

The Impact of Agility Requirements on Business Intelligence Architectures

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Abstract

Business Intelligence (BI) promises a coordinated and integrated approach to management support. This goal, however, is constantly challenged by de-central and isolated systems that emerge on the side of the user departments and that seriously affect the overall effectiveness of BI. This contribution explores how requirements for “agility” might explain the situation and what measures can be taken on the architecture side to deal with them. After discussing the concept of agility, it is argued that some degree of de-centrality might be unavoidable in turbulent business environment due to the very nature of BI. In a series of case studies it is explored how the situation can be dealt with in a systematic manner. The results show that agility requirements can be effectively confined to areas more exposed to turbulence as long as the architecture is designed in a pertinent way – and if it is supported by suitable organizational measures.

1. Introduction

The approaches and systems for IT-based management support that are commonly subsumed under “Business Intelligence” (BI) [14, 34] are continuously growing in scale, scope, and relevance [36, 37]. The area of BI is intrinsically tied to the need for crafting integrated concepts that have a reach beyond individual applications and business units or that even reach across enterprise borders. In fact, many building blocks of established BI frameworks are of infrastructural character (in the sense of Keen [23]). Besides aspects of technical design, this also entails the need to craft overarching conceptual and organizational frameworks in order to ensure that solutions and content are semantically coherent [28, 29]. This poses serious challenges for the orchestration of BI development and maintenance activities.

The situation is aggravated by increasing pressures from the user side to develop or modify management support solutions faster – despite simultaneously increasing system complexity [45]. The prevailing insufficiencies of current BI approaches to deal with this

situation [45] are seen as relevant drivers for the continuing appearance of uncoordinated management support systems on the user department side (“shadow BI”) [8].

Given these developments, industry publications have recently picked up the idea of an “agile” BI that is more suited to deal with this situation [32, 45, 19]. However, the discussion is still limited by a narrow focus on a set of given development practices. It is based on an understanding of “agility” that mainly stems from the domain of software engineering.

Here, a wider conceptualization for “agility” is derived that highlights the ability to develop or alter a BI solution in a given timeframe even when unforeseen and/or volatile requirements arise. From this vantage point, the pivotal nature of the *BI architecture* and its interplay with *governance approaches* can be fully appreciated: While more de-centralized BI approaches with more leeway for user departments to develop their own solutions might foster agility, they also put enterprise-wide integration and efficiency goals at risk.

The term “BI architecture” is in the following understood as the *conceptual* application systems architecture that shows and structures the logical building blocks (components like data warehouses (DWHs), core data warehouses (CDWHs), data marts, analysis applications etc.) and their interplay [24, 39]. A BI architecture needs to reconcile both the requirements of the various user units and those that result from an enterprise-wide viewpoint. Aspects of BI architecture design have previously been empirically identified as central success factors for BI [47].

Current BI architectures are usually arranged in a multi-layered fashion, and the discussed conflict between de-central user needs and central enterprise considerations affects almost all layers: from the data acquisition with its routines for data extraction, transformation, and loading (ETL) and the various BI data repositories (data layer), over the applied analysis and reporting systems (logic layer), up to the portals that channel user access (access layer) [5]. A core issue in this context is the choice of a suitable approach to data management: Aspects of (de-)centralization often culminate in decisions on how to build DWHs and how to connect them with application specific repositories

(data marts) and/or operational data stores (ODS) that are added for the provision of integrated transactional data [2, 20, 21, 22]. The data marts are often organized in a multidimensional fashion – “cubes” – that store enriched excerpts of a (“core”) DWH [1].

Because BI requires an exceptionally tight interplay between business and IT departments and because the interwoven components undergo constant changes [29], the organizational side of BI is another cornerstone of BI success [47]. More and more companies are setting up dedicated units for BI, the so called Business Intelligence Competency Centers (BICCs) [28], that act as linking pins between the IT and the business side [4]. Going beyond the establishment of BICCs, BI specific governance approaches have emerged in the discussion that expand on existing IT governance approaches. A *BI governance* sets the framework for selecting BI application portfolios as well as for the design of organizational structures, processes, and architectures [18].

This contribution aims at exploring the role of BI architectures for achieving an adequately agile BI and at structuring relevant architectural design options under consideration of the related rules, roles, and responsibilities for system development and maintenance (as parts of the explicit or implicit BI governance of an organization). It thereby complements the currently dominating “development practices” discussion on agile BI.

