *"ability to integrate, build, and reconfigure internal and external competences to address rapidly changing environments […] to achieve new and innovative*

forms of competitive advantage" (Teece et al., 1997). With the explicit consideration of surrounding factors the dynamic capabilities theory addresses the criticism of the resource-based view (RBV) of an organization (Wernerfelt, 1984). In RBV theory, competitive advantage can be achieved with the use and configuration of its available tangible and intangible resources (Barney, 1991; Wernerfelt, 1984; Wade and Hulland, 2004). Beyond, dynamic capabilities theory combines two aspects: "dynamic" and "capability". Dynamic refers to the ability to renew competences according to changing environments (Teece et al., 1997), whereas capabilities are repeatable patterns of actions that turn assets into outputs of greater value. Assets include technical or managerial skills or processes like software development. They may be anything tangible, i.e. physical (e.g. IT hardware) or intangible (e.g. software) that an organization can use to develop, produce and offer its products or services (Wade and Hulland, 2004). Transferred to BI, exemplary assets are BI applications or data contained in BI systems. If BI assets are used for information gathering, help to make better decisions and adapt to dynamic business environments, they turn into dynamic BI capabilities. This ability to build, integrate and reconfigure existing assets into new capabilities (resource renewal) can lead to greater capabilities than the sum of its individuals (Nevo and Wade, 2010; Cosic et al., 2012; Pavlou and El Sawy, 2006). Thus, we understand dynamic BI capabilities as the ability to act in and to cope with changing business environments by building, reconfiguring, integrating and managing BI assets combined with other (tangible or intangible) assets (such as people, routines and processes) and transform them into assets of greater value. Therefore, the theory of dynamic capabilities is considered the most adequate one for studying BIA and its antecedents in changing environments.

2.2 Business Intelligence and In-Memory Databases

BI can be understood as *"a broad category of applications, technologies, and processes for gathering, storing, accessing, and analyzing data to help business users make better decisions"* (Watson, 2009). It is an umbrella term for systems and processes that turn raw data into useful information (Wixom and Watson, 2010; Chen and Siau, 2012). BI systems support decision makers through business analyses on the basis of internal and external data (Chung et al., 2005; Watson and Wixom, 2007b; Abbasi and Chen, 2008). They have been introduced to measure corporate performance as well as to support problem and opportunity identification, decision-making and alignment of operations with the corporate strategy (March and Hevner, 2007).

With BI coming popular in the 1990s (Chen et al., 2012), the rising integration of external data sources such as social media and the resulting increase in unstructured data has become more and more important in recent years (Davenport and Harris, 2007; Laney, 2001). This trend is accompanied by technological advancements like IMDB. In contrast to traditional storage solutions using disk-resident databases (DRDB), e.g. magnetic hard disks, an IMDB keeps its data in the main memory permanently. Due to recent price reduction on the hardware market as well as dedicated compression data organization techniques, even the entire data of large-size organizations can be economically stored in-memory. Huge performance gains, up to a factor of 1000 with praxis data (Plattner 2009), allow for new analytic scenarios. Moreover, IM technology enables for more flexible DWH-based BI architectures (Knabke and Olbrich, 2011). IMDB will also support real time analysis of operational processes and might overcome the traditional separation of transactional and dispositive systems and thus initiate a shift in organizations´ IT and IS landscapes (Plattner, 2009; Schaffner et al., 2009). This paradigm shift has the potential to change the way BI and the supply of information is currently done. Hence, BI as a technological basis will not only drastically expand and renew BI capabilities and affect BI and DWH architectures, but it also requires organizations to adopt their structures, infrastructure, processes and staff accordingly.

2.3 The Value of Agility for BI

Agility drew mainstream attention in business literature through the work of Goldman et al. (1991). It is considered crucial for business success and the term agility has been used in many domains and

industries (Overby et al., 2006; Sharifi and Zhang, 1999; Sambamurthy et al., 2003; Conboy, 2009; Towill and Christopher, 2002). Definitions of agility often have the ability to cope with unforeseen changes in common. Nevertheless, they are ambivalent in scientific literature and industry (van Oosterhout et al., 2006; McCoy and Plummer, 2006). Only some have made attempts to derive a holistic definition of agility conducting a cross-discipline literature review. For instance, Conboy and Fitzgerald define agility as "*the continual readiness of an entity to rapidly or inherently, proactively or reactively, embrace change, through high quality, simplistic, economical components and relationships with its environment*" (Conboy and Fitzgerald, 2004).

