A Criteria Catalogue for Evaluating Business Process Pattern Approaches

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Abstract. Process models are an important element of business process management. Modelling and management of these models can be supported by business process patterns. In recent years, various approaches for defining such patterns were introduced. The aim of this paper is to promote the precise classification of these approaches by presenting a catalogue consisting of several criteria developed by means of a systematic literature review. A first evaluation of this catalogue is conducted by classifying ten pattern approaches.

Keywords: business process patterns, process modelling, classification

1 Introduction

Process models are of particular importance for designing, implementing, and evaluating information systems. Furthermore, they are used for multiple other purposes like supporting organisational communication, project documentation, and employee training [20]. Due to this fact, organisations already have modelled a wide variety of business processes and are continuously improving them.

Patterns have long proven to be effective concerning their ability to preserve existing knowledge, to abstract from concrete problems, and to foster communication between participitants [14]. While the usage of patterns has a long tradition in fields like software design, e.g. [19], patterns in the context of business process models (business process patterns, BPP) still constitute a rather unstructured research area. Despite several proposed approaches so far, the field still lacks a common terminology and general criteria on how to compare different pattern variants.

This work aims at increasing the understanding about BPP by presenting a catalogue of criteria for classifying different pattern approaches. In addition to this aim, the work presented here is embedded in a broader research programme concerning the configuration of complex services. Questions in this area are how to assemble a service model based on smaller BPP. Furthermore, we want to analyse how service configuration can be supported by BPP approaches. A first evaluation of service configuration approaches can be found in [7].

In this paper, we present and discuss the criteria catalogue. To evaluate the applicability of the criteria, we exemplarily analyse ten existing BPP approaches using the catalogue. For that reason, the remainder of this paper is organised as follows. In the next section, we present the theoretical background of BPP and give a brief overview of how we identified BPP approaches. The criteria used to compare BPP with each other are presented in Section 3 and applied to existing approaches in Section 4. The paper is concluded by discussing limitations and future research steps in section 5.

2 Theoretical Background

To increase the understanding about BPP, we give some additional theoretical background in this section. First, the concept of BPP is elaborated in more detail. In addition, we present our methodology for establishing the criteria catalogue and identifiying existing BPP approaches.

2.1 Business Process Patterns

According to [29], patterns are a means to establish an "abstraction from a concrete form" that occurs frequently "in specific non-arbitrary contexts". Patterns have two distinct application areas. Whereas in *forward engineering* patterns are used to create new models, during *reverse engineering* existing processes can be analysed regarding the existence of predefined patterns [18].

These two application areas coincide with different advantages from using BPP mentioned in literature. For example, BPP in forward engineering are a way to increase efficency and effectivity of process modelling by reusing existing business functions [37]. In reverse engineering, BPP can be used to identify improvement possibilities of existing processes [5] and to check the adherence to previously defined organisational or legal compliance rules [38]. On a more abstract level, it is possible to use BPP for comparing process modelling languages with each other [1].

Even though several specific approaches for specifying BPP exist, it is possible to identify various common attributes that are necessary for every pattern description [16, 18]. Table 1 presents these attributes in condensed form together with a short description of each attribute.

2.2 Research Methodology

For identifying existing BPP approaches and establishing the criteria catalogue, we are currently conducting a systematic literature review based on the methodology presented in [23]. The review is structured according to the following four steps.

1. *Establish a research question*: The main goal of this paper is to establish and discuss the critera catalogue. This is supported by identifying existing approaches for specifying BPP, i.e. we deal with the question how BPP can be described. This question is embedded in a broader research programme as presented above.

