

## Application of Business Process Quality Models in Agile Business Process Management

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**Abstract**— The increasing complexity of business process management projects requires a methodology that supports the tight and efficient collaboration between customer and process analysts. For that purpose, the agile methodology that is well-known in software projects has been transferred to business process management. However, in these agile environments governance regarding the designed processes is necessary for ensuring their high quality. This article demonstrates how to apply quality models for business processes in agile business process management environments and its specific challenges. To illustrate the application, a business process in the context of offer management has been captured by means of this approach.

**Keywords**— *business process; design; quality; agile; ISO 25000.*

### I. INTRODUCTION

High business process flexibility is required for companies to counter current challenges. Fast and efficient adaptability to business processes becomes an increasingly important competitive factor [1]. Explicit knowledge about the structure and functionality of business processes is essential for the understanding of organizational sequences [2]. A targeted enhancement of Business Process Management (BPM) with the help of agile advantages generates new significant potential for the automation, modeling, interaction and optimization of business processes. Therefore, different (agile) approaches have been developed. The idea of agility is described as the ability to balance flexibility and structure [3] and to minimize risks for instance by conforming project changes rapidly [4]. One of these approaches is called BPM(N)<sup>Easy1.2</sup>.

With BPM(N)<sup>Easy1.2</sup> an agile BPM method is introduced [5][6]. BPM(N)<sup>Easy1.2</sup> describes a combination of Business Process Management and Business Process Model and Notation (BPMN) with the ambition of making BPM easier. The major intention of the method is to provide aspects of agile software engineering for BPM. The approach extents and supports the interaction between every participant with focus on more coherency without confronting them with unneeded complexity. Furthermore, it follows an empirical, incremental and iterative concept to increase predictability

of the process quality and to reduce project risks [5]. Hereby the efficiency and effectiveness of BPM will be enhanced.

However, within the prediction and control of the business process quality the participants have to know what constitutes a good process and how to evaluate processes [7]. But there are no general rules which define what a good process is. Aspects, such as the customer value, process standardization, and the employee well-being, can be a signal [8]. But this information is not sufficient to perform a systematic or even automatic quality analysis of business processes. Aggravating this situation, contradictory constraints and needs – for instance speed and quality – generate the need to focus on the delivering value [9].

To enable a systematic quality assurance in agile BPM, this paper introduces the application of quality models and quality gates. Quality gates define a specific point within a project to evaluate determined maturity and sustainability [10]. These quality gates ensure the synchronization and acceptance of all participants. For instance, an automated business process has to correspond with all predefined requirements and expectations. The introduced quality gates are supposed to close the gap especially at the beginning and during the business process modeling step. In the area of BPM and business process quality measuring, different approaches already exist. As quality model, these existing quality assurances are reused as well as evaluated and adapted [11] for applying and measuring them in BPM environments. Especially agile environments with short iterations and high interaction are suited for the continuous monitoring of the business process quality.

The paper is organized as follows: Section 2 analyses relevant literature regarding quality models for BPM and their application for agile BPM. In Section 3, the application of a certain business process quality model in agile business process management is illustrated by means of a scenario from offer management. Section 4 introduces the BPM(N)<sup>Easy1.2</sup> method and demonstrates where quality models can be applied within an agile approach. In addition, a possible tool support is shown. The last section presents a conclusion and outlook.

## II. RELATED WORK

This section describes the fundamental terms and existing work in the context of measuring the quality of business processes. For that purpose, work that targets the quality from both a functional and a technical point of view is considered. Furthermore, this work is examined in detail regarding its applicability in agile BPM environments.

The International Organization for Standardization (ISO) and the International Electro technical Commission (IEC) have created standards regarding the quality of software products. Both ISO/IEC 9126 [13] and the successor ISO/IEC 25000 ff. [14] define relevant terms for software product quality. Furthermore, they describe quality characteristics, their subcharacteristics, and their final quality measure elements. They hereby provide a wide overview of measuring the quality of software products. In order to apply these standards on business processes, the term “business process” has to be distinguished from “business process model”. As the standards refer to software products, they can only be directly applied on business process models as software artifacts. Also, in this case, only a subset of described characteristics is applicable. Heinrich et al. [16], Sánchez-González et al. [17], and YeonSeok et al. [18] show the adaptation of these standards on business process models. However, according to the introduction, we focus on the quality of business processes and their content instead of the models as software artifacts and their syntactical correctness etc. For that reason, the standards cannot be applied directly. Nevertheless, they provide good hints about characteristics that might be important for business processes as well.