In recent years, academia (e.g. Baars et al., 2014) and practice (e.g. Luftman et al., 2015) recognized the relevance for BIA. In a survey about key information technology and management issues "*business agility*" ranked on number two for key management concerns and "*analytics /BI*" on number two for "top application and technology investments" (Luftman et al., 2015). We draw on our previous work based on a structured literature review to understand agility in the field of BI (Knabke and Olbrich, 2013). Figure 1 shows the identified dimensions of BIA. *Change behavior* is a central construct of agility and describes the behavior of BI with regard to change. A system can behave reactively, proactively, create or even learn from change. *Perceived customer value (PCV)* highlights the importance of quality, simplicity and economy as value for the customer of BI. *Change absorption* describes the time frame or point in time at which BI is able to adapt to changing environments. It can either happen in a continuous process, planned or ad hoc. The actual physical length of time is dependent on the context of BI and may differ for strategic, tactical and operational BI. *Change processing* comprises the ability of BI to sense, analyze and respond to a change. *Data model & infrastructure* incorporates the architecture of BI. Agile BI may even require a new architectural approach which is among others, reusable, reconfigurable and scalable. Additionally, agile BI should support, improve or enable the *business model* of an organization (Rouse, 2007). As we focus on what impacts BI to become agile in this study and not how BI is addressed and created, we excluded the *approach*, i.e. agile vs. traditional methods, from the framework for understanding BIA depicted below. BI environment is dynamic and BI has to cope with these dynamics to adapt to it. Thus, we understand *environment*, e.g. the industry of an organization, as the main reason why BI agility has to be achieved and address it with the integration into the dynamic capabilities theory.

Creation of change	Proaction to change	Reaction to change	Learning from change	**Change Behavior**
Economy	Quality	Simplicity		**Perceived Customer Value**
Continuous	Ad hoc / Spontaneous	Planned		**Change Absorption**
Sense	Diagnose	Respond		**Change Processing**
Scalability	Reusability	Reconfigurability	Architecture	**Data Model & Infrastructure**
Support	Improvement	Enablement		**Business Model**

Figure 1. Framework for BI agility (adapted from Knabke and Olbrich, 2013)

3 RELATED WORK - DYNAMIC CAPABILITIES IN INFORMATION SYSTEMS AND BUSINESS INTELLIGENCE LITERATURE

We analyzed publications in leading IS journals to find out more about the complex structures that constitute BI, to gain an understanding of dynamic capabilities in the field of IS and how they can be aligned to BI (Knabke and Olbrich, 2015). In order to identify relevant sources, we started with the

Association for Information Systems (AIS) senior scholars' basket of journals, known as the "basket of eight" (Members of the Senior Scholars Consortium, 2011). We focused on these outlets because of their acknowledged quality and centrality in the IS discipline. Additionally, we included the Strategic Management Journal as leading articles about RBV and dynamic capabilities have been published here, e.g. Wernerfelt (1984), Teece et al. (1997), Helfat and Peteraf (2003) or Winter (2003). All journals were assessed from their first issue to the most recent issue available in the respective electronic databases (up to January 2015). We used EBSCO to search for articles with the phrase *("dynamic capability" or "dynamic capabilities" or "dynamic resource based view") and ("information system" or "information systems" or "business intelligence" or "business analytics" or "data warehouse" or "DWH")* in the title or abstract. As we are especially interested in the overlap of dynamic capabilities with IS or BI in particular, one of the expression in the first parentheses needs to occur with at least one expression in the second parentheses. This explains why not every accessed journal appears in the list below. Our search resulted in nine publications in these outlets (Table 1).