Table 1. Common Attributes for describing BPP

Attribute	Description
Name, Description	General criteria for identifying a BPP. Particularly in large collection of patterns, it is necessary to provide a self-explanatory name for each pattern.
Problem	A detailed statement about the problem that is addressed by a BPP. The problem can be stated in various ways, e.g. goal-oriented by defining a desired outcome [2] or by indicating constraints a process model needs to adhere to [3].
Context	The context describes requirements that need to be satisfied for applying a given BPP. Several levels of abstraction are conceivable to define a context, ranging from a broad point of view (e.g. the structure of a company) to necessary process states.
Solution	The solution section is the core of a BPP description and defines the necessary steps to apply a pattern. Based on the formality of the pattern representation, it is possible to include graphical representations like BPMN or UML activity diagrams.
Effects	In this section, the results of applying a BPP are described. This can be achieved by a purely informal description of the context. Furthermore, it is possible to identify performance indicators that are influenced by a specific BPP [16]. Though most approaches focus on defining positive effects, it is also necessary to keep side effects in mind.

2. *Develop a search strategy for identifying relevant contributions*: We started the literature survey by reviewing publications of main conferences and journals in the BPM area, searching publication titles for *pattern*, *template*, and *Muster* (German for pattern). To extend these first results, we searched for the terms *process pattern*, *process template*, and *Prozessmuster* (German for process pattern) in the general literature databases ACM DL, IEEE XPlore, ScienceDirect, and SpringerLink. To conclude the survey, a forward-backward-reference search based on the found results is currently conducted.
3. *Establish inclusion and exclusion criteria*: We include academic and practical approaches dealing with BPP, e.g. papers presenting a pattern catalogue or general approaches on how to specify patterns. Furthermore, we consolidate contributions describing equal approaches.
4. *Analyse obtained results*: Since the focus of this paper is to present the criteria catalogue and to foster discussions about its applicability, the literature review is still in progress. We only use a small selection of identified literature for evaluating our catalogue. A rigorously and soundly evaluated criteria catalogue is an important requirement for comparing BPP approaches with each other.

The search strategy applied in step 2 is a result of the detailed classification of our review according to the taxonomy presented by [12]: The *focus* of our review is on identifying research outcomes and practical applications regarding

BPP. We conduct the review with the *goal* to integrate existing approaches by generalising and summing up central statements. In doing so, a consistent terminology can be established and used for building linguistic bridges between different BPP approaches. Furthermore, we compare existing approaches based on a given criteria catalogue. In conducting the review, we present approaches from a neutral *perspective*. In the ongoing review, we want to analyse recent literature as completely as possibly and, thus, seek an exhaustive *coverage*. However, in this work, we only present selected approaches to evaluate the criteria catalogue. Since we focus on abstract ideas of process model patterns, we *organise* the literature review conceptually. Finally, the intended *audience* of our review consists of scholars specialised in BPM.

3 Criteria Catalogue

We developed the subsequently presented criteria catalogue for comparing different BPP approaches with each other. Every criterion is either obtained from literature about classification of processes or established inductively during the literature review (depicted using the letter i in Tables 2, 3, and 4). To distinguish between different types of criteria, we divided the catalogue into the three classes *general* criteria, *representational* criteria, and criteria regarding the *features* of pattern approaches.

3.1 General Criteria

The criteria for a general description of BPP are presented in Table 2. Every pattern approach is classified according to a specific *type*. This criterion was established inductively during the literature review. The type is used to group approaches that are based on similar fundamental ideas and allows for an identification of the wide variety on how BPP are applied in science and practice.

- *Metamodel* The most generic approaches present BPP metamodels, i.e. they define the structure that a BPP catalogue or BPPs need to conform to [26]. These contributions are valuable, since they lay the foundation for specifying pattern catalogues. While a large collection of BPP is of great value for practice, the academic world is usually interested in justified metamodels.
- *Design Patterns* Similar to the well-known software design patterns [19], design patterns for processes are used to support modelling new processes. It is possible to use these patterns for combining predefined modelling elements at high levels of abstraction [4]. Furthermore, using design patterns may support process maintenance similar to effects found in software engineering [22].
- *Anti Pattern* Anti patterns define situations that must not or should not occur in process models. Patterns that must not occur usually violate predefined constraints that may evolve from legal or organisational requirements. Furthermore, it is possible to identify situtations that reduce the performance of a process and, thus, should be avoided. Based on the degree of

formalisation of the pattern representation, it is possible to automatically identify process parts with anti patterns. However, knowledge about anti patterns can also support creating better process models and to adhere to business process modelling guidelines [6].

