

# Barriers to BI&A Generativity: Which Factors impede Stable BI&A Platforms from Enabling Organizational Agility?

*Completed Research Paper*

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## Abstract

To enable organizations to swiftly sense and respond to market changes, organizations have noticed the need to analyze the exploding amounts of available data. Therefore, employees frequently extend their Business Intelligence and Analytics (BI&A) platforms with numerous supplementary silo systems. However, those supplements also bear numerous threats such as replication of data and functionality. Therefore, extant literature recognized the need to implement highly generative BI&A platforms which evoke vast agility to users while at the same time providing a stable platform for further developments.

Our work addresses this challenge by exploring contemporary BI&A platforms. We adopt a case study design to examine the BI&A platforms of four organizations. Our inquiry indicates five impediments and reveals how these organizations cope with them. We believe that these findings may help professionals to design generative BI&A platforms that empower users to perform exploratory analyses, integrate internal and external data, and enhance organizational agility.

## Keywords

generativity, business intelligence (BI), analytics, data warehouse architecture, multiple case study

## Introduction

Organizations have made large investments into implementing standardized software products with the expectations that the resulting enterprise systems integrate data and processes, allow control and reduce costs (Maas et al. 2012). However, research indicates that many software products do not achieve these goals due to numerous reasons such as missing flexibility and long implementation times necessary to change them (Györy et al. 2012). To mitigate this problem, users tend to develop and adopt supplementary silo systems (Behrens 2009).

This phenomenon has recently gained momentum because individuals today may choose from, and are able to use, an unlimited pool of advices and services (Baskerville 2011). In addition, contemporary systems are developed as platforms, i.e., extensible codebases that provide core functionality to potential extensions (Tiwana et al. 2010). The domain of business intelligence and analytics (BI&A) is particularly affected because many users frequently develop and use supplementary, individually tinkered spreadsheets for reporting purposes. However, supplementary systems also constitute dangerous threats for organizations (Behrens and Sedera 2004) and, thus, literature recommends encouraging them only within defined boundaries (Györy et al. 2012).

Therefore, exploring how IT enabled organizational agility may be improved without seducing users to develop silo systems is highly interesting to industry and academia. Rather than continuously installing additional supplementary systems, organizations should target stable platform bases which evoke the

creation of new output, that is, generative platforms (Tilson et al. 2010; Yoo 2013). Specifically, such an inquiry could guide future research in the area of paradoxical tensions within software platforms (Smith and Lewis 2011), highlight antecedents of imbalances between stability and flexibility, and guide organizations to design stable BI&A platforms that enable organizational agility (Chakravarty et al. 2013). Hence, our work addresses the following research questions:

*RQ1. Which factors impede stable BI&A platforms from enabling organizational agility?*

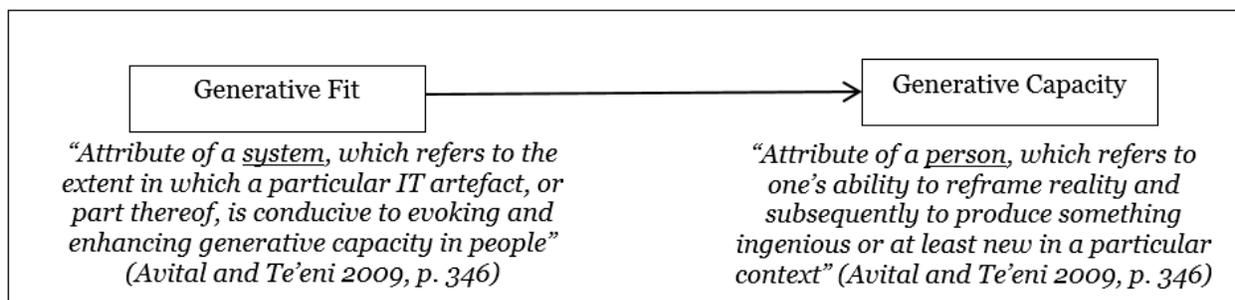
*RQ2. How do organizations cope with these impediments?*

The remainder of this article is organized as follows. Section 2 introduces generativity as guiding theory base. Upon that, section 3 explains the applied multiple case study design to answer our research questions. Section 4 presents and categorizes factors which impede generativity of BI&A platforms and section 5 discusses the findings and summarizes how organizations deal with them. Finally, section 6 concludes our work and indicates limitations and further research opportunities.