Authors / Year	Journal	Dynamic Capabilities
Banker et al. (2006)	MISQ	Manufacturing capabilities (just-in-time manufacturing, customer & supplier participation programs) by resource planning systems, operations management systems, electronic data interchange applications
Pavlou and El Sawy (2006)	ISR	Reconfigurability operationalized by market orientation (sensing the environment), absorptive capacity (learning), coordination capability (coordinating activities) and collective mind (integrating interaction patterns)
Butler and Murphy (2008)	JIT	Organizational and managerial processes, namely integration, learning, reconfiguration and transformation
El Sawy et al. (2010)	ISR	Improvisational (spontaneous) dynamic capabilities (by project and resource management systems and collaboration work systems), planned dynamic capabilities (by organizational memory systems)
Kim et al. (2011)	JAIS	IT personnel expertise, IT infrastructure flexibility, IT management capability
Singh et al. (2011)	JAIS	Processes that learn, value-based governance, dynamic personal accountabilities/dynamic commitments, modular processes and services/modular design
Roberts and Grover (2012)	JMIS	Customer agility as a dynamic capability consisting of customer sensing capability, agility alignment and customer responding capability
Drnevich and Croson (2013)	MISQ	Collusion/coordination, governance, competence, flexibility
Daniel et al. (2014)	JSIS	Business objectives drive projects, multiple and dynamic prioritization criteria, dynamic balancing of risk and reward, cancel/reconfigure in-flight projects

Table 1. Summary of dynamic capabilities in an IS and BI context

We searched the publications for dynamic capabilities, grouped the results to higher level constructs and mapped them to the field of BI. This resulted in three main capabilities based on the reviewed literature that are relevant for BI, namely *adoption of (BI) assets* (AOA), achieving *market understanding and intimacy* by using BI (MUI) as well as supporting *business operations* with BI (BO). We understand all three capabilities with regard to BI. AOA comprises the adoption and configuration of the used BI technology or the education of personal working with BI as well as all tools used for BI and its applications. We put special emphasis on the influence of technology as highlighted by several authors, e.g. Kim et al. (2011) or Pavlou and El Sawy (2006).

MUI summarizes all knowledge and insight about customers, suppliers, etc. generated with BI. It addresses the view towards the outside of an organization. Pavlou and El Sawy (2006) underline the importance of market orientation to reconfigure resources whereas Roberts and Grover (2012) focus on customers in their study. This capability summarize the knowledge that an organization achieves with BI about itself, its position in the market, its performance, its products or services, its customers

and suppliers, its competitors, new product developments as well as potential new market entrants, also known as Porter´s five forces (Porter, 1979).

The third identified capability, BO, describes the support and enablement of business operations with BI and reflects the internal view of an organization. It comprises all primary, e.g. manufacturing, and auxiliary, e.g. accounting, processes as mentioned by Banker et al. (2006) or Daniel et al. (2014). It focuses on the planning and execution activities that are supported by BI and are directly connected with the creation of products and services offered by an organization. All three identified dynamic BI capabilities explicitly include coordination, governance or organizational topics, as e.g. mentioned by Drnevich and Croson (2013) or Butler and Murphy (2008).

4 RESEARCH MODEL AND HYPOTHESES DEVELOPMENT

Our research model is depicted in Figure 2. It is developed based on the literature review on dynamic capabilities (Table 1) and the BI agility framework (Figure 1).

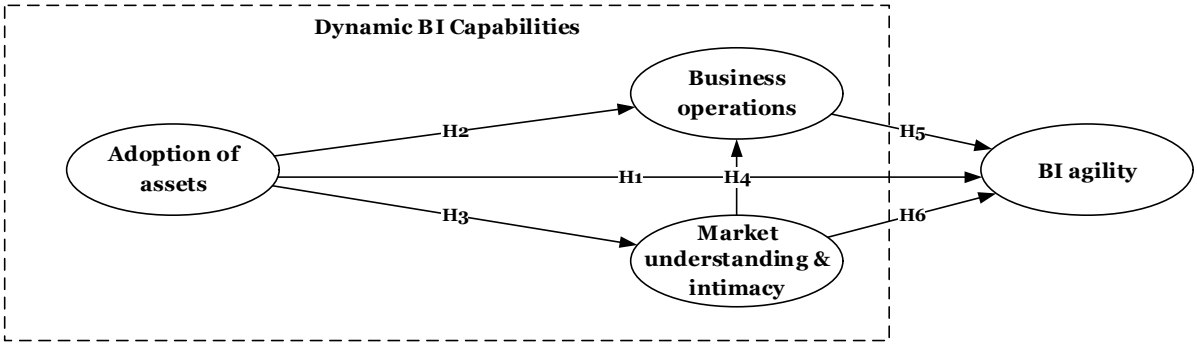

Figure 2. Research Model

Both tangible and intangible assets are crucial components of BI. Organizations require staff and corresponding structures to apply technologies and develop and integrate BI. Sambamurthy et al. (2003) argue that IT investments influence the performance of a firm through (amongst others) agility. To successfully apply emerging technologies like IMDB for BI, an organization needs to invest in that technology, teach its staff accordingly, integrate it into its technology stack and adopt it for the use for BI. Thus, a viable use and adoption of technology assets will likely have a positive impact on the business model as one dimension of BI agility (Figure 1). With the evidence that new technological advancements like IM technology bring various benefits for BI and might serve as a technology enabler for more agile BI (Knabke and Olbrich, 2011; Plattner, 2009), we stipulate: *Adoption of assets positively impacts BI agility (H1).*