- *Compliance Pattern* This type of pattern can be seen as the positive counterpart to anti patterns, since compliance patterns describe situations that process models need to adhere to. They are usually related to business rules which can, for example, be represented using the ECA paradigm (event, condition, action) [24]. Similar to anti patterns, compliance patterns might be triggered by legal or organisational requirements. Furthermore, it is possible to use compliance patterns as design patterns to foster the development of valid process models.
- *Mining Patterns* Unlike the aforementioned pattern types, mining patterns are the result of process mining activities in existing event logs. Thus, they represent situations that frequently occur in workflows. These patterns can be used to increase the understanding of a specific domain. For example, it is possible to identify co-occurring activities or order relations between activities [35]. Based on these data, tools for process modelling can be enhanced by recommendations [25]. Since mining patterns are more fundamental compared to the other pattern types, they can serve as an empirical basis for derive design patterns.

The *origin* describes the author of a pattern approach. It is possible to distinguish between patterns from research and patterns from industry. While scientific approaches are usually more complex and founded on a rigorous theoretical underpinning, approaches from practice are mostly tailored to specific challenges of companies and more lightweight. This criterion was adopted from [17].

The *scope* of a BPP determines its application area. Patterns can be tailored for a specific industry. In doing so, it is possible to compile a best practice catalogue. Contrary, there also exist pattern approaches that are not focused on one domain but provide a general method for the specification of BPP. The criterion was derived from the criterion domain used in [17]. However, the specific domains used as values are established inductively during literature review.

Access describes the availability of BPP. Organisations may have approaches to model BPP and pattern catalogues that are not publicly available due to various restrictions. In contrast, scientific approaches are often available for the public audience. Somewhere in between are BPP offered via limited access, e.g. by purchasing from third party providers. This criterion was adopted from [17].

In terms of analysing existing research approaches, the *pattern origin* is a valuable criterion. It is possible to deduce BPP by conducting case studies in different industries. In doing so, existing processes of companies are either manually or automatically analysed for the existence of patterns. A more academic approach is to review existing literature about processes and to identify commonalities. Finally, it is possible to (semi)automatically extract patterns by mining processes from event logs.

Table 2. General Criteria for Comparing Business Process Patterns

Criteria	Source	Values				
Type	i	Metamodel	Design	Anti	Compliance	Mining
Origin	[17]	Research			Industry	
Scope	i	Domain Specific			General	
Access	[17]	Closed		Limited		Open
Pattern Origin	i	Case Study		Literature Review		Process Mining

3.2 Representation of Business Process Patterns

The following critera address the representation of BPP and are summarised in Table 3. In general, every pattern needs to be defined in a specific *notation*. This can be done by using an existing notation, e.g. BPMN or UML. Furthermore, it is possible to extend an existing notation with necessary elements for representing BPP. On the one hand, these extensions can be facilitated by the used modelling notation. For example, UML provides capabilities to establish so-called UML profiles, an extension of the language w.r.t. the metamodel [28]. On the other hand, it is possible to extend the metamodel and to establish new notational elements. Besides using and extending existing notations, it is also possible to develop a new notation for representing BPP. This criterion was inspired by [17] where the criterion modelling language is used.

