


Lecture Notes in Business Information Processing

391

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Business Modeling and Software Design

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Proceedings

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Preface

BMSD (<http://www.is-bmsd.org>) is an annual international symposium on **Business Modeling and Software Design** that brings together researchers and practitioners interested in *enterprise modeling* and its relation to *software specification*. This book contains the **proceedings** of **BMSD 2020**, held in *Berlin, Germany*, on 6-8 July 2020.

In the preface of the previous proceedings (*LNBIP 356*), we have referred to *Julian Lennon* - he had observed in 1991 that even though we had achieved *impressive (technical and technological) advances*, we were still *failing to adequately respond to some essential real-life issues*. The good news is that now (nearly three decades later), we seem to be *benefitting more from technology*, including *ICT* – the *Information and Communication Technology*. Currently, it is easier and affordable for many people to gather information, to communicate, and to get things done from distance. With regard to this, **SOFTWARE** plays a crucial role. Nevertheless, many researchers and practitioners claim that *what we have today could have been even better*. Some of the key current software products have not evolved very much after the initial design, for example: [Microsoft] *Windows 10* and *Windows XP* do not differ that much, and the same holds for *Office 2003* and *Office 2016*; [Apple] The current *MacOS* looks nearly the same as the one from 10 years ago; [UNIX] *Linux* has been nearly the same for 30 years already; and so on. From one perspective, this is understandable because of companies' *competing for customers* most of whom would not want to learn a new and differently looking package. But from another perspective, *the societal context and customer needs (and preferences) are changing over time*; this means that some of the key “infrastructure”-level software products are becoming *less and less focused on the needs of customers*. Unfortunately, it is rarely the case that the software being developed is adapted to the user but just the opposite - the user needs to adapt his or her actions to the software environment at hand; otherwise, the value of using the software would be just partial. Good news here is that some *smaller-scale software applications* are trying to fill in that gap, by “acting on behalf of the user” in such environments. Anyway, we cannot and we should not differentiate between large-scale software and small-scale software. Software is about reflecting user needs in software specifications that are in turn realized, implemented, and deployed for the benefit of the **USER**. Hence, the **evolution challenge** is to be seriously taken into account when drawing visions for the *software of the next decade*. Next to that are two key desired features, namely **robustness** and **resilience**. In our view, during the *SARS-CoV-2 pandemic*, it showed up that there is much room for improvement, when it comes to robustness and resilience. Indeed, *ICT* helped a lot during the pandemic: *IT infrastructures and networks kept functioning* (for example, in hospitals, banks, and so on); employees were *working from home* and students were *studying from home*, supported by *ICT*; kids were able to *video-call* to their grandparents while in isolation; business people were able to *collaborate distantly*, supported by *videoconferencing*; and so on. But at the same time, some *weaknesses* popped up: *Enterprise information systems*

featuring *supply chains* and/or *enterprise resource planning*, could have been more resilient - this would have facilitated supplies and decreased costs. Further, developing software that is adequate as it concerns **public values** and **regulations** is claimed to be a challenge as well: During the pandemic, we used to see IT systems that were often “wandering” between *regulations* (a number of countries across the world have declared a state of emergency, this leading to constantly changing regulations) and *public values* (they are “constant” but would often appear to be in conflict with some “fast written” new pandemic regulations). It is still an open question how to resolve such tensions. This is not trivial and goes beyond the technology itself; hence, it is not surprising that during the pandemic, key software development persons were stating social, even political attitudes. In this way, those persons had implicitly claimed an even bigger role for software, beyond the reflection of objectivized user needs in software specifications. What we observe today is that software is also “instrumental” as it concerns societal and even political issues, this going beyond servicing the user. Unfortunately, it seems to be insufficiently clear HOW it is established what a software system does with regard to *regulations* vs *public values*, for example. Finally, going back to the *evolution challenge*, we have observed during the pandemic that many software systems have failed to effectively adapt to the fast changing user needs. And what are the lessons learned after all? We argue that essentially, information systems and software applications are (and are to be) driven by the goal of BRINGING VALUE TO USERS, which makes them societally-relevant; but at the same time, developers should be careful when the “societal relevance” enters the territory of politics – in such cases, there should be *clear rules and criteria* as it concerns the conformance to *regulations*, *public values*, and so on. Next to that and beyond the above considerations, we argue that underestimating the crucial importance of *user needs* as THE inspiration when specifying software, is a key software failure over the last several decades. Improving this can only be achieved if methodologically aligning business (enterprise) modeling and software design – this brings the BMSD Community together. As mentioned in the *LNBIP 356* preface, **we are inspired to dream of better ways of developing (enterprise) information systems and software applications; we are active in proposing innovative ideas, encouraging open discussions, and stimulating community building, driven by the goal of contributing to the area of ENTERPRISE INFORMATION SYSTEMS.**

