Recommendation System for Integrating Controls in Business Process Models

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Abstract. *Laws and regulations are forcing companies to implement compliant business processes. Since the majority of companies already have established automated business processes, automating controls is a promising solution.*

Creating these controls is a complex task performed manually by compliance experts. Since compliance experts have the knowledge to identify controls in business processes, their work should be supported by methods, techniques and tools.

This paper presents a novel approach using recommendation technology for helping compliance experts to identify controls in business processes, using the level of congruence between business process graphs with controls and new or existing business processes without them.

Keywords. controls; recommendation system; business process management; compliance

1 Controls in Business Process Models

Owing to the current trouble in financial markets governments are introducing new laws and regulations. Companies need to map these regulations into their company and follow them in their business processes. [3]

Today, almost every business process can be performed automatically or can be supported by information technology. Companies use controls to force their business processes to be compliant with the regulations and wherever possible, these controls should also be automated. [7] As a completely automated solution does not seem feasible in the near future, the implement action of controls has to be performed manually by compliance experts. [5] Compliance experts know what kind of controls are needed where in the business processes.

For building IT systems based on business processes enriched with controls, models are used to structure the business processes and can include additional information, such as what kind of control must be used where. In related literature, annotation solutions for implementing controls into business process models are known. [1], [10], [8] Compliance experts can use annotation solutions to make it feasible for business process experts to know what kind of control has to be implemented where in the business process. [8]

What is lacking, is a solution that helps compliance experts to identify controls and make them feasible in the business process graphs. The work presented in this paper adresses this area by presenting a control recommendation system that assists compliance experts to identify controls and helps to annotate the controls in business process models. The information already in the business process models, enriched with an annotation solution, is used as a source for recommendations in this paper. Figure one demonstrates the principle procedure for obtaining a control recommendation for compliance officers by comparing graph structure information.

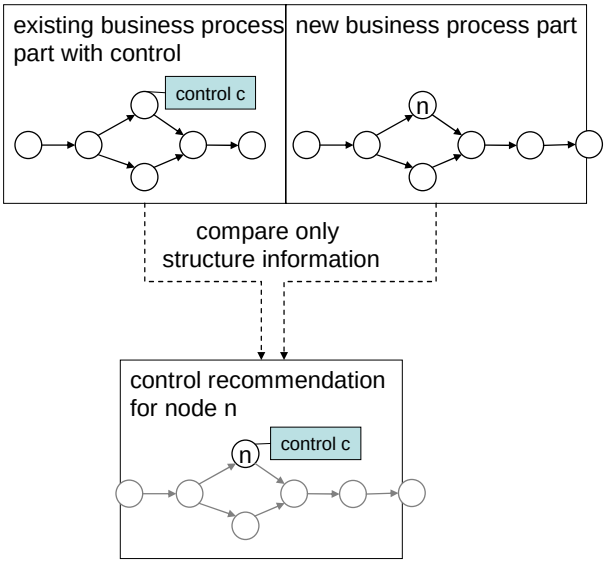

Figure 1: Approach for control recommendations

The approach described in this paper follows the applicability check method as depicted in [6]. It is therefore a research-in-progress paper that is in the initial stage and as a next step, a first applicability check for the approach has to be carried out.

The remainder of the paper is structured as follows: The next section formally defines the business process model. Section three introduces the congruence of business processes and the possibility to measure it. Section four presents the approach of a control recommendation system for business processes. The paper concludes by discussing limitations of the approach and by proposing possible solutions.

2 Formal Definition of the Business Process Model

A simple business process model can be defined as a directed graph. The business process model (D) is defined as an ordered pair (nodes (N), directed edges (A)). A single business process is defined as $d \in D$. The number of nodes (N) is finite and the number of directed edges (A) is defined as $A \subseteq N \times N$. [4], [9]

For a business process model, N can be split into a set of tasks (T) and a set of events (E) (begin, end) as well as a set of gateways (G) (and, or, xor-split).

$$N = T \cup E \cup G \quad (1)$$

The number of incoming arrows is defined as I(n) for node n, $\forall n \in N$. O(n) is the number of outgoing arrows from node n, $\forall n \in N$.

