Public Processes Legal Issues Verification using YAWL

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Abstract: Improving public processes to build an effective e-government system has become a necessity for many governments. For the purpose of providing quality electronic services to citizens, businesses and other public institutions. However, this is not as easy as it seems, due to the nature of e-government system and the requirements of its processes specially the legal ones. As a matter of fact, the law is one of the important sources of knowledge that rigorously describes administrative procedures and their end results. Hence, process verification will be a mandatory task to detect and to prevent process problems at the deployment phase. Therefore, this paper aims to introduce an approach to assess public process legal issues against soundness property using YAWL.

1 INTRODUCTION

Governments become nowadays subject of modernization through the adoption of information and communication technologies (ITC) (Cherouana et al, 2017). Therefore, building an efficient e-government system is one of the ultimate objectives of contemporary governments. For the sake of enhancing the access to and delivery of government information and services to citizens, business partners, and government entities (Layne and Lee, 2001).

It is worth mentioning that e-government cannot be achieved by simply implementing good software (Alpar and Olbrich, 2005), even though these later have proven their effectiveness in the private sector. This is due to the e-government system nature and requirements of its processes, namely, political, organizational, technical and especially the legal requirements (Cherouana et al, 2017). Indeed, according to (Hasan et al, 2015) the policies and regulators become one of the most significant barriers to reengineering public administration processes.

Nevertheless, (re) engineering the public processes without respecting legal constraints is rather dangerous (Alpar and Olbrich, 2005) and leads to inconsistent situations which may cause an enormous loss of trust and reputation (Hasan et al, 2015).

However, regarding their informal nature, regulations could be source of many problems (Aravanis et al, 2018): 1. *Misinterpretation of legal texts because of the difficulty of understanding.* 2. *Lack of legislation or Legal vacuum.* 3. *Self-contradictions* 4. *The origin of legal texts from several sources can lead to overlapping regulations at different levels of authority, and could sometimes produce contradictions or conflicts between them.* 5. *Frequent change and evolution of regulation over time …Etc.*

For these and other reasons, large amount of work exists in the field of business process verification, to maintain e-government's proper functioning. Among them, the approach proposed in the current paper. It allows to perform a twofold process model verification: formal and informal verification. Using YAWL (see section 3), that will act as a simulator, allowing to apprehend processes design issues that may affect performance before proceeding to their implementation.

The reminder of this paper is organized as follows: some related works are presented in the following section with a discussion about it. Section 3 introduces the proposed approach of process verification as well as the research context. Section 4 will describe the case study used to illustrate the approach application. Finally, we conclude the paper with proposition of some future perspectives in section 5.

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2 RELATED WORK

According to (Groefsema and Bucur et al, 2013), the formal business process verification has mainly four goals: 1) Basic process correctness: aim to verify process basic properties such as termination, 2) Process compliance: aims to address and provide solutions to the alignment between business process and regulations (Hashmi et al, 2018), 3) Variability: aims to support different versions of the same process. It uses rules to specify how each version of a process should behave, 4) Processes including multiple parties: aim to verify the compatibility between processes (*for example*).

The following table (Table 4) summarizes some of the related work about business process verification.

Table 1: Related work.

Article	Verification Method	Verification Purpose
(He et al, 2018)	The authors propose a workflow nets with incorporation of data constraints and define four level of soundness and use the reachability graph to verify the soundness property of the processes.	Detecting errors from the data-flow perspective (missing data, conflicts….).
(Aravanis et al, 2018)	The idea here is to reduce the workflow while preserving its properties using six novel reduction rules, then substituted the analysis of the soundness property of the reduced workflow; thus, carry out the verification of soundness property on a smaller WF-Nets.	Verifying the crucial business processes of a system with large size and big complexity.
(Birukou et al, 2010)	This method combined two constraints solving methods: CLP (Constraints Logic Programming) and SMT (Satisfiability Modulo Theory), they report that SMT approach has much better results than the CLP, except for a conflict free workflow net. For this reason, they combined the two of them.	Verifying the modal specifications of the business processes (that describe the necessary behaviours of processes).
(De Moura et al, 2010)	Business rules are represented using the OCL language, considered as a pre- or post-condition for business processes represented by the UML Activity Diagram. The model validation is based on the simulation of the execution of process instances based on specific scenarios. If the violation is detected -with the help of the USE tool- than the execution is stopped and the violation is reported and returned to the modeler whom could rectify the rule or the input or outputs.	Checking the compliance of business processes with the business rules (represented in OCL) at the Run-Time phase.
(Corradini et al, 2010)	The authors defined a quality framework which classifies the delivery processes of an e-government digital processes and they implemented a tool applying a model checking techniques, to verify that developed e-government digital processes satisfy the properties defined in the quality framework	Ensuring quality of governmental processes by comparing it to a set of properties.
(Gilliot and Accorsi et al, 2009)	They use the model-checking technique based on linear temporal logic (LTL) and statistical reasoning. And the result could be one of the 4-valued logic: “true,” “false,” “presumably true,” or “presumably false.”	Anticipating obligation violations at “Run-time”.