Since 2011, we have enjoyed nine successful BMSD editions. The first BMSD edition (**2011**) took place in **Sofia, Bulgaria**, and the theme of BMSD 2011 was: “Business Models and Advanced Software Systems.” The second BMSD edition (**2012**) took place in **Geneva, Switzerland**, with the theme: “From Business Modeling to Service-Oriented Solutions.” The third BMSD edition (**2013**) took place in **Noordwijkerhout, The Netherlands**, and the theme was: “Enterprise Engineering and Software Generation.” The fourth BMSD edition (**2014**) took place in **Luxembourg, Grand Duchy of Luxembourg**, and the theme was: “Generic Business Modeling Patterns and Software Re-Use.” The fifth BMSD edition (**2015**) took place in **Milan, Italy**, with the theme: “Toward Adaptable Information Systems.” The sixth BMSD edition (**2016**) took place in **Rhodes, Greece**, and had as theme: “Integrating Data Analytics in Enterprise Modeling and Software Development.” The seventh BMSD edition (**2017**) took place in **Barcelona, Spain**, and the theme was: “Modeling

Viewpoints and Overall Consistency.” The eighth BMSD edition (**2018**) took place in **Vienna, Austria**, with the theme: “Enterprise Engineering and Software Engineering - Processes and Systems for the Future.” The ninth BMSD edition (**2019**) took place in **Lisbon, Portugal**, and the theme of BMSD 2019 was: “Reflecting Human Authority and Responsibility in Enterprise Models and Software Specifications”. The 2020 edition in Berlin marks the **TENTH EVENT**, with the theme: “Towards Knowledge-Driven Enterprise Information Systems.”

We are proud to have attracted distinguished guests as keynote lecturers, who are renowned experts in their fields: **Jose Tribolet**, *IST - University of Lisbon*, Portugal (2019), **Jan Mendling**, *WU Vienna*, Austria (2018), **Roy Oberhauser**, *Aalen University*, Germany (2018), **Norbert Gronau**, *University of Potsdam*, Germany (2017), **Oscar Pastor**, *Polytechnic University of Valencia*, Spain (2017), **Alexander Verbraeck**, *Delft University of Technology*, The Netherlands (2017), **Paris Avgeriou**, *University of Groningen*, The Netherlands (2016), **Jan Juerjens**, *University of Koblenz-Landau*, Germany (2016), **Mathias Kirchmer**, *BPM-D*, USA (2016), **Marijn Janssen**, *Delft University of Technology*, The Netherlands (2015), **Barbara Pernici**, *Politecnico di Milano*, Italy (2015), **Henderik Proper**, *Public Research Centre Henri Tudor*, Grand Duchy of Luxembourg (2014), **Roel Wieringa**, *University of Twente*, The Netherlands (2014), **Kecheng Liu**, *University of Reading*, UK (2013), **Marco Aiello**, *University of Groningen*, The Netherlands (2013), **Leszek Maciaszek**, *Wroclaw University of Economics*, Poland (2013), **Jan L. G. Dietz**, *Delft University of Technology*, The Netherlands (2012), **Ivan Ivanov**, *SUNY Empire State College*, USA (2012), **Dimitri Konstantas**, *University of Geneva*, Switzerland (2012), **Marten van Sinderen**, *University of Twente*, The Netherlands (2012), **Mehmet Aksit**, *University of Twente*, The Netherlands (2011), **Dimitar Christozov**, *American University in Bulgaria – Blagoevgrad*, Bulgaria (2011), **Bart Nieuwenhuis**, *University of Twente*, The Netherlands (2011), and **Hermann Maurer**, *Graz University of Technology*, Austria (2011).

