THE INFLUENCE OF LEGAL CONSTRAINTS ON BUSINESS PROCESS MODELING

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Abstract

Businesses are not only restricted by economical threats but also by legal regulations formulated on different administrative levels - from cities over states and nations up to international agreements like in the European Union. Although they are undoubtedly of significant importance to the structure of businesses, surprisingly there exists just a little work on integration of legal constraints into private business or public workflow models. In our paper, we integrate legal constraints into a formal business process model and use the resulting specification as a reference model for workflow implementations. We analyse a business-to-government process where the legal framework has a strong influence on the processes on both sides. As an example we consider the process of applying for premium rate service numbers at the German regulation authority for telecommunication and post.

Keywords: Legal constraints, Business Process Modelling, formal modelling, E-Government.

1 INTRODUCTION

Business process models are developed to understand, improve and automate the modelled processes. Their logical structure bases on causal dependencies observed between the tasks within these models. Absence of dependencies enables to conduct the related tasks independently from each other such that the overall processing time can be reduced. In order to increase the overall performance, one has to relax regulations concerning the arrangement of the tasks as much as possible, i.e. down to the intrinsic necessities of the tasks.

Consequently, the possibility to improve the business processes depends on the ability to relax regulations. In public administration, the scope for process improvement is often restricted by laws and further regulations of the same obligation. Especially in the European Union where regulations are formulated on several levels - from local administration, states, nations up to the European Commission - there is a need to keep track of and emphasise them in process models. Consequently, there is much research to be observed introducing standard processes into the public administration and there emerging E-Government programs, to measure and optimise the overall processes (Seel and Daun 2005).

While on the first view this seems to be a problem of public administrations (Snellen, Zuurmond 1997) only, we can observe a comparable trend for companies as well. In order to adapt the living and working conditions in the European Union, the number of laws and regulations for processes of private enterprises increases especially in human resource management, industrial safety and product and service quality assurance. They enforce to extend existing business process modelling methods by means for the representation of legal restrictions of tasks and (partial) processes.

In this paper, we investigate the process of applying for so called premium rate telephone services (0900 phone numbers) in Germany and demonstrate at this example the influence of legal restrictions on the formulation of business process models.

After pointing out the characteristics of public processes, we start with a description of the registration procedure and emphasise task and process related restrictions formulated in the official registration document. Afterwards, we translate the regulation document step-by-step into a formal process notation which allows synthesising the entire reference process model from these fragments. We demonstrate how to implement a concrete workflow on the base of this formal framework at an example. We close our paper with a conclusion in which we show further applications of our modelling approach.

2 CHARACTERISTICS OF PUBLIC PROCESS

Given the (democratic) system of the separation of powers, the public administration is defined as the sum of state activities that do not belong to the legislature, jurisdiction or the executive body (Thieme 1984). Positive definitions describe the administration as a non-governmental executive body that is supervised by the jurisdiction and controlled by the legislature (Reichard 1987). Hereby these definitions refer to the organisational structure and not to the processes.

Another - more process orientated - definition can be derived from the tasks, the output, and the organisational structure of public authorities: the public tasks are determined by public and national interests articulated in political debates. As executive bodies that fulfil these tasks, public administrations are organised and regulated by a legal framework which is the basis of all administrative processes. Accordingly, not only the output of the administrative workflow but each public process (single process steps, decision making, document regulations, etc.) is well defined in public law (Wimmer, Traunmüller, Lenk 2001).

The output of a public process is usually the result of an information process (Lenk 1999). Hence, the authorities - as producers of informational output - need a knowledge base and information as input. This general structure needs to be applied to individual situations for which civil servants have to find the administrative discretion within the legal framework. To support the civil servants in their judgment, the authorities are organised in accordance with Max Weber's bureaucracy model (Weber 1972). The characteristics of this model are legal obligations, functionally structured institutions, strictly separated areas of competence, hierarchical organisation, and the precept of filing each administrative step.

This bureaucracy means the main difference between public and private organisations. Furthermore, it is the reason why public processes are hardly defined completely with formal methods: they are strictly regulated and therefore resistant against reorganisation due to the legal framework. Hence, all laws, regulations, and administrative guidelines have to be taken into account when public processes are modelled and analysed. Within these regulations, however, civil servants must interpret the legal framework and apply it to individual situations. So, some aspects are highly regulated while others are not. A distinction into these two groups is only informally given.