BI, as a subset of IS, is an essential component for action and decision-relevant information (Krawatzeck and Dinter, 2015). If an organization can align its IT and BI activities with the overall business strategy, meet demands for business services and implement reliable and cost-efficient BI applications, it can outperform competitors (Kim et al., 2011). In contrast, with a lack of this expertize, the redesign of processes and the enablement of business operations in changing environments will fail (Rockart et al., 1996; Kim et al., 2011). The postulation to integrate information into the core business processes (Kim et al., 2011) turns BI, its underlying technology as well as the staff adopting it to a substantial part and antecedent of business operations. Hence, we argue that an organization´s capability to adopt BI-related assets grows its capacity to improve business operations and hypothesize: *Adoption of assets positively impacts business operations (H2).*

BI and analytical ability are important means to be competitive in markets and achieve customer agility (Roberts and Grover, 2012; Krawatzeck and Dinter, 2015). The required expertize needs to be developed and shared throughout the organization to enable staff to be familiar with the use and adoption of existing and new BI and technology assets. As BI and analytical abilities make a

significant impact to create knowledge about customers and achieve customer agility (Roberts and Grover, 2012; Kim et al., 2011; Rockart et al., 1996), we argue: *Adoption of assets positively impacts market understanding and market intimacy (H3).*

Roberts and Grover (2012) discovered that analytical ability and thus BI are useful in the process of (customer) knowledge creation. Market knowledge is required to shape core processes effectively. As BI is a viable mean to gain market understanding, this suggests the conclusion that market orientation and particularly market understanding and intimacy is related to business operations. Hence, we hypothesize: *Market understanding and market intimacy positively impact business operations (H4).*

BO comprises all primary and auxiliary processes as well as their corresponding decisions. BI helps users to make better decisions and can be used on a strategic, tactical and operational level (Watson, 2009; Marjanovic, 2007). BI that is integrated in BO is closely connected to the business model of an organization which is a dimension of BI agility. As support, improvement and enablement of business processes are characteristics of agile BI, a connection between BO and BIA seems to be obvious. Furthermore, if BI is well integrated to BO it is likely to gain customer value. Therefore, we state that: *Business operations positively impact BI agility (H5).*

BI supports the creation of market-oriented knowledge, e.g. by providing sensing and responding capabilities (Roberts and Grover, 2012) which is important to respond to dynamic environments (Singh et al., 2011). As market orientation addresses drivers of environmental change (Overby et al., 2006) and sensing, analyzing and responding to changing environments are key for BI agility, we hypothesize: *Market understanding and market intimacy positively impact BI agility (H6).*

5 METHODOLOGY AND FIRST RESULTS

We plan to test our research model using partial least squares structural equation modeling (PLS-SEM) with smartPLS 2.0.M3 as software tool (Ringle et al., 2005). It is an appropriate and acknowledged method for testing and estimating causal relations in the field of IS (Gefen et al., 2000; Urbach and Ahlemann, 2010). Particularly, we rate PLS higher than covariance-based methods for our study as we expect a small sample size (n=100-150), the investigated phenomenon is new and measurement models need to be newly developed (Urbach and Ahlemann, 2010). All constructs cause their indicators and are thus modelled reflective. As they are newly developed for BI, we could we could not draw from existing measurement scales, but adopted existing scales and used literature whenever possible. For example, we used Porter´s five forces (Porter, 1979) to derive our indicators for MUI. The corresponding questionnaire was developed following the rules of Dillman et al. (2009) and a structured, self-administered survey (Leeuw et al., 2008) will be used as data collection technique. With a survey-based approach, participants' responses can be aggregated in a standardized manner and used for quantitative analysis (Bhattacherjee, 2012). We executed a pre-study (n=16) to scrutinize our approach and questionnaire with a group of researchers from our institute as well as senior BI experts from industry. The questionnaire consists of five components, one for each construct of the research model (e.g. BO) and one for statistical purposes asking for background information like work experience of the participants. The constructs consist of four to six indicators. The participants will be asked to give their level of agreement to one statement per indicator. Each statement is given in twofold logic. First the general point of view of the respondent is asked for and afterwards the participants are asked to give a rating for the organization they work for. One example for this twofold logic is "*The capability to adopt and integrate new technological developments, e.g. IM technology, to the existing technology stack for BI is important for organizations in general*" and "*… is sufficient in our organization*". We are able to compare the overall importance of a construct with the specific occurrence in organizations, and make a contribution to both theory and practice with this approach. Additionally, this approach enables us to conduct a group comparison and analyze the impact of IM technology on BIA (Henseler and Chin, 2010). Apart from statistical questions the answers in the questionnaire consist of non-dichotomous rating scales (7-point Likert scales). In addition, the questionnaire includes control questions (Bhattacherjee, 2012) and asks for the size of the