The high quality of the BMSD 2020 technical program is enhanced by two keynote lectures delivered by outstanding guests: **Manfred Reichert**, *Ulm University*, Germany (the title of his lecture is: “Data-Centric, Large-Scale Process Management Software: Engineering, Technologies, Applications”); **Mathias Weske**, *HPI - University of Potsdam*, Germany (the title of his lecture is: “Business Processes: From Modeling to Mining and Back”). Also, the presence (physically or distantly) of former BMSD keynote lecturers is much appreciated: *Roy Oberhauser* (2018), *Norbert Gronau* (2017), and *Mathias Kirchmer* (2016). The technical program is further enriched by a panel discussion (featured by the participation of most of the abovementioned outstanding scientists) and also by other discussions stimulating *community building* and facilitating possible *R&D project acquisition initiatives*. Those special activities are definitely contributing to **maintaining the event’s high quality and inspiring our steady and motivated Community**.

The BMSD’20 Technical Program Committee consists of a Chair and 109 Members from 37 countries (*Australia, Austria, Brazil, Bulgaria, Canada, China, Colombia, Czech Republic, Denmark, Egypt, Estonia, Finland, France, Germany, Greece, India, Indonesia, Italy, Lithuania, Grand Duchy of Luxembourg, Malaysia, Mexico, New Zealand, Palestine, Poland, Portugal, Russia, Singapore, Slovakia, Slovenia, Spain,*

Sweden, Switzerland, Taiwan, The Netherlands, the UK, and the USA, listed alphabetically) – all of them competent and enthusiastic representatives of prestigious organizations.

In organizing BMSD 2020, we have observed **highest ethical standards**: We guarantee *at least two reviews per submitted paper* (this assuming reviews of adequate quality), under the condition that the paper fulfills the BMSD'20 requirements. In assigning a paper for reviewing, it is our responsibility to *provide reviewers with relevant expertise*. Sticking to a **double-blind review process**, we guarantee that the reviewers would not know who the authors of the reviewed papers are (we send anonymized versions of the papers to the reviewers) and the authors would not know who has reviewed their papers. We require that reviewers *respect the content of the reviewed papers* and do not disclose (parts of) the content to third parties before the symposium (and also after the symposium in case the manuscript gets rejected). We *guarantee against conflict of interests*, by not assigning papers for reviewing by reviewers who are immediate colleagues of any of the paper's co-authors. In our decisions to accept / reject papers, we **guarantee against any discrimination based on age, gender, race, or religion**. As it concerns the EU data protection standards, **we stick to the GDPR requirements**.

We have demonstrated for a **TENTH CONSECUTIVE YEAR** a high quality of papers and as mentioned in the LNBIP 356 preface, we are happy to have succeeded in establishing and maintaining (for many years already) a high scientific quality (as it concerns the symposium itself) and a stimulating collaborative atmosphere; also, our Community is inspired to share ideas and experiences.

As mentioned already, BMSD is essentially leaning toward **ENTERPRISE INFORMATION SYSTEMS (EIS)**, by considering the **MODELING OF ENTERPRISES AND BUSINESS PROCESSES** as a basis for **SPECIFYING SOFTWARE**. Further, in the broader EIS context, BMSD 2020 addresses a large number of research areas and topics, as follows:

› **BUSINESS PROCESSES AND ENTERPRISE ENGINEERING** - *enterprise systems; enterprise system environments and context; construction and function; actor roles; signs and affordances; transactions; business processes; business process coordination; business process optimization; business process management and strategy execution; production acts and coordination acts; regulations and business rules; enterprise (re-) engineering; enterprise interoperability; inter-enterprise coordination; enterprise engineering and architectural governance; enterprise engineering and software generation; enterprise innovation.*

› **BUSINESS MODELS AND REQUIREMENTS** - *essential business models; re-usable business models; business value models; business process models; business goal models; integrating data analytics in business modeling; semantics and business data modeling; pragmatics and business behavior modeling; business modeling viewpoints and overall consistency; business modeling landscapes; requirements elicitation; domain-imposed and user-defined requirements; requirements specification and modeling; requirements analysis and verification; requirements evolution; requirements traceability; usability and requirements elicitation.*

› **BUSINESS MODELS AND SERVICES** - *enterprise engineering and service science; service-oriented enterprises; from business modeling to service-oriented*

solutions; business modeling for software-based services; service engineering; business-goals-driven service discovery and modeling; technology-independent and platform-specific service modeling; re-usable service models; business-rules-driven service composition; web services; autonomic service behavior; context-aware service behavior; service interoperability; change impact analysis and service management; service monitoring and quality of service; services for IoT applications; service innovation.