Since the mid 80ies, we observe several efforts to change the organisation of public institutions from bureaucratic to economic incentive systems (Pröller, Schedler 2000). These changes are typically done along workflows and are undoubtedly E-Government activities to find future organisational structures which are more process oriented (Mehlich 2002). However, these activities are not as formal as they could be. Only formal approaches as the ones introduced in this paper, however, support semi-automatic process synthesis and automatic process integration. Moreover, formal methods are prerequisites for analysing processes against specifications and concerning efficiency (Vossen 2005)

Nonetheless, we have seen lately a lot of progress in E-Government that could be achieved without using structured modelling techniques. This holds true especially for the improvement of auxiliary processes (like E-Procurement, information providing web pages, inviting tenders online, etc.) which are achieved by copying similar E-Business solutions. Such auxiliary processes are characterised by being implemented without significant changes in conception or workflow. Developing systems which carry out primary public processes, however, requires an analysis on a more detailed level and therefore formal methods. Their reconstruction towards E-Government - i.e. employing the potentials of modern ICT to the states institutions - is crucial to respect the characteristics of the public processes. Increased efficiency and reduced costs by using ICT can only be achieved by reorganisation, breaking inefficient structures, and strong strategic leadership (Reinermann 1995).

Consequently, most of the E-Government programs (on national and federal state level) consider business process (re-)engineering as crucial to achieve their goals (e.g. BundOnline, FirstGov, etc.). A suggestion for a specific method or tool, however, is not given within these programs. Nevertheless, executive and legislative bodies will be forced to use formal methods to successfully introduce E-Government although this has not been of primary interest in the recent years (Wimmer, Traunmüller 2003). In Business Process Management, the need for formal methods has been recognised (Vossen 2005). We address this problem and show an application of a formal process modelling approach to a complex primary public process.

3 REGISTRATION PROCESS REGULATIONS

Before the liberalisation of the German telecommunication market in 1989, the state owned German Post (now Deutsche Telekom AG and Deutsche Post AG) was the only distributor and provider of phone lines and numbers in Germany. Since the customers addressed their needs directly to the German Post, the application process for phone services was rather simple. Due to the variety of providers after the liberalisation of the telecommunication sector, there was the need to regulate and control the liberalised market. Hence, the distribution of new phone numbers to private providers fell to the German regulation authority for telecommunication and post (Regulierungsbehörde für Telekommunikation und Post, RegTP). The legitimisation of the RegTP is derived from the German state law on Telecommunication (Telekommunikationsgesetz, TKG) paragraphs one and two.

With the appearance of private actors on the telecommunication market, a need to introduce legal regulations against misuse especially in the area of so called premium rate telephone services (0900 phone numbers) originated. The regulations on existing premium rate numbers have been recently extended by §§43a, b, c TKG. Moreover, there exists a strict application process which is installed to prevent abuse of these numbers from the beginning of an application for such numbers.

The application process of the RegTP is one of the first German E-Government processes that can be carried out completely online. Even though there are also other ways to apply, we focus on the online process since it respects the core governmental process completely (Lenk 1999). For this, the RegTP provides a standard electronic application form and checks the completeness of an application automatically as soon as it is received. The TKG allows every private person or company to apply for (service) phone numbers as long as they are registered at the RepTP (formalities on applying for phone numbers in general are checked within the registration process, §§3,43 TKG) and a fee has been payed in advance (§16 VwKosG). Moreover, the RegTP requires a qualified electronic signature (§1 SigG) on every online application form for a (set of) service number(s). Only if these requirements are fulfilled, the application is further processed.

If the application is formally correct, it is checked in content afterwards. For this, the application must not interfere with the general terms on market regulations, superior competition regulations (e.g. European Union guidelines) or any other public law (§2 TKG). The criteria of §43b TKG - the terms

on how to legally offer 0900 services - are inspected with respect to the applying company resulting in an acceptance or rejection of the application.

If the application is rejected in case that it does not fulfil the legal requirements, the RegTP sends a rejection notification. Otherwise the application is granted on base of §43 TKG, the requested numbers are allocated and tested. Meanwhile, a bill is printed and sent to the applying company. Fig. 1 illustrates this process in an extended Event driven Process Chain model (eEPC, (cf. Scheer 1994)). Within this diagram, we make use of information objects to model the respective paragraphs controlling each single step.

