Invigorating Event-driven Process Chains – Towards an integrated meta model for EPC standardization

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Abstract: When deciding about appropriate modelling languages, the degree of standardization often represents an important decision criterion. Although the EPC is commonly used for process modelling in the last decades, the absence of an official standard leads more and more to its non-consideration. A coherent meta model is a pillar for the specification of process modelling languages. Accordingly, this work builds the basis for further standardization by providing an integrated meta model for the EPC. The resulting meta model therefore supports the invigoration of the EPC by impelling the future standardization effort.

Keywords: EPC, meta model, model integration, process modelling language specification

1 Meta modelling as a key factor for EPC standardization

In the area of business process management, various modelling languages have emerged over time, exemplary the Business Process Modelling Language or the Unified Modelling Language. In order to facilitate model exchange, the communication between model stakeholders and the reduction of transaction costs, many of these languages have been standardised by respective standard development organizations. Standardization has been identified as relevant both for successful business process modelling [In09, RB10] and for rather specialized criteria like reducing outsourcing risks [WW07]. Hence, standardization can be emphasized as pertinent to the design and choice of an adequate modelling language in terms of graphical representation, syntax and semantic.

The event-driven process chain (EPC) represents a possible option when deciding about an appropriate modelling language. It is well recognised in research as well as in practice [Aa99, DKK14, MA07, MN06]. However, in contrast to its maturity, the EPC still lacks an official standard. Therefore, this paper aims to establish a basis for a successful EPC standardization by providing an integrated EPC meta model. In addition to other relevant language components such as the specification of an exchange format, a grounded meta model is a vital pillar for standardization. In order to address this issue, the paper is structured as follows. Section 2 introduces theoretical background with special focus on

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the EPC and meta modelling. In section 3, the underlying research method is presented. In section 4, we discuss prior EPC research and agree on a mutual understanding of a basis EPC meta model. Subsequently, section 5 provides an overview of relevant EPC literature dealing with meta models and language variants. Consequently, section 6 underlies the significance of a meta model for EPC standardization. Finally, we discuss the relevance of our results for standardization purposes in section 7.

2 Theoretical background and related work

Initially, the EPC emerged from a collaboration between the Institute for Information Systems in Saarbrücken and SAP [KNS92]. Since then, many proposals regarding an extension or alteration of the basic EPC have been made. In order to formalize the respective suggestions, many authors applied their own developed meta models. However, meta models in business process management are not only be used for describing modelling languages, but also facilitate the verification of the syntax and therefore partly the correctness of the whole model [Be00].

A comprehensive consolidation of existing EPC meta models has not been conducted to date. [Th09] presents a consolidated meta model, but as the work does not focus on meta model integration it only considers two models and does not explicitly describe the consolidation steps. [HKM06] do not merge EPC, but XPDL and BPEL meta models. The applied integration process builds the basis for our upcoming integration methodology. Other consolidation approaches, such as [LK06], develop a generic meta model for modelling languages in general, inter alia the EPC, but negate proposed extensions and only concern the basic EPC. Furthermore, there are approaches in literature in the field of the EPC that have to agree on a common EPC basis. For example, [MN06] develop a XML-based interchange format for the EPC, but do not previously consolidate existing extensions. Instead, they agree upon one formal definition of the EPC (in this case [NR02]), which in turn is based on the extended EPC [GS94, HKS93, KT97]. Furthermore, [Ri16] has listed different variants of the EPC language and evaluates them for potential EPC standardization. Similarly, [Ka16] analyses the implementation of EPC concepts in BPM modelling tools.