› **BUSINESS MODELS AND SOFTWARE** - *enterprise engineering and software development; model-driven engineering; co-design of business and IT systems; business-IT alignment and traceability; alignment between IT architecture and business strategy; business strategy and technical debt; business-modeling-driven software generation; normalized systems and combinatorial effects; software generation and dependency analysis; component-based business-software alignment; objects, components, and modeling patterns; generic business modeling patterns and software re-use; business rules and software specification; business goals and software integration; business innovation and software evolution; software technology maturity models; domain-specific models; crosscutting concerns - security, privacy, distribution, recoverability, logging, performance monitoring.*

› **INFORMATION SYSTEMS ARCHITECTURES AND PARADIGMS** - *enterprise architectures; service-oriented computing; software architectures; cloud computing; autonomic computing (and intelligent software behavior); context-aware computing (and adaptable software systems); affective computing (and user-aware software systems); aspect-oriented computing (and non-functional requirements); architectural styles; architectural viewpoints.*

› **DATA ASPECTS IN BUSINESS MODELING AND SOFTWARE DEVELOPMENT** - *data modeling in business processes; data flows and business modeling; databases, OLTP, and business processes; data warehouses, OLAP, and business analytics; data analysis, data semantics, redundancy, and quality-of-data; data mining, knowledge discovery, and knowledge management; information security and business process modeling; categorization, classification, regression, and clustering; cluster analysis and predictive analysis; ontologies and decision trees; decision tree induction and information gain; business processes and entropy; machine learning and deep learning - an enterprise perspective; uncertainty and context states; statistical data analysis and probabilistic business models.*

› **BLOCKCHAIN-BASED BUSINESS MODELS AND INFORMATION SYSTEMS** - *smart contracts; blockchains for business process management; blockchain schemes for decentralization; the blockchain architecture - implications for systems and business processes; blockchains and the future of enterprise information systems; blockchains and security / privacy / trust issues.*

› **IoT AND IMPLICATIONS FOR ENTERPRISE INFORMATION SYSTEMS** - *the IoT paradigm; IoT data collection and aggregation; business models and IoT; IoT-based software solutions; IoT and context-awareness; IoT and public values; IoT applications: smart cities, e-Health, smart manufacturing.*

BMSD 2020 received 65 paper submissions from which 28 papers were selected for publication in the symposium proceedings. Of these papers, 15 were selected for a 30-minute oral presentation (full papers), leading to a **full-paper acceptance ratio of**

23% (compared to 22% in 2019 and 19% in 2018) - an indication for our intention to preserve a high-quality forum for the next editions of the symposium. The BMSD 2020 keynote lecturers and authors come from: Algeria, Austria, Belgium, Bulgaria, Germany, Greece, Indonesia, Kazakhstan, Palestine, Portugal, Sweden, The Netherlands, Tunisia, Turkey, the UK, and the USA (listed alphabetically); that makes a total of 16 countries (compared to 10 in 2019, 15 in 2018, 20 in 2017, 16 in 2016, 21 in 2015, 21 in 2014, 14 in 2013, 11 in 2012, and 10 in 2011) to justify a strong international presence. Four countries have been represented at all ten BMSD editions so far – **Bulgaria**, **Germany**, **The Netherlands**, and the **UK** – indicating a strong European influence.

Clustering BMSD papers is always inspiring because this gives different perspectives with regard to the challenge of **adequately specifying software based on enterprise modeling**. Some BMSD'20 papers are leaning towards business processes: from more *philosophical considerations*, through *business rules / logic (declarative semantics)*, to *business process management*, and related *notations*; there are papers bringing this towards *organizational modeling* and *requirements*, considering relevant *modeling languages*, such as *UML* (the *Unified Modeling Language*), in general, and in particular -the *UML Use Case Diagram* and the *UML Sequence Diagram*; further, there are papers touching upon *product-line engineering*. Other papers are leaning towards information systems / software design, touching upon *IT architectures*, *service-level agreements*, *microservices*, and *resilience of EIS for large-scale disruptions*; further, there are papers considering *pattern recognition*, *executable protocols* as well as *IoT applications*. Still other papers are addressing data analytics and machine learning, as well as open data, in the perspective of *enterprise modeling* and/or *EIS specifications*. Finally, there are papers touching upon knowledge management and visualization tools as it concerns *enterprise architectures*. In this, the BMSD'20 papers are addressing many application domains of high societal relevance, such as *healthcare*, *education*, *transport*, *telecommunications*, and so on.

