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Assessing Clinical Processes – Lessons Learned

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Abstract

Introduction: This paper deals with the systematic assessment of clinical processes. In this context, an own assessment approach is introduced. It was developed during a two year lasting cooperative project. Aim: The aim of this paper is to share the experiences that were made with the selected approach. Method: Processes are assessed with the help of "views" and "rule-sets": Within a view selected elements of a clinical process are combined in a matrix. The analysis determines which details are needed. Specific flaws are then detected by applying rule-sets on these views. Results: The strengths and limitations which were observed during the evaluation of the approach are summarised in a structured way. Conclusion: The experiences in this paper contribute to future developments in process assessment. The approach itself could support the process oriented information management in hospitals.

Keywords:

process assessment (health care), process measure, public health informatics, information system

Introduction

Clinical processes can be seen as complex interactions between several hospital departments. Each department has its own objectives that lead to specialised workflows, role definitions and proprietary tools. This cooperative environment with its high demand on communication (e.g., [1]) is often seen as a main reason for the weaknesses clinical processes show, e.g. regarding their efficiency [2-4]. Similar problems are already known outside of the health care domain. Thus it seems feasible to adopt concepts like the well established Business Process Reengineering (BPR). One of its main principles says that companies can only improve their efficiency by focusing on their main processes [5]. The successful application of the BPR in turn depends on adequate process descriptions [6] which are analysed for possible weaknesses, in order to derive improvements (according to Deming's Plan-Do-Check-Act cycle, [7]). In fact, there are established tools which are meant to model and assess processes regardless of their professional context (e.g. the ARIS toolset [8]). Hence, their application on clinical processes basically seems possible. Based on the understanding of authors like Harrington who named in [9] measurements as the keys to improvement, BPR tools often equate assessment with measuring discrete process attributes (e.g. temporal or monetary details). But measurements themselves have no value without a context in which their results are judged [10]. This context is explicit process knowledge that guides measurements and helps to interpret results. In case of clinical processes this kind of context is missing. Thus, the degree in which the versatile capabilities of the BPR tools contribute to a feasible process assessment strongly depends on the subjective viewpoint of the person who uses these functions. A possible conclusion is therefore, that a systematic assessment of clinical processes is still missing [11].

The MedFlow project

Motivated by these drawbacks, the MedFlow project was initiated together with partners from the Leopold-Franzens-University of Innsbruck and the health care IT company ITH (Information Technology for Healthcare). The project lasted from 2004 until 2006 and aimed to develop a practical method and appropriate tools that support the systematic assessment of clinical processes. In this context, processes were regarded as interrelated actions that were augmented by descriptions of involved tools, roles and information objects. The resulting method takes this into account by declaring a core model that integrates sub-models for each of these four process aspects. The developed concept for assessing clinical processes bases on the application of so called "views" and "rule-sets": Within a view selected elements of at least two sub-models are combined in a matrix. Here, the kind of analysis determines which sub-models are combined. Specific flaws are then detected by applying rule-sets on these views. Each rule-set represents a pattern which is searched for in the view-matrix. The combination of a view with a corresponding rule-set is referred to as a "quality check".

The idea of the quality checks is further explained with an example in the following method section. However, the focus of the paper lies on summarising the strengths and limitations of the newly developed approach (i.e., applying rule-sets on views). These were gathered by applying the method on the process of ordering radiological examinations.

Aim of this paper

This paper is meant to share the experiences that were made with an assessment approach which uses rule-sets on appropriate extractions of process models.

Materials and methods

Preconditions for process assessment

Dealing with proper process assessment, the following open issues or rather conditions were identified:

- Important quality criteria for the regarded process must be determined in advance. On the basis of these criteria the relevant process details are identified.
  1. The model must adequately describe all details of the examined process which have been identified as relevant in 1.
  2. The model details must be organized in a way that they are accessible for the assessment.
  3. In order to avoid that criteria are skipped during the assessment, all criteria must be collected and arranged in a structured way.
  4. There must be a practical way to test the process for each criterion.

