Developing a Process Quality Improvement Questionnaire – A Case Study on Writing Discharge Letters

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Abstract. Business process quality assessment plays an important role in business process management. Business process quality is often assessed by identifying potentials for improvement. In practice, a questionnaire is a commonly used means. However, creating a questionnaire requires a high expertise because systematic approaches are missing. Moreover, questionnaires for process improvement often focus on single quality aspects. In this paper, we describe a systematic approach to create a questionnaire to identify business process quality problems. The approach is based on a comprehensive business process quality model. We applied the approach in a case study at a German university hospital and present results of the preliminary evaluation phase.

Keywords: Business Process Quality, Business Process Quality Improvement, Quality Model, Health Care Process, Case Study

1 Introduction

Business process quality is a central aspect of business process management. However, it is not easy to capture quality adequately. One means to capture quality is benchmarking [2]. Benchmarking assesses quality in an abstract way, for example by comparing Key Performance Indicators between organizations or classifying processes in a maturity model like COBIT [12] or the BPMM [15]. However, benchmarking does not provide insights in specific quality problems. To capture details on quality problems several techniques are available such as analyzing the process output, monitoring errors of involved IT systems or asking for the actor's opinion. In this paper, we focus on the identification of process quality problems from the actor's view. Therefore, a questionnaire is an effective means. However, developing such a detailed questionnaire to identify business process quality problems is a non-trivial task. It requires a lot of a priori knowledge, for example, of the domain, the process to be assessed or typical problems. Often, this task is not performed in a systematic way.

Moreover, questionnaires for business process improvement often focus on single quality aspects. For example, [5] mainly focuses on time and cost aspects of a process. [4] considers effectiveness and resource utilization. Both do not consider e.g. safety, analyzability or maturity of the process. One reason for this may be that there is no common quality model for business processes. In contrast, software product quality is standardized in the ISO/IEC 9126 quality model [9]. We developed a comprehensive quality model for business processes [7], [8] which is based on software product quality standards and allocated quality aspects from business process management literature. The model aims at providing a common view on business process quality. It serves as a basis for business process quality improvement, business process quality simulation, support for management decision and quality requirements elicitation.

In this paper, we describe one possible application of our model in practice. We show how to develop a questionnaire to identify quality problems from the actors' view. Thereby, the quality model serves as a checklist. To evaluate the approach we are conducting a case study in cooperation with the University Hospital Heidelberg. The case study is conducted in the hospital context as especially in the medical domain business process quality plays an important role [4]. In this paper, we present our experience gained in the preliminary evaluation phase.

The paper is structured as follows: In Section 2, as a background, we present our research on a comprehensive and practically relevant quality model for business processes. Section 3 discusses related work. Section 4 describes our approach to identify quality problems. Section 5 presents the case study and describes the results of a preliminary evaluation. Section 6 concludes the paper and presents future work.

2 Background

Process quality is in the focus of research and practice since some decades in the quality initiative domain and there are many high level and expert based techniques like TQM, Kaizen or Six Sigma. [17] gives a good overview of quality initiatives. However, a comprehensive and detailed view on the – in particular non-financial – quality aspects of a business process is still missing.

Therefore, we developed the comprehensive Business Process Quality Reference-Model (BPQRM) [7], [8] using characteristics we transferred from software product quality standards. To the characteristics we allocated a broad range of detailed quality aspects from business process management and business process assessment literature. We use a hierarchical structure of quality aspects defined as follows. A *business process quality characteristic* is a category of business process quality attributes, for example the maturity of an activity. A *business process quality attribute* is an inherent property of a business process that can be distinguished quantitatively or qualitatively, for example the error density of an activity. A *business process quality measure* is a variable to which a value is assigned as the result of measurement. Measures can be defined as *base measures* or *derived measures*. A base measure is a measure for which the value is directly applicable to the process, e.g. the number of errors or the number of (sub) activities. A derived measure is a measure

that is defined as a function of two or more values of base measures, e.g. the number of errors per activity size.

