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The concept of information architecture in the context of enterprise architecture

Svyatoslav Kotusev
HSE University, Moscow, Russian Federation, and
Sherah Kurnia and Rod Dilnutt
University of Melbourne, Melbourne, Australia

Abstract

Purpose – Information architecture (IA) is often understood as a comprehensive master plan for organizational data assets and is widely considered as an essential component of broader enterprise architecture (EA). However, the status and practical operationalization of IA still remain largely unclear. In order to clarify these questions, this paper investigates what instruments related to IA are actually employed in organizations.

Design/methodology/approach – This study builds on the analysis of architecture practices in 27 diverse organizations. Based on the semi-structured interviews with architects and the examination of utilized architectural documents, we explore IA-related instruments with their usage scenarios that have been adopted in the studied organizations.

Findings – The authors identify 12 distinct instruments used in the industry and analyze in detail their features, properties and relationships. This paper analysis shows that these instruments are rather diverse and largely inconsistent across different organizations. The study findings also suggest that IA cannot be considered as a comprehensive plan for information, but rather as a variable set of loosely related instruments and practices that help organizations manage information.

Originality/value – The study offers a unique perspective on the concept of IA, as it is practiced in the industry today, as well as a critical scrutiny of the respective prescriptions abundant in the existing literature. Although this study does not attempt to theorize on the findings, it makes a significant empirical contribution by offering a solid evidence-based view of IA and its key instruments currently missing in the available literature.

Keywords Information architecture (IA), Enterprise architecture (EA), Instruments, Usage, Problems, Artifacts

Paper type Research paper

1. Introduction

Decades ago, information engendered an entire new branch of technology widely known today as information technology (IT) (Whisler and Leavitt, 1958). Information also represents the lifeblood of the modern economy, organizations and their electronic systems. Effective management of information has long been recognized as essential for staying competitive in the market (Diebold, 1979). Now, in the era of big data, companies need to manage information even more carefully than before (McAfee and Brynjolfsson, 2012). Big data opens innovative opportunities for organizations to leverage information for improving their businesses (Davenport, 2014). Unsurprisingly, the recent Society for Information Management (SIM) IT Trends Study (Kappelman *et al.*, 2018) demonstrates that (1) data analytics and management is the third most critical organizational IT-related issue, (2) technical skills related to big data, data science and business analytics are the second most important and hard-to-find skills for organizations and (3) investments in big data, business intelligence, data mining and analytics are the largest IT investments made for many years in a row.

The need for deliberate planning of corporate information or data resources had been recognized in the industry long ago (Evernden and Evernden, 2003) [1]. Even the earliest proposed methodologies for organization-wide information systems planning paid close

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attention to the data aspects of information systems. For example, the Business Systems Planning (BSP) methodology initiated in the late 1960s explicitly addressed data classes and files required by information systems (BSP, 1975). Later, Information Engineering introduced in the early 1980s implied even more detailed planning of data assets at the level of specific data objects and their attributes (Martin and Finkelstein, 1981). These methodologies essentially originated the concept of information architecture (IA) as a comprehensive master plan for organizational data assets (also known as enterprise information architecture).

The contemporary literature typically considers IA as a narrow information-centric subset of the broader concept of enterprise architecture (EA) (Martin *et al.*, 2010; Newman *et al.*, 2008; Sun *et al.*, 2012). Since EA embraces all domains relevant to corporate information systems including business, data, applications, technology and security aspects of organizations, IA today can be viewed simply as one element of EA. For instance, all mainstream EA frameworks such as TOGAF (TOGAF, 2018), FEAF (FEAF, 1999), IAF (van't Wout *et al.*, 2010) and EA^{3}Cube (Bernard, 2012) include information, or data, as an essential component of EA.

However, early information systems planning methodologies proved ineffective and disappeared from the market (Goodhue *et al.*, 1992; Lederer and Sethi, 1988; Shanks, 1997). Current architecture frameworks also do not have any documented examples of their practical implementation (Kotusev, 2017), seemingly even cannot be successfully implemented (Buckl *et al.*, 2009; Lohe and Legner, 2014) and are used in organizations mostly symbolically (Kotusev, 2018; Smith *et al.*, 2012). Therefore, the status of IA actually remains largely unclear. Although the concept of IA has a solid standing in the literature, its practical materialization and operationalization provoke many questions.

In order to address this gap, this paper investigates what IA instruments have been adopted across the industry. Specifically, this paper aims to analyze (1) what documents or artifacts related to IA are used for managing information in organizations and (2) what the typical usage patterns of these documents are.

Importantly, this study does not attempt to theorize on IA, but rather to make an *empirical contribution* to the literature (Agerfalk, 2014; Avison and Malaurent, 2014; Hambrick, 2007) by means of providing "a novel account of an empirical phenomenon that [...] reveals something previously undocumented" (Agerfalk, 2014, p. 594). This paper is deliberately "theory light", or even atheoretic, and intends to uncover important factual information on IA that can provide new insights and stimulate further developments in this area (Agerfalk, 2014; Avison and Malaurent, 2014; Hambrick, 2007; Miller, 2007).

This paper continues as follows: (1) we discuss the concept of IA, the problems with this concept and motivation for this research, (2) we describe the research design, data collection and analysis procedures, (3) we describe the identified IA-related instruments and their usage scenarios, (4) we provide a detailed comparison of these instruments, (5) we present an integrated view of IA, (6) we discuss our findings in light of the existing literature and (7) we conclude the paper.

2. Literature review

In this section, we introduce the concept of IA with its various meanings and specific instruments related to IA, then discuss the problems associated with the practical implementation of IA and finally explain the motivation for this study and formulate our research question.

2.1 The concept of information architecture

The term "information architecture" has multiple diverse interpretations in the literature and is used rather inconsistently to represent different, sometimes even entirely unrelated concepts. Specifically, at least four distinct meanings of this notion can be distinguished in the extant literature.

First, in the early literature on information systems planning, IA was often understood broadly as a set of all data models, application models and other diagrams unrelated to information that are used to document the structure of the business and IT landscape (Allen and Boynton, 1991; Brancheau *et al.*, 1989; BSP, 1984; Carter, 1999; Cook, 1996; Periasamy, 1994; Periasamy and Feeny, 1997). For example, Carter (1999, p. 183) explained that "information architecture is the collective term used to describe the various components of the overall information infrastructure […]. Prime components are the data architecture, the systems architecture and the computer architecture". In a similar vein, Periasamy and Feeny (1997, p. 198) defined IA as "a set of high level models which complements the business plan in IT-related matters and serves as a tool for IS planning and a blueprint for IS plan implementation", which is essentially equivalent to the modern term "enterprise architecture".

Second, some publications understand IA simply as the corporate database and information management IT infrastructure (Krasowski, 1991; Patrick, 2005). These publications view IA not as a collection of documents or models intended to facilitate planning of the information aspect of organizations, but as a physical part of organizational IT landscapes dealing with information and its handling that is being planned, i.e. as an object of planning, not an instrument of planning.

Third, in the modern literature, the term "information architecture" is often used in relation to visual design, webpage structuring and interface usability (Miller and Remington, 2004; Morrogh, 2002; Resmini and Rosati, 2012; Rosenfeld *et al.*, 2015; Russell-Rose and Tate, 2012; Toms, 2002). Its companion term "enterprise information architecture" upscales the concept to denote the overall structure of informational contents in corporate intranets and enterprise portals aimed to resolve information accessibility and searchability issues in the organizational context (Smith, 2008).