Table 1: Related work (Cont.).

Article	Verification Method	Verification Purpose
(Jiang et al, 2015)	Authors propose A compliance and consistency checker framework CCCF that takes as input: business process represented with modelling language then formalized into event-sequence and regulations represented with Norms Nets. Then provides three results: whether regulations are consistent, whether business process are compliant and in case of non-compliance which operation to be rectified.	Analysing both processes compliance with regulations and self-consistency of laws
(Governatori et al, 2006)	Business constraint in the contract is represented by a rule in FCL language. While the business processes scenarios are represented by BPMN then transformed into an event pattern (same thing for the contract conditions in order to facilitate the checking task). The comparison results between the events are as follows: ideal "none violation detected", sub-ideal "violation detected but could be repaired", a non-ideal "a violation detected without a reparation" and irrelevant situation "there isn't a rule to apply in this situation.	Use of logic in analysing the compliance of business processes with business contracts.

2.1 Discussion

From the works of the table above, we observe that there are several characteristics to process verification, that could be divided like so:

2.1.1 Concerning the Process

1. Process Perspective: the focus is on one of the process perspectives (Van Der Aalst and Ter Hofstede, 2005) namely: control-flow, data-flow or resource-flow perspective.
2. Process Sector: the process could be for the public sector or for the private sector (Corradini et al, 2010).
3. Process Complexity: i.e., a complexity factor which specifies how far the process is complicated (Aravanis et al, 2018).

2.1.2 Concerning the Method of Verification

1. Verification Phase: means at what phase of the process life-cycle the verification will be performed. According to (Hashmi et al, 2018) there are three main strategies, namely: de-sign-time, run-time or audit (post-execution).
2. Verification Type: stands for: 1) compliance verification of the process with norms or 2) consistency verification of the regulations governing processes, or 3) both.
3. Employed Methods: refers to the methods used to perform the verification, naming: use of logic, use of well-known AI methods or conceptual ones…. etc.

2.1.3 Discussion

The majority of the studied papers focus on the control flow perspective except for the (He et al, 2018) that treats the data flow perspective, without precising the targeted sector excluding (Corradini et al, 2010) that aims at proposing a quality framework to ensure public processes (governmental processes) quality. They also perform their verification at different time of the process-life-cycle. Also, we notice that the works mostly emphasis on the compliance verification of processes with the regulations -norms- and few of them have evoked the regulation consistency verification. In the exception of (Jiang et al, 2015) that perform the two of them at once. We remark that various methods were used to help in proposing verification approaches, we can cite: logic in multiple works (Gilliot and Accorsi et al, 2009) (Governatori et al, 2006). Finally, many papers have used the model checking techniques to check the applicability of the verification method.

The ultimate objective of proposing this approach for process verification; is to detect legal problems (legal vacuum, legal conflicts and obsolete law), through analyzing public processes during the design-time phase (build-time).

3 PUBLIC PROCESS VERIFICATION APPROACH

3.1 Definitions

The following definitions are necessary for understanding the rest of the paper:

***Workflow-net*:** is a subclass of Petri nets often used in the context of workflow management and business process management (systems) (Process Mining course) WF-nets specifies the dynamic behaviour of a single case in isolation (Van Der Aalst, 2000). In fact, one of the most important notions in the WF-nets is that it has a well-defined input start and output end.