BPP can be represented using different degrees of *formalisation*. First of all, it is possible to describe BPP without any formalisation. This is often the case when patterns are described in natural language as a best practice catalogue for an organisation. Due to the lack of formality, these patterns can only be used as a starting point for modelling, since it is not possible to use them directly as modelling elements. Contrary to this, the syntax and semantics of BPP can be defined formally. Thus, the usage of patterns (formal syntax) and their meaning (formal semantics) is clearly defined. While informal description of patterns might lead to ambiguities and misunderstandings [36], formally defined patterns might be too restrictive. Since it is sometimes not necessary or not possible at reasonable expense to define formal semantics for every notational element, semiformal approaches exist. This criterion was adopted from [9, p. 59].

Similar to the formalisation degree, the *representation* of a BPP depends on the used notation. Patterns can either be represented textual or graphical. While textual representation may be based on natural language or formal logics, graphical representations use elements like rectangles and arrows to describe BPP. This criterion was adopted from [27]. Though existing research partly argues for using graphical representations to increase efficiency [39], it is susceptible to debate whether it is possible to transfer these finding to the BPP area.

To establish a catalogue of BPP, it is sometimes necessary to define *structural relations* between patterns. A rather simple approach is to indicate related patterns, e.g. patterns that solve similar problems or can be used in similar contexts. A more advanced approach for structuring a catalogue of predefined

Table 3. Representational Criteria for Comparing Business Process Patterns

Criteria	Source	Values		
Notation	[17]	Existing	Extension	New
Formalisation	[9]	Formal	Semi-Formal	Informal
Representation	[27]		Graphical	Textual
Structural Relation	i		Related	Hier. Restriction
Compositional Relation	i	Sequential	Hier. Composition	Notation Dependent
Level of Abstraction	i		L-0	L-1

patterns is to define hierarchic restrictions between these patterns. In doing so, it is possible to describe specification and generalisation relations.

Besides structuring the pattern catalogue, it is possible to define *compositional relations* to specify how patterns can be combined with each other. In a solely sequential way, patterns can be used as consecutive modelling elements. Furthermore, it is possible to compose complex patterns from more simple ones, i.e. patterns are organised in a hierarchical way. If patterns are presented in an existing process modelling language, it is also possible to use the patterns in combination with other modelling elements, i.e. the relations are notation dependent. The values of this criterion were established inductively during the literature review.

The *level of abstraction* on which BPP are presented directly affects the way patterns are applied during modelling. With a L-0-representation, patterns are presented on the same level of abstraction as process modelling elements. It is necessary to note that this does not directly correspond to the usage of an existing notation. Instead, patterns might be presented language independent for being applicable in different notations. If BPP are presented in a more abstract way than processes, we call this a L-1-representation. This criterion was inspired by existing literature about metamodelling, e.g. [11]. In this sense, L-0 approaches present BPP as models and L-1 approaches are metamodels for concrete models. This criterion might be susceptible to discussion, since notations for modelling business processes have different abstraction levels of their own. However, we present this criterion as it seems important for describing a pattern approach.

3.3 Features of Business Process Patterns

The last group of criteria describes features that are supported by approaches for defining BPP; it is summarised in Table 4. Existing notations for modelling business processes allow for modelling different *views*. For a holistic representation of patterns, it is necessary to cover not only one view. We analyse pattern approaches based on the support of these views. This criterion was established inductively during research. However, it was inspired by the separation of views according to [40]. In addition to the known views control flow, data flow, and resource, we add two new views. BPP supporting the message view allow for describing the interaction between different process participants. Approaches with

Table 4. Feature Criteria for Comparing Business Process Patterns

Criteria	Source	Values				
Views	i, [40]	Abstract	Control	Data	Resource	Message
Adaptability	i	Static	Design Choic.		Configuration Pts.	Formal
Guidelines	i	Yes			No	
Tool Support	i	Yes			No	
Predefined Patterns	i	Number				

an abstract view are not focused on a specific view but rather provide general descriptions of BPP.

The *adaptability* of BPP defines the degree to which the patterns can be customised for a specific use case. On the one hand, static BPP can be used to create new or evaluate existing models. However, there is no predefined way on how to adapt them for specific needs. On the other hand, there exist pattern approaches that define how patterns can be configured. This can be achieved on several ways, e.g. by giving modellers various design choices at hand, by defining fixed configuration points, or by using a formalised configuration approach. This criterion was established inductively during the literature review.