Finally, today IA is most often understood as a narrow "slice", layer, subset or domain of overarching EA (embracing business, data, application, technology and some other aspects of organizations) as defined, for instance, by Gartner (Newman *et al.*, 2008) and implied by other authors (Evernden and Evernden, 2003; Martin *et al.*, 2010; van den Hoven, 2003). Prominent EA frameworks also consider IA as such (Bernard, 2012; FEAF, 1999; Sun *et al.*, 2012; TOGAF, 2018; van't Wout *et al.*, 2010).

In this article we stick to the last of these views and discuss IA specifically as a component of EA focused on the structure of corporate data assets. Different meanings of the term "information architecture" and their relationship to the subject of this study are summarized in Table 1.

2.2 Instruments of information architecture

In the sense in which this concept is understood in this article (Table 1), the emergence of IA can be traced back to early methodologies for organization-wide information systems planning, which proposed to develop, among other deliverables, comprehensive and systematic plans for corporate data assets. Such methodologies as IBM's BSP (BSP, 1975; BSP, 1984), Arthur Andersen's Method/1 (Arthur Andersen, 1987), Strategic Data Planning (SDP) (Martin, 1982; Martin and Leben, 1989), multiple different versions of Information Engineering (Arthur Young, 1987; Brathwaite, 1992; Davids, 1992; Finkelstein, 1989; Inmon, 1988; Martin, 1989; Martin and Finkelstein, 1981) and other similar methodologies (Connor, 1988; Gallo, 1988; Tozer, 1988) all recommended creating a number of documents to define IA. Two core instruments employed by these methodologies for describing IA were CRUD matrices and entity-relationship models. CRUD matrices are intended primarily to capture

Meaning of IA	Source(s)	Relationship to this study
IA is understood broadly, essentially as EA, i.e. covering business, data and applications aspects of organizations	BSP (1984), Brancheau *et al.* (1989), Allen and Boynton (1991), Periasamy (1994), Cook (1996), Periasamy and Feeny (1997) and Carter (1999)	The broader superset of IA discussed in this article
IA is understood as the corporate database and information management infrastructure	Krasowski (1991) and Patrick (2005)	The object of planning for IA discussed in this article
IA is understood as the way of presenting information, structuring webpages and ensuring effortless access to the requisite knowledge	Morrogh (2002), Toms (2002), Miller and Remington (2004), Smith (2008), Resmini and Rosati (2012), Russell-Rose and Tate (2012) and Rosenfeld *et al.* (2015)	Does not relate to IA discussed in this article
IA is understood as a narrow element of EA focused specifically on the structure of corporate data assets	FEAF (1999), Evernden and Evernden (2003), van den Hoven (2003), Newman *et al.* (2008), Martin *et al.* (2010), van't Wout *et al.* (2010), Bernard (2012), Sun *et al.* (2012) and TOGAF (2018)	The precise meaning in which IA is discussed in this article

Table 1. Different meanings of information architecture and their relationship to this study

the relationships between data entities and information systems in terms of the operations performed by the systems on these entities (create, read, update and delete). Entity-relationship models intended to depict the interrelationships between these data entities and their essential properties.

The earliest EA methodology (Spewak and Hill, 1992) also involved organization-wide data modeling encompassing data entities, their attributes and relationships, as well as entity-to-function and entity-to-application relationship matrices. Modern architecture frameworks imply probably even more sophisticated and comprehensive IA descriptions using various instruments for this purpose. For example, IAF (van't Wout *et al.*, 2010) recommends developing numerous artifacts including information interaction models, information service collaboration contracts, information object views, logical information components, information component interaction models, information standards, rules and guidelines as well as many other artifacts to describe IA. EA^{3}Cube (Bernard, 2012) proposes eight artifacts for describing IA: knowledge management plans, information exchange matrices, object state-transition diagrams, object event sequence diagrams, logical data models, physical data models, CRUD matrices and data dictionaries. Finally, TOGAF v9.2 (TOGAF, 2018) includes nine IA artifacts: data entity/data component catalogs, data entity/business function matrices, application/data matrices, conceptual data diagrams, logical data diagrams, data dissemination diagrams, data security diagrams, data migration diagrams and data lifecycle diagrams.

Consequently, the extant literature offers a rather inconsistent view of IA from the perspective of associated instruments, but still allows making a number of general observations regarding these instruments. First, different sources provide different lists of instruments for IA and these lists tend to become lengthier and more diversified over time. Second, different sources use different labels for effectively the same instruments. For example, slightly different variations of entity-relationship diagrams can be called corporate data models, conceptual data models, enterprise data models or similar titles, depending on the author. At the same time, to the best of our knowledge, no efforts to review the existing literature on the subject have been attempted and no comprehensive lists of IA instruments have ever been complied. An overview of major classes of instruments for IA advocated in prominent architecture sources is presented in Table 2.

Class of instruments	Prominent source(s)	Description
Relationship matrices, e.g. CRUD, entity-to-system, entity-to-function, etc.	BSP (1975), Martin (1982), Martin and Leben (1989), Spewak and Hill (1992) and TOGAF (2018)	Large matrices showing the relationship between data entities and other business or IT elements
Entity-relationship diagrams with various modeling notations and abstraction levels	Martin and Finkelstein (1981), Martin (1982), Martin and Leben (1989) and Spewak and Hill (1992)	Comprehensive organization or business area-wide diagrams depicting data entities, their attributes and relationships
Entity, attribute and association definitions, catalogs, dictionaries and glossaries	Finkelstein (1989), Davids (1992), Spewak and Hill (1992), Bernard (2012) and TOGAF (2018)	Formalized textual definitions of the logical meaning of data entities, their attributes and relationships
Information standards, rules and guidelines	van't Wout *et al.* (2010)	Documented requirements for handling information that all corporate IT systems should adhere to
Information architecture principles	van't Wout *et al.* (2010) and TOGAF (2018)	Abstract general imperatives for organizing and managing corporate data assets
Entity lifecycle models, e.g. state transition and event sequence diagrams	Bernard (2012) and TOGAF (2018)	Graphical diagrams explaining the temporal progression of the status of data entities in the business context

Table 2. Major classes of instruments for IA advocated in the literature

2.3 Problems with information architecture

Despite the broad advocacy of IA in the literature, the actual empirical experience in organizations with IA in the form recommended by mainstream planning methodologies seemingly has been negative. Many early studies of architecture planning efforts in organizations unanimously concluded that the resulting data architectures were found too expensive and largely useless for all practical purposes (Beynon-Davies, 1994; Davenport, 1994; Goodhue *et al.*, 1986, 1988, 1992; Lederer and Sethi, 1988, 1992; Periasamy, 1994; Shanks, 1997; Shanks and Swatman, 1997). For example, Beynon-Davies (1994, p. 87) reported that more than five million British pounds have been invested in the development of comprehensive IA in the UK National Health Service (NHS), but the produced IA was "not used in any real sense by either [NHS departments] in developing their information systems or commercial software suppliers in offering packaged solutions". Similarly, Goodhue *et al.* (1992, p. 11) analyzed the experiences of nine US companies and concluded that formal architecture planning methodologies "may not be the best way to develop a "data architecture", given the required level of commitment of talented individuals, the cost, the potential errors, and the high level of abstraction of the result". These conclusions have been echoed by Shanks (1997, p. 87), who studied architecture planning initiatives in Australian banks: "[Following a formal planning methodology] may not be the best way to build a data architecture [...]. It is an expensive undertaking which can involve the time of many people for lengthy periods". Periasamy (1994, p. 162) reports the following story about IA in Thames Water and other UK water suppliers:

> Thames Water views data models to be of little use in business and IS planning. [...] A CDM [corporate data model] was at one time considered to be an imperative. A group was set up in 1989 to build Thames Water's CDM. The effort expended was considerable [...]; a senior IT manager estimates the total cost to be about £0.25 million. The resulting corporate data model was however found to be dysfunctional. Thames Water's IT department sought information from the IT departments of the other nine large UK water-sewage companies on their corporate data modelling experience. A situation similar to that of Thames Water was revealed across the companies. The companies were in the process of developing or had CDMs but none of them reported deriving any

> major value from their data models. Hence, after much deliberation, Thames Water decided to abandon its CDM effort

Issues with IA in the context of modern architecture frameworks are also widely reported. For example, Lohe and Legner (2014) demonstrate that the attempts to follow the frameworks' recommendations lead to significant practical problems analogous to the ones observed earlier with the mainstream information systems planning methodologies: they require enormous efforts and produce largely useless architectural documentation. Molnar and Proper (2013) notice that frameworks are too rigid and complex to be used in some companies even after appropriate tailoring. Earlier Buckl *et al.* (2009, p. 15) even concluded that architecture frameworks "appear theoretical and impossible to implement". Unsurprisingly, organizations either do not use these frameworks at all or use them loosely, at best as idea contributors (Basten and Brons, 2012; Buckl *et al.*, 2009; Winter *et al.*, 2010). For example, detailed case studies of TOGAF-based architecture practices (Kotusev, 2018; Smith *et al.*, 2012) show that none of these companies developed comprehensive IA as prescribed by TOGAF. Therefore, the practical realization of the concept of IA, as advocated in the literature, seems to be highly problematic.

2.4 Research question

Even though creating IA is widely recommended in the literature and many instruments have been proposed to define it (Bernard, 2012; TOGAF, 2018; van't Wout *et al.*, 2010), these recommendations seem rather questionable and the current status of the concept of IA still remains largely unclear. Despite the existence of multiple methodologies that can be used to develop IA, the actual situation in the industry in relation to IA appears to be uncertain. Most importantly, it is not clear what instruments of those prescribed in the literature (or not mentioned in the literature) proved useful in organizations for shaping IA as well as what usage scenarios are supported by these instruments to govern information and its use. To address this gap, in this paper we investigate what IA-related instruments have been adopted in the industry and how exactly they work. Specifically, our research question can be formulated as follows:

> What instruments related to IA are utilized in the industry and what are their usage scenarios?

3. Research design

This research is qualitative, inductive and exploratory in nature since the answer to our research question can be obtained only by means of speaking with people directly involved in architecture practices and analyzing the reported use of IA and its components in their organizations.

3.1 Data collection

Data for this study has been collected as part of a broader research effort intended to explore the usage of various architectural documents, including IA artifacts. In total, we took 63 face-to-face and Skype one-hour semi-structured interviews with various denominations of architects from 27 diverse organizations mostly in Australia, but also in New Zealand and Europe (importantly, in most organizations dedicated full-time positions for information architects were missing and all the necessary IA-related activities were handled by more "general" architects). These organizations have been selected based on the theoretical sampling considerations (Eisenhardt, 1989; Strauss and Corbin, 1998). In particular, we aimed to cover organizations of different sizes and from disparate industries, but excluding those with immature architecture practices, i.e. having no permanent architecture teams or practicing architecture for less than 1–2 years. Accordingly, organizations in our sample employed from tens to thousands of IT staff and represented different industry sectors including finance and insurance, food and retail, manufacturing and delivery, education and telecommunication, energy and natural resources, government agencies and emergency services as well as some other industry sectors (the full list of these organizations is provided in Appendix 2).

All the interviewees have been asked to list key types of architectural documents, including IA artifacts, used in their organizations and then to describe in detail their informational contents and various aspects of their usage, e.g. users, use cases and purposes. The conducted interviews have been recorded with the permission of the interviewees for further qualitative analysis. Numerous samples of architectural documents demonstrated by the interviewees were captured and analyzed as well.

3.2 Data analysis

As this study intends to make an empirical contribution to the literature (Agerfalk, 2014; Avison and Malaurent, 2014; Hambrick, 2007; Miller, 2007), our research question is primarily descriptive, largely atheoretical and highly heuristic in nature. Accordingly, our data analysis was informed and guided only by the general ideas about what IA might be offered by the existing literature (Martin and Leben, 1989; Spewak and Hill, 1992; TOGAF, 2018; van't Wout *et al.*, 2010), but not by any specific theoretical lenses due to their acknowledged ability to reduce rich empirical findings to a narrow conceptual framework dictated by the chosen theory (Avison and Malaurent, 2014; Hambrick, 2007; Helfat, 2007; Miller, 2007) [2].

Specifically, the data analysis in this study has been performed via a qualitative thematic interpretation approach (Creswell, 2007; Miles and Huberman, 1994). First, during the interview and documentation analysis, we identified architectural documents that can be related to IA and, therefore, considered as IA artifacts or instruments relevant to our research question. Second, we identified the typical usage patterns of the IA artifacts described by the interviewees to understand the intent and practical purpose of these artifacts. Third, we compared samples, descriptions and use cases of IA artifacts between each other to identify differences, similarities and overlaps in their usage and, thereby, establish an "orthogonal" set of distinct types of IA artifacts utilized in the industry. Following these procedures allowed producing the list of 12 instruments and associated usage scenarios for IA that arguably constitute the core of what is generally called "information architecture". Appendix 1 provides some examples of the analytical procedures applied in this research. Appendix 2 provides more detailed information regarding IA-related instruments identified in different organizations.

4. Instruments of information architecture

Our analysis of IA artifacts used in 27 organizations suggests that the concept of IA is operationalized mainly through using 12 distinct instruments that constitute the essence of IA-related activities in organizations (though far from all of them are adopted in an "average" organization, see Figure A1). These instruments with their usage scenarios are described below in alphabetical order under their most common titles (though their actual titles in many organizations may differ from the ones provided below).

4.1 Conceptual data models

Conceptual data models (CDMs) are very abstract, executive-level data models capturing the structure and relationship between key data entities critical to the business of an entire organization. CDMs avoid detailed attribute definitions, field types and other technical aspects (e.g. primary and foreign keys), but describe only the most essential aspects of data entities relevant to business leaders. They also do not intend to provide a comprehensive definition of all data entities across the organization, but focus on a limited number of core entities pivotal to business operations, e.g. customer, product and order. Essentially, CDMs embody certain rules for capturing, storing and shaping information resources that do not relate to a particular point in time, but are largely timeless.

CDMs are developed collaboratively by information architects [3] and business leaders to define the required structure of data assets in the organization. After being agreed upon, they guide further solution development activities and ensure conceptual data consistency across all business units and their IT systems. Using CDMs helps standardize and consolidate corporate data assets, accumulate information in data warehouses and enable sound analytical capabilities.