In the MedFlow project, the first condition was met by using methods like system analysis and literature research (e.g. [12, 13]). In this way quality criteria like "Number of distinct input information objects" or "Existence of media breaks" were gathered for the example process of ordering radiological examinations. Necessary process details are determined by deriving weak points from each criterion.

In order to meet the second and third precondition, a new core model which uses an own meta-model was developed: This core-model consists of four sub-models (process model, information model, tool model, organisational model) with each concentrating on distinct aspects of a process (i.e., control flow, data flow, tool usage, organisational information) – they are realised for instance on top of UML Activity Diagrams [14] and the Three Layer Graph-Based Meta-Model (3LGM², [15]). Additionally, own elements were introduced. Details can be found in [16].

The fourth condition was fulfilled by sorting the found criteria into a catalogue. In accordance to the basic quality aspects that are provided in [13] the catalogue was structured as follows:

- Quality of structures: This aspect can be further divided into the quality of documentation, logical and physical tools and finally the quality of integration between those tools.
- Quality of the processes
- Quality of the outcome (i.e., the degree the process contributes to achieve the hospital's strategic goals)

Thus, the above mentioned criteria "Existence of media breaks" can be found in the catalogue under the aspect "Quality of documentation" (which is part of "Quality of structures").

The fifth precondition was considered by developing a generally applicable assessment concept: In this concept the assessment is regarded as a series of questions. Each question scrutinises the existence of one process weak point. Because every weak point pertains to only one certain quality criterion, each question is answered on the basis of a specific subset of the details within a process model. This subset can either just list the elements of one sub-model or combine the elements of two sub-models. Because of this selective view on the process model the subsets are also called "views". In order to test a process model for a weak point, a specific pattern is searched within the appropriate view. Every pattern is expressed as a "rule-set". The combination of view and rule-set is also stored in the structured catalogue. Table 1 illustrates the structure of the catalogue entries using the example of media breaks.

Table 1 – Excerpt from the criteria catalogue

Quality Criteria	Quality Check		Possible weak point
	View	Rule-set	
Existence of Media breaks	Information-Model x Media Info	All information objects which are stored electronically and paper-based	Media cracks potentially cause inconsistencies in information objects.

Example for the detection of weak points

This section provides a small example on how the assessment method is used to detect media breaks. According to the appropriate catalogue entry (shown in Table 1), this criterion is assessed on basis of a view that combines the logical sub-model with the info.

An extraction of such a view is shown in Table 2: The lines of the matrix contain the information objects (e.g., a CT image, report) which are created, read, written or copied in the process. The columns contain the possible media states in which information objects can reside (e.g., in Table 2 "persistent (digital)" means that the information object is stored permanently on a server or a PC where it is available for distributed access). An information object can reside in only one media state at a time. If copies exist these copies should be stored at least on the same media type (i.e., paper-based or digitally). A common weak point in this context is that an information object is stored on different media types which is also called media break.

Media breaks are detected by selecting all lines (i.e., information objects) of the view which have multiple cross points. A cross point means that an information object is represented at least once in this state. Thus, multiple cross points in one line with different media type indicate media breaks. This is the case for the information object "Order form" in Table 2.

Table 2 – Excerpt of the view for detecting media breaks (see highlighting)

Media Information / Inform. object	…	persistent (digital)	persistent (paper-based)	…
CT image		X		
Order form		X	X	
Report	…	…	…	

Results

This section first shortly summarises the major achievements of the MedFlow-project in terms of its aim. After that, the second part explains the experiences regarding strengths and especially limitations of this approach.