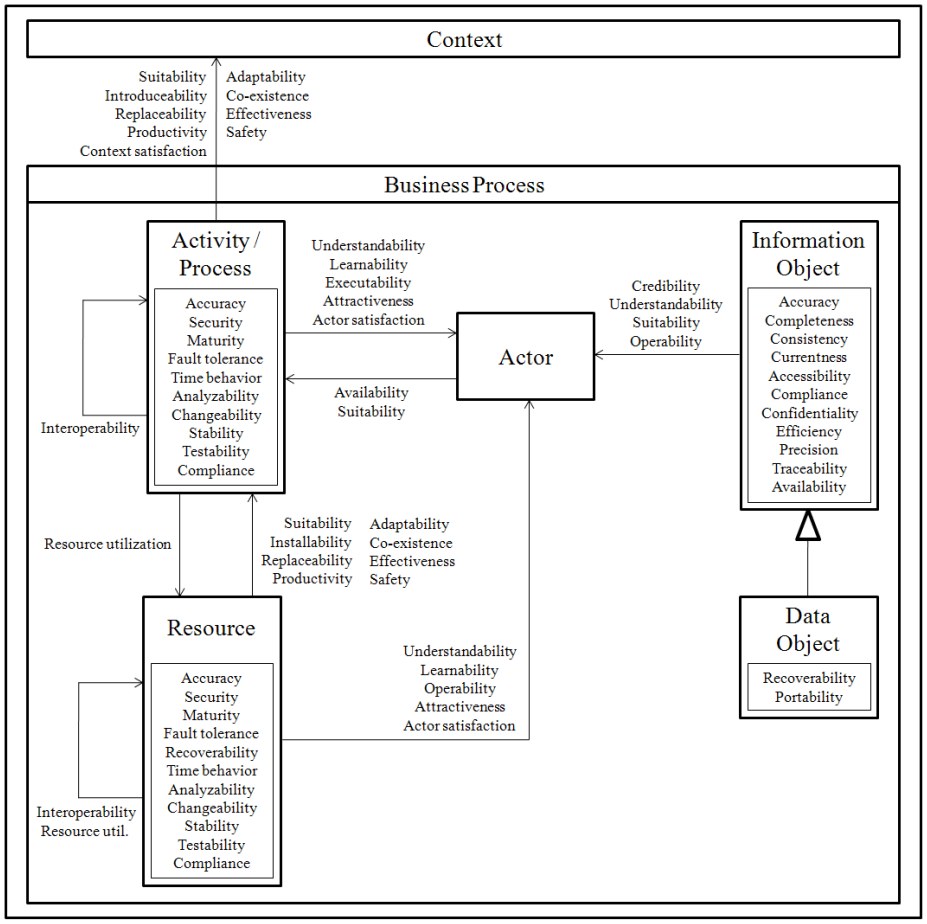

Fig. 1. Business Process Quality Reference-Model

Business process quality refers to the components of a business process. Components are the activities of the process, the actors performing these activities, the objects handled and created by the process as well as the resources necessary for execution. As an activity can be subdivided into sub activities, we consider a process itself as an activity. In the BPQRM we associated a set of quality characteristics to each component of a business process. We took the ISO/IEC 9126 software product quality characteristics for resources and also adapted them for activities. For information objects we took the ISO/IEC 25012 [11] data quality characteristics. The actor characteristics we developed based on quality aspects from practice. Figure 1 shows the BPQRM (characteristic level). The nodes correspond to the components and the characteristics are listed either within the node or on an edge between nodes. If the assessment of a characteristic depends on information of another component,

we located it on the edge.

The focus of this paper is to present and evaluate our approach to identify process quality problems. Furthermore, we utilize the study presented in this paper to evaluate the practical applicability of the BPQRM, as our approach is built on the BPQRM. If we are able to derive a meaningful questionnaire from the model, we consider the involved attributes as relevant in practice.

3 Related Work

We conducted a literature research for general advice on how to generate a process quality improvement questionnaire. The only relevant source we could identify is [5]. The process check list in [5] is a collection of typical business process problems. Thus, it is based on the assumption that quality is often threatened by similar problems in different organizations or projects. The creation of a process checklist requires a high expertise, however, there is no systematic procedure described.

To ensure the relevance of the resulting questionnaire to the domain of health care we also identified several health care related process improvement approaches. As mentioned in the introduction, benchmarking [2] is often used to assess the quality of business processes and IT-support in health care practice. For example, [3] monitors IT systems that support the creation of discharge letters and therefore focuses on time-to-completion of discharge letters and usage of patient scheduling. [6] presents the results of a systematic search to identify evidence-based quality and efficiency indicators relevant to hospitals or physicians' practices. Indicators of structural quality as well as indicators of process quality were identified. However, this publication does not sufficiently cover the complexity of quality issues in health care processes and the point of view of the actor. In prior work one author of this paper presented quality indicators for the actor view [1]. Our current work can be seen as a refinement as it is based on a comprehensive quality model and further describes the creation of a questionnaire.