3 Heading for an integrated model

To establish the foundation for a meaningful development of an integrated EPC meta model, a systematic approach is applied throughout the presented work. Starting point is a baseline EPC meta model that represents essential constructs of the EPC and eEPC and serves as a basis for further enhancement and refinement. The development of an integrated EPC meta model is conducted by taking two primary data sources into account. First, EPC extensions that have been proposed over the last decades are considered for a possible consolidation. Second, multiple authors have already created meta models describing the EPC language. Those existing meta models are evaluated against a potential integration as well. To acquire both sources, a structured, keyword-driven literature review based on [WW02] and [Br13] is carried out. The search phrases "event-driven process chain" and "Ereignisgesteuerte Prozesskette" have been kept rather general on purpose in order to ensure a broad coverage of EPC literature. The phrases have been used to query the scientific databases SpringerLink and ScienceDirect. Additionally, the proceedings of the EPC workshop from 2002 to 2009 as well as the working paper series of the University of Saarbrücken, Institute of Information Systems, have been considered. All results have been analyzed whether they specifically address EPC extensions or meta models. To further reduce the number of findings, we considered the scientific impact of each publication, hence the amount of citations when conducting a forward search. This was done in line with steps outlined in [Ri16]. To acquire an integrated EPC meta model the consolidation of results adheres to the steps proposed in [HKM06]: Regarding schema preparation, all identified models and variants are transformed into Entity-Relationship (ER) models first to ensure comparability. For schema matching, the models are analyzed in terms of similarities and differences. Subsequently, schema merging takes place by enhancing the baseline EPC meta model with additional concepts and constructs identified in the final results. Ultimately, schema refactoring omits model redundancies and yields an integrated EPC meta model, which is able to sufficiently unify the EPC language.

4 The (extended) EPC language

The initial EPC as presented by [KNS92] consists of functions, events and connectors. Functions represent activities performed in a business process, events present a current state and the connectors AND, OR and XOR can be used to split or join the control flow. Functions and events need to be alternating and processes have to start and end with an event. Although functions, events and connectors are sufficient to model simple business processes, the EPC language lacks information on resources to this point. With an early publication, [HKS93] suggested to annotate resources to functions, which over the years has led to an understanding of event-driven process chains often referred to as "extended EPC" (eEPC) in literature (see e.g. [HKS93], [GS94], [Ro96] or [KT97] for definitions).

The eEPC offers different types of resources to be annotated to functions, for example organizational units, which represent the responsibility to perform the respective function, or IT and application systems that are utilized during the execution of a function. Additionally, the eEPC offers process refinements, which enables the embedding of sub-processes for greater reusability of (partial) process models.

While there exist several meta models for the eEPC in literature (e.g. [HS94], [Be03], [SV05] or [STA05]), we selected the meta model proposed in [Be03] as a base for our work (see Fig. 1) for two reasons: First, the meta model presented by [Be03] follows closely the initial definition of the eEPC, whereas other identified models add model-specific characteristics. Second, the selected model is kept rather simple and intuitive. Hence, we consider the model by [Be03] best suited for model enhancement. The model is created via the Enhanced Entity-Relationship Diagram notation (see e.g. [Ho93] or [Ta00]), which uses minimum and maximum cardinalities as specified by [SS83] and constraints for specializations, which can be disjoint (D) or non-disjoint (N) and incomplete / partial (P) or total (T).

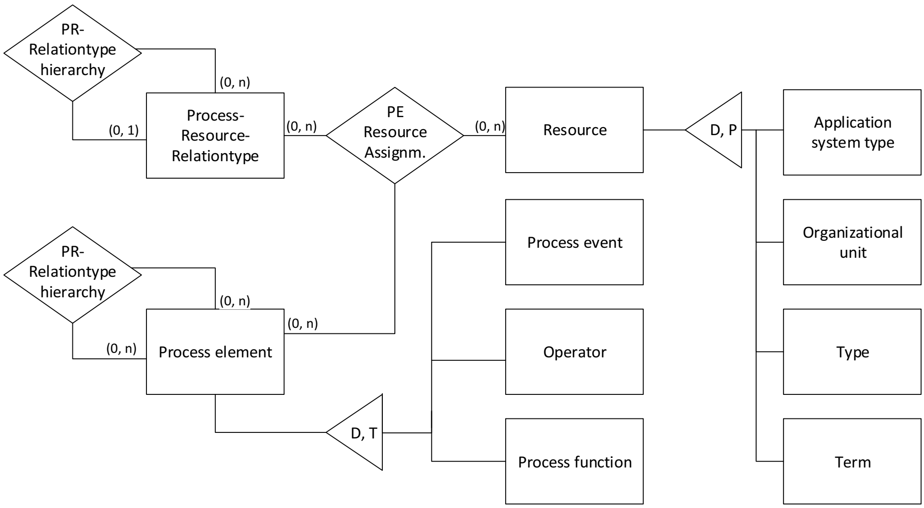

Figure 1: eEPC meta model according to [Be03]