organization and the use of agile project management approaches. Knowing the pros and cons of *"don't know responses"* (Beatty et al., 1998; Dillman et al., 2009) we will use mandatory questions concerning our hypotheses test as the respondents' best subjective estimation is adding value to our analysis. For data validation we will follow the guidelines of Straub et al. (2004) and Lewis et al. (2005) as described and recommended by Urbach and Ahlemann (2010). In addition, we will take validation guidelines for IS research into account (Boudreau et al., 2001).

Due to the preliminary nature of this study we are currently unable to provide a complete analysis, but can share first findings from the pre-study (n=16). The group had an average BI experience of more than 8 years. In the evaluation of the survey responses and the following discussion with three participants we discovered that emerging technologies such as IMDB seem to be essential for achieving BI agility (H1). An increase in the use of IMDB-based BI appears to be a technology enabler for BIA. IM technology allows for DWH-based BI architectures with reduced complexity that are more flexible for adapting and analyzing additional data sources. But, each organization needs to embrace IM technology particularly for its use and well-educated staff is required to leverage its full potential. Hence, a direct impact of AOA on BIA is indicated. Nevertheless, the results from the preliminary study did not confirm a positive effect of MUI on the BIA. On the contrary, so far the impact tends to be negative. One participant explained this observation by rephrasing our overall assumption: By investigating turbulent market environments, fundamental DWH-based BI assumptions (like robustness) are violated. Another participant remarked that market orientation has to be closely connected to business activities. Otherwise it will neither have an impact on the support of the business model of an organization nor on change behavior or PCV. These comments are supported by the observation of a positive impact path (hypotheses path H3, H4, H5) with MUI as well as BO as a mediator. It seems that the impact between AOA and BIA is intensified if emerging technologies and BI are closely connected and used for market orientation (H3). Insights gained with this capability seem to positively affect BO (H4) which then results in a positive effect on BIA (H5). The respondents highlighted BI and analytical capabilities as adequate means to analyze customers and suppliers in particular (H3). For example, a better understanding of customer needs and transparent supplier conditions for the whole organization achieved by BI might positively influence the way business is operated (H4). Another feedback was that sensing a change in customer buying behavior can trigger an adaption of a business process to stay competitive. In return, the measurement of business processes is the basis for further process improvement (H5).

6 INTENDED CONTRIBUTION AND OUTLOOK

Overall, we aim to contribute to the field of agility in the context of BI. Therefore, we conducted a literature review to identify dynamic BI capabilities and proposed a research model as depicted in Figure 2. As of now we only have first indications (n=16) on the relationships between the dynamic capabilities of BI and their influence on more agile BI. These preliminary results have to be carefully reflected in light of the research-in-progress status of our paper. Currently, we are collecting data from questionnaires sent out to BI experts at a globally operating consulting company, the Data Warehouse (TDWI) and professional social networks.

We expect practitioners to benefit first-hand from the expected results as we aim to identify promising capabilities to achieve BI agility. This may support organizations to move their BI away from historic reflections to actively shape the future. Furthermore, practitioners may need to evaluate and re-think their BI and asset adoption strategies based on the results of our study. From a theoretical perspective, the results may also provide a basis for further research in academia. The planned study sheds first light on the importance of dynamic capabilities for BI agility. Moreover, we intend to analyze the impact of technological assets for BI agility. Additionally, we will provide new measurement instruments in the field of BI. These measures are anchored in literature and may serve other researchers in their studies.

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