The Research Field "Modeling Business Information Systems"

Current Challenges and Elements of a Future Research Agenda

Conceptual modeling research has a long tradition in the scientific discipline of Business and Information Systems Engineering (BISE). The present paper highlights research shaping the research field, discusses challenges likely to substantially impair the development of the research field in the coming years, and outlines elements of a future research agenda. The research field "Modeling Business Information Systems" provides the opportunity to maintain a consistent profile of the discipline of BISE without abandoning a pluralistic approach to research in that it integrates knowledge from different research fields of BISE.

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1 Introduction

Research in Business and Information Systems Engineering (BISE) has from its very beginnings aimed for the development of theories, methods, and tools that support the implementation, use, and maintenance of business information systems. To achieve such an objective, approaches are required which allow to reduce complexity and to increase the productivity of the development and maintenance of information systems as well as their quality. Different from Computer Science, BISE emphasizes the joint consideration of information systems and corresponding organizational action systems, thus suggesting the involvement of participants with different professional specializations. Given the remarkable differences between specialized technical languages and cultures, it is necessary to develop approaches that are suited to address the inherent divergences and the resulting frictions effectively. Models as purposefully constructed abstractions are key instruments of every scientific discipline aimed at reducing complexity and at providing a medium for analyses and communication. In contrast to natural sciences and to engineering disciplines, the "object" of inquiry of BISE is not constituted primarily of physical objects but of linguistic constructions. In order to take into account the specifics of its object of inquiry, BISE aims for conceptual models. A conceptual model of a domain is created by a (re-)constructing act of abstraction of domain concepts, i.e., concepts of a domain which are deemed relevant for a particular purpose. Conceptual models are designed by means of dedicated modeling languages that offer language concepts aimed at appropriately taking into account relevant perspectives on a domain. In addition, it should generally be possible to link modeling concepts to concepts of implementation languages to support the creation and maintenance

of software systems based on respective conceptual models. Against this background, conceptual modeling research in BISE aims at developing and studying modeling techniques, modeling languages, and software tools to support the development and analysis of conceptual models.

This paper is motivated by two concerns: First, it is intended to underline that conceptual modeling research in BISE addresses research objectives constituent to the discipline and, moreover, that conceptual modeling research also is well-suited to coherently integrate contributions from different research fields of BISE and its neighbor disciplines. Second, this paper outlines elements of a future research agenda in conceptual modeling research in BISE.

2 A Synoptical Review of the State of the Art

A short synopsis of the research field's development to date provides the starting point for the following discussion.

2.1 Synoptical Retrospect

In retrospect, conceptual modeling research in BISE began with contributions to data modeling (among others: Wedekind and Ortner 1980; Sinz 1987). Shortly afterwards, studies followed on process modeling (e.g., Keller et al. 1992; Ferstl and Sinz 1995) and enterprise modeling (Ferstl and Sinz 1990; Scheer 1991; Frank 1994; Österle 1995) as well as on reference models (e.g., Scheer 1994; Becker and Schütte 1996). Historical antecedents of conceptual modeling research in BISE can be seen in Computer Science (such as Petri 1962; Chen 1976) and in Business Administration (esp. Grochla and Bischoff 1974). Meanwhile, the research field has substantially diversified. In addition to studies that primarily focus on the support of systems development, there are approaches that support model-based managerial analyses and decision scenarios (including vom Brocke et al. 2009; Strecker et al. 2012) and refer to a further research focus, enterprise architecture management (e.g., Braun and Winter 2005). Moreover, the usage context and the application of the models – and thus behavioral research designs – are increasingly becoming the focus of research (e.g., Fettke 2008; Mendling et al. 2012). Information system architectures (Sinz 2002) and reference models at the object level (e.g., Fettke and Loos 2004) still constitute central objects of study as well as, more recently, domain-specific modeling languages (DSML), which can be interpreted as reference models at a higher level of abstraction (e.g., Becker et al. 2007; Reinhartz-Berger et al. 2013). Methods for the construction of modeling methods ("Method Engineering") (e.g., Bucher et al. 2007) have seen a renewed interest in recent years. The design of modeling tools as well as assessing the quality of conceptual models (e.g., Frank 2006a; Becker et al. 2012) constitute another research focus. Here, a partially lively exchange with Computer Science can be observed. Among other aspects, this concerns the formalization of process modeling languages (e.g., Klai et al. 2011), meta-modeling (e.g., Kühne 2009), and approaches to visualize models (e.g., Schaub et al. 2012).

2.2 A Brief Appraisal

This brief synopsis can only touch on the presented artifacts and on principal contributions to the body of knowledge but should illustrate the broad spectrum of the topics of previous contributions. As a result of prior research, a comprehensive and sophisticated concept of conceptual modeling has been established. Thus, conceptual models are considered to be linguistic (re-)constructions that are capable to purposefully structure and to clearly describe complex issues in the enterprise. They are used as a versatile tool to support a wide range of analyses. In this respect, an articulate impact on business practice can be observed (Fettke 2009), but still remains below its expected potential due to specific challenges that arise in conceptual modeling research.