In the chosen EPC baseline meta model process elements are used as an abstract representation of either functions, events or operators. Process elements are related to each other, which reflects the control flow throughout the process. Resources represent a generalization of different resource types. For each resource, its relationship to a process element is specified. Additionally, the model allows for relationship type hierarchy [cf. Be03]. The ternary relation between resource, process element and process-resource-relationship type assigns the resource to the process element using the determined relationship type.

5 Overview of EPC meta models and variants

Following the applied methodology as carried out in section 3, the results of the structured literature review are presented in Table 1. During our research, we identified 14 different EPC variants. Four of those are considered as highly relevant according to their impact factor. Similarly, we found 16 contributions that dealt with process meta models. For a final consolidation, only eight of them are considered as relevant, since they specifically deal with EPCs.

In terms of EPC variants, we consider the basic EPC as specified in [KNS92] for a potential consolidation. In their work, [KNS92] establish the foundations of the EPC language. The contribution introduces basic constructs like information objects, events, functions and connectors (AND, XOR, OR). The previously mentioned eEPC adds resources, organizational structures and process refinements. A refinement towards risk modelling is conducted by [RM05] and [RW08]. In their work, the EPC language is extended by risk-based constructs. Exemplarily, [RM05] use a risk element which can be attached to EPC functions in order to distinguish between different risk types. In [RW08], the basic EPC is extended by i.e. risk events and corresponding ways to manage risks within a business process. One of the most popular EPC variants in literature is the configurable EPC (C-EPC). Core concept of this EPC variant is the configurability of EPC process elements, which allows the creation of multiple process instances out of a single EPC process model, each of them tailored for different purposes [RA07, Re05]. To achieve this, functions, events and connectors of an EPC model are assigned with an additional attribute altering the visibility of the respective element.

Findings	References	Type (EPC)
EPC	[KNS92]	Variant
Extended EPC (eEPC)	[HKS93] [GS94] [KT97]	Variant
Risk EPC extended	[RM05] [RW08]	Variant; Meta model
Configurable EPC (C-EPC)	[RA07] [Re05]	Variant
EPC/eEPC meta model	[HS94]	Meta model
Process meta model	[Be02]	Meta model
ARIS meta model	[STA05]	Meta model
eEPC meta model	[SV05]	Meta model
EPC meta model	[BDK07]	Meta model
Integrated EPC meta model	[Th09]	Meta model

Table 1: Literature review results

Whereas presented EPC variants are different by nature, most EPC meta models identified during our review share common characteristics. One of the first meta-model based specifications has been proposed by [HS94]. Despite its early stage, the meta model includes most major EPC elements. Additionally, eEPC elements are considered in the presented model. However, differences with regard to other meta models primarily lay in the detailed specification of element attributes and primary keys. In addition, the model refrains from recognizing connector types and instead emphasises on rather unspecific conjunction groups. In [Be02], a generic process meta model is proposed. Although not specifically designed for representing the EPC language, it resembles to a large degree the overall structure of common EPC meta models in literature. Besides EPC core elements, the model focuses on resources, since it introduces e.g. roles, competencies or knowledge on top of common EPC resources. A distinguishing characteristic is the differentiation between function (general functional activity that can be reused in multiple process models) and process function (actual modelling element) [Be02]. Another way of EPC-related meta modelling is carried out by [STA05], who introduce the ARIS business process meta model. This model does not contain most of the element relationships and the syntactical structure known from previous models. Instead, main concern of the contribution is the EPC function and its relationship to process resources. In contrast to other propositions that lay a specific focus on resources, [STA05] additionally detail the type of each resource relation in terms of visualization and semantic. [SV05] present a meta model that appears very similar to the meta model presented by [Be03], which serves as the baseline meta-model in this paper. Main differences lay within the way resources are treated in the model. In fact, the meta model proposed by [SV05] is the only one identified that relates resources specifically to functions instead of generic process elements. Furthermore, the model by [SV05] enables a resource hierarchy, e.g. for cases where organizational units are aligned in a reporting structure. Similarly, the model found in [BDK07] already strongly resembles the identified baseline meta-model. Again, differences can be noticed in the splitting of the function element (cf. [Be02]) and additional resources (e.g. Entity type). An integrative approach has been facilitated in work by [Th09], who refers to both [Be02] and [BDK07] in order to establish an EPC meta model to serve as a basis for the introduction of the Fuzzy EPC. Subsequently, the model encompasses basis EPC constructs and structures known from previous models, such as the relationship between resources and process elements, rather than between resources and functions. The meta model by [Th09] mainly sets itself apart by explicitly covering all three EPC connector types (AND, XOR, OR) in the meta model.

