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Business Modeling and Software Design

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Proceedings

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Preface

This book contains the *proceedings* of **BMSD 2022** (the 12th International Symposium on **B**usiness **M**odeling and **S**oftware **D**esign), held in *Fribourg*, *Switzerland*, on *27–29 June 2022* (https://www.is-bmsd.org). BMSD is an annual event that brings together researchers and practitioners interested in enterprise modeling and its relation to software specification.

Witnessing the *migrant crisis* in Europe from 2015–16, the *SARS-CoV-2 pandemic* starting in 2020, and the current *war in Ukraine*, one would ask "What's next?", and a key desire in such cases is MITIGATION. We should have known better what would come and we should have acted better at the beginning of all those crises. What is the meaning of "better"? In political terms this concerns governments (this goes beyond our current focus) and in terms of *ICT* (*Information and CommunicationTechnology*) this concerns RESILIENCE. *ICT* is especially mentioned because it enables very many current business processes regardless of the application domain. Hence, what we need today is *ICT*-driven *resilience against disruptive events*. This assumes *adaptive information systems* that in turn require CONTEXT-AWARENESS. We currently observe *context-aware applications* that are developed in various domains. Most of those applications are technology-driven (a "bottom-up" perspective), aiming to show new technology applications, without a thorough understanding of the effects produced by the corresponding *context-aware services* on the *user* and his/her environment and their contribution to context-dependent user goals (a "top-down" perspective). The latter is receiving increasing attention to date and it essentially concerns the ***context-aware servicing of user needs*** – they are changing during a *disruptive event*, for example: much of what a person needs would change during a lockdown. Further, system-internal processes are to be addressed as well in many cases – this concerns information systems supporting (critical) infrastructures, logistics, institutions, and so on; ***system-internal optimizations*** would be needed during a *disruptive event* when (many) process failures would inevitably occur, for example: during a lockdown, electricity outages and/or personnel unavailability may occur that in turn would affect corresponding information systems. Finally, ***public values*** (such as *privacy*, *transparency*, *accountability*, and so on) are to be taken into account as well, for example: during a lockdown, personal freedoms may be restricted, which means that many technical systems should start working differently. What is important with regard to all those challenges, is that they concern both ENTERPRISES and SOFTWARE since they both would be affected by such *disruptions*. Hence, ***aligning enterprise modeling and software design*** is important in this regard. What is also important is TRUST – if people would not trust the institutions and/or the key technical systems during a *disruptive event*, then the user cooperativeness would go down that would in turn decrease the effectiveness of provided ICT services.

It is inspiring for the *BMSD Community* to consider those challenges and it is not surprising that last year the BMSD Theme was: TOWARDS ENTERPRISES AND SOFTWARE THAT ARE RESILIENT AGAINST DISRUPTIVE EVENTS, and this year the BMSD Theme is: INFORMATION SYSTEMS ENGINEERING AND TRUST.

Since 2011, we have enjoyed **eleven 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 tenth BMSD edition (**2020**) took place in **Berlin**, **Germany**, and the theme of BMSD 2020 was: "Towards Knowledge-Driven Enterprise Information Systems". The eleventh BMSD edition (**2021**) took place in **Sofia, Bulgaria** (*We got back to where we once started!*), and as mentioned above, the theme of BMSD 2021 was: "Towards Enterprises and Software that are Resilient Against Disruptive Events". The current edition brings BMSD back to Switzerland (ten years after BMSD-Geneva-2012) – to Fribourg. BMSD-Fribourg-2022 marks the **12th EVENT**, with the theme: "**Information Systems Engineering and Trust**."

We are proud to have attracted distinguished guests as keynote lecturers, who are renowned experts in their fields: **Manfred Reichert**, *Ulm University*, Germany (2020), **Mathias Weske**, *HPI -University of Potsdam*, Germany (2020), **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 **and 2021**), **Oscar Pastor**, *Polytechnic University of Valencia*, Spain (2017), **Alexander Verbraeck**, *Delft University of Technology*, The Netherlands (2017 **and 2021**), **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), **Hend*erik* 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 2022 technical program is enhanced by a keynote lecture delivered by an outstanding scientist: **Hans-Georg Fill**, *University of Fribourg*, Switzerland (the title of his lecture is: "Augmented Enterprise Modeling - Status and Future Directions"). Also, the presence (physically or distantly) of former BMSD keynote lecturers is much appreciated: *Norbert Gronau* (2017, 2021)*, Roy Oberhauser* (2018), *Mathias Kirchmer* (2016), *Marijn Janssen* (2015), and *Marten van Sinderen* (2012). The technical program is further enriched by a panel discussion (featured by the participation of some 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'22 Technical Program Committee consists of a Chair and 108 Members from 37 countries (*Australia*, *Austria*, *Brazil*, *Bulgaria*, *Canada*, *China*, *Colombia*, *Denmark*, *Egypt*, *Estonia*, *Finland*, *France*, *Germany*, *Greece, India*, *Indonesia*, *Italy*, *Latvia*, *Lithuania*, *Grand Duchy of Luxembourg*, *Malaysia*, *Mexico*, *New Zealand*, *Palestine*, *Poland*, *Portugal*, *Russia*, *Singapore*, *Slovak Republic*, *Slovenia*, *Spain*, *Sweden*, *Switzerland*, *Taiwan*, *The Netherlands*, *UK*, and *USA*, listed alphabetically) – all of them competent and enthusiastic representatives of prestigious organizations.