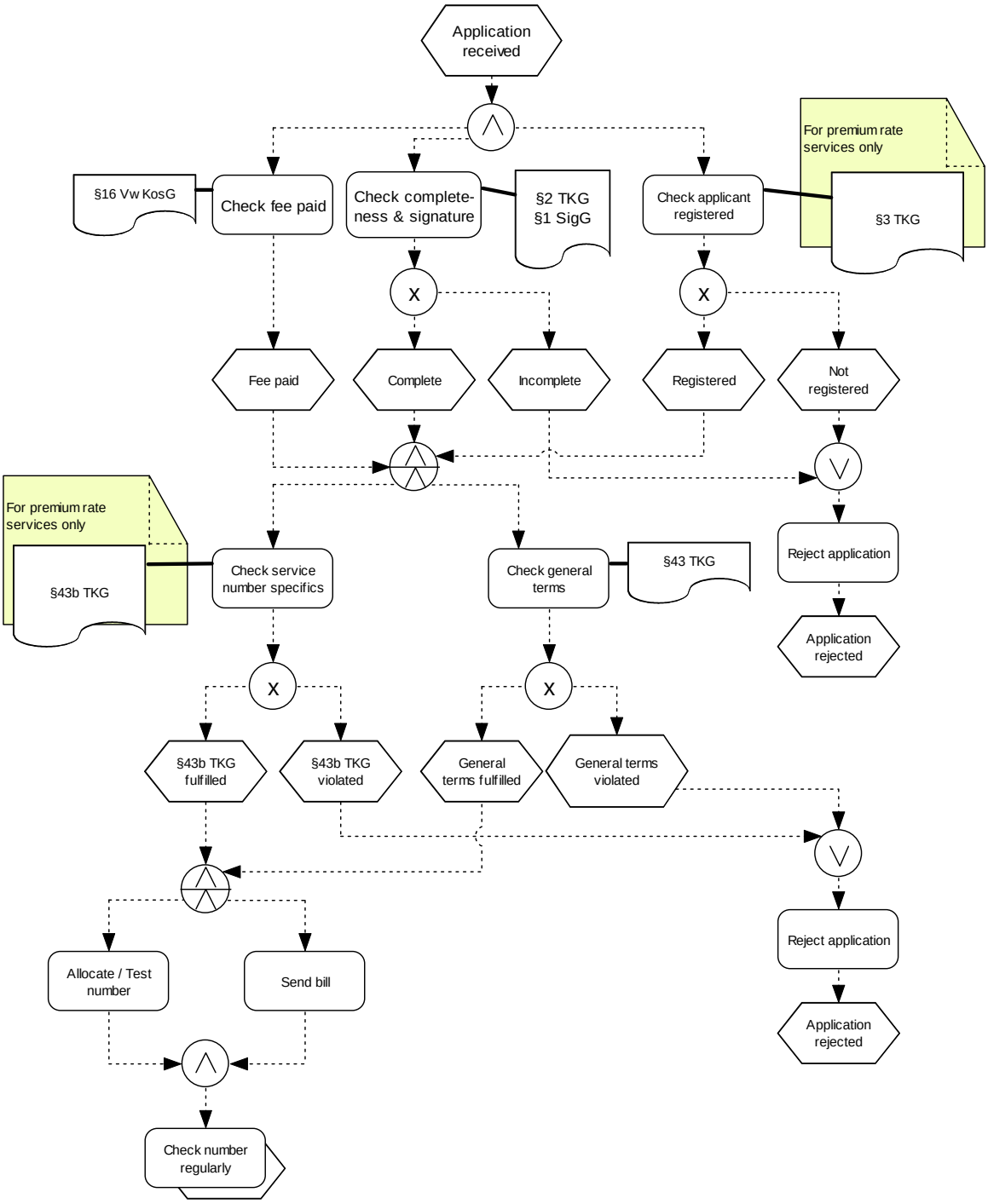

Figure 1. Application process in eEPC model.

Anyway, the actual application process closes with the submitted answer of the RegTP. Since law codes mostly know no grammatical negation (Radbruch 1963), the TKG knows, by law, no regulation on how a negative answer (i.e. the notification on rejection) should look like or on how the process continues after a negative answer. Consequently, we can assume the process to start over at the point before the application took place. However, with many process steps involved in a successful application, the question is which steps have to be undone for a process to end unsuccessfully (e.g. do the fees have to be re-transferred, the registration to be cancelled, etc). We will refer to the rollback of process steps later in our analysis.

In case of a successful application, the regulation process is still continued, since the RepTP must verify that all information in the application form were filled out correctly and that the premium rate number is provided in compliance with §§43a,b,c TKG. In case of violation of these laws (e.g. the bill was not paid, premium numbers are further distributed or abused), the RegTP can revoke the entire application process (§§48, 49 VwVfG). Such a revocation process (possibly ending with the retraction of the number) must begin with a hearing.