6 Developing an integrated EPC meta model

Based on the results, this section presents the consolidated meta model. Initially, each meta model and extension from our result set has been compared to the underlying meta model by [Be03]. Thereby deviations have been highlighted. In order to ensure a coherent result, the deviations have been subsequently inspected whether commonalities can be found. For this purpose, also homonyms, synonyms and other linguistic discrepancies had to be dissolved. Figure 2 presents the consolidated meta model as an enhanced ER-model.

Additional elements to [Be03] in Figure 2 are emphasized by a hatched shape. Accordingly, blank shapes illustrate the original set of meta model elements. We relinquish the description of these elements at this point, as it is already carried out in section 4. One striking commonality between EPC meta models is the entity *Process model* or *Process* [BDK07, Be02, HS94, RW08, SV05, Th09]. One process may contain an unlimited number of elements, but a process element is always linked to a specific process. Therefore, we added the *Process* entity with (1,1) and (1,n) cardinalities. Additionally, another specialisation to *Process element* has been added with the *Process Interface* entity [BDK07, Be02, HS94, RW08, SV05]. Furthermore, we adopted the annotation for the predecessor/successor relation, as we assume the possibility to determine the exact cardinalities of process element relations as highly relevant. Due to the lack of space, the elaboration of cardinalities using formal algebra will not take place in this paper. Related work can be found in [Be02, De06]. If a process contains an interface, it is always linked to one specific process and represents a refinement of a "normal" function with a (1,1) cardinality. Surprisingly, just a few meta models from literature concretize the specialisation of the *Operator* entity [HS94, Th09]. In order to gain a holistic consolidation, we included the respective items. Moreover, it has to be decided which specific resource elements should be appended on the meta model. Considering the meta models from literature, a highly extensive set of suggestions can be retrieved. Especially [Be02] and [RW08] propose many possible extensions. With the purpose of retrieving a consensus between a holistic and simultaneously comprehensive meta model, the manifold proposals from literature have been derived to the rather abstract entity *Data object*. Furthermore, despite the fact that they are only included in one meta model respectively, the elements *Relation Type* and *Process Element Relation Type* have been added. The *Relation Type* entity in conjunction with the *Resource Structure* relationship enables the EPC process to handle the relations among e.g. organizational units. These relations might be of the type "reports to" or "is responsible for" [SV05].