To increase usability of BPP, it is often necessary to lead modellers by giving them *guidelines* on how to use and combine patterns in different phases of the BPM life cylce, e.g. a handbook describing the application of patterns during process modelling. We analyse the pattern approach by means of existence of such guidelines. For the sake of brevity, we present this criterion based on a simple yes-no-distinction, since comparing guidelines is a separate research topic.

While a collection of patterns or a metamodel providing general pattern attributes contributes to the academic discussion about BPP, *tool support* is necessary for making pattern approaches applicable in practice. Depending on the type of the approach, a conceivable tool might be an implemented collection of reusable patterns for existing process editors. Furthermore, it is possible to develop tools for defining process models adhering to a specific metamodel. In this work, we do not detail the tool type but restrict the values to yes and no.

The last criterion we use is the amount of *predefined patterns* an approach presents. This criterion ranges from no predefined patterns to exemplary descriptions (e.g. in terms of use cases) to a given catalogue of patterns. Though the amount of existing patterns is no functional characteristic of an approach, it might indicate approaches that require additional evaluation.

4 Results

In this section, a first evaluation of the criteria catalogue described above is conducted by comparing ten BPP approaches from science with each other. It is necessary to note, that the number of BPP approaches presented does not raise the claim of a comprehensive survey. Since the focus in this stage of our research is to complete and evaluate the criteria catalogue, completeness is not required up to now. In the following, we present intial findings according to the different types general criteria, representational criteria, and feature criteria. We have selected the presented BPP approaches to point out a wide variety of different strategies.

4.1 General Criteria

Table 5 presents the evaluation of the analysed approaches regarding the general criteria of the catalogue. The most important criterion in this class is the type of a pattern. As stated above, it was developed inductively during the review process. Therefore, it was possible to classify every identified approach.

Table 5. Evaluation of general criteria

No.	Source	Type	Origin	Scope	Access	Pattern Origin
01	[16]	Metamodel	Science	Process Improvement	Open	LR
02	[18]	Metamodel	Science	General	Open	ISO standard
03	[4]	Design	Science	Configurable Processes	Open	LR
04	[8]	Design	Science	Social Processes	Open	LR, CS
05	[37]	Design	Science	General	Open	CS
06	[31]	Design	Science	General	Open	?
07	[34]	Design	Science	Change Management	Open	CS
08	[35]	Mining	Science	General	Open	PM
09	[5]	Anti	Science	General	Open	CS
10	[38]	Compliance	Science	General	Open	CS

For this paper, the review was restricted to academic contributions. Therefore, every pattern approach originates from science and is, thus, open to the public. This allows for discussing the approaches and comparing them with each other. However, the restriction to academia is a severe limitation, too. It is reasonable to assume that a multitude of pattern approaches exist in organisational practice. Particularly considering the fact that companies maintain process repositories of hundreds or even thousands of process models [15], it would be naive to assume that practice is waiting for academic pattern catalogues. However, academia can foster the pattern discussion in practice by providing new methods for identifying and describing BPP.

The interrelationship between practice and academia can be seen in the evaluation of the pattern origin criterion, too. Most of the BPP approaches presented here are based on case studies (indicated by CS in Table 5) and on literature reviews (indicated by LR). However, there is also an approach describing BPP identified via process mining (indicated by PM) and one approach that established BPP according to an existing ISO standard. By utilising case studies, process mining, and ISO standards, it is possible to develop BPP that are found in practice. Contrary, scientifically grounded patterns might be found by literature reviews.