Yawl: stands for Yet Another Workflow Language, is a workflow system (business process management system) fully open-sourced. It is a language with a strictly defined execution semantics inspired by first: Petri Nets with graphical representation, able to support verification (Corradini et al, 2018), also YAWL is based on the workflow patterns (http://www.workflowpatterns.com). Yawl is a successor of Workflow-Nets (Adams and Hofstede, 2020).

***Soundness Property*:** A Workflow-net is sound if and only if the following properties hold:

- ***Proper Completion*:** if the sink place is marked, all other places are empty,
- ***Option to Complete*:** it is always possible to reach the marking that marks just the sink place, and
- ***Absence of Dead Parts*:** for any transition there is a firing sequence enabling it.

***Law*:** the law is any system of regulations to govern the conduct of the people of a community, society or nation, in response to the need for regularity, consistency and justice based upon collective human experience (Law dictionary).

***Obsolete Law*:** The term is applied to statutes which have become inoperative by lapse of time, either because the reason for their enactment has passed away, or their subject matter no longer exists, or they are not applicable to changed circumstances, or are tacitly disregarded by all men, yet without being expressly abrogated or repealed (The law dictionary).

***Legal Void (Vacuum)*:** intuitively refers to a space in which there is no law, is considered as a gap in the law. In fact, it has a largely pejorative connotation for those who feel that the law is the best means of binding individuals and to ensure that everyone's freedom is respected, while it will have a very positive connotation for people who see the law as a negative constraint and therefore, in its absence, a space of freedom (Dinh, 2007).

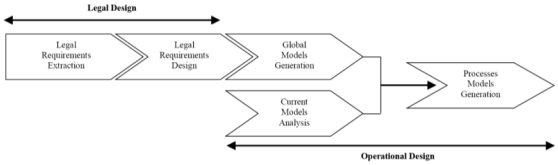

Figure 1: Framework for governmental processes design (Cherouana et al, 2017).

3.2 Research Context

In previous works, a framework dedicated to generate public processes from their legal texts was proposed (Mahdaoui and Cherouana, 2012). The developed solution was an evolutionary framework comprising a sequence of two major phases allowing a priori design in compliance with the law (see Fig. 1), namely: a) *legal design*, b) *operational design* (Cherouana et al, 2017).

The following table gives a brief description of each phase as well as their inputs and outputs:

Table 2: Public process design phases.

N°	Phase	Input	Description	Output
1	Legal Design	Legal corpus	Extract from the legal texts the different characteristics constituting the public process and represent it with the workflow-net formalism.	Global Model (Abstract Process)
2	Operational Design	Current models & Abstract process	Add the operational aspect not necessarily defined in the law to the abstract process and specific to each public institution.	Public Process ready to deployment

Despite, the conformity of the generated process model with the law, it cannot be definitely said that it is valid and ready to be deployed yet. For the simple reason that regulations and legal texts may include

some shortcomings that certainly have a negative impact on process validity.

Accordingly, we believe that detecting gaps and inconsistencies in the legislation is of great importance to ensure that the designed public process will act properly when implemented.

Hence, we aim to propose verification approaches at different steps of the process development as depicted in the diagram (see Fig. 2), to be specific: a) *legal corpus verification*, b) *abstract process verification*, and c) *global model verification*.

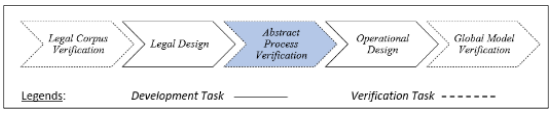

Figure 2: Steps of process development with verification tasks.

Indeed, we have previously proposed a pre-verification approach (Mezaache and Mahdaoui, 2020) a verification of the consistency of the legal corpus, that will serve as a basis for extracting the process at a very early stage (before "legal design" phase).

Therefore, in the current paper, we are interested in the verification of the *Abstract Process* (see the coloured verification task in figure 2).

3.3 Abstract Process Verification Approach

So that, in this sub-section, we detail the verification of the generated model from the "Legal Design" phase: *the abstract process*. Which is a twofold procedure: Formal verification & Informal validation.

3.3.1 Formal Verification

The abstract process is the result of the legal design phase in the development of the process. During this phase a law study is performed to extract the activities, roles and constraints of the to-be process, besides the logic of the control-flow of the latter, then represented it in workflow-net formalism. At this stage, our concern in this paper is to check that the generated process is not subject to problems.