> Enterprise data model is where everything exists in one big picture. We have product, customer, service, connection, desk connection, all these sorts of things that exist in our business. Each one of those will be potentially mastered somewhere as a dataset. [...] Customer is known in many different places in our systems and, from a business perspective, we need to have one definition. And the same bit of information about a customer might exist in different systems, but we have a common name for it and that then translates to this field in this system. [...] Data models are working in the background, they are describing what the rules are by which that data must be captured

4.2 Enterprise data portfolios

Enterprise data portfolios (EDPs) are rather abstract, one-page depictions of all the existing data assets mapped to respective business capabilities. EDPs provide a holistic picture of all main databases in the whole organization and show which business capabilities they belong to and originate from (these artifacts can be equally related to both the business and information domains of architecture). Essentially, they indicate "where" in the organization specific types of data are created, handled and mastered. EDPs can be considered as one-page views of the entire corporate IT landscape in its current state from the perspective of information. Structurally, they highly resemble rather widely used enterprise system portfolios.

EDPs are maintained predominantly by information architects to stay up-to-date and, therefore, evolve continuously together with the IT landscape. They provide convenient reference materials on the available data repositories for architects. On the one hand, they support strategic thinking via suggesting what data assets can be leveraged by the organization in the future to gain a long-term competitive advantage. On the other hand, they are also used during the planning of new IT solutions to help architects understand where the necessary information can be found and obtained from. However, EDPs are used in organizations relatively rarely.

4.3 Guidelines

Data guidelines are technical and IT-specific instructions for storing, processing and managing information in corporate systems. Guidelines offer rather detailed and concrete prescriptions regarding the information and its proper handling within the organization. For example, they may describe how exactly particular types of information should be encrypted, transferred, protected and backed up in respective databases (in some cases, they may fairly overlap with security architecture). Due to their narrow focus, the applicability of guidelines is often limited to specific situations and business areas. They represent certain conceptual rules that stay active as long as they exist, without referring explicitly to any timeframes, current or future states.

Data guidelines are typically formulated by information architects with the involvement of relevant subject-matter experts. Due to their technical nature, they are irrelevant to business leaders. After being established, guidelines apply to the designs of all IT systems falling within the realm of their effect. Specifically, designated architects usually supervise project teams and review corresponding project documentation to ensure that the appropriate measures for dealing with information are taken. The use of guidelines helps achieve more uniform handling of information and reduce the risks related to its misuse and leakage.

> In [our company], we have a dedicated information architecture team. [Among other things], they define standards, or guidelines, for information and information management. [These guidelines] impact on how we design projects – each project is expected to follow guidelines

4.4 Information management capability models

Information management capability models (IMCMs) are very abstract, one-page views of the corporate IT landscape from the perspective of its information management capabilities. In other words, IMCMs show everything that the organization and its systems can do with data, e.g. analysis, reporting, integration, transformation, cleansing and replication. Visually and structurally, they highly resemble widely used business capability models, but concentrate on information management capabilities instead of business capabilities. Although the capabilities themselves are largely timeless and their basic set changes relatively infrequently, IMCMs can be best viewed as change-oriented, future-focused artifacts as their key purport is to help understand in which capabilities further improvements are required.

IMCMs are created, maintained and owned by information architects to control and guide the evolution of the organizational IT landscape from the information management perspective. In particular, they allow translating strategic business needs, often expressed in terms of required business capabilities, into the language of IT and articulating the corresponding IT capabilities necessary for the business development. Put it simply, IMCMs help convert strategic business requirements into strategic IT requirements. However, IMCMs are rather "exotic" artifacts rarely used in organizations.

4.5 Inventories

Data inventories are comprehensive catalogs of the data assets available in the whole organization and their essential properties. Typically, inventories list all existing databases, describe their contents, purpose, usage and some other relevant properties, e.g. business owners, IT owners, annual maintenance costs, occupied volume, underlying technology and infrastructure. Although inventories focus on the current situation, often they also indicate the disposition of respective assets, e.g. whether the data asset should be retired, maintained, merged or developed as strategic in the future.

Data inventories are populated and maintained by information architects to provide holistic coverage of the corporate IT landscape from the perspective of data assets. On the one hand, inventories help evolve the IT landscape in terms of reusing the most appropriate data assets in the future and getting rid of the inappropriate, duplicated or redundant ones. On the other hand, inventories also provide a useful point of reference to all architects involved in solution planning activities and help understand where the necessary information can be retrieved from.

> [Data inventory describes] what kind of data we have, where it resides, which is the master, which is the slave. [...] When I design something and I need certain data, I need to figure out where that data might be. And so I talk to a data architect, he shows me the data inventory and he says "Well, we can

get it from this system or that system", that kind of thing. [...] You cannot reuse assets unless you have a list of assets

4.6 Landscape diagrams

Landscape diagrams are simple graphical diagrams depicting the high-level structure of some areas of the corporate IT landscape from the perspective of business processes, information systems, databases, underlying infrastructure and their relationship (these artifacts can fairly be related to multiple different domains of architecture, including information). Landscape diagrams focus mostly on the current state of the landscape, but in some cases they may also show its planned future modifications. Sometimes they are drawn with specialized architectural modeling notations, e.g. ArchiMate (ArchiMate, 2016; Lankhorst, 2013).

> Our architecture repository captures (or should capture) the structure of our IT landscape in its entirety, and that includes all platforms, applications, data sources and data entities traveling around. [...] We can general various views out of that, for example, to see the connections between systems and databases

Landscape diagrams are created, maintained and owned primarily by architects and get periodically updated to reflect changes in the organizational IT landscape, e.g. after a new solution is deployed. They provide a helpful baseline of the existing landscape for planning purposes. For example, during the planning of IT solutions architects can leverage landscape diagrams to understand what databases exist in the landscape, what applications are using them and how they are connected, and then properly integrate new systems into the existing IT environment. Landscape diagrams help manage complexity and optimize the overall structure of the IT landscape through all architecture "layers", including the data layer.

4.7 Logical data models

Logical data models (LDMs) are rather concrete, semi-technical data models describing the structure and relationship between core data objects used in the business operations of an organization. They provide detailed field definitions with their data types, attributes and other flags (e.g. keys, indices and constraints) meaningful only to IT specialists. Typically, LDMs focus only on prominent data objects (e.g. customer, transaction and supplier) that do not "belong" to specific systems, but are exchanged between multiple heterogeneous systems across the IT landscape. In some cases, they may be expressed via using formal modeling notations, e.g. UML class diagrams (Fowler, 2003; UML, 2015).

LDMs are created mostly by information architects, often based on more abstract CDMs agreed with business leaders. After being developed, LDMs prescribe standardized data structures to be adopted in all information systems. For example, every IT system dealing with customers is expected to use a common structure for customer objects defined in LDMs. Establishing LDMs and adhering to their structures helps ensure data consistency, logical and "syntactic" interoperability between various IT systems, ease data integration, accumulation and analysis.

> In a modelling tool you will describe the tables, their columns and associations between them, and then you will hit the button and generate that [logical data model]. If I want to build that as a database in Oracle, then I push the button and out comes a script. [The main consumers of data models are] solution architects and developers. This is a cornerstone of the system when you develop it. So, you might build a message schema, you hand it to the business-to-business people and they will use that for data definition, for moving data through the system

4.8 Master data maps

Master data maps (MDMs) are graphical diagrams showing master data sources and their replicas maintained in the organization or its business units for different types of data. MDMs provide snapshots of databases existing in the IT landscape and explain their logical relationships, e.g. synchronous replication, asynchronous replication, periodical backups and reserve copies. Essentially, MDMs represent specialized landscape diagrams focused exclusively on data.