Further standards regarding quality management focus on quality management systems. Examples are ISO 9000 ff. [15], or branch-specific manifestations, such as the European Norm (EN) 9100 for aerospace. There also exist standards for the quality management in projects, such as ISO 10006. Even though they consider the quality in business domains and in some cases also describe business processes, the quality of the business processes themselves is not explained in detail. This is also the case when choosing Capability Maturity Model Integration (CMMI) or IT Infrastructure Library (ITIL).

In [8], Krogstie describes criteria for so-called good processes. He introduces dimensions of value that is valid for most customer groups. Furthermore, he summarizes heuristics for good business processes. Even though no metrics are provided, these heuristics can be good starting points to derive more concrete quality aspects that again enable a systematic and automatic evaluation of business processes. In addition, this work helps to understand the purpose of business processes and why it is important to have good processes. Thus, it forms the framework for a quality model as it focuses on the motivation and strategic goals of business processes.

In order to enable a more systematic quality analysis of business processes, Kneuper created the quality model Gokyo Ri based on existing standards, such as ISO 9000, CMMI, and ITIL [19]. It refines the quality of business processes so that their quality can be determined. Even

though this quality model focuses on business processes and their content, the quality model is still too abstract to be used in agile business process management environments. In agile projects the quality has to be determined in short intervals best automated based on modeled business processes. Thus, Gokyo Ri has to be further refined until at least a subset of the quality attributes can be determined automatically or with short user interaction intervals.

Similarly, Lohrmann et al. introduce quality attributes for business processes [7]. Also, in this case the quality attributes are derived from business-related quality concerns and focus on the content of the business process and not the artifact. Lohrmann et al. distinguish between the efficacy and efficiency of business processes that can be either determined on basis of business process models and running instances. Former is called business process design and implement efficacy and efficiency. Latter is described as business process enactment efficacy and efficiency. Even though Lehrmann et al. do not describe an entire quality model, they introduce quality attributes that are relevant for the business process quality as considered in this article. Nevertheless, similar to the quality model introduced by Kneuper the quality attributes are still too abstract to be applied in an agile environment. They first have to be refined so that they can be determined either based on business process models or by answering simple questions by process analysts.

Regarding a more technical point of view, Suarez et al. [20] describe best practices for modeling business processes using certain languages, such as the Business Process Model and Notation (BPMN). Even though this article also focuses on BPMN as modeling language, these best practices mostly consider syntactical correctness of created models or related issues. The content of the processes and their quality from a functional point of view is not considered. The described best practices are also not aligned with a holistic quality model. So, the impact of these best practices on abstract quality characteristics is not obvious. The best practices can increase the quality of modeled business processes. They are also applicable in agile business process management environments as they can be easily determined or can be even measured automatically by tools. Nevertheless, they do not target the kind of business process quality considered in this article.

Thus, this overview shows that there exists work considering the quality of business processes from a functional point of view as required in this article. However, the introduced quality attributes are too abstract to be measured directly and especially too heavyweight to be determined in agile environments. Other work focuses on fine-grained quality aspects, such as syntactical correctness that can be easily determined, however does not provide value for the quality of business process from a functional point of view. This article shows how to fill this gap by reusing existing work as introduced by Lohrmann et al. [7] and breaking these quality attributes down into aspects that can be either directly measured on business process models or easily answered by process analysts.

The methodology applied in this article has already been successfully applied for service-oriented architectures [12]. Also, in this case, existing abstract quality attributes were refined to enable a fully or partially automated quality assurance. As result, a solution was created to ensure the systematical creation of a flexible and maintainable architecture.

### III. SCENARIO

A sample business process model has been selected to apply the quality model. The business process model originates from a real business process model repository of an industry partner. The model describes the business process of an “offer creation”. The activities consider the aspects from setting up a new offer until sending it out to a potential customer. The business process model is modeled with BPMN<sup>Easy1.2</sup>. BPMN<sup>Easy1.2</sup> is a business process modeling language which uses BPMN 2.0 [21] but reduces the complexity of the first modeling step. In the second step, the model can be enriched and used, e.g., for business process automation. Fig. 1 shows the business process model.