Results of the MedFlow project

The aim of the MedFlow project was the development of a method that supports the systematic assessment of clinical processes. As explained in the methods section, the approach assesses process models by applying specific rule-sets on appropriately selected details. Considering this, the significant results can be resumed as follows:

- The development of the core model with its integrative meta-model: It allows to model processes with those details which were identified as relevant for process assessment. The organisation of the details into the specialised sub-models allows the access to those details for the assessment.
- The compilation of the structured catalogue: It contains essential quality criteria – not only with respect to processes but also the documentation and the involved tools. A first version of the catalogue comprised 38 useful quality criteria (see Table 3). However, it was not possible to develop checks for all criteria. The limitations, their reasons and the further efforts are explained in more detail in the succeeding section
- The implementation of a prototypic software: Making use of the newly developed meta-model this software is able to assess process models which were described in the MedFlow-notation. It has interfaces for established modeling suites like Microsoft's Visio. Elements are stored in a repository which can be queried for assessing the process model. The output is provided in a web front-end. The result of a check is presented in a view which is similar to that shown in Table 2.

Table 3 - The quality aspects and the related criteria

Quality Aspect	Sub-aspect	Quality criteria
Quality of structures	Quality of documentation	Correctness, integrity, reliability, completeness, accuracy, relevance, authenticity, availability, confidentiality & security, backup
	Quality of logical tools	Functionality, reliability, usability, efficiency, maintainability, portability
	Quality of physical tools	Adequacy, availability / accessibility, versatility, efficiency, adaptability, stability & reliability, security, harmlessness, usability, degree of standardisation
	Quality of integration	Adaptability & extensibility, controlled redundancy of data
Quality of processes	-	Efficient information logistic, adequate number of tools, information acquisition & usage, controlled data transmission, patient-centered information management
Outcome quality	-	Efficient communication, availability of all relevant patient data, comprehensive (electr.) patient record, increased usage of mobile information processing tools, optimised user interfaces, patient access on the own record, availability of medical data for research

Strengths and limitations of the developed approach

As already explained in the previous sections, the MedFlow project introduced an own approach for assessing clinical processes (i.e., "views" and "rule-sets"). In order to evaluate this approach a typical and sufficient complex clinical process was selected – the ordering of radiological examinations, and the communication of the related findings. Those processes were described based on a system analysis performed at the University Hospitals of Innsbruck, Austria. Here, the following strengths and limitations could be experienced:

Regarding the strengths:

- The concept of view/rule-set is flexible in configuration and generally applicable. New quality checks can be defined very quickly on the basis of details available in the core model.

- Assessment results just include those details which are essential for the certain quality check and the underlying question. Thus, the results can be anticipated more easily.
- Because of its structured and methodical way this approach guarantees that none of the registered process aspects (which are identified as relevant) are skipped.
- Including also descriptions about which information is needed to answer the checks and how to use them properly, the catalogue is applicable on all kinds of BPR tools.
- The resulting catalogue itself could be used as a collection of requirements which helps to improve BPR tools or as a guideline for the development of new assessment software.

Regarding the limitations:

The limitations must be separated into two groups: The first group contains general limitations which are common to all model-based process assessment methods. The second is made up of limitations specific to the new approach.

General limitations:

- The feasibility of the assessment is directly dependant on the quality of the process model. Aspects of this quality are for instance the correctness, consistency and completeness of the model. In order to avoid poor model quality, additionally acquisition guidelines must be defined in advance and used during the modelling stage.
- Even if the assessment is applied on adequate process models, it showed that the found results can be just regarded as hints on possible weak points. Found weaknesses like redundant information objects can be already known and even intended.

Specific limitations:

According to their reasons, the limitations in this group can be further divided into the following sub-groups:

- Limitations due to the implementation-specific meta-model: The meta-model describes the relationships between the elements of one sub-model and also between the elements of different sub-models. It defines details like directions of associations and cardinalities. However, the meta-model must be translated into a machine-useable form before it can be used to build a model repository which can be queried for assessing its details.
- It showed that the implementation puts strict restrictions on the associations within the meta-model. In consequence, not all necessary views could be generated by the latter prototype. Although improvements were applied relatively easy on the theoretic meta-model, several views could not be generated because the required associations could not be implemented.