Fully respecting the desire of some participants not to travel abroad (because of the abovementioned pandemic), we have allowed, **as an exception**, distant participation for those Colleagues. Anyway, the unpleasant developments from the first half of this year did not bring us down! We are as successful as in previous years. We are as physical as we can be, inspired for collaboration, discussions, knowledge co-creation, and community building.

BMSD 2020 was organized and sponsored by the *Interdisciplinary Institute for Collaboration and Research on Enterprise Systems and Technology (IICREST)* and co-organized by the *University of Potsdam*, being technically co-sponsored by *BPM-D*. Cooperating organizations were *Aristotle University of Thessaloniki (AUTH)*, *Delft University of Technology (TU Delft)*, the *UTwente Digital Society Institute (DSI)*, the *Dutch Research School for Information and Knowledge Systems (SIKS)*, and *AMA-KOTA Ltd.*

Organizing this interesting and successful symposium required the dedicated efforts of many people. First, we thank the *authors*, whose research and development achievements are recorded here. Next, the *Program Committee members* each deserve credit for the diligent and rigorous peer reviewing. Further, we would like to mention the excellent organization provided by the *IICREST team* (supported by its *logistics*

partner, AMAKOTA Ltd.) – the team (words of gratitude to *Aglika Bogomilova!*) did all the necessary work for delivering a stimulating and productive event, supported by our German Colleagues – *Prof. Norbert Gronau* and *Marcus Grum*. We are grateful to *Springer* for their willingness to publish the current proceedings and we would like to especially mention *Ralf Gerstner* and *Christine Reiss*, appreciating their professionalism and patience (regarding the preparation of the symposium proceedings). We are certainly grateful to our *keynote lecturers*, *Prof. Reichert* and *Prof. Weske*, for their invaluable contribution and for their taking the time to synthesize and deliver their talks. Last but not least, I take the opportunity to personally address my supervisor and Colleague from *Delft University of Technology*, and BMSD'17 keynote lecturer, *Prof. Alexander Verbraeck*, mentioning my gratitude and appreciation for all his valuable feedback concerning the BMSD'20 preparations; I benefited a lot from Alexander's help!

We wish you inspiring reading! We look forward to meeting you next year in *Sofia, Bulgaria*, for the *11th International Symposium on Business Modeling and Software Design (BMSD 2021)*, details of which will be made available on: <http://www.is-bmsd.org>. In 2021, BMSD will get back to where it once started. We hope to see next year in Sofia very many of you, dear Colleagues from the BMSD Community!

June 2020

Boris Shishkov

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Manfred Reichert	Ulm University, Germany
Mathias Weske	HPI - University of Potsdam, Germany

Abstracts of Keynote Lectures

Data-Centric, Large-Scale Process Management Software: Engineering, Technologies, Applications

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Abstract. The utmost importance of data for process-aware software systems has led to the emergence of data-centric process support paradigms, e.g., artifact-centric, object-aware, and data-driven approaches to BPM. By tightly integrating process and data, these approaches differ significantly from the widely used activity-centric process paradigm, aiming at the support of data-intensive business processes and offering by far the highest flexibility. In particular, the progress of a data-centric process depends on the availability of data rather than on the completion of activities. Moreover, the focus has shifted from large, monolithic activity-centric processes towards rather small data-driven processes (e.g., object lifecycles), which need to collaborate in order to reach a particular business goal. The keynote speech will provide profound insights into fundamental concepts, features, and enabling technologies of data-centric approaches to BPM. Moreover, it will discuss how this process support paradigm opens up new avenues with respect to the engineering, automation, and monitoring of large-scale business processes in the era of digitization and Industry 4.0.

Business Processes: From Modeling to Mining and Back

Mathias Weske

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Abstract. Business process management is a well-established discipline to improve working procedures in organizations. Traditionally, business process models are developed to capture the essence of these procedures. Based on process models, process analysis and improvement techniques are applied, processes are improved and automated using dedicated software systems. More recently the research focus has broadened to include process mining, which use process execution data to analyze processes. Currently there is massive interest in process mining, both in academia and industry. The talk will introduce some questions addressed and some solutions provided by process mining. Finally, we discuss the relationships between process modeling and process mining as well as potential applications of process mining to the area of digital health.

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