The process structure as described so far, does not take time considerations into account although they are also part of the discussed laws and regulations. For instance, after the acceptance letter has been sent, a 90 day period starts during which the number must be activated depending on the customer's wishes. If no specific date is picked or the period is too short, the RegTP executes the process as fast as possible - following a first-in-first-out approach - usually within seven days. A second example for relevant time periods is that unlike usual phone numbers premium rate numbers must be used regularly. Therefore, the RegTP checks whether such a number is used at least seven times a year.

The regulations on time get even more complicated, if the process of revocation is included in the analysis. The RegTP differentiates between recollected numbers that have been in use already and numbers that have not been used yet. In the first case, the RegTP only distributes the number after a period of 180 days. In the latter case of numbers that have not been in use but have been allocated, the RegTP starts using the number again after 90 days. Possible further delays by, for example, legal objections are still not respected.

We believe, these regulations - whether they are given by law or internal public regulations - to be crucial for the processes of both parties: the applying Phone Company and the RegTP (Alpar, Olbrich 2004). Therefore, this legal framework must not be ignored when developing a formal process model either on public or on private business workflow.

4 A FORMAL MODEL OF THE REGISTRATION PROCESS

The eEPC model of Fig. 1 gives an overview over the application process. Such approaches of semi-formal process documentation are – because of the need of process documentation to successfully introduce E-Government (Scheer, Kruppke, Heib 2003) – more and more emphasised with the E-Government programs (see BundOnline, ForstGov, etc.). Although this might be sufficient for humans to get an overall comprehension of these regulations, it is not (and was not intended to be) a formal specification against which an actual workflow implementation can be verified.

In the following we use a Petri net based approach for process specification applied to business process modelling in (Simon, Rebstock 2004, Simon, Dehnert, 2004) already and extend this concept by time periods as proposed in (Simon 2002). We use the legal framework described in the previous section and develop a formal specification of the application process. In the next sections, we explain how to base an implementation of public and private business workflows on this specification.

Our approach is to use so called *Module nets* to specify sets of processes. Module nets are a variation of relaxed sound *Workflow nets* (cf. (Aalst 1998) for Workflow nets and cf. (Dehnert 2003) for relaxed soundness) with explicit *start* and *goal* transition (where the preset of the *start* and the postset of the

goal transition are empty). Within Module nets, a *process* is a firing sequence reproducing the empty initial marking where each *start* and *goal* transition occurs exactly once (at the beginning and the ending, respectively). The transitions firing in the meantime are interpreted by actions and their sequence of occurrence indicates the process.

Besides giving a formal specification of a set of processes, this representation allows the verification of process implementations against such specifications given that the implementation can also be described by a Module net. For this we build the intersection between the specification net and implementation net which is done by joining equally interpreted transitions, i.e. transitions that represent the same kind of actions. If after this join none of the processes of the implementation net are lost, we then can conclude that it must fulfil the specification. The proof for this is as follows: assume, after the join there exist less processes than initially given in the implementation net. Then the processes lost are not in the result because they were not specified. However, then the implementation does not fulfil the specification. We use this proofing technique in Section 6.

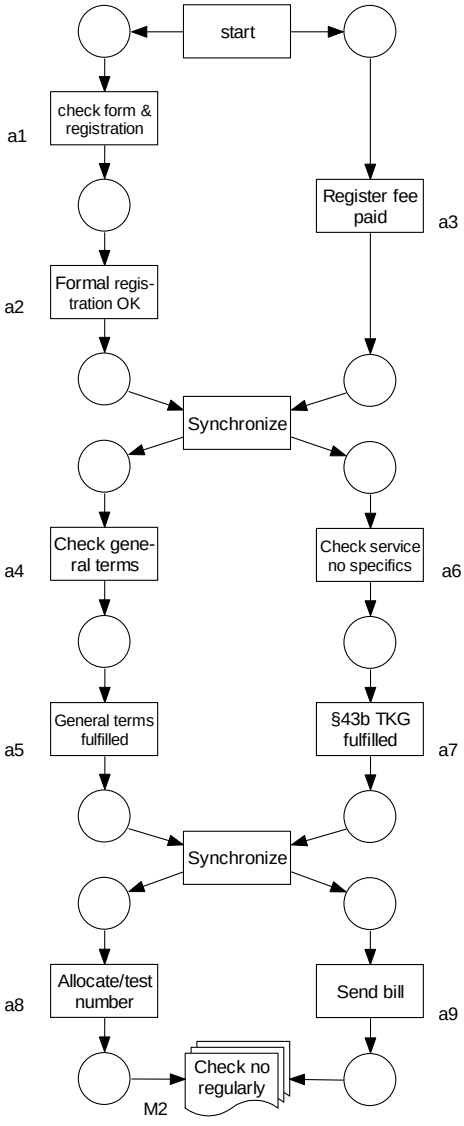

Fig. 2 specifies the intended (successful) application process as a Module net. We observe that actions and decisions are modelled as transitions. In opposite to this, in our eEPC model of the application process we do not model the decision making but only the result as an upcoming event.