MDMs are owned and maintained by information architects to accurately reflect the current state of the corporate IT landscape from the perspective of master data sources. MDMs are used mostly by architects during the design of IT solutions. Specifically, they help architects find out where specific information is stored, from which databases this information should be best retrieved and how it can be accessed from new IT systems. MDMs promote the use of proper sources of information, which in turn leads to reduced data duplication and redundancy, minimized data inconsistencies and parallel modifications. However, they are used in organizations rather rarely.

4.9 Policies

Information management policies are high-level compulsory rules governing the use of information in the whole organization. Policies are rather concrete, unambiguous and do not allow flexibility in their interpretation. However, they also avoid any low-level technical details and are perfectly understandable even to the executive-level business audience. Policies often regulate the issues related to information storage (e.g. which information can be trusted to external cloud providers), information exchange (e.g. which information can be safely shared with partners) and other aspects of information processing (some of them may fairly overlap with security architecture). As generic rules for dealing with data, they do not refer to any specific time moments, but stay active until abolished.

Information management policies are developed collectively by architects and business leaders to control the handling of information in the organization. After being endorsed, policies shape the designs of all IT solutions. Every new system must comply with the established policies to be approved for production deployment. The use of policies helps ensure proper access to information, reduce information-related risks and keep sensible information with the organization.

> [Our information management policies include] specifically things like information security policies and data exchange policies. There are two types of policies: one comes from the industry (we want to comply with the industry standards) and another is policies specific to our enterprise. So, it is a strong driver of any architecture and it is one of the ways we use to influence a particular solution

4.10 Principles

Data principles are overarching highest-level imperatives relevant to the data-related aspects of the organization and its business. Principles are very abstract, brief, technology-neutral and meaningful to C-level executives or even to the board of directors. For example, they may specify which types of data should be owned separately or shared between all business units, e.g. different lines of business or geographical divisions. The rules defined by principles are fundamental, very stable, if not timeless, but may be the subject of yearly revision.

Data principles are created collaboratively by architects and senior business leaders to define the overall corporate attitude towards data and its processing. After being agreed upon, principles guide all data-related decision-making in the organization and may have significant implications for the technology selection processes, for the high-level structure of the entire IT landscape and even for the structure of separate IT solutions. Every planning decision is expected to align with principles, though certain deviations may be discussable. The use of principles helps establish a consistent approach to data and information management aligned with the organizational business strategy.

> Our architecture principles are really to guide decision-making and they reflect some policy-level decisions that we have already made. For example, an architecture principle [in the information domain] will be "We want to have a centralized customer information repository". It does not tell you exactly how we are going to do it, but we have taken the decision that we do not want multiple. [...] Principles are high-level guidelines posed to help decision-making, that helps frame up solutions, helps scope things out. We have a lot of principles. [...] At a project level, you get more detailed principles, there will often be a set of principles defined in a solution architecture that says: "Here are some of the principles that guided this solution architecture and should guide the project going forward"

4.11 Solution overviews and designs

Solution overviews, solution designs and some other solution architecture documents (e.g. solution options) are technical or semi-technical descriptions of separate IT solutions. These artifacts typically cover all "layers" of the architecture stack for respective solutions, including their data layer (they can fairly be related to multiple architecture domains, including information). For example, they may explain what data is used in the new IT solution, where this data is obtained from, what format this data has, how this data is processed and where the resulting data is transferred. Solution architecture documents are the most detailed and low-level of all the identified artifacts.

> Solution architecture is an end-to-end document. Then, as you go deeper, it splits into applications, information, security, infrastructure. And then you go further, for example, into infrastructure split: you do storage, network, etc. So, as you go down, the document splits into different domains. But at a higher level it is end-to-end

Various solution architecture documents are developed at different stages of the solution delivery lifecycle and take into account all the "previous" suggestions regarding the use of information contained in other types of IA artifacts. At the early stages of the lifecycle (e.g. solution initiation), they are agreed mostly by their senior business sponsors and architects, while at the later delivery stages (e.g. solution implementation) they are agreed upon between architects and other members of project teams (e.g. software developers and database administrators). All these solution architecture documents eventually turn into working IT solutions constituting the corporate IT landscape. Since these documents are the only immediately implementable IA artifacts, their use allows materializing all the data-related decisions and considerations reflected in other IA artifacts, i.e. converting conceptual suggestions into physical IT systems.

4.12 Target states

Target states are very high-level, often one-page descriptions of the desired long-term future state of the organization or its separate business areas. Target states may depict the relationship between major information systems, business functions, data sources and other organizational elements (these artifacts can fairly be related to multiple architecture domains, including information). For example, they may describe the availability requirements and necessary access to different types of data from main business departments and their core information systems. Due to their focus on the distant future, often up to 3–5 years ahead, target states are highly conceptual.

> In the customer space, for example, the blueprint [a company-specific title for target states] spells out the fact that we will have SAP CRM, we will have Salesforce and talks about what data each of them

holds for which segments, how it gets updated, how they interrelate to each other, how the various channels are used, etc.

Target states are developed collectively by architects and business leaders to define the general direction of the organization in the long run. After being agreed upon, target states may have significant implications for data sharing and information management, e.g. indicate where certain data should be stored, how and for which systems it should be accessible. The use of target states helps shape the high-level structure of the corporate IT landscape from the perspective of data and information management in accordance with the organizational business strategy.

5. Comparison of information architecture instruments

The 12 instruments with their typical usage scenarios described above represent the essence of IA-related activities uncovered in the industry. A detailed analysis of these instruments suggests that they are very diverse in nature and differ in many critical aspects and basic properties (these aspects and properties came to light only after the performed empirical analysis, rather than before it, and are quite evident from the descriptive accounts of IA instruments presented earlier). First, from the perspective of their organizational scopes, IA artifacts range from an entire organization (e.g. EDPs) to narrow business areas (e.g. landscape diagrams) to separate solutions (e.g. solution overviews and designs). Second, from the perspective of their abstraction levels, IA artifacts range from highly abstract (e.g. principles) to moderately detailed (e.g. MDMs) to highly specific ones (e.g. LDMs). Third, instances of some artifacts cover only the information domain (e.g. CDMs and LDMs), while instances of other artifacts can cover multiple architecture domains simultaneously including information (e.g. EDPs cover the business and information domains at the same time). The comparison of IA artifacts from the perspective of their organizational scopes, abstraction levels and exclusive focus on information is provided in Table 3.

Besides the basic static properties analyzed in Table 3, IA artifacts also have a number of less obvious behavioral and “semantic” differences (these differences also came to light only after the analysis and ensue from the descriptions of IA instruments and their usage scenarios provided earlier). First, from the perspective of the essential stakeholders involved in their development and usage IA artifacts may be relevant only to information architects (e.g. inventories and MDMs) or to other actors as well including business leaders (e.g. policies) and project teams (e.g. solution designs). Second, IA artifacts may focus on the current state (e.g. EDPs), desired future (e.g. target states) or considered as “timeless” rules having no definite time focus (e.g. CDMs and LDMs). Third, for some IA artifacts the objects of their description are logical data entities (describe the structure of information, e.g. CDMs and LDMs), for some artifacts these objects are physical databases (describe where the information is stored, e.g. inventories and MDMs), while for others these objects are information management capabilities (describe what can be done with information, e.g. policies and guidelines). Finally, from the perspective of their general meaning in architecture practices, IA artifacts can represent conceptual rules (e.g. principles), existing environment (e.g. inventories), future visions (e.g. target states) or implementation plans (e.g. solution overviews and designs). The comparison of IA artifacts from the perspective of their key stakeholders, time focus, described objects and general meaning is provided in Table 4.