## Theoretical Foundations

Generativity research provides a suitable basis for studying how BI&A platforms may advance organizational agility, i.e., fostering the continual readiness of an organization to rapidly embrace change (Conboy and Fitzgerald 2004). Organizational agility encompasses flexibility and speed (Bernardes and Hanna 2009). Thus, enabling organizational agility requires BI&A platforms to be flexible and empower users to swiftly make use of this flexibility. However, at the same time it also requires BI&A platforms to be stable to integrate knowledge exchange and provide predictable means to connect to (Glenn 2009; Tilson et al. 2010). Increasing “the ability of any self-contained system to create, generate, or produce a new output, structure or behavior without any input from the originator of the system” (Tilson et al. 2010, p. 750) while balancing the paradoxical tensions (Smith and Lewis 2011) between stability and variability is referred to as generativity.

Multiple research agendas recently called for a more sophisticated examination of this phenomenon. Scholars would have to target “a more precise and nuanced understanding of the nature of digital technology that enables and constraints activities and produces generative innovations” (Yoo 2013, p. 231) and to “guide actors to establish generative platforms by instituting a set of control points” (Tilson et al. 2010, p. 754). Furthermore, generative fit of a system and generative capacity of a person may be distinguished (Figure 1).



**Figure 1: Generative Fit and Generative Capacity**

Zittrain (2008) emphasized the need for generative systems to establish boundaries in the long run. While he embraced technologies such as the internet that anybody could build on at any time, he also raised concerns about such technologies ending up being abused. Therefore, openness has to be tempered with some actions that help to preserve it. (Zittrain 2008). For instance, while Wikipedia started out as an extensible platform without any restrictions, contributions and changes today are reviewed by a global community which assures Wikipedia’s high degree of generative fit. Such a self-protection mechanism is essential to assure sustainable generativity (Zittrain 2008).

Building on Zittrain (2008), the importance of managing the tensions between stability and variation have been determined (Gaskin et al. 2011). “Digital infrastructures simultaneously need to be stable and flexible” (Tilson et al. 2010, p. 753). This emphasis on balancing stability and flexibility distinguishes generativity

from other research streams and justifies it as an appropriate theory base for studying which factors impede stable BI&A platforms from enabling organizational agility.

Besides the generativity research stream, we acknowledge that some studies indicate the beneficial effect of business intelligence competency centers (BICCs) for aligning business functions with IT departments and balancing stability and flexibility (Forrester Research 2013; O'Neill 2011). BICCs are specialized organizational units with a formal and permanent structure (Unger et al. 2008). They perform cross-functional tasks regarding effective and efficient development, operation and support of BI&A platforms across a company. However, since BICCs are a purely organizational measure, we base our work within the generativity research stream.