[4] presents a screening instrument to identify problems of hospital processes. It uses a matrix that relates quality aspects of a hospital process with criteria to assess the aspects. Problems are identified based on selected matrix cells. The instrument utilizes different methods for the evaluation of the criteria. One of that is a questionnaire. However, the selection of the matrix cells and the creation of the questions are not described in detail. Moreover, the quality aspects used in this instrument are a subset of the BPQRM.

4 Approach to Identify Quality Problems

In this section we describe how to create a questionnaire for an interview study. A questionnaire is an effective means to identify process quality problems from the actor's view. However, the selection of the questions is crucial to the success of the study. To support this selection we propose the BPQRM as a checklist. Figure 2 gives an overview of the four phases of our approach.

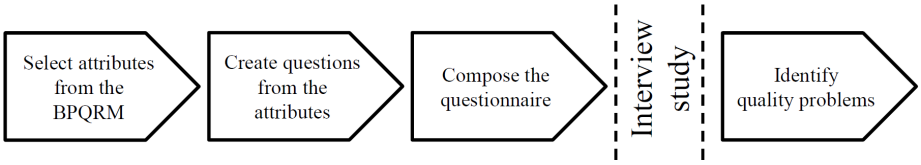

Fig. 2. Deriving a Questionnaire to Identify Quality Problems

Phase 1, select attributes: In [8] we collected example attributes and measures for each characteristic in Figure 1. Note that in the following we abbreviate base measure by using the term measure. Because of the large number of attributes, we first have to choose a subset which is suitable to identify problems of a specific process. We developed a set of selection criteria to select attributes from the BPQRM. The selection criteria are presented in Table 1. Note that these criteria can be used to select attributes for an arbitrary assessment method. In this publication we focus on assessment by interview, so we only select attributes whose measures can be captured in an interview. The selection criteria are inspired by literature on the selection of requirements engineering tools [16] and criteria for selecting measures in ISO/IEC 15539 [10]. We adapted the idea to define different views on the attributes from [16]. The criteria domain, expressiveness, effort and method are adapted from [10].

Table 1. Criteria for Attribute Selection.

View	Criterion	Description
Domain View	Domain	Is the attribute suitable and relevant for the domain?
Outcome View	Expressiveness	How high is the expressiveness of the attribute's measures?
	Knowledge added	Does the attribute promise to provide new information?
Operational View	Effort	How high is the effort to capture the attribute's measures?
Method View	Method	Are the attribute's measures able to be captured using the available method?
Customer View	Importance	How high is the attribute's importance for the customer?
	Constraints	Are there any constraints from the customer regarding the attribute?

In the following, we give a more detailed description of the views and criteria. An attribute may be highly relevant in one domain whereas it is less relevant in another domain. For example, precision or security has a higher relevance in the medical context than in a general office context, where it may be neglected for cost reasons. Therefore, we consider the suitability and relevance of an attribute to a specific domain in the domain view. In the outcome view we consider the expressiveness of the attribute's measures with respect to the ability to derive improvements. There are measures with high expressiveness which directly provide information about problems in the process, e.g. measures capturing inadequate IT support. Furthermore, there are measures with lower expressiveness that result from observations, e.g.

processing time values of an activity. Time values must be compared to other time values to interpret the value and decide whether improvements are needed. In the outcome view we also consider whether the capture of the attribute promises to provide new information in comparison to the current state of knowledge. Although an attribute is relevant, expressive and provides new information, there may be high effort required to capture the attribute's measures. For example, diagrams or other auxiliary means have to be created in case of an interview. Thus, we consider effort in the operational view. The method view is concerned with the methods available to capture the attribute's measures. Examples of methods are monitoring, data analysis or interview. For the attribute selection one must consider that the attribute's measures can be captured by the available method. For example, consistency of a data object can be determined easier using the method data analysis than using an interview. As in this approach we want to create a questionnaire for an interview study, we focus on the method interview. The customer's opinion should be considered, too. The customer is the organization whose business processes are analyzed. In the customer view we consider the importance of an attribute to the customer. Moreover, constraints from the customer should also be considered, for example the assessment of employees of the customer may be problematic. Each attribute in [8] is analyzed using the selection criteria. To support the reproduction of the analysis each criterion must be justified. We propose to use a matrix form with the selection criteria on one axis and the attributes on the other axis to document the justification. In addition to attributes in [8], domain specific knowledge such as standards, guidelines and policies should be considered as a source of attributes, too.