We subsume the checking for a complete form and whether the applicant is registered at the RegTP in one transition to simplify our model. We also model the testing for a paid fee in a single transition. Since this transition fires only if the money flow is recognised, no extra transition for an upcoming event must be included.

Alternatively to the Module net, we also use a formal notation to describe the desired behaviour in the module

M1 := [[a1 < a2] ^ a3]] <

[[a4 < a5] ^ [a6 < a7]] <

[a8 < a9] < M2

Hereby symbol < indicates a sequence of (sub-) processes, ^ indicates that processes occur independently. M2 is a module on its own specifying a complex behaviour as discussed later.

Figure 2. Successful application as module net.

In a stepwise refinement approach, we now extend this model by exceptional behaviour for the case that some check action fails. For example, assume that the applicant is not registered at the RegTP.

Then the application is rejected. We therefore extend M1 (using the symbol ·= for the extension operation) by an action for the recognition of this circumstance and the actual rejection action. In a module we formulate this as

$$M1 \cdot= a1\bullet < [\text{Incorrect registration form} < \text{Reject application}]$$

Hereby a1● is the process state after a1 occurs (i.e. check form & registration has been conducted). Fig. 3 shows this first extension:

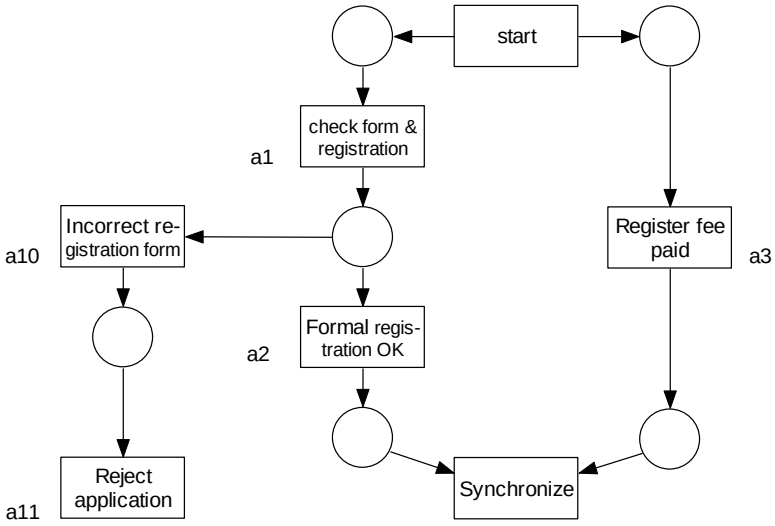

Figure 3. Recognition of an incorrect application form.

Obviously, this is not sufficient, since in Module nets a process is a firing sequence which reproduces the empty initial marking. However, although a11 is a transition that removes tokens from the net without putting new one on it, we find no such firing sequence in which a11 occurs. The reason for this is that a10 and a11 leave the places in the pre- and postset of a3 untouched.

It is the nature of independent (business) processes that in the case of an exception in one of the independent traces also the others have to be terminated correctly. In our case this means a twofold reaction: firstly, if the fee is already paid (indicated by firing of a3) there must be a rollback on this operation which can be expressed by

$$M1 \cdot= a3\bullet < [\text{Rollback fee}] < \bullet a3$$

Secondly, the token on the preset of a3 must be removed by firing transition a11.