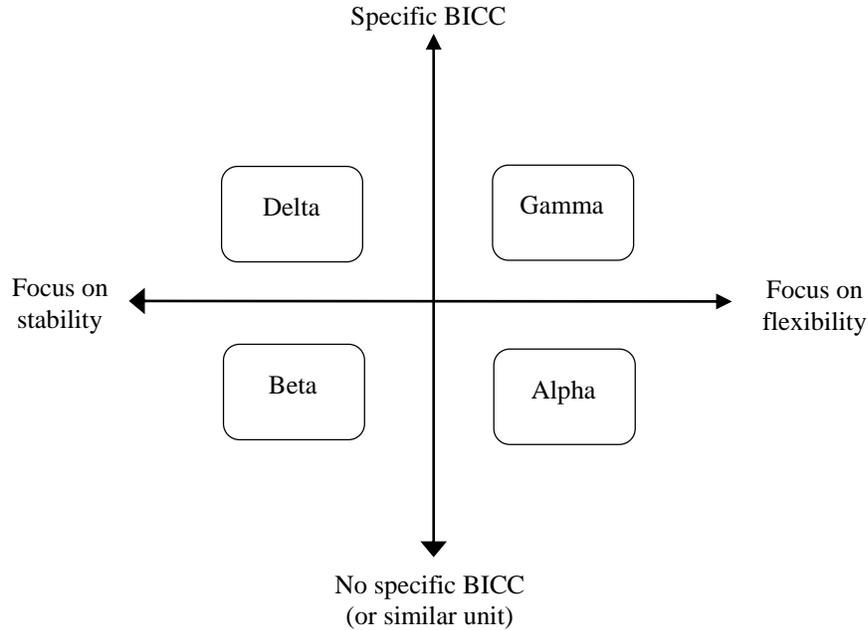
## **Research Method**

Our study of generative BI&A platforms builds on the aforementioned theoretical foundations. We aim at identification of impediments to BI&A generativity. As such an inquiry requires flexibility for examining aspects of generativity that may not be completely identifiable at the outset of the study, we adopted a qualitative research approach (Eisenhardt 1989; Myers 2008). Specifically, we chose a multiple case study design to answer our research questions. Methodologically, we relied upon a grounded theory approach due to the absence of a strong theory base on building generative platforms (Glaser and Strauss 1967). Grounded theory provides us with the opportunity to think outside the confines of existing schemas while providing guidelines to approach the nature of the phenomenon in a structured way.

### **Sites**

Four sites were selected on the basis of theoretical relevance and to ensure an adequate foundation for comparison and to maximize variation (Guba and Lincoln 1989). Specifically, based on our personal experiences from working and collaborating with potential organizations, we selected two sites that focus on platform stability and two sites that focus on flexibility. Furthermore, we assured that two organizations implemented BICCs and two organizations do not. Figure 2, Table 1 and Appendix A provide detailed information about the theoretical sample.

We decided to focus on vehicle manufacturing companies, because different regulatory requirements due to varying industries could have biased companies' needs for organizational agility. Vehicle manufacturing companies are suitable, because they use BI&A platforms for manifold scenarios which are comparable across firms (e.g., financial accounting, process analyses, material analyses, logistics monitoring). Regarding platform provider, the two companies with BICCs are using the same leading, large BI&A platform (Gartner 2014). Conversely, the two companies without such a unit are using BI&A platforms of two different, small niche players.



**Figure 2: Theoretical Sample**

Company	Country	Employees	Respondents (total: 20)
Alpha	USA	300-500	3 IT professionals [1 IT director, 2 BI&A experts], 3 power users [1 program manager, 1 lean manager, 1 financial analyst]
Beta	UK	300-500	2 IT professionals [1 IT director, 1 BI&A expert]
Gamma	Germany	20.000	1 IT professional, 2 BICC experts, 3 power users [1 marketing & sales, 1 cost accounting, 1 logistics]
Delta	Germany	10.000	1 IT professional, 3 BICC experts [1 BICC director, 2 BICC experts], 2 power users [1 logistics power user, 1 supply chain management director]

**Table 1: Descriptive Case Information**

**Data Collection and Analysis**

We conducted semi-structured in-depth interviews to gain detailed, rich, and real-life data. We first interviewed managers from the IT side, because they were able to provide us with rich context information about their BI&A platform. Additional respondents were recruited using snowball sampling and their suitability to provide additional insights (Patton 2002). The final sample included 12 IT professionals (developers, managers and administrators of BI&A platforms) and 8 power users from finance, sales, lean and product management departments. An interview guide was developed following methodological recommendations from Schultze and Avital (2011). As needed, specific questions were asked to ensure completeness of data and comparability of cases. The interviews lasted 30-50 minutes and were transcribed and translated into English. Transcripts were analyzed according to the Strauss and Corbin (1990) coding paradigm, consisting of open, axial, and selective coding, as it provided a thorough and structured approach for examining the phenomenon of interest. Resulting codes were used to identify impediments and according remedies to BI&A platform generativity. Furthermore, codes were used to validate whether companies focused on stability or flexibility (Appendix A). Data collection was supplemented by review of internal documents, e-mail discussions and the companies’ webpages.

## Findings: Impediments to Generativity of BI&A Platforms

The designed case study was used to identify and explain impediments to stability as well as impediments to flexibility of contemporary BI&A platforms.

### (1) Source Identification Difficulty and Lack of Transparency

Source identification difficulty occurs when a user does not know where to obtain the information he is looking for (Day et al. 2009). It is caused by a lack of transparency that precludes the user from understanding which type of information is available when accessing the BI&A platform. The following excerpt illustrates how cluttered platforms cause source identification difficulties.

*“We have very detailed possibilities for analyses. [...] I fear it is less a problem that a required report doesn't exist. Rather the user gets buried by the bulk of options for selecting the report.”*  
(BICC expert 2, Gamma)

Not knowing where to get the needed information tempts users to create new reports instead of reusing existing reports – which again reduces transparency and complicates source identification. This is a vicious circle for organizations: If existing reports are less often reused across individual teams and departments, scale effects cannot be achieved and operational efficiency decreases (Gaskin et al. 2011).