4.2 Representation of Business Process Patterns

In Table 6, the evaluation of the representational criteria is summarised. The abbreviations in this table need to be interpreted as follows. The second column notation contains shortcuts for natural language (NL), UML Activity Diagrams (UML AD), Event Driven Process Chains (EPC), and Semantic Business Process Modeling Language (SBPML). The values in the third column (degree of formalisation) are either formal (F) or semiformal (SF). Column 4 depicts whether a BPP approach is based on graphical (G) or textual (T) representation. The structural and compositional relations between BPP are represented as HR (hierarchic restriction), RP (related patterns), ND (notational dependent), and HC (hierarchic composition). The last column represents the level of abstraction.

Table 6. Evaluation of representational criteria

No.	Notation	Form.	Repres.	Struct. Relations	Comp. Relations	Abs. Lev.
01	NL,UML	SF	T,G	RP	ND	L-1
02	NL,UML AD	SF	T,G	none	ND	L-1
03	Abstract	SF	T,G	none	ND	L-1
04	BPMN Extension	SF	G	HR	ND	L-0
05	UML AD	SF	G	RP	ND	L-0
06	Petri Nets	F	G	HR	HC,ND	L-0
07	NL,EPC	SF	G	none	ND	L-1
08	Formal Logic	F	T	RP	n/a	L-1
09	SBPML	SF	G	none	ND	L-0
10	Abstract	SF	T	none	ND	L-1

It is noticeable that all approaches present BPP at least semiformally defined. This is due to the fact that the description of BPP is usually not restricted to natural language but rather supported by graphical representations using an existing process modelling language. This method has two benefits. First, the natural language definition allows for a detailed description of the problem and context factors addressed by a specific BPP apporach. Second, the graphical representation can be used as a starting point for using a BPP either for creating new models or for searching for patterns in existing models.

The evaluation of the criteria unveils a correlation between used notation and compositional relations. Of course, BPP of approaches based on an existing notation can be combined according to the rules of this notation, i.e. their compositional relations are notationally dependent. The same holds for BPP approaches that are not tied to a specific notation but use an abstract representation. On the one hand, this can be achieved by giving guidelines for implementation of a BPP in different languages (e.g. [4] presents implementations for Configurable EPCs [30] and for Provop [21]). On the other hand, formal logics can be used to specify restrictions processes need to adhere to [38].

An interesting result regarding the compositional relations criterion is revealed by the mining approach number 08. The criterion is not applicable for mining patterns, since it cannot be said in which form BPP are mined from existing process logs. In [35], formal logics is used to specify the mined BPP. Thus, compositional relations between these patterns are at least conceivable.

4.3 Features of Business Process Patterns

The results concerning the evaluation of feature criteria are presented in Table 7. In the second column presenting views of the BPP approaches, shortcuts for control flow (CF) and message flow (MF) are used. The criteria guidelines and tool support are presented solely based on a yes-or-no evaluation. However, a no in these columns does not automatically indicate that there is no support for these BPP approaches. In particular, for approaches based on existing process modelling languages, it is not necessary to develop distinct software tools. Instead, it is possible to reuse existing tools, possibly enhanced by pattern repositories. The same applies for guidelines that exist for process modelling languages, too.

Table 7. Evaluation of feature criteria

No.	Views	Adaptability	Guidelines	Tool Support	Predefined Patterns
01	Abstract	Static	No	No	2
02	CF	Static	Yes	No	1
03	CF	Design Choices	No	No	10
04	CF,MF	Static	Yes	No	7
05	CF,MF	Design Choices	Yes	Yes	7
06	CF	Static	Yes	No	43
07	CF	Config. Points	No	No	14
08	CF	n/a	No	No	n/a
09	CF	Static	No	No	18
10	CF	Static	Yes	No	16

The prevalence of approaches focussing on the control flow must not be considered as an indicator for evaluating a broader amount of BPP approaches. Instead of this, it is entirely based on the subjective selection of presented approaches. Particularly, the workflow patterns community has published several techniques for defining other views, too. The interested reader is referenced to the seminal works about data flow [33] and resource flow patterns [32].