The presented research is rooted in research on BI architectures and BI organization [25, 18, 4, 8, 29]. Its *theoretical contribution* lies in connecting these subjects to agility concepts on the one hand and in providing a conceptual frame for the delineation of architectural options based on agility requirements on the other. The concept is also seen as a relevant *practical contribution* that might help guiding practical design decisions.

Because of the dearth on knowledge on the link between architectures and BI agility as well as the complexity of the underlying structures these objectives are mainly achieved by a qualitative research approach. It is based on identifying, analyzing, and comparing concrete combinations of architectural choices. Core insights are drawn from a series of case studies on mature large-scale BI-installations that allow in-depth qualitative analysis. The insights lead to a concept for aligning application characteristics with architectural design options.

2. The context of agility

The concept of agility is central to both the domain of strategic management theory where it is a major

pillar in the so called dynamic capabilities approach (DCA) and to systems engineering. “Agile process models” have proven to be successful tools for organizing systems development endeavors in dynamic environments [9, 10]. Although these approaches differ regarding their unit of study, their application context, and their objectives, there are areas of overlap.

The DCA is a variant of the resource-based view (RBV) that focuses on the internal resources and capabilities of a firm in order to explain differences in performance [7, 17, 40]. While the “classical” RBV discusses properties of resources that lead to a long-term competitive advantage (value, rarity, inimitability, immobility, cf. [7]), the DCA concentrates on the “ability to integrate, build, and reconfigure” a given resource base of a firm [35]. It is argued that these capabilities are of central importance in the nowadays common turbulent business environments [13]. In this context, agility becomes relevant. While the definitions for agility vary [31, 33, 44], their commonality is that they all stress the ability to quickly respond to unforeseen changes.

Despite variations in the concrete conceptualization, most studies on the DCA have particularly emphasized the role of knowledge [16, 42] and the purposeful application of IT has been shown to be an antecedent for knowledge-based capabilities [42]. This is particularly relevant for BI as an approach that is aiming at recognizing and understanding potential changes in the internal and external business environment (“sensing capabilities” in the sense of Overby [30]). Indeed, both infrastructural BI components like DWHs and individual management support systems have been studied from this angle [44, 49]. A consequence of this is the requirement that the BI systems, their design, and their development processes have to become agile too, as a change in the business environment will inevitably entail changes in the relevant data fallout. While similar conclusions might be drawn for other systems as well, the domain of BI is disproportionately affected because of its heavily data-centered nature and because subject to managerial decision making are not only factual changes but also *potential* ones. It has been argued that this might even have the consequence that some degree of de-centrality is unavoidable [25]. For some application areas of BI, especially those linked to turbulent business environments, this might indeed be a valid conclusion.

Such requirements on the system side build the bridge to the concept of agility in the systems engineering sense which can be considered a paradigm shift: While it was taken as a given for decades that manageability of systems development requires a rigid, phase-based process with a thorough systems specification, agile process models have proven that there are

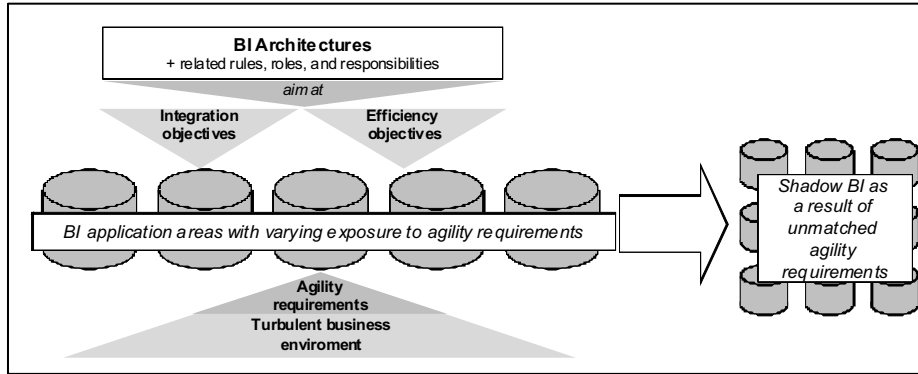


Figure 1. Conceptual framework

alternatives – especially for environments with high uncertainty and dynamically changing systems requirements [9, 10]. Approaches like Extreme Programming, the Dynamic Systems Development Method, or Scrum follow various paths to achieve “agility” in this context [11].