*“In many big firms, there are small reports that only certain departments know about. [...] If one could create transparency there, many others would benefit from it or say ‘We are doing it differently and it is much easier!’ Then one could use synergies.”* (User 2, Alpha)

*“The problem I see is this identification. [...] How do you identify ‘Oh, this is so great that others need it too’. You somehow have to provide a possibility to make this public.”* (BICC expert 2, Delta)

In addition, a lack of transparency also hampers users from tracing data back to its original sources. This effect combined with the increased number of reports for the same business purpose destroys users' trust in the correctness of the reports and avoids comparability of reports across teams and departments.

*“The main goal is transparency and comparability.”* (BICC expert 3, Delta)

*“You have to ask the question, where does this information come from? [...] If you don't know how you got the information, the report is worthless.”* (User 3, Alpha)

### (2) Inflexible Data Model

Fit between the BI&A platform's capabilities and the users' tasks is a key driver for users' individual efficiency (Goodhue and Thompson 1995). It is achieved through an extendable data model. Users need to be empowered to load additional data into their platforms and enrich reports with additional fields (Burnett and Scaffidi 2013; Germonprez et al. 2012; Tam and Ho 2006).

*“The BI system takes away flexibility. [...] And sometimes its data is wrong because, for instance, it was not correctly interpreted. And then you have to adjust something manually to reflect the reality again.”* (User 3, Alpha)

*“We got a lot of problems now which we wouldn't be experiencing if we just used something else from where users could extract the data. Then they would be able to get all the reports from there.”* (IT professional 1, Beta)

Inflexible data models increasingly impede BI&A platforms, because organizations are increasingly combining their internal data sources with external data sources such as the web and data acquired from other companies (Forrester Research 2013). For instance, Alpha buys data from a global market research institute that provides information on the size of the economic market for Alpha's main products and services. Through joining this information with internal data, Alpha is able to identify market trends, compute its market share, and evaluate its performance in relation to its competitors.

*“We also have what's called the XXX. It's a database. [...] This takes data from a company called XXX in the UK. [...] It includes information related to our product. And we use it to [...]”*

*derive our market share. [...] Our database is extracted, and combined with the data that we have and that is used by our sales people and our executives to figure out where the market's going and how much market share we have.*" (IT professional 2, Alpha)

Furthermore, inflexible data models prevent bi-directional data flow and impede organizations from reusing large parts of their data. Users frequently extract data from their BI&A platform and then modify the data model (e.g., add fields). However, if the modified data model outside of the platform is not used to update the platform's internal data model again, then other users of the platform cannot access the extra information and are not able to reuse it and benefit from it.

*"I only have the flow from BI into the spreadsheet."* (IT professional, Delta)

*"We take some spreadsheets that the users are maintaining and they save them to a folder which is mounted in way that the UNIX machine can read the same folder. [...] And then I can use it in my BI platform."* (IT professional 3, Alpha)

### **(3) Complex and Time-Consuming Customization**

Time-consuming customization prevents users from adjusting their BI&A platforms to their individual needs. Consequently, they start developing their own, personal stand-alone systems – commonly known as Shadow IS (Behrens 2009).

*"The system did not grow with the firm but stagnated at some point. Things which were required were not quickly enough implemented and then siloed applications were built to help out. This now results in giant chaos."* (User 3, Alpha)

Further interviewees similarly mentioned that customization of BI&A platforms would be too complex. Influenced by the capabilities of other IS, they proposed automatic adaptability mechanisms as corrective remedies. In contrast to user-induced customization, automatic adaptation relieves users from the burden of maintaining their BI&A platforms and enables them to focus on their actual tasks (Avital and Te'eni 2009).

*"Most of the BI software I have seen is way too complicated for most users to create anything. The menus have far too many options that can easily overwhelm them. So, why not create software that learns about the user's abilities and adjusts accordingly? For example, based on keystroke/clicking speed, number of reports created/saved/run, or other clever criteria, the program could offer more or less functionality. The program could even offer developmental testing for users, and use that information to decide what level to set the user at, and/or what functionality to offer them. This dynamic 'ability level' rating could be stored on a user by user basis spanning sessions. [...] This is my dream. [...] That kind of adaptability is already in use in the gaming world. And there is no reason I think that it could not be used in a business environment."* (IT professional 3, Alpha)