Contrary to this, the prevalence of static BPP approaches can be seen as more representative. This is attributable to the used process modelling languages, since most of them do not support process configuration [30]. To overcome this shortcoming, BPP approaches present different design choices for several BPP. For example, approach 05 presents at least two variants of every BPP resulting in different UML Activity Diagrams. Approach 07 pursues another strategy. Instead of defining configurable BPP, they define BPP elements that can be combined according to predefined configuration rules.

5 Conclusion

During the evaluation of the criteria catalogue, several questions arose which should be discussed in this section. A major challenge we had to deal with, is the lack of a rigorous BPP definition resulting in discussions about what counts as a BPP and what not. Though in general it is clear what is meant by the word pattern, this might be controversial for concrete approaches.

As stated above, the definition given by [29] includes that patterns need to be an "abstraction from a concrete form". However, this might not be applicable for BPP that are defined in an existing process modelling language and, above this, for BPP in abstraction level L-0. Since these BPP can be directly used as modelling elements, one might argue that these are not patterns but process parts. Though the decision whether an approach describes BPP does not severly influence the criteria catalogue, it needs to be considered during literature review and empirical evaluation of the catalogue.

During classification of BPP approaches according to the criteria, it was sometimes difficult to assign a type to a specific BPP approach. It has been shown that the types design, anti, compliance, and mining pattern might not be mutually exclusive. This is due to the fact that this criterion is based on the usage of a BPP. However, it is possible to use a specific BPP in more than one way, e.g. using compliance patterns as design patterns. Furthermore, transformations between anti patterns and compliance patterns are conceivable. However, we still argue for this criterion from a practical point of view, since it allows for a simple classification of BPP approaches.

In this paper, we propose an approach for establishing a unified BPP terminology and first steps for integrating existing BPP approaches. In doing so, we have identified the two criteria structural relations and compositional relations that seem of special importance for future research. It can be expected that BPP approaches allowing for the definition of relations between BPP can be combined with approaches by other authors more easily. This is due to the fact that these relations can be used to identify commonalities between different BPP.

Currently, the criteria catalogue is limited by two shortcomings that need to be overcome in future research. Though we conducted a first evaluation of the criteria, we cannot ensure consistency of the classification as of yet. Instead, we present the catalogue as a basis for discussion to increase its rigour. Using the results of the literature survey, the catalogue can be further strengthened by evaluating inter-rater reliability and, if necessary, adjust criteria.

The second shortcoming is a result of the criteria used so far. Currently, the majority of them can only be applied to classify existing BPP approaches according to several characteristics. In doing so, it is possible to identify BPP approaches that meet specific requirements. For example, a process modelling project for automated processes needs to adhere to other requirements than modelling highly collaborative human processes. While the first might lay its focus on the control flow perspective, the latter needs distinguished message flow support. Chances are that it is possible to automate this step based on a catalogue of requirements that are linked with specific BPP characteristics.

However, the catalogue currently does not contain quality criteria like soundness or robustness. For example, completeness of BPP descriptions can be evaluated based on the structure presented in Table 1.

In the long run, the integration of BPP approaches should increase process modelling efficiency and effectivity by supporting modellers. Using BPP, it is possible to reduce errors that often occur during modelling [13] and to simplify business process improvement [16]. By using a unified terminology, existing tools for process modelling can be enhanced by pattern catalogues that are not limited to a single approach.

Our next research step ist to extend the criteria catalogue based on the feedback of the scientific community. The final outcome of this step should be an extensive catalogue consisting of both descriptive and discriminative criteria. The catalogue is continuously evaluated by means of the BPP approaches identified during the literature review. This should have a twofold effect: besides classification, the catalogue is further strengthened. Based on the evaluation of existing BPP approaches, our research aims at identifying use cases for applying BPP to model complex business services. Since services need to be modelled according to different views [10], it is of special importance to combine different BPP approaches with each other.

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