Publications on agile methodologies and BI [19, 32] indicate that those approaches are now increasingly discussed in the field of BI. However, given the overarching role of BI, solely focusing on “development practices” that strive for simplicity and satisfaction of user requirements [46] could jeopardize enterprise wide BI objectives. It needs an architectural and organizational backdrop that ensures a pertinent degree of integration.

Nevertheless, the principles documented in the “agile manifesto” [15] provide valuable conclusions that can be applied to architecture and organizational design as well, particularly the general openness for change, the breakdown of large processes into small iterative steps, and a close interaction between user and developer. These traits ensure that the BI development project – which in fact becomes a process – is absorbing frequent, unforeseen, and/or unspecified changes.

Another lesson learned from agile systems development is that a balance between *discipline* (in the sense of adhering to defined rules, standards, and processes) and *agility* needs to be found – and that the line between discipline and agility varies from context to context [9, 43]. As discussed in section one, drivers for discipline in BI particularly encompass efficiency and integration objectives.

In summary, agility in the DCA sense refers to a trait of an organizational system, whereas it describes the process itself in systems development. Here, the wider perspective of the DCA is preferred as a starting point: BI is seen as a set of information system resources that need to be constantly integrated, (re)built, and reconfigured for sustaining analytic (sensing) capabilities.

This leads to the following resulting working definition: *BI agility* is here understood as the ability to react to unforeseen or volatile requirements regarding the functionality or the content of a BI solution in a given time frame. This can incur changes on all affected layers of the BI architecture (data and ETL, logic, access).

The above discussion is captured in the conceptual framework of the presented research as depicted in Figure 1: Following the DCA, it can be expected that a subset of BI systems will be exposed to turbulent business environments and that there will be a constant need for changes in those application areas in order to keep up dynamic (sensing) capabilities.

Such requirements are challenged by counter-forces that call for a more disciplined approach. Unmet agility requirements might lead to “shadow BI structures”.

This contribution specifically addresses role of the architecture and the related rules, roles, and responsibilities for BI development and maintenance as parts of a BI governance in the context of BI agility.

3. Methodology

Although theory can act as guidance when it comes to structuring the subject in discussion, it does not become concrete enough to come to an actionable concept. This is mostly a result of the novelty of the subject matter: The concept of “BI agility” in general and its relation to BI architectures in particular are rather new and neither the dominating forces nor the relevant design options can be carved out in satisfactory detail based on the current theoretical base alone. The exploratory-design oriented nature of the research objectives and the complexity of the structures in discussion objectives led to the choice of a qualitative research approach that is geared at hypothesis generation rather than hypothesis testing – the research is addressing the context of discovery [3, 48, 26]. In general, qualitative research aims at “gaining familiarity with the subject

area” and at gathering “insight for more rigorous investigation in a later stage” [12].

The study, its design, and the appreciation of the results are built upon a socket of prior research in the fields of BI and BI organization that has been built up in the course of more than a decade. The selected study design is that of multiple interpretative case studies [41, 48] that have been conducted during the year 2010 in large German companies with mature BI installations (each of at least eight years of age). The insights have primarily been gathered on-site with in-depth qualitative interviews [27] with BICC managers that took on average three hours. The BICC managers were selected because of their hinge function between IT and user department [4].

The applied interview guidelines were structured along the conceptual framework depicted in Figure 1 and were validated and adjusted after a pre-test with the CEO of a mid-size BI consultancy. All interviews were recorded, transcribed, and evaluated based on an open-coding approach [26]. Additionally, all interviews were supported with architecture graphs that have been developed collaboratively with the interviewees. The results were complemented with information from documents on the BI units, the BI architectures, the BI strategies and the BI governances, as well as with results from additional contacts and discussions with various members of the organizations. Table 1 gives an overview on the companies, the size of their BICCs, and the number of applied tools.

In May 2011, the results and the derived conclusions were presented and validated in a workshop with ten experts from user, IT, and the BICC department.

4. Results

First of all, “shadow BI” structures were considered a serious and continuous issue across all seven companies – no matter if the chosen governance approaches were rigid (e.g. in companies 2 and 4) or rather flexible (e.g. in companies 1 and 6). The second conclusion from the interviews was that this was indeed the effect of a perceived lack of agility in the development and provision of new or the change of existing features or solutions. A need to apply urgent changes fast and without “bureaucracy” was considered a core motivation of the users to circumvent the central BICC or IT units with their defined processes. This was also highlighted univocally in the interviews. In the following, a

closer look is taken at the agility and discipline requirements before the chosen solutions for dealing with them are discussed.