*"I believe an adaptive platform may really assist if it is very intelligent. [...] For instance, I am looking at something and notice I made a mistake: I delivered late. Then I would like to know why and the system would need to say 'Okay, from here you can jump to this query or this query. Then you get additional information which your current query does not provide.'" (User 1, Delta)*

### **(4) Insufficient Contextualization and Embedding within Operational Platforms**

With the proliferation of large amounts of data within organizations, increasingly complex statistical analyses are performed to predict economic trends and simulate business scenarios (Shmueli and Koppius 2011). Although organizations hire particularly trained data scientists to explore and exploit such data (Davenport and Patil 2012), business analysts with foundational skills will continue to perform the vast majority of analyses (Wixom et al. 2014).

To enable business analysts to focus on interpretation, BI&A platforms need to be integrated with those operational applications that analysts are using most frequently during their daily tasks. These encompass a word processor, a spreadsheet application, and a program for presenting the results to management.

*“De facto you always have to use and visualize data in spreadsheets and presentations. [...] Therefore, this extractability is always required. Tools where you only have those web interfaces but are not able to continue processing the data – that is almost useless.” (User 2, Delta)*

*“Spreadsheets continue to be the analyst’s tool of choice. [...] Well, it is a combination of word processors, spreadsheets, and presentation programs.” (IT professional 3, Alpha)*

### **(5) Immediate Distribution of Standard Reports to all Departments and Lack of Possibilities to Discuss Standard Reports**

With increasing agility of BI&A platforms, integrated possibilities for users to collaborate with each other are increasingly important. A lack of collaboration causes transparency issues and avoids reuse of reports. Instead of requiring users and IT professionals to design and develop large, standardized reports, BI&A platforms should provide possibilities to discuss reports and data models. Such possibilities would facilitate collaboration between IT professionals and users.

The following excerpt indicates how Delta benefited from such techniques. An IT professional trained users from several teams and enabled them to disseminate the knowledge about the tool within their teams.

*“You do not have to deliver the overarching standard right away; but you have to provide a platform where people can discuss that. [...] With another tool I was able to create a wikipedia which exactly describes how the tool functions, how one may use it, and what the preconditions are. Thus, I managed to enable one person from each team to becoming a disseminator. [...]. And then he may spread knowledge about the tool within his team.” (IT professional, Delta)*

IT professionals from further organizations also confirm the need to discuss reports and data models. Reports also should be developed and updated sequentially.

*“We work with all the people [...] to give us their requirements and then build the reports around what they need.” (IT professional 2, Beta)*

*“In my experience, it’s best if I don’t try to define a standard in the beginning that suits all users, but rather try to build something open which suits, for instance, two areas. Then I see whether I can include areas 3, 4, 5.” (BICC expert 2, Gamma)*

## **Discussion**

To enable organizational agility and to harness the possibilities of generativity, digital infrastructures need to be viewed as a duality (Farjoun 2010) in that they need to be simultaneously stable and flexible (Tilson et al. 2010). While stability assures predictable interfaces to connect to, flexibility assures variation at the edge to broaden, deepen and maintain the BI&A platform (Tilson et al. 2010).

Through our inquiry of BI&A platform generativity, we found impediments to accomplishing organizational agility while maintaining a stable platform base. Table 2 synthesizes our findings empirically and theoretically. Columns 2, 3, 4, and 5 represent a sequence consisting of cause, impediment, threat and action which provided us with an anchor point during the selective coding process (Day et al. 2009). Each combination represents a theoretical proposition that could be subjected to empirical testing. Thus, each row of the table – by virtue of its hypothetical nature – represents a contribution to theory (Lee and Baskerville 2003; Day et al. 2009).