Phase 2, create questions: After the selection of the attributes the questions have to be created. As questions created ad-hoc from the attributes may be relatively abstract, we relate questions to a specific business process model. Thus, before creating the questions, the process to be evaluated should be captured in a process model, e.g. by using one of the commonly used business process modeling notations like BPMN [14]. The process model helps the interviewees to understand the questions by visualizing the activities they perform, the objects they handle, the IT systems they use (in some modeling tools) as well as the interfaces between the process components. Before starting the interview the process model is explained to the interviewee. Then, the interviewee has to mark the activities s/he performs in the process model. Section B1.1 in Table 2 presents an example.

To create questions for the attributes one should consider how to measure the attributes. As a measure per definition (see Section 2) is used to measure the related attribute, it gives a good idea of what to ask for. However, further adaptations are necessary to create concrete and useful questions for an interview situation.

Based on the attributes two types of questions can be derived: qualitative and quantitative questions. A qualitative question for example is "what is the problem?". A quantitative question for example is "how many problems are there?" or "how much time does it take?". The answers to qualitative questions directly describe quality problems, but are not presented in a measureable manner. The answers to quantitative questions are measureable. They can be used to compare one process to another or process components with each other and thereby identify problems. Note that there is no relation to the expressiveness of the attribute's measures. For each attribute qualitative questions as well as quantitative questions are possible. As

answers to quantitative questions are hard to estimate by the interviewees, we recommend avoiding them, where possible, and instead asking a qualitative question from which a quantitative statement can be derived. In other words, one should avoid asking for the number of process components (e.g. activities) that have a specific property. Instead, one should better ask the interviewee to name process components which have a specific property. Thus, the number is provided implicitly. For example, the attribute *attractiveness* of the process may be determined by the measures *number of activities which are considered as attractive by the actors* and *total number of activities*. Thus, we ask the interviewees for the activities they like to perform. In Table 2, the first question in section B1.2 is a qualitative question, however, one can derive a quantitative statement from it. The total number of activities can be determined from the process model. The second question in B1.2 is a qualitative question which leads to a qualitative statement. Here, the interviewee describes the problems with the activities.

Table 2. Example of a Questionnaire.

B1	**Questions on activities**	
Now, present the process model to the interviewee.		
	General questions on activities	
1	Which activities in the process do you perform? (Please mark your activities in the process model) _____ _____ Are there any activities you perform in the process that are not contained in the process model? If yes, please add these activities to the model.	
	Questions on actor satisfaction and attractiveness of the process	
2	Attractiveness	Which of your activities in the process do you like to perform? _____ _____ What bothers you about the activities you do not like to perform? _____ _____

For estimations a good granularity of the metric (e.g. output per day/week/month) is important to help the interviewee to give a meaningful answer. Therefore, typical frequencies of execution, error rates and amounts of objects in the process should be considered. This information should be captured before creating the questionnaire.

Phase 3, compose questionnaire: The questionnaire is composed by arranging the questions in a meaningful manner. Guidelines for this can be found in literature from psychology and social sciences such as [13]. An example of a questionnaire structure is presented in Section 5.1.

Phase 4, identify quality problems: As described above (phase 2), potentials for improvement either directly arise out of the interviewee's answers (in case of a qualitative statement) or are derived by comparison (in case of a quantitative statement). In case of questions on errors (deviation from the specified behavior), we

also recommend to ask for the frequency and the severity of the errors in order to prioritize the errors.

Our approach provides a systematic way to select attributes from the BPQRM. For the derivation of the questions from the attributes we provide heuristic support as this includes context-specific adaptations. The results of the interviews of course depend on the interviewer and the interviewees. Expertise is still required in all the phases. It is not the goal of our approach to enable a non-expert to create a meaningful questionnaire. However, we aim to provide a methodical support that can be used by experts.

5 Case Study

We conducted a case study to evaluate our approach. We study the process of writing discharge letters at a German university hospital. A discharge letter is a summary of the performed patient treatment and is used for communication between physicians for follow-up treatments. The process of writing discharge letters is chosen because all the process components of the BPQRM are contained in the process and there are a large number of quality aspects to be captured. In the study the people are interviewed separately. We do not conduct group interviews.