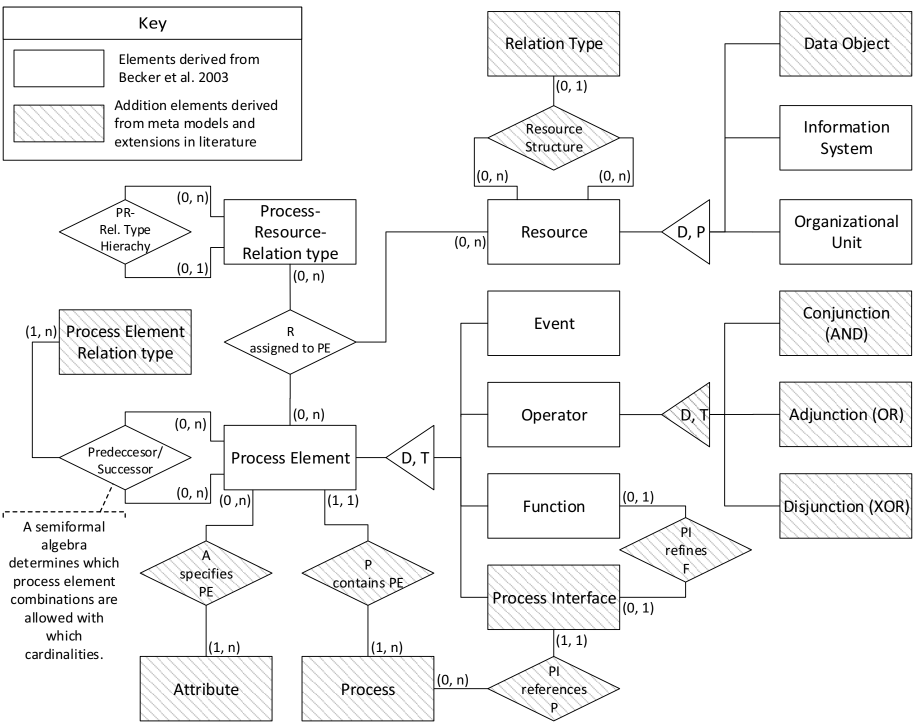

Figure 2: Consolidated EPC meta model

In the above described consolidation steps, we only considered basic EPC and eEPC meta models or their respective parts in exceeding meta models [cf. RW08]. Beyond that, the risk EPC extended and the C-EPC elements have to be taken into account as they also have been identified as significant in our research. While there is no meta model for the C-EPC in literature yet, [RW08] proposed a comprehensive meta model for the risk EPC extended. Therefore, additional C-EPC elements had to be derived from textual and figurative descriptions. Overall, there was a total set of over 20 additional elements that can be included in our consolidated meta model in terms of conformity with the C-EPC and the risk EPC. Considering the comprehensive-holistic ratio, we decided not to integrate all these elements but instead adding the entity *Attribute* to our meta model to meet basic requirements of both extensions. As a result of this, the main concept behind the risk EPC and the C-EPC can be added to the EPC process model by linking a specific attribute to the respective process elements. Since an attribute can specify more than one process element and a process element can be specified by more than one attribute, we applied (0,n) and (1,n) cardinalities. Exemplary, the attribute "configurative" can be linked to any connectors or functions and therefore mark them as a configurable element in accordance to the C-EPC. Referring to the risk EPC, e.g. an attribute "risk event" may be linked to an event and thus cast it to a risk event. By specifying the attributes' text even more, the risk event can also be differentiated between a "beforehand deterministic risk event", a "direct apparent risk event" and an "delayed apparent risk event", as proposed in [RW08]. A downside is that our approach eliminates the specific figurative representation of additional extension elements like the thick lines of configurative elements [Re05] or the completely new designed break operator [RW08]. However, in order to integrate as many elements as possible without creating an unintelligible, specialized meta model, our approach strikes a balance.

7 Towards EPC standardization

A comprehensive meta model is an integral part of every process modelling language and therefore represents an essential component for the standardization of each respective language. In our work, we have identified relevant literature dealing with meta models concerning the EPC language using a structured literature review. In addition, popular EPC variants have been taken into account for model refinement. Ultimately, the paper at hand establishes an integrated meta model that consolidates existing models and variants. Although each consolidation process implies a certain degree of generalization, hence the omission of rather specialized elements and constructs, the resulting model is able to represent a unified EPC meta model that strives for meeting the requirements of previous EPC research. Subsequently, the proposed model is able to serve as a foundation for successful EPC standard-making.

In future work, the integrated EPC meta model can be used as a blueprint for further language specification, since a holistic standardization requires a detailed definition not only of the language elements as specified by the model, but also of syntactical and semantical aspects that are based on element relationships determined in the meta model.

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References

[Aa99] Aalst, W.M.P. van der.: Formalization and verification of event-driven process chains. Information and Software Technology 41, pp. 639–650. 1999.