Every business process model has a single beginning and end event, which is defined

$$\exists n \in E, s.t. I(n) = 0 \quad (2)$$

as begin node and

$$\exists n \in E, s.t. O(n) = 0 \quad (3)$$

as end node.

As defined in [8] the following control tags are used:

- Flow Tag: A flow tag represents a control objective that would impact on (the flow of) the business activities, e.g. approval of leave must occur before payment for travel.
- Data Tag: A data tag identifies the data retention and lineage requirements, e.g. a medical practice must retain the time of commencement of pathology tests.
- Resource Tag: A resource tag represents controls relating to access, role management and authorization, e.g. persons performing cash applications and bank reconciliations must be different as this allows differences between cash deposited and cash collections posted to be covered up.
- Time Tag: A time tag identifies controls for meeting time constraints, such as deadlines and maximum durations, e.g. a water leakage complaint must be investigated within 12 hours of lodging.

The control tags (C) can have possible changes to the task set (N) and/or the arrows (A) represeting the order of execution. Every control tag (c) can be stick to a task (t) with $(c \in C \wedge t \in N)$

Next, the number of nodes around the specific node with control is defined. Equation four is the size of the business process parts which are selected to measure the congruence later on. For that purpose the n-reference-entity (nRE) is defined as

$$a = n \times n, n \in N \wedge a \in A \wedge \exists c \in C. \quad (4)$$

A reference-entity with higher number – meaning more nodes are compared and match – will be ranked higher in the later discussed recommendation system. Because the quality the recommendation has for creating a control into the business process depends on the number of nodes which are compared.

In the next chapter, the possibility to measure the congruence of business processes is discussed.

3 Measurement of Congruence in Business Process Models

The measurement of congruence is the comparison of two business process graphs. To be able to compare them, the assumption is made that tasks, processes as well as controls in the model have the same level of detail.

Congruence, as used in this paper, has two properties to fulfil – reflexivity and symmetry. The

function $cg : nRE \times nRE \rightarrow [0,1]$ is called a congruence function for business processes, if $\forall nre_1, nre_2 \in nRE$:

1. cong (nre_1, nre_1) = 1 (Reflexivity) (5)
2. cong (nre_1, nre_2) = cong (nre_2, nre_1) (Symmetry) (6)

Being able to measure the congruence of two business process parts, the following definition is used:

1. cong (nre_1, nre_2) = 1 if ($N_1 \setminus N_2$) $\cup$ ($N_2 \setminus N_1$) = Ø (equivalence) (7)
2. cong (nre_1, nre_2) = 0 if $N_1 \cap N_2$ = Ø (disjointness) (8)
3. cong (nre_1, nre_2) $\in]0,1[$ if $N_1 \cap N_2 = \{n | (n \in N_1) \wedge (n \in N_2)\} \wedge N_1 \neq N_2$ (intersection) (9)

The best congruence between two parts of business processes would be the equivalence. The congruence in intersection will be considered in the control recommendation system if at least

$$\text{cong}(nre_1, nre_2) \geq \alpha . \quad (10)$$

In equation ten, α is a factor which can be influenced by the user, the level of congruence influences the number of recommendations and should therefore be selected by the compliance officer as needed. In my prototype, α = 0.5 is an assumption which has to be proven in the evaluation in daily use. Moreover, by changing α the compliance officer can influence how close the business process without control is to the already control-enriched business process.

The measurement of congruence of the business processes in this paper focuses only on structural information. The control tags described in chapter two should be considered in the recommendation later on and can be integrated in the approach by extending the nodes with an additional set of controls. However, to keep the first approach as simple as possible, the tags will not be integrated in the control recommendation approach until the first applicability check has been performed with positive results.

4 Control Recommendation System for Business Process Graphs

The modelling of controls has several reasons: Exposure of hidden dependencies between controls will be possible, as well as compliance by design can improve the situation compared to a detection approach. Furthermore, an overall analysis of the business process model, the control aims and their impact of controls will be possible. [8]

To fulfil this aim, in the previous chapter the factors to determine the similarity of business processes were described. They are now used for recommendations as to which controls are needed where in the "new" or existing business processes without controls.