At the beginning of the case study we captured the current state of the process in a BPMN process model. Therefore, the authors of the Institute of Computer Science cooperated with the authors of the Center of Information Technology and Medical Engineering (ZIM) of the hospital. The process model is created based on documents provided by the hospital and on interviews with our health care expert co-authors. It consists of 15 activities, 5 information objects, 4 actors and 1 IT system (hospital information system, HIS). Due to the limited space we cannot display the process model here. As described in phase 2 in Section 4, this process model is used as a basis for the interviews.

We evaluate our approach by assessing the effort to create a questionnaire (see Section 5.1) and the adequacy of the questions to identify problems in a preliminary evaluation (see Section 5.2). Thus, we use the following research questions (RQ).

- RQ1: How much effort is necessary to develop a questionnaire based on the BPQRM? The effort is measured in person hours.
- RQ2: Are the questions adequate to identify business process quality problems?

As we have not yet conducted a full interview study we report the results of a preliminary interview study with 3 interviewees.

5.1 Effort to Develop a Questionnaire

In this section, we describe how we developed the questionnaire for the case study from the BPQRM and present the effort required. Out of more than 200 attributes in

[8] we finally selected 20 attributes which fit best the selection criteria shown in Table 1. There are further relevant attributes in [8]. However, because of a time restriction of a maximum of one hour for the interview, we have to limit ourselves to 20 attributes. Table 3 presents the selected characteristics and attributes per component of the business process. The characteristics are presented in bold and the attributes are listed below. See [8] for more information on the characteristics and attributes.

Table 3. Selected Characteristics and Attributes.

Activity	**Maturity**: Error density, Callbacks	**Time behavior**: Transport time efficiency	**Interoperability**: Freedom of collision
	Attractiveness: Attractiveness	**Resource utilization**: Adequate resource usage, Capacity of the resource	**Actor satisfaction**: Problems of the actors, Challenging work
	Suitability: Significance	**Understandability**: Understandable purpose	
Res.	**Maturity**: Error density	**Interoperability**: Freedom of collision	**Attractiveness**: Ergonomics
	Understandability: Understandable purpose	**Learnability**: Correct Execution	
IO	**Availability**: Availability	**Operability**: Ease of manipulation	**Currentness**: Currency
	Compliance: Conformity		

In the medical domain, attributes of characteristics such as security, precision or maturity are highly relevant. We considered this in the domain view. In the outcome view we excluded attributes whose measures are not sufficiently expressive. For example, we did not ask for help accessibility to assess learnability as we consider this as less expressive than the frequency of faulty operations (correct execution). Moreover, we excluded attributes which do not promise to bring additional knowledge. For example, we did not ask for actor documentation as we already knew that there is no documentation available. In the operational view we focused on attributes which can be captured without additional auxiliary means. Therefore and as we considered time values as hard to estimate by the interviewees (method view), we excluded questions on time (transport time efficiency focuses on transport means and routes). However, the questionnaire contains a general question whether the entire process takes too long. This is the only question on quality which is not directly related to an attribute. Our health care expert co-authors put high emphasis on characteristics like maturity and actor satisfaction and less emphasis on characteristics like changeability or adaptability of the process. We considered this in the customer view. Moreover, on request of the hospital, we excluded attributes which directly or indirectly allow the assessment of the quality or capability of the process actors. For example, we did not ask for the precision of the discharge letter as this may assess the capability of its author.

After selecting the attributes for the case study we created questions for the interview based on the selected attribute's measures. We created qualitative as well as

quantitative questions. Altogether, we created 43 questions on quality for the study. The row IO in Table 3 presents the selected attributes related to information objects. Due to the time restriction we decided to ask only for availability for all the objects within the process. The other attributes are asked solely for the discharge letter.

The questionnaire consists of 2 parts (A and B) and 5 Sections. Section A asks for personal details of the interviewee such as her/his role in the process or contact details for possible further queries. Section B contains the questions to assess the quality of the process and consists of 4 sub sections. Section B1, B2, B3, and B4 contain questions respectively on the actor satisfaction and the attractiveness of the process, on the quality of the supporting IT system, on the quality of the information objects used in the process and on errors within activities, the IT and the discharge letter.