4.1. Agility and discipline requirements

The rate of changes that involved a formal change request varied between “yearly” and “daily” for the discussed application areas – with the majority falling in the high-frequency area (weekly, daily). Furthermore, it was stated that the rate of change was increasing and the predictability of changes was rather low.

Next to external driven changes that call for a build-up of dynamic (sensing) capabilities (as expected due to of the DCA-driven conceptualization), internal drivers turned out to be equally relevant for the BI in the companies. Although this is in line with literature on organizational change [6], it needs to be pointed out that such changes should actually not come unexpected and therefore not require agility. However, from the vantage point of the BICC, the concrete manifestations of such changes, e.g. in the form of new data-delivery or reporting requirements, often came on short notice.

For a more detailed classification of the identified reasons for change, a scheme from [38] has been applied that further distinguishes between internal business driven changes, external market driven changes, and external uncontrollable changes. Examples from the cases for those drivers are:

- Internal business driven changes: new mergers and acquisitions (all cases), cost reduction initiatives (all cases), internal reorganization (case 1 and 5).
- External market driven changes: introduction of new products (case 3, 5, 6 and 7), entering new markets (case 1, 2, 4 and 6).
- External uncontrollable changes: Changes in regulations like Basel II or III (case 5, 6, 7) or changes to legal consolidation (cases 1, 2, 3, 4, 5 and 7).

Not fitting in this scheme is a group of changes that will be given the name *exploitation driven changes* here. Exploitation driven changes refer to a result of learning processes on the user side. They are directed more towards expanding sensing capabilities proactively rather than towards adjusting them to changed requirements. Examples for exploitation driven changes are changes due to a better understanding of BI in matters of tools, applications or data (all cases).

Table 1. Overview on the interviews

Company	1	2	3	4	5	6	7
Industry	Automotive	Manufacturing	Telco	Manufacturing	Bank	Bank	Insurance
Total revenues / assets	> 50 Bil. €	> 1.5 Bil. €	> 3 Bil. €	> 5 Bil. €	> 300 Bil. €	> 1.5 Bil. €	> 3 Bil. €
Employees	> 100,000	> 4,500	> 5,000	> 35,000	> 3,500	> 400	> 3,000
BICC	Central in IT	Central in IT	Central in Finance	Central in IT	Central in IT	Virtually led by IT	Central in Finance & Virtual
Size of BICC	20 - 50	5 + external	~ 180	5	~130	7	8 + external
(Strategic) BI-Tools	5 to 10	4	5	6	7	1	3

* banks / insurances: assets, other: revenue

Figure 2. Different degrees of integration for the BI layers

Logic	Free Access	Sandbox Approach	Mart-based Approach	Ad-hoc Reporting	Standard Reporting	Other Analysis Tools	
Data	Data Marts	Multidimensional Data Mart			Relational Data Mart		
	Application-independent	CDWH – fully integrated	CDWH – partially integrated	ODS as CDWH-Supplier	ODS and CDWH as Suppliers for Data Marts	Several DWHs	Data Copy
Interface & ETL	Heterogenous ETL			Integrated ETL		Direct Access	

4.2. Drivers for discipline

With respect to the drivers for discipline, two classes are distinguished. On the one hand, (as expected) efficiency and standardization goals are forces that curb the leeway for quick and uncoordinated changes. On the other hand, discipline can be the result of an integration of BI solutions within operational contexts – “Operational BI” does not allow arbitrary changes. Being part of the operational systems landscape, these functions are subject to the same disciplining forces that drive, among others, the implementation of tightknit structures like the IT service management frameworks e.g. IT Infrastructure Library (ITIL), Control Objectives for Information and Related Technology (COBIT), etc.

It is noteworthy that *all* of the BI initiatives discussed in the interviews were originally driven by standardization and efficiency goals. At the time the respective architectures were designed, questions of agility were not considered important. This resulted later in shadow BI structures that undermine the original standardization efforts.