3 Specific Challenges

Modeling research in BISE is confronted with a number of significant obstacles concerning the idiosyncrasies of the object of inquiry, the employed research methods, and aspects relating to the organization of scientific conceptual modeling research in BISE.

3.1 Idiosyncrasies of the Object of Inquiry

The object of inquiry of conceptual modeling research is strikingly broad in two respects. The range and diversity of potential domains (universes of discourse) is remarkable – and thus also the number of corresponding technical languages to be reconstructed for the development of models or modeling languages. In addition, the idiosyncrasies of implementation (programming) languages have to be taken into account to support software development.

Models are designed for a specific purpose and specific (group of) stakeholders. This mainly applies to the intended analyses and design objectives and to the typical groups of modelers and model users. An appropriate consideration of the preferences and abilities of the particular groups of stakeholders also requires to account for inquiries in the social sciences.

3.2 Methodological Aspects of Research

The object of inquiry of modeling research – linguistic artifacts – links to fundamental epistemological problems of justification to meet scientific standards. The design of artifacts in modeling research is carried out with a descriptive and prescriptive intention: On the one hand, it aims for substantial descriptions of existing information systems and their surrounding action systems; on the other hand, it should also include proposals for innovative forms of design and use of future business information systems. This claim is embedded in the designed artifacts: They should identify possibilities and give concrete suggestions that do not yet exist but which are not only imaginable but also useful from today's perspective (Frank 2006b, pp. 11 ff.). Against this background, the obligatory demand for a justification of scientific knowledge is connected with considerable challenges which in parts are not yet met convincingly in current research practices.

3.3 Aspects of Organizing Research

The development of elaborate and carefully documented artifacts (e.g., industry reference models and modeling methods) requires resources that even well-equipped research groups at universities do not have at their disposal. At

the same time, cooperation among research groups of differing disciplines is recommended in many cases. Unfortunately, there were only limited opportunities for research collaboration in the past. Similarly, the transfer of research results to business practice proves challenging: Apart from individual cases and the expected effects of university teaching which is certainly not to be underestimated, there are no convincingly applied approaches for the further distribution and adoption of research findings so far.

4 Elements of a Research Agenda

While the research field has progressed, promising potential for further inquiry still remains untapped. It links to specific research topics, to corresponding reflections on research methodology, and to the organization of research. The research topics outlined below represent particularly important issues for modeling research in the field of BISE from the authors' point of view. Nonetheless, they could be extended to further aspects, for example, to cross-cutting issues like security and business/IT alignment.

4.1 Modeling Objects

New phenomena: Recently, we have been able to observe innovative forms of organization, new business models, cooperation and interaction forms, which may reach considerable complexity and place high demands on the design of information systems. Modeling research is well advised to take into account future developments, to create models, languages, and methods that can be adapted to changing conditions (first contributions are made, e.g., by Seidel et al. 2008).

Projects: Due to constant organizational change, forms of project organization gain growing importance. In case of project activities it is expected, however, that these are specified only to a certain extent, as they may have to be adapted to specific requirements – therefore requiring concepts which, for example, explicitly take semi-structured processes into account (initially discussed by, e.g., Schauer 2009).

Further industries and types of organizations: The results of modeling research in recent years show the need for further research to support analyses and design tasks for industries and types of organizations that have previously not been considered at all or only in a limited way. For example, public administration, healthcare, and energy industries are faced with specific requirements which suggest extensions and adjustments to existing modeling approaches. First approaches can be found in the literature (e.g., Schlieter and Esswein 2011; González Vázquez and Appelrath 2010).

4.2 Modeling Languages and Methods

Language architectures and DSML: The development of new DSML requires language architectures that reduce the conflict between the breadth of use and the benefits of the depth of use in a specific case. Here, language architectures should be considered that integrate modeling languages for wider domains (discussed among others by Frank 2013) – such as, e.g., "language dialects" for retail and wholesale in the domain "trade".

Reuse and configuration of models: Reuse of models usually requires an adaptation to specific requirements. Thus, language concepts are required that support a reasonable compromise between width or reuse and model integrity (e.g., Delfmann 2006; vom Brocke 2006). In particular, with respect to reuse and adaptation of business process models, however, the currently available approaches have significant limitations, because of the lack of powerful concepts of abstraction (e.g., Frank 2012).

Integration with additional language paradigms: Modeling languages used today are – for good reasons – geared to the semantics of common implementation languages. They usually do not enable deduction. Language paradigms from other disciplines such as artificial intelligence support deduction but are limited in other ways. The integration of different language paradigms would provide for a significant improvement of models as a basis for a variety of decision-making and planning tools (e.g., Clark et al. 2008).