6. Integrated view of information architecture

As the analysis of the identified instruments relevant to IA suggests, the concept of IA is very multifaceted and implies a number of diverse activities ranging from defining overarching corporate data principles to planning the data aspects of separate IT solutions. To better

Instrument	Scope	Abstraction	Information domain only
Conceptual Data Models	Entire organization	High	Yes
Enterprise Data Portfolios	Entire organization	Moderate	No
Guidelines	Narrow business area	Low	Yes
Information Management Capability Models	Entire organization	High	Yes
Inventories	Entire organization	Moderate	Yes
Landscape Diagrams	Narrow business area	Moderate	No
Logical Data Models	Entire organization	Low	Yes
Master Data Maps	Organization or business area	Moderate	Yes
Policies	Entire organization	High	Yes
Principles	Entire organization	Very high	Yes
Solution Overviews and Designs	Separate solution	Very low	No
Target States	Organization or business area	High	No

Table 3.
The comparison of IA artifacts from the perspective of their basic properties

Instrument	Key stakeholders	Time focus	Objects	Meaning
Conceptual Data Models	Mostly architects and business leaders	No time focus	Data entities	Conceptual rules
Enterprise Data Portfolios	Mostly architects	Current state	Databases	Existing environment
Guidelines	Mostly architects	No time focus	Capabilities	Conceptual rules
Information Management Capability Models	Mostly architects	Desired future	Capabilities	Future visions
Inventories	Mostly architects	Current state	Databases	Existing environment
Landscape Diagrams	Mostly architects	Current state	Databases	Existing environment
Logical Data Models	Mostly architects	No time focus	Data entities	Conceptual rules
Master Data Maps	Mostly architects	Current state	Databases	Existing environment
Policies	Mostly architects and business leaders	No time focus	Capabilities	Conceptual rules
Principles	Mostly architects and business leaders	No time focus	Capabilities	Conceptual rules
Solution Overviews and Designs	Architects, business leaders and project teams	Desired future	Mix of multiple objects	Implementation plans
Target States	Mostly architects and business leaders	Desired future	Databases	Future visions

Table 4.
The comparison of IA artifacts from the perspective of their advanced properties

understand IA as a whole, it can be represented as a graphical diagram showing all its components together organized in some or the other way.

Although there are certainly many ways to place all IA components "on a page" and the choice of any particular way of grouping, arranging and linking them will indubitably be subjective, the closer examination of their properties summarized in Tables 3 and 4 suggests that some ways of representation can be more explanatory than the others. Namely, of all their key properties (scope, abstraction level, stakeholders, time orientation, objects of description and general meaning), only the meaning dimension clarifies the relationship between different instruments, while all the other properties merely reflect some of their intrinsic features that arguably do not allow joining these instruments into a coherent conceptual model.

As it is evident from the typical usage scenarios of IA instruments described earlier that define their practical meaning, any abstract suggestions contained in these instruments can be materialized only when they are embedded into concrete implementation plans, and these plans are represented only by solution overviews and designs. For this reason, to have any tangible impact on the corporate landscape, all other instruments should somehow influence the implementation plans captured in solution overviews and designs.

From the perspective of their meaning, these remaining instruments can be loosely separated into conceptual rules, future visions and existing environment (see Table 4). This classification clarifies exactly how these instruments influence solution overviews and designs (see the descriptions of their usage provided earlier). First, conceptual rules shape implementation plans, e.g. policies and data models provide certain guidelines for solution overviews and designs. Second, future visions guide implementation plans, e.g. target states and IMCMs, provide certain goals for solution overviews and designs. Finally, the existing environment informs implementation plans, e.g. inventories and MDMs provide a baseline for solution overviews and designs.

The logical relationships between different IA instruments explicated above allow integrating all these instruments into a unified conceptual graphical view of IA. For illustrative purposes, all IA instruments can also be color-coded or otherwise marked to indicate their various properties (see Tables 3 and 4). However, due to a large number of pertinent properties, some balance between information richness and overload should be found, i.e. not all, but only the most important properties should be visualized. Even though the choice of particular properties to be reflected in a diagram is, again, undoubtedly subjective, some properties can be considered more explanatory. One of these properties is arguably the objects of description as it is this property that best characterizes the informational contents of IA instruments. Another critical property is stakeholders as it is this property that clarifies who uses an instrument in the organizational context. An integrated view of IA demonstrating all its components and their relationship from the meaning standpoint with their two most important properties highlighted, as described above, is shown schematically in Figure 1 [4].

7. Discussion of findings

A detailed understanding of IA-related instruments adopted in the industry (see Tables 3 and 4) allows making a number of interesting analytical observations regarding the general concept of IA, specific instruments for IA and the respective inconsistencies between literature and practice.

7.1 Information architecture as a general concept

Both the early and modern literature on the subject (Martin and Finkelstein, 1981; TOGAF, 2018) tend to present IA as some sort of comprehensive tangible master plan defining the structure of all corporate data assets. For instance, TOGAF v9.2 states that data architecture "describes the structure of an organization's logical and physical data assets and data management resources" (TOGAF, 2018, p. 11). However, our findings demonstrate that in none of the studied companies is there a single unified organization-wide plan for information that can be called "information architecture" or "data architecture". Instead, there is only a

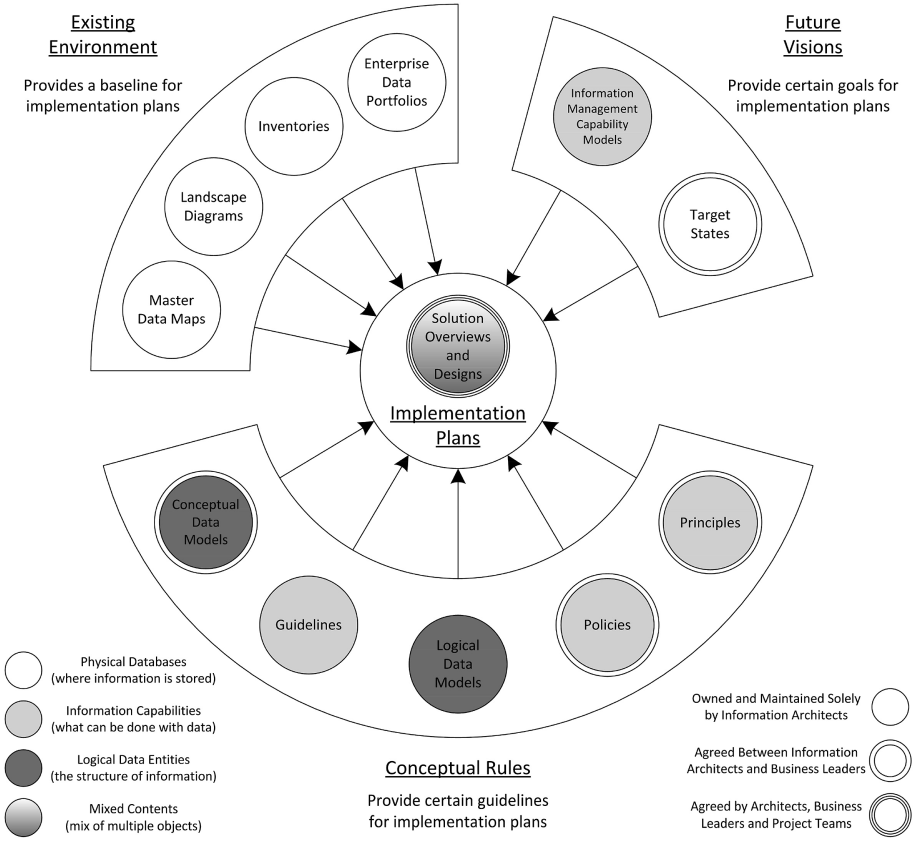

Figure 1.
An integrated view of IA

number of diverse and loosely related instruments for controlling various aspects of information, its use and management in organizations, which are leveraged selectively (see Figure A1). In light of these conclusions, IA can be viewed, at best, only as a broad, metaphorical umbrella term for referring to the whole set of possible instruments for governing the use of information.