5. Solutions

The architectural solutions found in the companies can be described based on their degree of (logical) integration for the various layers (cf. Figure 2). While such a variety is well-known in the DWH literature for the data layer [2], the cases highlight that this also extends to the data extraction and pre-processing, the metadata management, and the analysis and reporting components – with a wide spectrum of possible combinations. The more integrated the solution, the more it supports efficient and standardized approaches whereas architectures that don’t enforce the reconciliation of components and contents can naturally be more quickly aligned with differentiated user requirements that require agility.

Choice already exists for handling the data extraction and the initial data transformation: While enterprise-wide integrated data repositories imply integrated ETL processes, disjoint and heterogeneous data repositories on the data layer can also build up on central and integrated data extraction and preparation routines. The companies 2, 3, 5 and 6 chose this approach in order to be able to guarantee data consistency across the DWHs for selected fields only. This allowed building up partial compatibility for selected group-wide reporting applications without already enforcing a strict enterprise wide DWH – and therefore a balance between agility and discipline.

On the data layer, a further differentiation can be made regarding application-independent data repositories (CDWHs, ODS, raw data copies) and different forms of application-specific data marts. The application-independent repositories can keep data based on different degrees of transformation, beginning with raw data copies, pre-processed transactional data that is stored in an ODS, up to enriched and aggregated data in several business-area or division-specific DWHs or in a single enterprise-wide DWH. As the companies 1, 2, 3, 5 and 7 show, there is an additional distinction on the data mart level: It needs to be differentiated whether the marts are simply relational excerpts of the DWH or multi-dimensional structures / cubes which need to include application-specific dimensionality and aggregation logic and cannot be changed as rapidly (e.g. when trying to include additional dimensions, KPIs etc.).

A reoccurring theme in the interviews is the provision of “sandboxes”, self-contained, application area specific data excerpts for experienced users. Unlike a data mart, the sandbox is not seen as a pre-defined data repository but rather as a data access component with the permission for user-based modifications. This encompasses the integration of additional data, transformation routines, and analysis functionality. In some cases these modifications are later used by the BICC teams as templates for the design of new analysis applications, modifications in the data repositories or even (as in companies 6 and 7) new ETL processes for a DWH.

Table 2. Architectural choices found in the study

	Interface & ETL			Application-independent Data					Data Marts		Logic						
	Standardized ETL	Heterogeneous ETL	Direct Access	CDWH - fully integrated	CDWH - partially integrated	ODS as CDWH-Supplier	ODS and CDWH as input for specific data repositories	Several DWHs	Raw Data Copy	Multidimensional	Relational	Free Access	Sandbox Approach	Mart-Based-Approach	Ad-Hoc Reporting	Standard Reporting	Other Analysis Tools
Company 1		X			X				X	X	X		X	X	X	X	X
Company 2	X			X			X	X	X	X		X	X	X	X	X	X
Company 3	X		X	X					X	X	X			X	X	X	X
Company 4		X	X					X	X								X
Company 5	X				X	X			X	X		X	X	X	X	X	X
Company 6	X			X					X		X	X	X	X	X	X	X
Company 7		X			X				X	X	X	X	X	X	X	X	X

Different degrees of standardization can also be found on the analysis and access layers. “Standard” and “ad-hoc-reporting” applications already carry the standardization aspect in their name. Furthermore, the agility/discipline distinction is also relevant on the content side (e.g. KPI definitions, aggregation hierarchies etc.), and eventually, the inclusion (or exclusion) of portals for the standardization of access and presentation is also an option that can be freely combined with the discussed architectural choices. The links to the organizational side of BI governance are the metadata components that allow for an automatic enforcement of data access or system modification rules. These can be defined for all different layers.

The different combinations of the options mentioned above open different levels of freedom for user-based development and therefore for agility. The ones found in the interviews are depicted in Table 2.

Next to highlighting the variety of architecture designs, the study results also underline the complementing nature of rules, roles, and responsibilities. Variations were particularly found with respect to the strictness of rules for the development of business unit solutions, the definition of the responsibilities of the BICC, and the distribution of roles between BICC and user departments. One core factor that was brought up in all interviews was the user competency to translate information needs into a running report or analysis – a relevant factor despite often highly user-friendly tools. This was explained with the innate complexity of the underlying concepts.

The individual cases show a variety of examples for possible organizational measures. In the following, different options of combining architectural and organizational options as found in the cases are introduced – ranging from uncoordinated approaches over the (textbook) variant of a strictly governed central approach, up to more sophisticated bundles of measures.