In organizing BMSD 2022, 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'22 requirements. In assigning a paper for reviewing, it is our responsibility to *provide reviewers that have relevant expertise*. Sticking to a **double-blind review process**, we guarantee that a reviewer would not know who the authors of the reviewed paper are (we send anonymized versions of the papers to the reviewers) and an author would not know who has reviewed his/her paper. We require that a reviewer *respects the content of the reviewed paper* and would not disclose (parts of) its 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 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 12th consecutive year a high quality of papers. We are proud 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 2022 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; augmented and virtual-reality-based enterprise modeling; 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 2022 received 56 paper submissions from which 21 papers were selected for publication in the symposium proceedings. Of these papers, 12 were selected for a 30-minute oral presentation (full papers), leading to a **full-paper acceptance ratio of 22%** (compared to 23% in 2021 and 2020, 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 2022 authors come from: Bulgaria, Cyprus, Finland, Germany, Indonesia, Norway, Portugal, Switzerland, The Netherlands, and USA (listed alphabetically); that makes a total of 10 countries (compared to 16 in 2021 and 2020, 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. Three countries have been represented at all twelve BMSD editions so far – **Bulgaria**, **Germany**, and **The Netherlands** – 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**. (a) As it concerns the BMSD'22 Full Papers: some of them are directed towards BUSINESS PROCESS MANAGEMENT AND MODEL VERIFICATION while others are touching upon KNOWLEDGE MANAGEMENT AND DECISION SUPPORT SYSTEMS; some papers address issues concerning ENTERPRISE MODELING AND REQUIREMENTS SPECIFICATION while others are leaning towards TRUST AND SECURITY. (b) As it concerns the BMSD'22 Short Papers: some of them are directed towards BUSINESS PROCESS MODELING while others are touching upon CONTEXT-AWARENESS AND PRIVACY-BY-DESIGN; some papers are directed towards OPEN DATA AND RISK ASSESSMENT while others address CCTV-AWARENESS AND RELATED PRIVACY ISSUES; finally, there is a paper touching upon INTERNET-OF-THINGS and particularly – on the assessment and visualization of device-usage-effects on human health.

BMSD 2022 was organized and sponsored by the *Interdisciplinary Institute for Collaboration and Research on Enterprise Systems and Technology* (*IICREST*),

co-organized by the *University of Fribourg*, and 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 *AMAKOTA 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, appreciating the hospitality of the *University of Fribourg*, 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 the *Uni-Fribourg team* (words of gratitude to Fabian Muff!). We are grateful to *Springer* for their willingness to publish the current proceedings and we would like to especially mention *Ralf Gerstner*, *Christine Reiss*, and *Abier El-Saeidi*, appreciating their professionalism and patience (regarding the preparation of the symposium proceedings). We are certainly grateful to our *keynote lecturer*, *Prof. Hans-Georg Fill*, for his inspiring contribution and for his taking the time to synthesize and deliver his talk.

We wish you inspiring reading! We look forward to meeting you next year in *Utrecht*, *The Netherlands*, for the *13th International Symposium on Business Modeling and Software Design* (*BMSD 2023*), details of which will be made available on: https://www.is-bmsd.org.

June 2022   Boris Shishkov

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Invited Speaker

Hans-Georg Fill   University of Fribourg, Switzerland

Augmented Enterprise Modeling - Status and Future Directions (Abstract of Keynote Lecture)

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Abstract. Enterprise modeling is today a standard practice for the holistic engineering of socio-technical information systems. Besides their traditional role as formal representations of requirements for system development and the support of human communication and understanding, enterprise models may be processed algorithmically by machines. This is well-known for domains such as business process modeling and the execution of workflows or the conduction of impact analyses in enterprise architecture management. In this talk we will explore how the machine-based processing of enterprise models can be generalized in the form of augmented enterprise models. Based on examples from business plan generation, data-driven business process improvement, risk simulation or blockchain-based attestation we will describe the current state and derive possible future.

Contents

Short Papers