(1) BI&A Platform Generativity Impediment	(2) Support in literature that give rise to this impediment (cause)	(3) Definition of impediment (impediment)	(4) Generativity adversely impacted (threat)	(5) Strategy applied (action)
Source identification difficulty and lack of transparency	Heterogeneous IS environment and reliance on supplementary silo systems (Behrens 2009; Györy et al. 2012; Glenn 2009)	Users cannot discover and reuse reports	Reuse	Further development of redundant reports and silo systems (→ vicious circle)
Inflexible data model	Slow and complex IT approval processes; focus on data integration; need to compute exploratory analyses (Davenport 2014); increasingly diverse opportunities to create value through data-driven decision making (Gillon et al. 2014; Dhar 2013)	Users cannot add/modify data	Agility (i.e., flexibility and speed of change)	Excessive data extraction into spreadsheets without feeding changes back to the BI&A platform
Complex and time-consuming customization	Increasingly important need for organizations to be responsive in today's global economy (Swafford et al. 2008; ) and to adjust to new requirements rapidly (Bernardes and Hanna 2009; White et al. 2005)	Users actively need to customize their platform; lack of system-induced (automatic) adaptation	Agility	Development of stand-alone systems (if less time-consuming than platform customization)
Insufficient contextualization and embedding within operational applications	Rise of specialized departmental desktop BI tools (Evelson 2013); business users are increasingly asking for abilities to perform analyses (Brown et al. 2013; Chen et al. 2012; Weber 2013)	Users can only perform reduced functionalities using add-ins for office applications	Ability to respond to new requirements at all	Waive implementation of some requirements and accept a reduced set of capabilities
Immediate distribution of standard reports to all departments and lack of possibilities to discuss standard reports	New possibilities for discussion (Aral and Walker 2012; Kolfschoten et al. 2009); replacement of traditional ways for collaboration with social media networks (Kane et al. 2014; Koch et al. 2012)	New/updated standard reports are distributed to all departments; users cannot provide feedback on reports and data models	Very few, if any, standard reports that are reused across departments	Personal meetings; very few IT professionals distribute standard reports sequentially

**Table 2: Summary of Findings**

## Conclusion, Limitations, and Future Research

The key for IT to enable organizational agility is generativity in terms of evoking vast flexibility while providing a stable platform for further developments (Tilson et al. 2010). This holds true for BI&A platforms in particular. The amount of data available to businesses is exploding, but at the same time needs to be thoroughly analyzed to provide a highly valuable corporate resource (Mithas et al. 2011). Therefore, BI&A platforms not only need to remove boundaries around their standardized data models in favor of empowering users to perform exploratory analyses, but BI&A platforms also need to allow users across multiple departments to reuse extended data models and benefit from the results of each other.

Our case study of BI&A platforms of manufacturing organizations has revealed issues that may otherwise have gone unobserved. Identifying impediments of current BI&A platforms to avoid the same pitfalls in the future is vital (Day et al. 2009). Our research has taken an initial step and provided a set of impediment categories that can either be subjected to empirical testing or serve as design considerations for future BI&A platforms. However, as we focused on manufacturing companies in order to avoid varying regulatory requirements, generalizability of our results may be limited.

Finally, future research may build on our study to build a stronger theory base on generativity. Specifically, it could investigate what drives organizations to focus either on stability or flexibility, which effects change that, how would an according transformation process look like, and how could a balance be sustained.

## Appendix

### A. Validation of the Theoretical Sample

We applied theoretical sampling to select manifold companies for our case study. Based on personal experiences and internal knowledge from previous work, we selected two companies which emphasize agility and two companies which emphasize stability. In addition to revealing impediments to BI&A platform generativity, we used our findings to provide evidence for our theoretical sample (Table 3).

Company	Focus	Exemplary excerpts indicating focused orientation
Alpha	Agility and variation	“From the platform <u>most of the reports are pulled out</u> and are either electronically or manually <u>fed into spreadsheets</u> . From there pretty graphs and charts and key figures are developed. [...] User queries are developed into reports in spreadsheets.” (IT professional 3)
Beta	Stability	“You <u>can’t get any data out of the BI platform</u> .” (IT professional 1) “The idea is that the reports are web-based and users can put the parameters what they want to see and then they’re getting the results they want. There’s <u>no messing around with macros</u> or anything like that anymore. [...] All they see is the end-report. All they need to know is <u>just what parameters</u> they need for the reports. That’s all they need to do.” (IT professional 2)
Gamma	Rather agility and variation	“We have a <u>few standard reports</u> . Obviously these are usually official reports or on the basis of official reports. But we are not able to realize every single business case and that’s why <u>users view BI as download platform and link data in their spreadsheets or own databases or through own SQL statements</u> . We agreed to use <u>own databases for short-term ad-hoc reports</u> and <u>BI for long-term, official and recurring standard reports</u> .” (User 3)
Delta	Stability	“For each area we have a <u>reporting process owner</u> who gives his blessing and <u>signs whether an extensions indeed is relevant for the entire organization</u> . Well, Delta currently sets great value on <u>standardization</u> . There are <u>barely individual things</u> .” (BICC expert 2)

**Table 3: Theoretical Sample Validation**

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