Moreover, different organizations studied as part of this research used different types and numbers of instruments related to IA (see Figure A1). This observation suggests that IA is not an "all or nothing" approach that can be either adopted by an organization fully or not adopted at all. Instead, IA essentially represents an entire toolkit of various instruments and practices that may be helpful for addressing different types of business problems related to information and should be adopted selectively when necessary for particular purposes, matching unique organization-specific needs.

7.2 Specific instruments of information architecture

The analysis of the IA instruments identified in the industry (see Tables 3 and 4) suggests that these instruments overlap with the instruments discussed in the literature (see Table 2) only partially. Most strikingly, CRUD or relationship matrices persistently advocated by the mainstream literature for many decades (Bernard, 2012; BSP, 1975; Cook, 1996; Martin, 1982; Spewak and Hill, 1992; TOGAF, 2018) have not been adopted in the industry at all. Many other, less prominent IA artifacts mentioned in the literature, including information interaction models and service collaboration contracts (van't Wout *et al.*, 2010), object state-transition diagrams and knowledge management plans (Bernard, 2012), data dissemination and lifecycle diagrams (TOGAF, 2018), also have not been identified in practice in any form. Comprehensive corporate data models covering all data entities used in the organization very widely advocated earlier in the literature (Finkelstein, 1989; Martin, 1982; Martin and Finkelstein, 1981; Martin and Leben, 1989) have not been adopted either. However, their limited subsets in the form of CDMs and LDMs focusing only on the most critical data entities enjoyed a rather broad acceptance in the industry.

The reasons explaining why many of the proposed instruments for IA have been rejected across the industry are sometimes obvious and sometimes not. For instance, extensive and meticulous corporate data models have long been found overwhelming for business stakeholders and "many people withdrew in horror when it (CDM) was presented to them" (Periasamy and Feeny, 1997, p. 201). Likewise, relationship matrices can hardly be viewed as an intuitive presentation format, even for IT specialists. In other cases, the reasons for rejection are less evident and can only be speculated about. For example, various forms of entity lifecycle models can arguably be helpful only in very specific situations (e.g. in concrete IT projects dealing with entity lifecycles) and, thus, have not been embraced as full-fledged IA artifacts. Or, the existence of formal entity definitions, dictionaries and glossaries arguably does not bring any serious implications for planning and decision-making and, for this reason, sooner or later these artifacts are likely to be abandoned as non-value-adding. The statuses of all major classes of instruments for IA advocated in the literature (see Table 2) with their possible explanations are summarized in Table 5.

As Table 4 clearly showcases, far from all instruments for IA prevalent in the literature have demonstrated their practical utility. On the contrary, some instruments identified in the industry, most importantly EDPs and IMCMs, have not been mentioned in the extant literature in any form.

Instrument	Status in practice	Possible explanation
Relationship matrices	Not adopted in practice in any form	Relationship matrices are widely recognized as an inconvenient and unintuitive form of presentation
Entity-relationship diagrams	Adopted in practice, but either in a simplified form (conceptual data models) or with a limited scope (logical data models)	Comprehensive entity-relationship diagrams have long been recognized as awkward and stupefying
Entity definitions and dictionaries	Not adopted in practice, at least as "living" IA artifacts	Maintaining formalized dictionaries arguably does not bring substantial practical value
Information guidelines and standards	Adopted in practice (guidelines, and maybe policies)	Guidelines proved useful as instruments for controlling the handling of information
Information architecture principles	Adopted in practice (principles)	Principles demonstrated their utility for guiding decision-making at a high level
Entity lifecycle models	Not adopted in practice apart from specific IT projects	Lifecycle models can arguably be helpful only in rather special situations and contexts

Table 5.
IA instruments advocated in the literature and their status in practice

7.3 Inconsistencies between literature and practice

The analysis presented above demonstrates significant inconsistencies between literature and practice from the perspective of IA instruments. In particular, many instruments for IA strongly advocated in the literature have not been adopted in practice (see Tables 2 and 5), whereas many instruments used in practice cannot be traced to any literature sources (see Tables 3 and 4). This discrepancy naturally poses a number of curious questions on the relationship between literature and practice, and especially on the reasons for their considerable divergence. To clarify these questions, it is necessary to refer to some earlier observations on managerial innovations and fashions made in the scholarly literature [5].

On the one hand, all prominent sources relevant to IA (see Table 2), from early BSP to recent TOGAF v9.2, originate from so-called fashion-setters, e.g. consultancies, gurus and industry consortia (Abrahamson, 1991, 1996; Gibson and Tesone, 2001; Kieser, 1997). These sources are purely prescriptive in nature and disseminate faddish ideas, whose validity is based solely on the perceived authority and status of their creators, rather than underlying empirical evidence. All the respective methodologies and frameworks have been promoted for purely commercial purposes and cannot be considered objective and trustworthy. Interestingly, none of them even explains clearly how the recommended IA instruments should be used after being produced, as if their existence somehow automatically benefits organizations.

On the other hand, it has long been noticed that genuine innovations and best practices in management and related areas tend to originate *from practitioners* in organizations, not from consultancies, gurus or thought leaders (Birkinshaw and Mol, 2006; Davenport *et al.*, 2003; Hamel, 2006; Miller and Hartwick, 2002; Miller *et al.*, 2004; Pfeffer and Sutton, 2006). As Miller and Hartwick (2002, p. 27) put it, "[management] classics typically arise not from the writings of academics or consultants but emerge out of practitioner responses to economic, social, and competitive challenges". In a similar vein, the study of 11 management innovations by Birkinshaw and Mol (2006, p. 82) has found that "external agents [such as academics, consultants and management gurus] rarely if ever actually developed the new practices *per se*", but only "offered important inputs to both the process of experimentation and to the subsequent stage of validation". For this reason, prescriptive publications of consultancies and gurus can be regarded merely as the source of inspiration for practitioners, rather than the source of veritable practical guidance. These publications might have only inspired the development of truly helpful instruments for IA, but not defined these instruments.

Interestingly, some instruments prescribed in the normative literature have been used in the industry *before* being prescribed by any sources, i.e. they emerged in the industry and then were "borrowed" by the authors of prescriptive approaches, rather than invented by them. For instance, architecture principles have been used in the industry for decades (van Rensselaer, 1985), long before being included in the mainstream architecture frameworks (TOGAF, 2018; van't Wout *et al.*, 2010). Hence, despite being recommended by these frameworks, the idea of using principles cannot be credited to them, but seemingly belongs to some "nameless" practitioners. Likewise, by the time information guidelines and standards were advocated by van't Wout *et al.* (2010), they most likely had already been employed across the industry. An analogous situation can be observed in sibling fields as well. For example, business capability models (or maps), currently one of the most widely adopted instruments in the domain of business architecture (Khosroshahi *et al.*, 2018), also has unclear origination and evidently emerged somewhere in the industry as it cannot be traced back to any "definitive" sources that initially introduced it or proposed its usage.