Design of graphical notations: Due to the importance of graphical notations with respect to the acceptance and use of conceptual models, intensified exchanges with disciplines that deal with the creation and reception of visual languages is recommended (e.g., Marriott and Meyer 1998). Such an exchange promises to better understand the design of graphical notations (e.g., Figl et al. 2013).

4.3 Modeling Tools

Modeling tools for end users: We must assume that in the future end users will increasingly design and manage models. Modeling tools and corresponding languages developed according to requests from end-users should, therefore, move into the focus of research. First studies on module-based languages, for example, can be found in Becker et al. (2012). Closely connected to this are studies of user interfaces of modeling tools, a topic which so far has only marginally been discussed. A research focus which is already in progress is the discussion on multi-view modeling approaches (e.g., Bork and Sinz 2011).

Promotion of modelers' productivity: Economic development and use of models as a versatile analytical tool requires tools that go far beyond the functionality of today's model editors. Here the (semi-) automated analyses of models (e.g., Delfmann et al. 2010) and the approaches to support collaborative modeling (e.g., vom Brocke 2003; Rittgen 2010) have to be mentioned.

Integration of modeling tools and information systems: The use of models at runtime offers considerable potential. Future research should go beyond previous approaches (e.g., Blair et al. 2009) and strive for an integration of modeling environments with enterprise software (e.g., Frank and Strecker 2009), to enable users to adapt structure and behavior of systems by means of a comfortable and safe modification of models.

4.4 Application-Orientation of Modeling Research

Economics of modeling: The various interdependencies when determining economically relevant effects of modeling projects in practice are obstructive to superficially establishing general recommendations. Further efforts are needed to deepen and differentiate the current understanding of the efficiency and the effects of modeling projects in practice and, ideally, also of individual recommendations given to modeling practitioners (e.g., vom Brocke et al. 2009).

Support for extensive modeling projects: To support requirements of the modeling practice regarding the management of large modeling projects (Houy et al. 2011), further investigations on methodical support when handling extensive models and model collections,

Abstract

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The research field "Modeling business information systems" has a long tradition in the scientific discipline of Business and Information Systems Engineering (BISE). The present paper highlights research shaping the research field, discusses challenges impairing the development of the research field in the coming years, and outlines elements of a future research agenda.

Keywords: Modeling business information systems, Conceptual modeling, Modeling research, Research agenda

for example the reuse of partial models, should be promoted.

Usage of models, languages, and methods: The contexts in which models, languages, and methods are used in practice are diverse and characterized by a variety of contingent factors (e.g., Fettke 2009). Starting from the assumption that knowledge about their use in practice may provide insights for the design of artifacts, it is recommended to further investigate the use context.

4.5 Methodological Aspects of Research

The specific epistemological challenges outlined in Sect. 3.2 suggest a further strengthening of the methodological basis of modeling research. The diversity of research topics and objectives of modeling require a correspondingly pluralistic methodological foundation, which takes into account both behavioristic studies as well as design-oriented approaches. In any event, a critical attitude toward research methods is recommended: Scientific research requires methods but should not be unduly restricted by these. On the one hand, this suggests a critical reflection of the conditions and consequences of the use of certain research methods and of the configuration of research methods suitable to the specifics of a certain study (Frank 2006b). On the other hand, it recommends itself to introduce the specific methodological challenges of modeling research to the international methodological discourse, not least in order to contribute to the development of the approaches presently discussed under the term "Design Science" (e.g., Österle et al. 2010; Peffers et al. 2007).

4.6 Organizational Aspects of Research

This outline of a research agenda also links to the question of overcoming current challenges in organizing research. In this respect, it is advisable to develop new forms of cooperation within the scientific community and with its practice. In addition, we should consider new forms of publishing research results, which allow easy access to and a comfortable interaction with large artifacts (Frank et al. 2007).

5 Concluding Remarks

Even though conceptual modeling research can look back on a long tradition in BISE, it is a research field of great topicality and persistent dynamics. The research agenda we outlined also demonstrates that there are a number of future research topics that are not only scientifically attractive, but also offer a considerable potential for the design and use of future information systems. The concern that a diversification of research topics may endanger identity has been the subject of numerous discourses in BISE (Winter 2007) as well as of the Anglo-American Information Systems Research (Kock et al. 2002; Benbasat and Zmud 2003). The research field "Modeling Business Information Systems" provides the opportunity to maintain a consistent profile of the discipline of BISE without abandoning a pluralistic approach to research in that it integrates knowledge from different research fields of BISE. For this purpose, an even closer cooperation with the disciplines of Business Administration and Computer Science seems necessary. Fortunately, an encouraging intensification of exchanges with Business Informatics and Computer Science has established itself for some time (e.g., in the Committee for Modeling of the German Informatics Society as well as in some IFIP working groups). Such cooperation, however, can only succeed if all involved gain benefits. Here, conceptual modeling research entails an offer which hopefully will be considered inspiring by some in other areas of BISE as well as in Business Administration and Computer Science. Conceptual modeling research in BISE would certainly benefit from closer cooperation on all accounts.

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