$$M1 \cdot= a3\bullet < [\text{Reject application}]$$

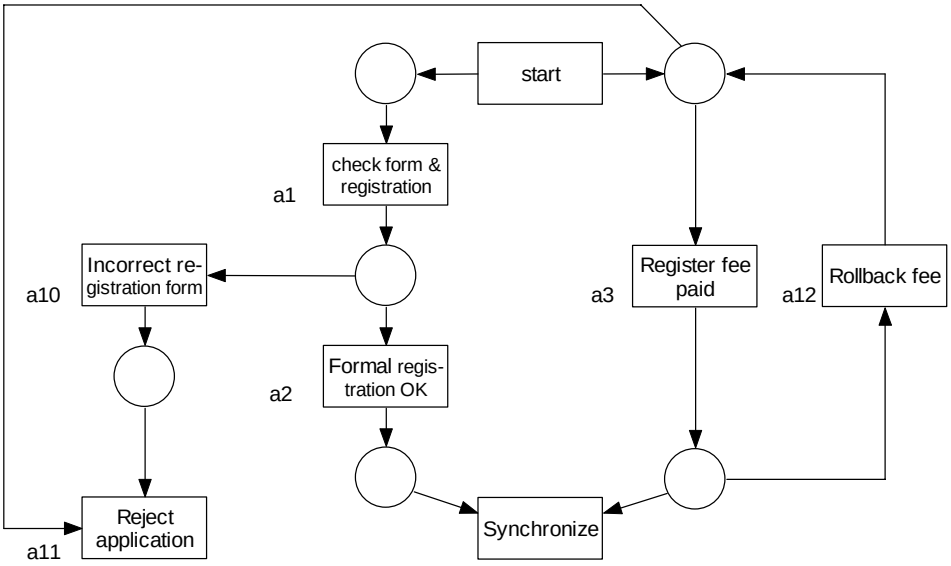

Figure 4. Rollback on fees.

Fig. 4 shows the implementation of these extensions in the Module net. In order to avoid a spontaneous rollback of the fee, we could also define a test arc (loop) between the postplace of a10 and the rollback transition.

The check actions a4/a5 and a6/a7 can be handled in a comparable way. Instead of discussing this in detail, we consider the second module M2 responsible for regularly evaluating service numbers after they have been assigned. Hereby, we especially concentrate on the time aspect.

There are several approaches to extending Petri nets by time (first publications are (Ramchandani 1974, Merlin 1974)). In (König, Quäck 1988) we find a discussion of the possibilities to represent time in Petri nets: firing duration associated with transitions, minimal/maximal length of stay for tokens on places and time constraints associated with arcs. In the following, we use the time extension of (Hanisch 1993) where time intervals at incoming arcs of transitions describe their permeability with respect to the moment the adjacent place is marked. It is therefore an appropriate representation for periods as they occur in the legal regulations discussed in the previous section. However, instead of using a clock concept for each place as proposed in (Hanisch 1993), we use timestamps on tokens to designate the moment they were put on their place. The advantage of this is that the entire state information (tokens and time) is totally coded in the marking and no additional concept is required.

The process of regularly observing a premium service number can now be described with the aid of a Module net with time extension as shown in Fig. 5:

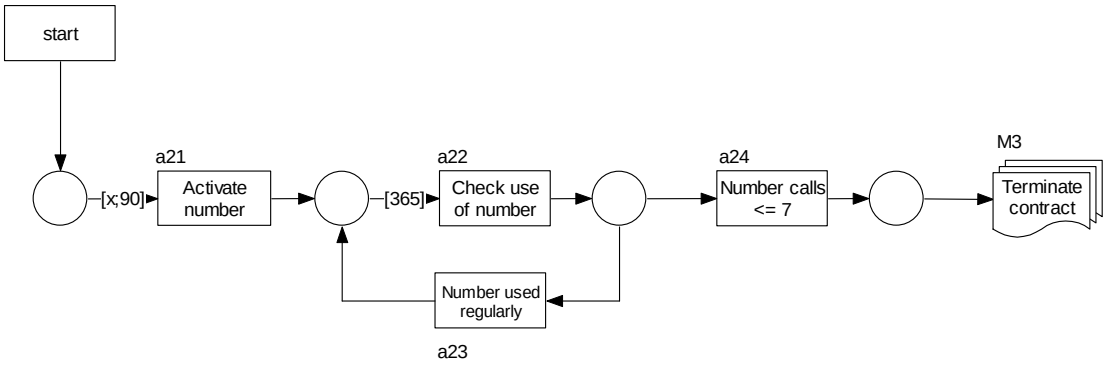

Figure 5. Check number regularly.

The service number is activated - as desired by the applicant - x days after the formal validation of the application has been finished (we assume that $0 \leq x \leq 90$ holds true). This restriction to the occurrence of transition *Activate number* is modelled by a time interval [x;90] at the incoming arc of this transition. Probably there exist other (e.g. technical) restrictions such that the activation might occur after more than x days. These further limitations, however, are out of the scope of the legal regulations and must be discussed when the government process is implemented.

Now, that the service number is activated, it is checked after one year (365 days) whether it is used frequently (i.e. more than seven times a year). Within our Module net, this is represented by a punctiform interval [365;365] (which we abbreviate by [365]). If after this time a sufficient use of the telephone service is observed, the next one year period begins. Otherwise, the service number contract is terminated (which is, of course, also a complex process).

Within our formal process language we specify the Module net of Fig5 as follows:

$$\begin{aligned} M2 := {}& {}_{[x;90]}a21 < \\ & {}_{[365]}a22 < (a23 < {}_{[365]}a22)^* < \\ & a24 < M3 \end{aligned}$$

Hereby, the time intervals in front of the actions specify the periods these actions are delayed. The *-operation indicates that the braced process is iterated zero or more times.