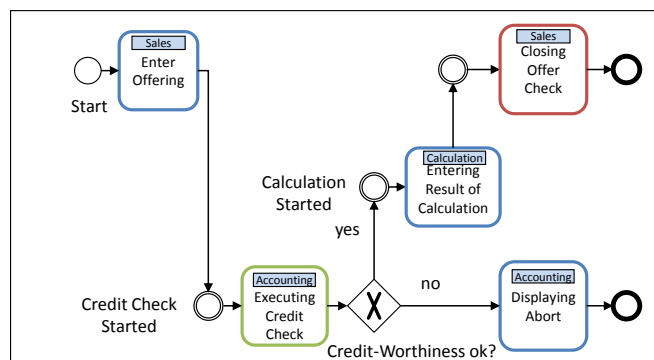


Figure 1. Offer creation business process.

The business process requires three roles: Sales, Calculation and Accounting and follows two different paths. In case of a successful credit check the Sales can finalize the offer otherwise the business process will be aborted. During the scenario the first draft of the business process model has been designed. BPMN<sup>Easy1.2</sup> provides three different activity types: manual (green form), semi-automated (blue form) and automated (red form). For instance, the “Enter Offering” activity is computer-aided and can be defined as a semi-automated activity. In addition, the required user stories have been described according to an agile methodology. To verify the correctness, participants interacted with each other closely. To prove the quality of the business process model it was necessary to use a specified quality model. In the following section, the developed quality model will be applied to this business process.

### IV. APPLICATION OF BUSINESS PROCESS QUALITY MODELS IN AGILE BUSINESS PROCESS MANAGEMENT

In order to apply a certain business process quality model in an agile business process management project, several questions have to be answered. These constitute the structure of this section.

#### A. Agile BPM

There are different approaches to agile BPM e.g. [5] [22] [23]. In the following section the agile approach BPM(N)<sup>Easy1.2</sup> [5] is used to show when (time of application) during the methodology the quality model is expected to be applied. BPM(N)<sup>Easy1.2</sup> enables highly sophisticated agile Business Process Management. It covers all aspects of Business Process Management – from process design and process execution to process controlling with focus on the integration of all process participants. The following Fig. 2 provides an overview of the approach and the including quality gates. Latter are displayed as stars:

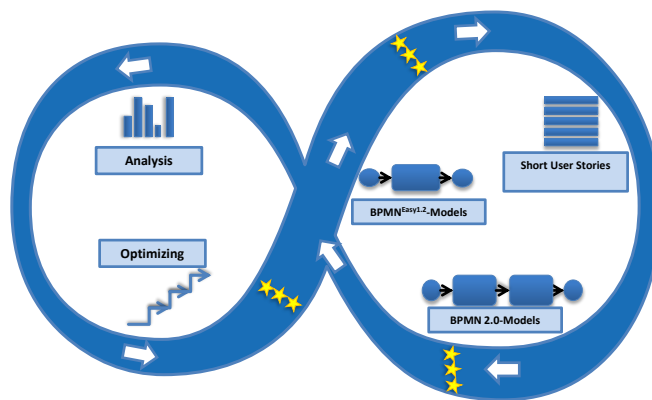


Figure 2. Illustration of the BPM(N)<sup>Easy1.2</sup> approach.

The approach consists of two connected cycles. One cycle is used to capture new BPMN<sup>Easy1.2</sup> models and short user stories. Both BPMN<sup>Easy1.2</sup> models and short user stories formulate the requirements of the activities within a business process. The BPMN<sup>Easy1.2</sup> models are used to design the flow in general and set up a first model very easily. The short user stories describe additional information, e.g., additional business rules. The formulated requirements are the basis for the modeling and implementation of an enriched BPMN 2.0 business process. For the enrichment a BPMN<sup>Easy1.2</sup> model and a number of user stories are selected to work on. Furthermore, the business process is modeled on the business user’s point of view. In addition, in consultation with a business user, an IT expert is able to use the business process model to automate the process. Once the modeling and implementation stages are completed the resulting BPMN 2.0 models are transferred to a final control. Within this control all participants assure that the result e.g. an automated business process corresponds with the BPMN<sup>Easy1.2</sup> models and formulated short user stories (synchronization and acceptance).

Immediately after the acceptance, new requirements can be taken and transformed into a business process model or implementation. If defined key performance indicators show optimization potential (analysis and optimizing cycle), new BPMN<sup>Easy1.2</sup> models or short user stories will be generated. The several iteration and high collaboration between every participant allows the continuous monitoring of the business process quality [5].