[BDK07] Becker, J., Delfmann, P., Knackstedt, R.: Adaptive Reference Modeling: Integrating Configurative and Generic Adaption Techniques for Information Models. In: J. Becker, P. Delfmann (eds.) Reference Modeling. pp. 27–58. Physica-Verlag HD, 2007.

[Be00] Becker, J., Rosemann, M., Uthmann, C. von, Uthmann, C. Von.: Guidelines of Business Process Modeling. Business Process Management 1806, pp. 241–262. 2000.

[Be02] Becker, J., Delfmann, P., Knackstedt, R., Kuropka, D.: Konfigurative Referenzmodellierung. Wissensmanagement mit Referenzmodellen. Konzepte für die Anwendungssystem- und Organisationsgestaltung. pp. 25–144. 2002.

[Be03] Becker, J., Delfmann, P., Falk, T., Knackstedt, R.: Multiperspektivische ereignisgesteuerte Prozessketten. In: EPK 2003. 2. Workshop der Gesellschaft für Informatik e.V. (GI) und Treffen ihres Arbeitkreises "Geschäftsprozessmanagement mit Ereignisgesteuerten Prozessketten (WI-EPK), pp. 45–60. Bamberg 2003.

[Br13] Brocke, J.M. vom, Simons, A., Niehaves, B., Riemer, K., Plattfaut, R., Cleven, A.: Reconstructing the giant: On the importance of rigour in documenting the literature search process. In: 17th European Conference on Information Systems, pp. 1–13. Verona, Italy 2013.

[De06] Delfmann, P.: Adaptive Referenzmodellierung. Methodische Konzepte zur Konstruktion und Anwendung wiederverwendungsorientierter Informationsmodelle. Advances in information systems and management science 25, pp. 266. 2006.

[DKK14] Drawehn, J., Kochanowski, M., Kötter, F.: Business Process Management Tools 2014. Stuttgart, Germany 2014.

[GS94] Galler, J., Scheer, A.-W.: Workflow-Management - Die ARIS-Architektur als Basis eines multimedialen Workflow-Systems. In: Veröffentlichungen des Instituts für Wirtschaftsinformatik (IWi), No. 108, Universität des Saarlandes 1994.

[HKM06] Hornung, T., Koschmider, A., Mendling, J.: Integration of heterogeneous BPM Schemas: The Case of XPDL and BPEL. In: Advanced Information Systems Engineering, 18th International Conference, CAiSE 2006, 2006.

[HKS93] Hoffmann, W., Kirsch, J., Scheer, A.-W.: Modellierung mit Ereignisgesteuerten Prozeßketten. In: Veröffentlichungen des Instituts für Wirtschaftsinformatik (IWi), No. 101, Universität des Saarlandes 1993.

[Ho93] Hohenstein, U.: Formale Semantik eines erweiterten Entity-Relationship-Modells. Teubner, Wiesbaden, Germany 1993.

[HS94] Hirschmann, P., Scheer, A.-W.: Konzeption einer DV-Unterstützung für das überbetriebliche Prozessmanagement. Veröffentlichungen des Instituts für Wirtschaftsinformatik (IWi), Universität des Saarlandes 1994.

[In09] Indulska, M., Recker, J., Rosemann, M., Green, P.: Business Process Modeling: Current Issues and Future Challenges. Advanced information systems engineering, pp. 501–514. 2009.

[Ka16] Karhof, A., Jannaber, S., Riehle, D.M., Thomas, O., Delfmann, P., Becker, J.: On the de-facto Standard of Event-driven Process Chains: Reviewing EPC Implementations in Process Modelling Tools. In: Proceedings of the Modellierung 2016, Karlsruhe, Germany 2016.

[KNS92] Keller, G., Nüttgens, M., Scheer, A.-W.: Semantische Prozeßmodellierung auf der Grundlage “Ereignisgesteuerter Prozeßketten (EPK).” In: Veröffentlichungen des Instituts für Wirtschaftsinformatik (IWi), No. 89, Universität des Saarlandes 1992.