5 IMPLEMENTATION OF THE GOVERNMENT PROCESS

In the previous section, we have demonstrated the modelling of legal regulations with the aid of Module nets and a formal process language. In this section, we apply this framework to the development of workflow implementations.

The task of transforming the previously developed model into an executable implementation comprises two activities:

1. The pure process orientation of Module nets does not cover other aspects of Workflow Management Systems such as organisational structures or information objects (the different views in business process modelling are e.g. discussed in (Scheer 1994, Jablonski, Bussler 1996). However, both are required to execute the specified action, e.g. for decision making. Since Module nets are Petri nets they allow the integration of these additional views by including high-level elements (for high-level Petri nets cf. to (Genrich, Lautenbach 1981, Genrich 1987, Jensen 1992). Transitions (specifying actions within a business process) can access and modify the marking of (high-level) places as demonstrated in (Simon, Rebstock 2004). This, however, does not change the process structure.
2. In Module nets, every firing sequence which reproduces the empty initial marking is a process. But not every reachable marking allows the reproduction of the empty initial marking. Therefore, we call this property of Module nets in analogy with Workflow nets *relaxed sound*. In order to transform them into an executable specification, the ability of Module nets to fire must be restricted such that from each reachable state the empty initial marking can be reproduced. In terms of Workflow nets this property is called *soundness* (Aalst 1998). However, since in (Dehnert 2003) the close relationship between Module nets and Workflow nets has been demonstrated and, furthermore, a minimal restrictive method has been developed to transform relaxed sound Workflow nets into sound nets, this problem can be considered as solved. It is, therefore, out of the scope of this paper.

6 IMPLEMENTATION OF THE PRIVATE BUSINESS PROCESS

The private business processes of an applicant build the counterpart to the public processes discussed in the previous section. In opposite to these processes, they are no refinement of the processes resulting from the legal regulations but follow their own rules. Nonetheless, they will only succeed if they are formulated within the given legal framework. Formally speaking, the models developed in Section 4 are a specification which an application process has to fulfil. As an example, we consider the beginning of an application process.

An applicant might start with paying the fee first, filling out the registration form afterwards (we assume that the company is already registered at the RegTP) and sending the application (with a qualified signature) electronically to the RegTP. Fig. 6 part 1) shows this process. Part 2) shows the respective part of the legal framework. Since we concentrate on this part in the following, we rename the *synchronise* transition into *goal* transition. Furthermore, we name all places.

In Section 4, we have discussed how to verify a Module net implementation against a Module net specification in general. We now demonstrate this approach at the example of the Module nets of Fig.6.

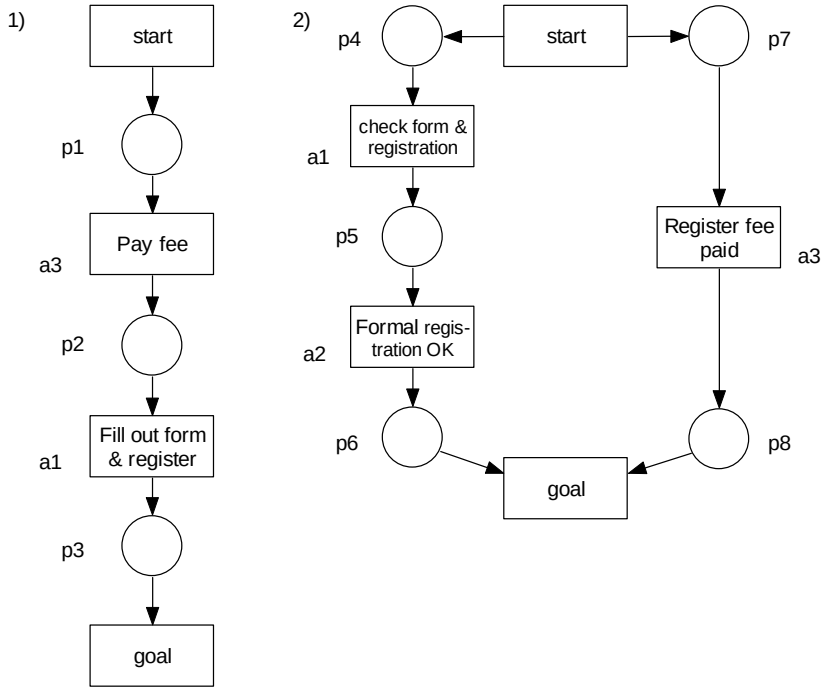

Figure 6. Process of an applicant.