The addressee for the control recommendation will normally be the compliance officers. Recommendation systems normally take into consideration which type of user gets the recommendation. In this approach the differentiation is not required.

Moreover, the aim is to get a recommendation which should be objective, but indeed is not possible because the existing controls are interpretations of a compliance officer and thus subjective by nature. Nevertheless, every company has the overall aim of becoming compliant with the regulations as an external demand and therefore the recommendation is the same for all users of the system.

The underlying recommendation algorithm works as follows:

In the first step a database is created. The content of this database are the specific nodes enriched with controls and the neighbourhood nodes of these specific nodes. Therefore, the crowd of existing business processes which is already enriched with controls is reviewed and all existing nodes enriched with controls tags are identified by the system.

Now it is possible that a business task can be influenced by several controls and a control can have an affect on more than one task. [5] By writing a new entry into the database, for each control activity pair, the possibility that more than one control can be aligned with one node is considered in the approach.

Every node enriched with a control which was found is taken, its neighbourhood nodes and their neighbourhoods. This will be done β times, so that all nodes around the specific node which can be reached in β steps before or after are documented, as defined in equation four as n-reference-entity. Every node network has at least two nodes and the maximum number of nodes is countable. The β is defined by the compliance officer who uses the control recommendation system. This β influences the runtime of the system, which should not be too long and even if the nodes beyond are taken into account, the recommendation does not seem to get better, which has two possible causes.

The first one is that a matching network of nodes must be found in the business process without controls, which becomes more difficult with every additional node.

The second one takes the entire business process as comparable node network, so that finding a matching network of nodes in the "new" business process without controls is the same as modelling a business process twice. The result will then be to copy all controls to the "new" process. However, this is an undesirable situation which should not happen; it would be a sign of bad business process management

modelling to have the same business process several times in a model.

At the end of the first step, a database with all node networks around a node with a control has been created and serves as an initial point for the comparison – the second step.

The second step begins by comparing the newly created or existing business process without controls with the database entries.

Beginning at the first node, all entries in the database are compared with that node and the nodes around. If a database entry is found that matches, then a list of possible matching entries is created.

If more than one match is found then an ordered list will be created. The list is sorted according to the number of matching nodes. The bigger node networks are ranked higher than smaller node networks. Here, the minimum number of nodes is again two.

The controls recommendation approach creates a list for every node which shows the compliance officer the similar business processes with controls that already exist. Now the compliance officer can decide if a control is needed in this process step and go on to the next activity. This second step is repeated until all nodes of the business process graph without controls are processed.

In the prototype, $\beta = 5$ was used, so that the database has normally four entries – node networks – for every specific node with control. This limitation to five nodes before or after seems to be suggestive because first tests show that it is consistent with the arguments previously presented.

5. Discussion and Outlook

Compliance officers have to integrated controls into business processes. Existing business process models already enriched with controls can be a basis for recommendations where controls are needed in new or existing business processes without controls. The approach for a control recommendation system which was explained in this paper can support compliance officers to define controls for business processes.

In the approach described, only syntax information is used to make recommendations. This has the advantage of being easy to use and a fast integration into existing systems as well as an easy extension of systems for business process modelling is possible.

An enhancement of the approach can be made in the ranking of the recommendations which does not take the usefulness of the control in the context of the business process into consideration. If a function u can be defined that measures the usefulness of control c in business process d, this u should be taken into consideration in the ranking of the recommendation. Due to the lack of a useful measurement in this area, it is not implemented into the ranking list in this paper.

Accuracy of the recommendation depends on the level of information which can be used. As described in [2], business processes with semantic information would be helpful but are lacking in working environments of companies today. An enhancement with semantic information would be desirable and is the aim in the future.

As a next step, the first applicability check will be carried out. Subsequently, the described extension of the recommendation, taking control categories also into account, will soon be integrated.

As the work for the explained approach has just begun and the research is in working process, the main limitation of the work is the lack of validation of the controls recommendation approach.

The control recommendation approach helps the compliance officer to make faster decisions and is a useful tool for daily work even if the decision as to what control is needed where in the business process is still made manually by the compliance officer.

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