[KT97] Keller, G., Teufel, T.: SAP R/3 prozeßorientiert anwenden. Addison-Wesley, Bonn 1997.

[LK06] List, B., Korherr, B.: An Evaluation of Conceptual Business Process Modelling Languages. 2006 ACM symposium on Applied computing, pp. 1532–1539. 2006.

[MA07] Mendling, J., Aalst, W.M.P. van der.: Formalization and Verification of EPCs with OR-Joins Based on State and Context. Proceedings of the 19th International Conference on Advanced Information Systems Engineering (CAiSE'07) 4495, pp. 439–453. 2007.

[MN06] Mendling, J., Nüttgens, M.: EPC markup language (EPML): An XML-based interchange format for event-driven process chains (EPC). Information Systems and e-Business Management 4, pp. 245–263. 2006.

[NR02] Nüttgens, M., Rump, F.J.: Syntax und Semantik Ereignisgesteuerter Prozessketten (EPK). Prozessorientierte Methoden und Werkzeuge für die Entwicklung von Informationssystemen P-21, pp. 64–77. 2002.

[RA07] Rosemann, M., Aalst, W.M.P. van der.: A configurable reference modelling language. Information Systems 32, pp. 1–23. 2007.

[RB10] Rosemann, M., Brocke, J. vom.: The Six Core Elements of Business Process Management. In: J. Brocke, M. Rosemann (eds.) Handbook on Business Process Management 1 SE - 5. pp. 107–122. Springer Berlin Heidelberg, 2010.

[Re05] Recker, J.C., Rosemann, M., Aalst, W.M.P. van der, Mendling, J.: On the Syntax of Reference Model Configuration – Transforming the C-EPC into Lawful EPC Models. In: Business Process Management Workshops: BPM 2005 International Workshops, BPI, BPD, ENEI, BPRM, WSCOBPM, BPS, pp. 60–75. Nancy, France 2005.

[Ri16] Riehle, D.M., Jannaber, S., Karhof, A., Thomas, O., Delfmann, P., Becker, J.: On the de-facto Standard of Event-driven Process Chains: How EPC is defined in Literature. In: Proceedings of the Modellierung 2016, Karlsruhe, Germany 2016.

[RM05] Rosemann, M., Muehlen, M. zur.: Integrating Risks in Business Process Models. Australasian Conference on Information Systems (ACIS), pp. 62–72. 2005.

[Ro96] Rosemann, M.: Komplexitätsmanagement in Prozeßmodellen. Gabler, Wiesbaden 1996.

[RW08] Rieke, T., Winkelmann, A.: Modellierung und Management von Risiken. Ein prozessorientierter Risikomanagement-Ansatz zur Identifikation und Behandlung von Risiken in Geschäftsprozessen. Wirtschaftsinformatik 50, pp. 346–356. 2008.

[SS83] Schlageter, G., Stucky, W.: Datenbanksysteme - Konzepte und Modelle. Stuttgart, Germany 1983.

[STA05] Scheer, A.W., Thomas, O., Adam, O.: Process Modeling using Event-Driven Process Chains. 2005.

[SV05] Seel, C., Vanderhaeghen, D.: Meta-Model based Extensions of the EPC for Inter-organisational Process Modelling. In: EPK 2005. 4. Workshop der Gesellschaft für Informatik e.V. (GI) und Treffen ihres Arbeitkreises "Geschäftsprozessmanagement mit Ereignisgesteuerten Prozessketten (WI-EPK), pp. 117–136. Hamburg 2005.

[Ta00] Talheim, B.: Entity-Relationship Modeling. Springer, Berlin/Heidelberg, Germany 2000.

[Th09] Thomas, O.: Fuzzy Process Engineering. Gabler Verlag, Wiesbaden 2009.

[WW02] Webster, J., Watson, R.: Analyzing the past to prepare for the future: writing a literature review. Management Information Systems Quarterly 26, pp. 8–13. 2002.

[WW07] Wüllenweber, K., Weitzel, T.: An empirical exploration of how process standardization reduces outsourcing risks. Proceedings of the Annual Hawaii International Conference on System Sciences 2007.