The attribute selection lasted about 20 person hours. The creation of the questions required about 8 person hours. The final arrangement of the questionnaire required further 2 person hours. The effort to create a questionnaire for the example process from the BPQRM is therefore about 30 person hours. Additionally, the composition of the process model required about 6 person hours. All the steps involved several iterations with our health care expert co-authors. In the opinion of the experts this is an adequate effort.

5.2 Adequacy of the Questions

To evaluate the adequacy of the derived questions to identify quality problems we conducted a preliminary study. The goal of the preliminary evaluation is to validate the developed questionnaire in practice before starting a comprehensive interview study. We consider the questions as adequate if the identified problems are assessed as useful by our health care expert co-authors. The preliminary evaluation was conducted with 3 employees of the ZIM who in the past were involved as actors in the process of writing discharge letters, but who were not involved in creating the questionnaire. Although these employees of the ZIM currently are not involved in the process, they can provide meaningful answers as they were involved in the past and they have good knowledge of the current process and the supporting IT system.

For the preliminary study we only analyze those questions of our questionnaire, which lead to qualitative statements (30 of the 43 questions), as we want to identify problems directly, not to compare the discharge process to another one. The questions were answered by the interviewees and the answers directly lead to the bullet points in the list below.

Note that the results of the preliminary study are not representative because of the small number of interviewees and the fact that the interviewees were not involved in the process of writing discharge letters at the time the study was conducted. Nevertheless, we identified major weaknesses of the process and the supporting IT system in the interviews. Altogether, we identified 12 quality problems. Due to the limited space we present an excerpt in the following.

- The entire process of writing discharge letters is considered as boring and annoying by the physicians. It is considered as additional bureaucratic effort which does not contribute to their core activities. More automation of the process

is required by the interviewees. We identified this by asking for attractiveness of the activities (attribute *attractiveness*).

- The entire process is considered as too time-consuming. This was the answer to the general question on time as mentioned in Section 5.1.
- The step *documentation of diagnosis* is performed twice in the activity *create discharge letter*. Once for clinical purpose and again for billing. The purpose of the repetition is not understood by the interviewees. We identified this by asking for activities whose purpose is not understood by the actors (attribute *understandable purpose*).
- The HIS used for writing discharge letters provides a Microsoft Word integration as a so called Word container. Data can be moved from the HIS to the Word container, however, there is no integration in the other direction. Data once contained in the Word container cannot be moved back to the HIS in a structured way. Thus, the actors often have to use copy and paste to transfer information between discharge letters. Moreover, data contained in the Word container cannot be updated. We identified this by asking for activities not adequately supported by the HIS (attribute *adequate resource usage*).
- Our questions for learnability and ergonomics of the HIS showed that the HIS is complex and hard to handle (attributes *correct execution* and *ergonomics*). The actors often do faulty operations or there are navigation problems, because there is no consistent menu guidance. Especially diagnostic findings are hard to access as the actors have to switch between single parts of the findings. An overview of the findings is missing in the HIS.
- The actor has to set a status to forward the discharge letter in the system. However, the interviewees prefer to send the letter directly to a person or a group of persons. Thus, setting the status is not used. We identified this by asking for activities not adequately supported by the HIS (attribute *adequate resource usage*).
- Our question on availability showed that after 9 months the access to findings is locked. However, the interviewees stated that sometimes they require old information (attribute *availability*).

We received positive feedback from our health care expert co-authors. The findings of the preliminary evaluation are assessed as useful input for process quality improvement. Our health care expert co-authors consider the derived questions as an adequate means to identify quality problems of the example process. However, further evaluations will be made before the questionnaire is applied in a comprehensive study.

Although the effort for the conduction of the interviews was already restricted to a maximum of one hour, it is still considered as relatively high by the interviewees. Therefore, we plan to reduce the number of questions in a full study.

6 Conclusion and Future Work

In this paper, we presented a systematic approach to identify business process quality problems. Based on a comprehensive quality model a questionnaire for an interview study was derived. As an example process we used the process of writing discharge

letters at a German university hospital. We presented the results of a preliminary evaluation of the approach. The results showed that the questions can be derived with reasonable effort and that they are an adequate means to identify quality problems.

The results of the preliminary evaluation convinced us to conduct a comprehensive and representative case study using our approach in the future. We want to apply our approach to further business processes of several domains to achieve a more comprehensive evaluation. Moreover, we plan to examine further application areas of our quality model.

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