However, in general there are still different weak points in agile methods. Mohammad [24] says short response times and high interaction during the agile development do not require the writing of documents which can lead to a reduced quality of documentation. Furthermore, Mohammad [24] mentions the increased collaboration time of the participants. But in fact in some circumstances there is not enough time for the required coordination or the participants are not at the same (physical) location [24]. In [25], agile methods are described as a risk of large or complex projects. The magnitude of uncertainty is increased. Therefore agile methods are mistrusted in most organizations. To counteract these disadvantages and related lack of quality it is required to introduce quality checks during the application of an agile approach. In [26], quality checks are suggested to be applied to different steps of agile approaches.

According to [26] and with the assumption that software engineering has the same goals as Business Process Management, e.g., cost reduction, collaboration enhancement, the quality gates listed in Table I are suggested for agile BPM approaches:

TABLE I. QUALITY GATES

Quality Gate	Time of Application	Comment
1	Formulation of user stories	Continuous feedback and collaboration between every participant
2	Modeling of business process	
3	Automation of business process	Test of process application
4	Acceptance testing	

Today, some of the quality gates have already been implemented to assure the determined quality. For instance, the quality gate 1 can be applied by a continuous feedback process between every participant or by means of standard assurance tests of the process application [27]. For quality gates 1, 3 and 4 methods already exists, which can be used to assess the quality e.g. real tests of a process applications.

Therefore, in this article, the quality gate number 2 that is applied during the modeling of business process is considered to improve and guarantee the expected quality.

### B. Quality Model Choice and Adaptation

In the previous section, quality gates during an agile methodology have been identified. One quality gate considers the quality of modeled business process. In order

to support this quality assurance, an appropriate quality model has to be prepared. For that purpose, first the most appropriate existing quality model has to be identified. Afterwards, its direct applicability has to be verified. As described in Section II, appropriate quality models are those introduced by Lohrmann et al. [7] and Kneuper [19]. However, in both cases, the introduced quality attributes have to be adapted for requirements in agile environments: As mentioned before, the quality of business processes has to be determined in short intervals, which again requires a quality analysis to be easy and lightweight. This requirement cannot be fulfilled by these existing quality models and the contained quality attributes. They are not formalized using metrics which hampers their automatic determination based on business process models. Furthermore, the informal description requires interpretation effort that can result in misunderstandings and thus wrong measures. This is a typical issue when performing quality analyses and has already been identified for other domains, such as the quality analysis of service-oriented architectures by Gebhart et al. [28][29].

Thus, after choosing a certain quality model, the quality attributes have to be refined if necessary until more fine-grained and comprehensible quality attributes are identified so that no interpretation is necessary any longer. They are called quality indicators, formalized as metric, and return a measure. It is not necessary that a quality indicator can be fully automatically measured on process models. If this is not possible as they require further knowledge, such as domain knowledge, the only condition is that it is possible to formulate unambiguous questions that can be answered by experts and do not require interpretation. Summarized, for every function and variable used within a metric, the criteria listed in Table II have to be fulfilled.

TABLE II. CRITERIA FOR FUNCTIONS AND VARIABLES IN METRICS

Criterion	Description
Technology Representation <i>for variables and functions</i>	A variable or function represents a certain aspect within the considered technologies, i.e., business process models in this case. This enables an automatic measurement.
Comprehensible Question <i>for variables and functions</i>	If Technology Reflection is not fulfilled, for example if expert knowledge is necessary, a comprehensible and unambiguous question can be formulated that can be answered by experts and does not require interpretation.
Composition <i>for functions</i>	If the previous criteria are not fulfilled, the considered function is composed of other functions using automatically measurable operators.

In this article, the quality model and its attributes introduced by Lohrmann et al. [7] are chosen. The refinement and application in an agile environment is exemplified by means of two quality attributes and their correlating quality predicates.

1) *Controlled resource consumption in activities:* According to Lohrmann et al. a business process fulfills this predicate when activities within the process are designed to avoid materials waste and capacity waste. This information is too abstract to be comprehensible on a certain business process model as it is not explained how this waste is reflected in process design. For that reason, the predicate and its quality attribute have to be refined into quality indicators.