The intersection of the process sets of both nets (the implementation (1) and the specification (2)) is built by joining these nets and comparing the result with the Module net of the implementation. For this, we first have to fusion all transitions interpreted in exactly the same way. While finding matching transitions for *start* and *goal* is simple, identifying appropriate transitions in the other cases are more difficult since the private business process is the counterpart process of the specification. Therefore transitions are named differently even if they describe the same kind of action since this is done from different perspectives. We are therefore forced to associate the matching transitions manually and indicate the transitions belonging together by the same short names. Afterwards, the join of the nets can be calculated automatically. Fig. 7 shows the resulting net.

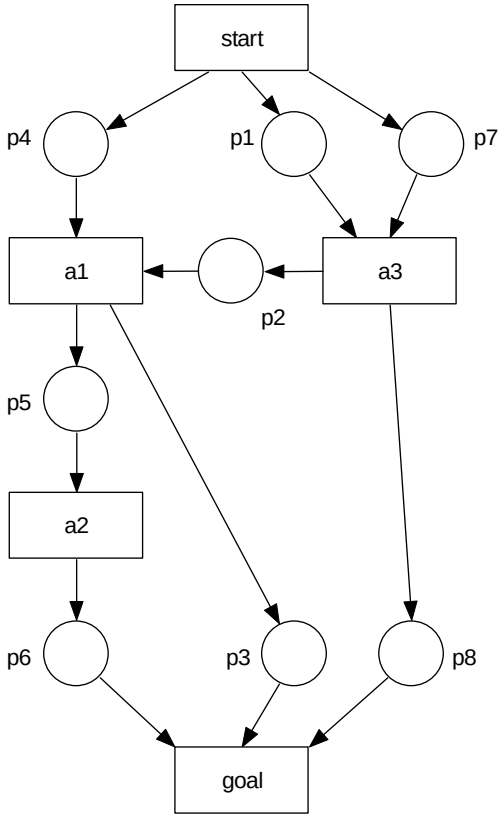

Figure 7. Applicant process joined with the specification.

The Module net of Fig. 7 can be simplified drastically without changing the represented process set. E.g. places p1 and p7 are redundant such that one of them can be deleted. But also the places p3, p4, and p8 can be deleted, since they are implicit invariant (cf. Couvreur, Paviot-Adet 1994) to the remaining places of the net. Fig. 8 shows the simplified net. Since this is equal to the Module net implementation of Fig. 6 (except the completion with respect to action a2 not mentioned in the implementation), we conclude that the implementation fulfils the specification.

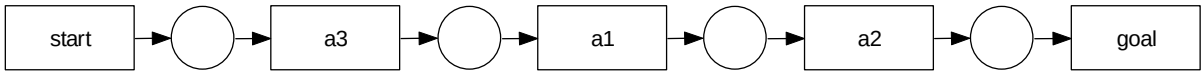

Figure 8. Simplified joined process.

7 CONCLUSION AND OUTLOOK

In our paper, we have demonstrated the influence of legal regulations on the definition and implementation of public and private business processes. As an example, we took the process of applying for a service telephone number at the RegTP in Germany. Hereby, we could demonstrate that the laws themselves specify a process which can be adapted for the definition of the public processes whereas it is the counterpart for the business processes of applying companies.

The example also shows that the legal framework can be specified with the aid of a formal process model. Only such a model allows verifying the actual workflow implementation of the public and

private sector against these models. A support for this thesis is the current trend in (German) public administrations to integrate process centred information systems (Wimmer, Traunmüller 2003) and to restructure the administration along these processes (Reinermann 1995).

However, also for the modelling of private business processes there is an increasing need to integrate legal regulations within business process models. For example, in human resource management standardised employment procedures must be implemented to guarantee fair and non-discriminating processes. Also quality management and consumer protection can only be guaranteed if standardised production and logistic processes are implemented. Their structure, however, is predefined by legal regulations. And especially in the mentioned examples, periods - also discussed in this paper - play an important role.

Our paper presents a solution to this problem in form of a formal process language and representation of the processes in Module nets. In opposite to other existing process notations like eEPCs or UML Use Cases (Rumbaugh, Jacobson, Booch 1999), our approach allows formal verification and simulation of the models in addition to a graphical visualisation. Since our models are Petri nets, they are based on a precisely defined state-semantic and consequently be used immediately as input for a Workflow Management System.

Our future work will be on the consequences of changes to legal regulations and the effect of these changes to the process structure. Hereby, we aim to formulate a change procedure which allows modifying the legal framework, the public and private business processes concisely with the same operations and operands.

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