In light of these observations on the origin of actual best practices, any inconsistencies between the superficial prescriptive literature and actual industry practice cannot be considered surprising. Moreover, any overlap between literature and practice in this case can be viewed essentially only as accidental, in the same sense in which some forecasts and predictions of the future occasionally materialize (Tetlock, 2005).

8. Conclusion

This paper investigated what instruments related to IA are utilized in organizations and identified 12 distinct instruments adopted in the industry (see Tables 3 and 4). The findings of this study suggest that IA cannot be considered as a comprehensive plan for information describing the current state, future state and transition guidance as defined, for example, by Gartner (Newman *et al.*, 2008), but only as a loose collection of diverse instruments and practices that help organizations control the use of information. Furthermore, specific instruments employed in the industry only partially overlap with those described in the literature.

8.1 Contribution to research and practice

From the research perspective, this study provides an empirical contribution (Agerfalk, 2014; Avison and Malaurent, 2014; Hambrick, 2007). Specifically, it offers a sound empirically substantiated descriptive view of the concept of IA and its key instruments currently missing in the literature. This view can be used by other researchers as a solid foundation for more advanced studies of IA and its role in the modern epoch of digitization, big data and powerful analytics.

From the practical perspective, this study offers a list of IA-related instruments that work in the industry with an explanation of their key properties. This list may be helpful as a toolkit for practicing information architects from which necessary instruments can be picked. Moreover, an integrated view of IA presented in this paper (Figure 1) can be considered as an empirically derived reference model of IA clarifying its major components and their roles in practice.

8.2 Limitations of this study

Since the data for this study has been collected as part of a broader research effort addressing the usage of various architectural documents in organizations, not only IA artifacts, the data collection procedures did not focus specifically on IA artifacts. For this reason, some instruments used in their organizations might have been overlooked or unnoticed by the interviewed architects and, therefore, might be missing in the resulting set of instruments. This fact can be considered as a limitation of this study. Additionally, most organizations visited as part of this research were Australian and, therefore, the resulting set of instruments for IA might be somewhat Australia-specific.

8.3 Directions for future research

This study leaves many important IA-related questions unanswered. For example, why do organizations use different instruments? Did these instruments actually prove useful or their use is purely accidental? When and in which cases may specific IA-related instruments be especially helpful? What are the relative advantages and disadvantages of different instruments serving a similar purpose? What types of organizations are more likely to need particular instruments for managing information? These and many other similar questions have no definite answers in the existing literature and, thus, provide interesting directions for further empirical research on IA.

Notes

1. In the context of this article, the terms "information" and "data" are used largely interchangeably.
2. Here under "theoretical lenses" we mean generic analytical frameworks provided by the well-known "grand" theories relevant to IS studies (Larsen *et al.*, 2015).

3. Here and further "information architects" should be understood as a role, rather than a position, as most organizations in our sample did not employ specialized information architects and this role there was fulfilled by some architects with more general responsibilities, e.g. enterprise architects.
4. As noted earlier, this integrated view of IA is merely one of many possible views selected subjectively on the basis of its perceived superior explanatory power, and the only way to exclude an element of subjectivity in this case would be to provide no such view at all. This integrated view of IA also represents merely a graphical summary of the key research findings, rather than an act of theorizing, as no new information missing in the text is added by the view.
5. Comprehensive discussion of these questions requires a separate volume and is far beyond the scope of this article.

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Corresponding author
Svyatoslav Kotusev can be contacted at: kotusev@kotusev.com

Appendix 1

Examples of Data Analysis

This appendix presents select examples of the analytical procedures applied in this research. Some fragments of the original empirical data (interviewee quotes and document samples) and their qualitative thematic interpretation are demonstrated in Table A1.

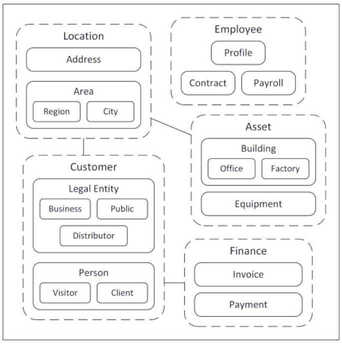
<table>
<tr><th>Source data</th><th>Thematic interpretation</th></tr>
<tr><td>Interviewee: "Data models will describe entities that the business is aware of and that it operates with, like the concept of customer, product, order and then the attributes that they need to have to describe one of those. How do you describe a product here at [our company]? How much information do you need? It's a data definition"</td><td>Conceptual data models describe critical business objects and their key attributes necessary for the business to operate</td></tr>
<tr><td>Interviewee: "We [architects] present them [our data models]. They get presented to [business leaders] in a diagrammatic form, boxes, lines and attributes. And we would say, "this is the design that supports this and this is how it works", and people will understand how to read that, and understand the business requirements, and will approve that"</td><td>Conceptual data models are presented by architects, discussed with and approved by business leaders to ensure their match with the business needs</td></tr>
<tr><td>Schematic document sample (conceptual data model):

</td><td>Conceptual data models are very simple, highly intuitive, abstract diagrams showing key business objects in an entire organization without any technical details of their storage in information systems</td></tr>
</table>

Table A1.
Examples of data analysis performed in this study

Appendix 2

IA Instruments in Organizations

This appendix clarifies which exactly IA-related instruments have been identified in each of the 27 studied organizations. A summary table providing the mapping between the organizations and respective instruments is shown in Figure A1.

	Conceptual Data Models	Enterprise Data Portfolios	Guidelines	Information Management Capability Models	Inventories	Landscape Diagrams	Logical Data Models	Master Data Maps	Policies	Principles	Solution Overviews and Designs	Target States
#1 University (Large)						■				■	■	
#2 Bank (Large)			■		■				■	■	■	
#3 University (Large)						■					■	
#4 Bank (Large)			■		■	■			■	■	■	
#5 University (Large)						■		■		■	■	
#6 Transport (Medium)			■		■					■	■	
#7 Retail (Large)			■		■	■				■	■	■
#8 Public Service (Small)		■	■							■	■	
#9 Telecom (Large)	■				■	■	■			■	■	
#10 Public Service (Small)			■							■	■	■
#11 Diversified (Medium)			■								■	
#12 Finance (Small)			■	■						■	■	
#13 Marketing (Medium)	■		■							■	■	
#14 Resources (Large)			■			■			■	■	■	
#15 Bank (Medium)			■								■	■
#16 Government (Small)			■		■						■	■
#17 Energy (Small)										■	■	
#18 Retail (Medium)			■			■				■	■	
#19 Delivery (Large)			■		■					■	■	■
#20 Insurance (Large)					■				■		■	
#21 Food (Small)			■		■	■			■		■	■
#22 Manufacturing (Small)											■	
#23 Telecom (Large)			■			■				■	■	■
#24 Government (Medium)	■					■	■			■	■	
#25 Resources (Large)			■		■	■					■	
#26 Resources (Medium)						■	■			■	■	
#27 Delivery (Medium)	■				■		■		■	■	■	■

Figure A1. IAs-related instruments identified in different organizations