5.1. Option 1 – Decentralization and freedom of business units

In company 1, the different business units enjoy large degrees of freedom regarding the design of their individual BI solutions. There are no rules regarding the selection of analysis and reporting tools, vendors or for building data repositories – this is left to the decentralized and independent development teams. The only restriction the BICC imposes is to channel all data used in the diverse BI solutions through the “Enterprise DWH”. This DWH actually does not truly live up to its name, as it is basically a physical collection of independent data marts.

On the one hand, this solution leads to mostly satisfied customers who get the applications they need fast and directly (agile). On the other hand, the lack of standardization defies many of the goals of BI as an integrated approach and significantly impedes efficiency objectives. This does not only leave an increasingly number of departmental BI-Solutions uncontrolled, but it also leads to a situation in which even minimum standards are ignored – in one group, even legal consolidation is conducted with a spreadsheet-based solution.

The limits of this laissez faire approach become apparent in the following complaints from the interviewed BICC members (translated):

“We very well see it as an issue of the BICC to avoid the appearance of the fifth controlling system, but as long as the subject of BI architecture is not located in the BICC, I am helpless.”

“During the last 1.5 years we have noticed that we reached a dead end. But as the weakest link of the chain we are fighting a lost battle.”

“People in the group notice that [a spreadsheet product] alone doesn’t do the job.”

5.2. Option 2 – Suppressing agility requirements

The second option found in the study comes close to a textbook approach with a highly integrated DWH: two of the companies (2 and 4) tried to rigorously restrict BI to stable standardized reporting and planning solutions – thereby suppressing any urges for agility. The respective architectures were built according to an integrated hub-and-spoke approach with central components on all architectural layers (in company 4: one for each of the heterogeneous business divisions). They were considered efficient and integrated and well-suited for standard-reporting.

However, when asked, the interviewees admitted that their rigid governance approach could not contain the spreading of a shadow BI – despite strict rules, defined processes, and a specified distribution of responsibilities, departmental management support solutions emerged large-scale because of a need to fulfill agility requirements. Company 2 reacted by (reluctantly) opening up sandboxes for application areas requiring more agility, although the BICC was not content with the situation (see option 3).

5.3. Option 3 – The technical approach: providing unsupervised sandboxes

As mentioned above, company 2 opened sandboxes for power users that require flexible analysis and therefore a degree of agility that a central architecture cannot deliver. The data is provided in the form of data excerpts that are by now feeding about 400 individual data cubes. The result is a lack of overview on solutions and services that have been built upon those repositories. Although originally conceived to serve ad-hoc data analysis, the cubes have been (ab)used also for “local” reporting applications that often challenge the central solution – and defy the defined set of rules. The resulting issues can be illustrated with the following statement (translated):

“Only long-time employees know the data well enough to work with it. Data fields are defined to store certain content but the user departments abuse the data fields according to their individual needs. [As a consequence] the same query based on the data of two units results in two completely different reports.”

Besides, the sandboxes are not only accessed by power-users but by a much broader user group. This leads to situations in which the design of rather complex reports is delegated to barely-trained interns. Besides all the consequences on the quality and integration side, this can have palpable consequences if poorly designed reports slow down the whole platform.

The results indicate that unsupervised sandboxes may be a way of providing power users with an environment that allows them to satisfy their informational needs in an agile fashion. However, they have to be supplemented by control structures that prevent a misuse for building up de-central, isolated systems. Furthermore, there is obviously a need for measures that deal with the legitimate requirements of “standard” users for a more agile reporting.

5.4. Option 4 – The service approach

The BICC from company 3 is very different from the ones discussed so far as its responsibilities go well beyond the design of the central BI architecture. It also acts as a service provider that develops and delivers individual reports and conducts analyses on request. The approach is built upon defined services: According to the complexity of a service request, it is labeled a “S, M, L, or XXL analysis” that all come with different price tags. By the use of a ticketing system, service fulfillment is tracked and monitored based on defined service levels. The solution is for the most part organizational – the analyses are conducted in the BICC by analysts that can access the DWH with hardly any technical restrictions besides access rights. There are also no separated application-specific data pools or sandboxes. The approach of dealing with shadow BI is to prove that the BICC provides better results faster than an analysis on the user side. The BICC even carries out competitions for this purpose. According to the BICC manager *“successful BI is not about building IT-Systems but rather about answering the questions of the departments.”*

BICC-based analysis services are obviously an option for delivering agility – but one that it comes at a high price. The number of analysts in the BICC for providing reports and analyses has already reached 50. The approach might be the best response to demanding “standard” users. Power users however might be efficiently satisfied with the sandbox option.