Limitations due to the expressiveness of views:

- In contrast to the previous one, this limitation is not caused by missing elements or associations. It rather means that some quality checks require process details that cannot be represented in form of a view (i.e., combining independent details in a matrix). An example for this limitation is for instance the criterion “adaptability & extensibility” which belongs to the aspect “quality of integrations”.
- Limitations due to the validity or rather adaptability of the used criteria: This is one of the most essential limitations to probably any assessment method. In case of the MedFlow approach especially those criteria that deal with the quality of documentation point to this kind of limitation (e.g., “accuracy” or “reliability”). Their checks mostly require the utilisation of the content of model elements. An implementation of methods for assessing these checks is hardly possible.
- On the other hand, the contribution of these checks to a meaningful assessment of the process quality is vague. It must be further examined in more detail for each of the affected criteria.

The approach is suitable for assessing aspects dealing with the quality of processes. Further, the media type information and the defined storage states within the information model support the basic assessment of the information object life cycle. In contrast, the approach lacks in the assessment of content-related or organisational issues. These include criteria like efficient staff employment, efficient communication or accuracy of information objects.

Discussion and conclusion

This paper deals with a newly developed method which is meant to supports the structured assessment of clinical processes. However, the main focus lies on the strengths and limitations of this approach: An own core model is used to integrate four sub-models with each concentrating on distinct aspects of a process (i.e., control flow, data flow, tool usage, organisational information). In order to assess the quality of a process, selected elements of at least two sub-models are combined in a matrix. Weak points are then detected by applying specific rule-sets on these views. Each rule-set represents a pattern of critical cross-points which are searched for in the appropriate view-matrix. A main component of this assessment approach is the structured catalogue. It contains essential quality criteria, according weak points and appropriate quality checks (see Table 3 in result section for a list of quality aspects and criteria).

The experiences presented in this paper result from the evaluation of the new method. In this evaluation the method was applied on the sufficient complex process of ordering radiological examinations (as observed in the University Hospitals of Innsbruck, Austria).

The limitations of the approach can be separated into general and approach-specific: The general limitations are common to all model-based assessment approaches. The feasibility of this kind of assessment directly depends on the quality of the process model. Thus, poor model quality aggravates the detection of possible weak points.

Limitations specific to the selected approach can be summarised as follows: The underlying architecture of the new assessment method (i.e., the core-model) is based on an integrative meta-model. The implementation of this meta-model has put restrictions on the possible associations. Therefore, not all quality checks could be implemented. Further, some quality checks required process details which cannot be represented in form of a view. In turn, other quality criteria within the structured catalogue required the examination of the content of process elements (e.g., content of information objects). Their implementation – as far as possible – would mean big efforts. However, the degree of contribution of these checks is still to determine.

The strengths of the presented approach can be summarised as follows: It is flexible in usage - new quality checks can be defined easily on the basis of available process details. It provides a structured way to assess clinical processes - all relevant quality checks are registered in the structured catalogue. Thus, none of the checks are skipped during assessment. Overlooking and understanding the results is facilitated - the assessment results just contain those details that are relevant for the specific quality check. Because the structured catalogue also defines which details are needed to check the existence of weak points it can be also used as a guideline for the process assessment with other BPR tools. Moreover, it can be seen as a set of requirements for the development of new BPR tools.

It turned out that the presented approach is best used to assess clinical processes regarding their control flow (i.e., the sequence of involved activities - including control elements like associations, conjunctions and disjunctions) and information handling. The latter represents criteria like “efficient information processing”, “appropriate amount of tools”, “controlled data transmission within processes” or “availability of information objects”. The information-handling deals with the acquisition of new information objects (e.g., final report or ordering of examination), their manipulation and storage. The correct handling of information objects directly influences the quality of communication between involved actors or hospital departments. This in turn is essential for good treatment processes.

The presented approach could help to improve the documentation and communication within clinical processes. This also includes the involved infrastructure in terms of logical tools (e.g., software applications) and physical tools (e.g., server). Therefore, further developments should concentrate on these aspects. After this, the resulting method could be used to derive performance indicators, e.g. by analysing the result-sets for critical patterns. Tools which will be implemented on the basis of this approach could be used in scope of the strategic and tactical information management.

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