According to PR Will Van Der Aalst soundness property is at the same time basic and most important property that each WF-net model should satisfy for being correct and free of anomalies.

YAWL, is concerned with the design time detection of certain undesirable characteristics in process models. It provides two verification approaches; the first approach is based on the ResetNet theory which supports the use of reduction rules while the second proposes the use of the wofYawl analysis algorithm (based on the concept of transition invariants "petri-net") (Adams and Hofstede, 2020).

Basically, the abstract process (i.e., global model) will be verified by the Reset-Net analysis tool to check the soundness property. Remember that the process model is an abstraction of the law, as such whether the result of the analysis is positive or negative, it reflects the consistency of the law.
Here comes our proposal to interpret the results of the soundness property legally.

Results Interpretations: To do so, we proceed by interpreting the negative results of soundness property analysis:

Deadlock: In fact, the existence of deadlocks means that one of the two properties "Option to complete" or "Proper completion" is not verified. Indicating, that there is no appropriate path to take (set of actions) through the model. Which implies that no corresponding legal text(s) that explains what is the next step or how to deal with this situation: this is called **the law void**.
Dead Parts (Transitions): The existence of dead parts means that the property "Absence of dead parts" is not verified. This means that there are tasks that cannot be performed in any scenario, this could indicate that the **law is obsolete** and doesn't respond to the needs anymore, or simply it is not useful.

The following table represents the resulting links between the four soundness properties and legal problems:

Table 3: Correspondence table between WF-nets properties (soundness) and legal problems.

Problem Encountered in The Process Model Analysis (Wf-Nets Properties)	Legal Interpretation (Legal Problems)
P1: Existence of deadlocks (The execution is blocked before reaching the end). => property 'Option to complete /proper completion' is not checked.	- Legal void. - Law incompleteness

Table 3: Correspondence table between WF-nets properties (soundness) and legal problems (Cont).

Problem Encountered in The Process Model Analysis (Wf-Nets Properties)	Legal Interpretation (Legal Problems)
P2: Existence of transitions that cannot be executed in any scenario (Adams and Hofstede, 2020). => property 'Absence of dead parts' is not checked.	- Legal texts not useful. - Law obsolete. - Law that does not fulfil the needs.
P3: Multiple tokens in a place at the same time. => Safeness property is not checked.	-Conflict situation. -Inconsistency.

It can be concluded that if there exists problems in the analysis report of the soundness property, then the legal texts on which the process is based are source of these problems. Therefore, it is necessary to return to the correspondence table to extract the appropriate legal interpretations of the problems encountered.

3.3.2 Informal Validation

The abstract process needs to be approved by public institution managers, owing to the fact that this model is considered as a draft that each public institution will enrich/complete it with its own operational aspect (new activities, roles, constraints, gates…etc.). That's why, public institution has an extremely important role in the final decision of the process model validity.

The results of the formal verification with both interpretations and eventual recommendations will be sent to the public institution for study. Even though the formal verification may contain some issues, it is up to them to decide whether these problems are fatal and need to be resolved, so the development process will be suspended until solutions are put in place or not.

This validation is informal, it comes back to the fact that the decision is made by humans and could not be formalized or automated.

4 CASE STUDY

We have chosen the process of managing competitive entrance exams to the Higher School of Social Security 'HSSS' (public institution) to obtain a professional master's degree, for applying the proposed validation approach. Three categories of applicants can be distinguished: 1) *External applicants*: coming from universities, preparatory schools, etc. 2) *Applicants from the social security organisms*, and 3) *Foreign applicants*: from foreign countries.

The process for the first category was generated from these legal texts 1) executive decree n°649 from the Ministry of Higher Education and Scientific Research 'MHESR' official site: https://www.mesrs.dz/fr/chapitre3 , and from 2) the school internal texts, in BPMN language. However, the second and third categories were generated from only internal texts because of the lack of legislation.

- **Process Generation in BPMN:**

Case 1: First Category

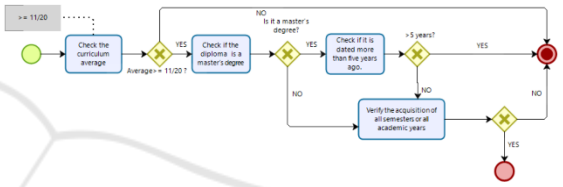

Figure 3: A part of the process: ' Verification of the result of the university course' in BPMN.