5.5. Option 5 – The integrated approach: service and tool supported sandboxes

The companies 5, 6 and 7 decided to combine services defined by a BICC with supervised and technically supported development platforms for the users.

In company 5, the BICC was made responsible for the centralized data provision, for the support and advancement of the BI-infrastructures, and for the development of complex reports. The board of the corporation decided that it is mandatory for all reports used for group-wide management to be based on the BI-

Infrastructures provided by the BICC. Besides those restrictions, the (well-trained) user departments were left with the right to develop their own reports or conduct analysis based on data from individual sandboxes, but according to defined rules e.g. regarding the choice of BI products. All tools are accessed via one strategic and integrated portal-based frontend.

The BICC manager described his perceived role as follows: *“The users know their data, they know their business processes and because of that they are the ones most qualified to make their analysis. Therefore, I see it as my objective to provide the users consistent data and powerful tools. If the 17,000 reports were all implemented by us, we would need 50 extra people in the BICC”*.

In this case, a conscious decision was made not to implement an integrated CDWH but rather to provide application-specific data marts that feed the sandboxes. This mirrors the heterogeneity of the supported units. The approach was combined with centrally managed ETL processes and an integrated ODS that allowed to ensure selected consistency. At the first glance, this appears to be similar to option 3 (unsupervised sandboxes) or even 1 (decentralized approach). However, in company 5, the sandboxes were not left unsupervised but instead embedded in a well-managed architecture, monitored based on clear rules and responsibilities, and supported by defined services. Among others, there are rules for the documentation of data and there is the defined role of the “data stewards” who are responsible for keeping an eye on the data and its usage. The users were also supported with IT tools, the most notable component being a metadata DWH that includes information on the data, technical components, functions,

services and data quality. Among others, this aims at facilitating the identification of available building blocks for new or modified solutions in order to foster reuse and integration and at the same time boost agility. In fact, most changes of company 5 can be implemented within one week.

Nevertheless, there is still a backlog of about 7,000 days for the integration of “legacy BI-solutions”. In contrast to option 1, 2, and 4 however, the BICC is aware of those solutions – there is transparency about the “shadow BI”. Indeed, it doesn’t deserve to be called “shadow” any more.

In companies 6 and 7, a similar set of conditions can be found – trained users who need fast changes that they can implement themselves – albeit with support and measures to ensure enterprise-wide consistency. However, there are some deviations in the chosen approach worth appreciating. The power users working with the sandboxes also have the right to apply fast changes on their own – up to the definition of individual ETL processes. Unlike in option 3, the sandboxes are monitored. As soon as they are considered to be stable, changes are transferred to the central BI environment after quality assurance. So while in company 5 the users are guided and supported *during* the development process in order to come up with an efficient and integrated solution, in companies 6 and 7 the BICC comes into play to standardize solutions and ETL processes *after* the departmental development. In both cases, this is done based on defined services, processes, and structures and is not left unsupervised.