For this purpose, best practices that could be identified in earlier projects are tested for their suitability to represent the considered predicate and its quality attribute. One best practice suitable in this case is that for every role at least two persons have to be available. This ensures that in case of a person being absent still another person can continue the work and other persons do not have to wait and to be idle, which represents a capacity waste. As the predicate refers to the business process as a whole, also the refinement has to be measured on the entire process. Thus, the indicator measures the degree to which the participating roles have more than one person assigned. This indicator can be formalized as metric (1) similar to the ones introduced by Gebhart et al. in [28]. Table III describes the used elements.

$$PAR(bp) = \frac{|F(R(bp),r,HSP(r))|}{|R(bp)|} \quad (1)$$

TABLE III. VARIABLES AND FUNCTIONS USED FOR PAR (1)

Element	Description
PAR(bp)	<i>Person Availability of Roles:</i> Degree to which roles in business process bp have more than one person assigned
R(bp)	<i>Role of Business Process:</i> roles used in business process bp
F(e, v, c)	<i>Filter:</i> filter the elements e by condition c that uses the variable v as iterator
HSP(r)	<i>Role Has Several Persons:</i> true if role r has more than one person

TABLE IV. FULFILLED CRITERIA FOR PAR (1)

Element	Fulfilled Criteria
bp	Technology Representation: The considered business process is represented by the BPMN process file
PAR(bp)	Composition: This function is composed of other functions and all operations can be automated.
R(bp)	Technology Representation: The roles are represented by the pools and lanes within the BPMN business process model
F(e, v, c)	Composition: This function is requires other functions as input and the filter operation can be automatically performed.
HSP(r)	Comprehensible Question: This aspect is not measurable on standard BPMN 2.0 artifacts. Thus, it has to be answered by an expert, but the question is easily to understand, unambiguous and comprehensible: "Are more than one person assigned to role r?" As input, a boolean value is expected.

In order to prove the suitability of this quality indicator as quality indicator in an agile environment, in Table IV for every element used in the formalization the criteria introduced in Table II are checked. As mentioned before, we assume business process models using BPMN 2.0 [21].

For the sake of simplicity, we focus on this best practice as solely quality indicator for the considered predicate. If further best practices, standards, or guidelines can be identified as influencing quality indicators they can be added later and have to be weighted.

Applied on the scenario introduced in Section III, the metric returns a value less than 1 as we assume that not every role is filled by at least two persons yet, i.e., HSP(r) is not true for all roles. Table V shows how to interpret this value. In order to fulfill the predicate of controlled resource consumption in activities, the metric is expected to return 1 as desired value. Thus, the business analyst is made aware to ensure that some further persons have to be assigned to roles with only one person. Even though if this is not possible, the business analyst gets the information that this fact represents a critical point for the efficiency of the business process.

TABLE V. INTERPRETATION OF VALUES FOR PAR (1)

Value	Interpretation
0	No role within the business process is filled with at least two persons
Between 0 and 1	Some roles are filled with less than two persons
1	All roles within the business process are filled with at least two persons

2) *Controlled skill employment:* A business process can only be efficiently performed when skill employment is controlled. According to Lohrmann et al. [7], this quality attribute or predicate is fulfilled when all activities are documented and trained. This refinement can be used as measurement. In BPMN, these activities are represented by manual tasks or tasks that are not further specified yet.

$$CSE(bp) = \frac{DT(bp)+TT(bp)}{2} \quad (2)$$

$$DT(bp) = \frac{|F(MT(bp),t,D(t))|}{|MT(bp)|} \quad (3)$$

$$TT(bp) = \frac{|F(MT(bp),t,T(t))|}{|MT(bp)|} \quad (4)$$

TABLE VI. VARIABLES AND FUNCTIONS USED FOR CSE (2, 3, 4)

Element	Description
CSE(bp)	<i>Controlled Skill Employment:</i> Degree to which skill employment is controlled in business process bp
DT(bp)	<i>Documentation of Tasks:</i> Degree to which manual tasks in business process bp are documented.
D(t)	<i>Documentation:</i> true if task t is documented
TT(bp)	<i>Training of Tasks:</i> Degree to which manual tasks in business process bp are trained.
T(t)	<i>Training:</i> true if task t is trained

Also, in this case, all used functions and variables are described in Table VI. They fulfill the required criteria described in Table II. The manual tasks represent certain aspects within the technology and the other functions are either composed of others or comprehensible questions can be formulated as for D(t) and T(t).

Applied on the scenario we assume that all tasks represent manual tasks as automation has not been specified yet. When the metric is calculated, the business analyst has to answer, whether all these tasks are documented and trained. We assume that the business analyst realizes now that this is not the case. Only some tasks are documented and trained. Thus, the metric returns a value less than 1. The interpretation of this value is shown in Table VII.