Case 2: Second Category

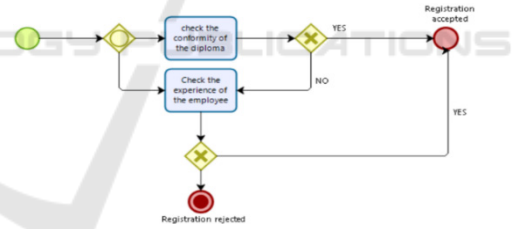

Figure 4: A part of the process in BPMN for competitors from the social security organisms.

- **Process Transformation:**

Then, the process will be transformed to the workflow-nets formalism.

Case 1: First Category

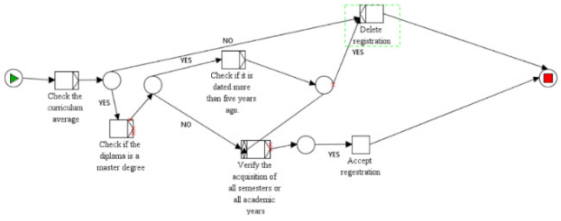

Figure 5: The transformed process model in YAWL.

Case 2: Second Category

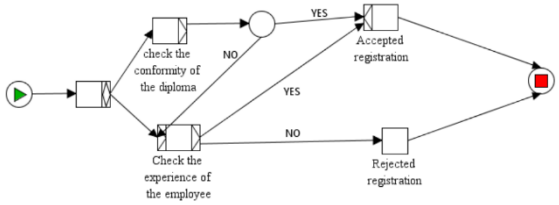

Figure 6: The transformed process model in YAWL.

- **Process Analysis (Problems Identification):**

The process will be verified using the Reset-net analysis tool of YAWL. It gives the observation about the three properties of the soundness property:

Case 1: first category

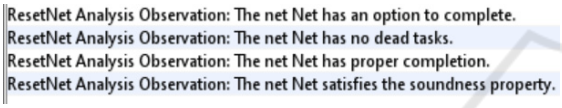

Figure 7: The analysis results of soundness property by ResetNet.

Case 2: second category

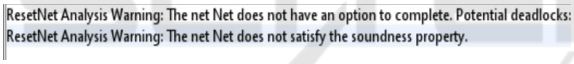

Figure 8: The analysis results of soundness property by ResetNet reveals deadlocks for the second category.

- **Report Generation and Recommendations:**

Case 2: second category

Table 4: Recommendations for the process of competitors from the social security organisms.

Problem number	Recommendations/Diagnosis
P1: is detected	- Need to Legislate Laws concerning the competitors from the social security organisms by the MLSS

Discussion.

This case study was a sort of comparative application of the presented approach on two process model variants: the external competitors and those from the social security organisms.

The results showed that the soundness property of the modelled process of external competitors (first category) are maintained, so it can surely be said that the process is valid and could be safely deployed.

Nevertheless, the verification of the second variant process (second category) pointed out some problems: " deadlocks ", returning to the correspondence table, this is due to the "legal vacuum", i.e., the lack of legal texts clarifying how to deal with competitors registration files. So, the process isn't valid and legislation activity is needed.

5 CONCLUSION

The effectiveness and efficiency of public processes are the key for e-government system success and improvement. Unfortunately, this cannot be achieved without maintaining compliance with the law.

In this context, the generated processes comply with the law because they are intended for the public sector.

Nevertheless, the law can sometimes be source of problems, resulting in the invalidity of the process, which could fail once deployed.

We believe, therefore, that detection of law deficiencies could help tremendously in improving public processes.

Hence, we propose an approach that interpret the results of correctness analysis of soundness property of the process. By leveraging the analysis features offered by workflow-net (YAWL tool).

These interpretations allow to detect legal texts problems whom the process is based on. Then, a report will be sent to the public administration managers to proceed the informal validation and give the final decision.

Since this type of analysis or verification is tidily concerned with the model quality (Van Der Aalst in Process Mining course). We intend to proceed the data perspective verification to integrate more semantics and to put interest in both content and model in future works.

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