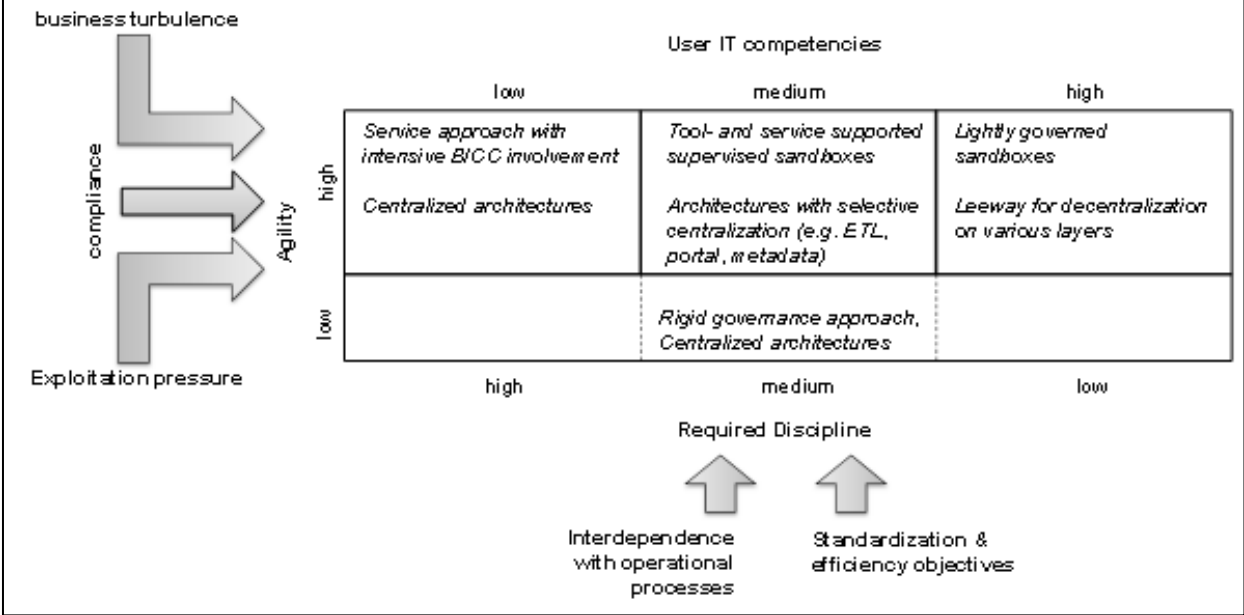


Figure 3. Dealing with discipline and agility requirements

6. Conclusions

The presented results support the argument that agility is necessary for some BI applications – and that the need for agility is also an important explanation for the observation that the shadow BI is so persistent. The agility requirements come from immediate (internal and external) changes on the business side as well as a tug from the user side to further exploit BI – with the effect of building up additional sensing capabilities. The demand for a more agile BI is not only confined to power users but more and more extends to user groups that have been traditionally classified as “passive consumers”. The fact that those users do not always have the skill for the professional design of individual solutions has been identified as a challenge of its own. Companies 2 and 4 (option 2) graphically illustrate the consequence of an attempt to lock out agility requirements – the appearance of a shadow BI is not easily stopped by strict rules alone. A closer look at the options also reveals there is no template for BI governance that can indiscriminately be applied across all situations. There are two aspects of this:

First, there is the need to distinguish between application classes – as can be seen in company 2 where it was (albeit reluctantly) accepted to treat power users with a need for ad-hoc analysis different from standard reporting and therefore combine the options 2 and 3.

Second, there is a variety of options to deal with agility requirements. The results especially illustrate how architectural alternatives on the different layers can be combined. Of special importance is the sandbox approach (option 3) which might be the right choice for power users. However, as company 2 shows, it cannot be left unsupervised as it easily turns into a gateway for a shadow BI. Option 4 seems to be the correct response to a situation requiring agility and/or that comes with demanding “standard” users. However, the required amount of personnel limits its broad application. Option 5 shows a compromise between options 4 and 3 – the empowered user departments are left with some flexibility but are guided through a holistic set of governance structures as well as technical support. In conclusion, with the exception of option 1, all other approaches found in the cases can be applied in certain application settings with dominant differentiators being the user competencies, the required agility and the needed discipline.

The respected findings can be bundled to a concept that is illustrated in Figure 3. Note that for reasons of clarity it was decided to depict the recommended decisions with discrete fields despite the fact that the involved dimensions are of a continuous nature – in reality the fields blur into each other. Also, in many larg-

er settings, it can be expected that a mix of different approaches will be applied.

7. Discussion and outlook

The practical contribution of this paper is that it uncovers the need to deal with agility which is one of the reasons leading to shadow BI. Furthermore, it carves out relevant design options and shows how they align with the requirements on the application side. The theoretical contribution comes with the combination of theories on agility with the design of BI architectures. It needs to be acknowledged that there are limitations to the study – most notably the number of cases and the dominance of the BICC view. In order to address these issues of external validity and to limit the extent of a possible introduction bias, all results have been critically reflected for their generalizability and their consistency with the existing body of knowledge on BI and were validated in a workshop that also included BI users in May 2011.

In summary, the presented research does not only show the need for agile BI architectures – but it also supports the hypothesis that this cannot be easily achieved by loosening governance structures. Much the opposite: agility requires significantly more structure than a standard solution in order to do not endanger the integration and efficiency goals associated with BI.

8. References

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