TABLE VII. INTERPRETATION OF VALUES FOR CSE

Value	Interpretation
0	No manual task within the business process is documented or trained
Between 0 and 1	Some manual tasks within the business process are documented and trained
1	All manual tasks within the business process are documented and trained.

By applying the refined metrics, the business analyst is made aware that the documentation and training is important for the efficiency of the business process. If the metric returns a value less than 1 the analyst gets the information that further documentation and training effort is necessary.

C. Tool Support

In order to increase the efficiency of quality analyses especially in agile environments, an appropriate tool support is necessary. For that purpose the already existing QA82 Analyzer [30] (Fig. 3) can be applied as it is suited for agile environments and hybrid quality indicators identified in the previous section.

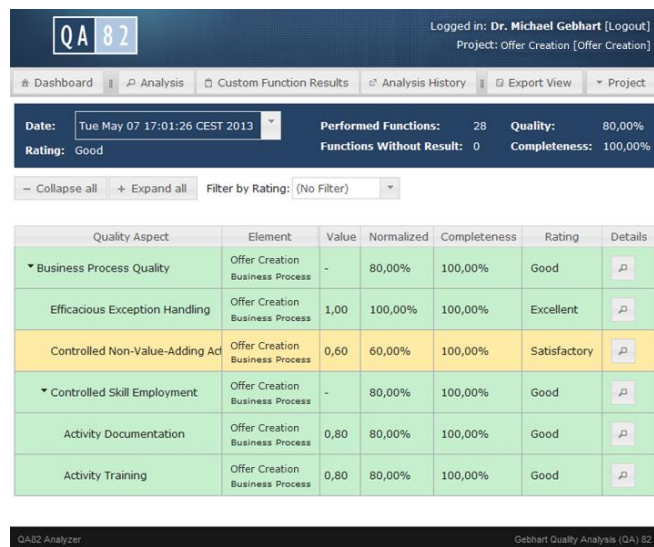


Figure 3. QA82 Analyzer to analyze business process.

First, it supports the integration of custom quality models and combines the measure of model elements with questions that can be answered by experts, i.e., process analysts in this case. Second, the QA82 Analyzer can be integrated in business process modeling tools, such as BPM(N)<sup>Easy1.2</sup>, using web services. This enables the display of quality analysis results directly in existing environments. Finally, the QA82 Analyzer allows the provisions of advices about how to improve the quality. As result, process analysts can model business processes using their modeling tool and directly get hints about how to design the process to improve their quality based on the custom quality model.

For that purpose, the quality model based on the quality attributes of Lohrmann et al. and the derived quality indicators has to be formalized and integrated into the QA82 Analyzer. This includes the mapping of functions to technology, i.e., to BPMN 2.0 artifacts, and the formulation of appropriate questions if necessary. As result, the QA82 Analyzer can be used to apply the identified quality indicators on any BPMN 2.0 compliant business process.

V. CONCLUSION AND OUTLOOK

In this article we demonstrated the application of business process quality models to support agile business process management and to assure a high quality of created solutions. For that purpose, we exemplarily chose the quality model introduced by Lohrmann et al. [7]. We identified the essential challenges and showed how to address them. First, the application of business quality models was aligned with an agile methodology. As essential deficit the abstraction of available quality attributes was identified. To solve this issue, we demonstrated how these quality attributes can be refined to be applicable in agile environments. Finally, we illustrated necessary tool support to increase the efficiency of quality analyses.

To illustrate our work, a scenario in the context of a real offer creation business process was chosen. The refined quality attributes enabled the systematic analysis of this process and the results helped the process analysts to revise the process and its environment in a quality-oriented manner. Even though the quality of a business process includes a lot of further aspects not covered in this article, the application of a fine-grained quality model increases the awareness of relevant aspects and supports the creation of high-quality business processes.

Thus, our approach enables companies and their process analysts to increase the quality of created business processes whilst reducing at the same time effort and costs for quality assurance. Process analysts can create business process models using their preferred modeling tool, such as BPM(N)<sup>Easy1.2</sup>, and directly receive feedback about their quality. Finally, derived advices are shown and help them to improve the created business models with regard to quality attributes that influence business-related goals.

Next, we will consider further quality attributes and derive appropriate quality indicators to enhance the created quality model. As described in this article, we will focus on reuse of existing quality attributes.

We also plan to refine the tool support. In particular, the integration with existing modeling tools has to be enhanced. Finally, the approach is expected to be applied in further business process management projects to identify advantages and also weaknesses that have to be examined.

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