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Visual legal analytics – A visual approach to analyze law-conflicts of e-Services for e-Mobility and transportation domain

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Abstract

The impact of the electromobility has next to the automotive industry also an increasing impact on the transportation and logistics domain. In particular the today's starting switches to electronic trucks/scooter lead to massive changes in the organization and planning in this field. Public funding or tax reduction for environment friendly solutions forces also the growth of new mobility and transportation services. However, the vast changes in this domain and the high number of innovations of new technologies and services leads also into a critical legal uncertainty. The clarification of a legal status for a new technology or service can become cost intensive in a dimension that in particular startups could not invest. In this paper we therefore introduce a new approach to identify and analyze legal conflicts based on a business model or plan against existing laws. The intention is that an early awareness of critical legal aspect could enable an early adoption of the planned service to ensure its legality. Our main contribution is distinguished in two parts. Firstly, a new Norm-graph visualization approach to show laws and legal aspects in an easier understandable manner. And secondly, a Visual Legal Analytics approach to analyze legal conflicts e.g. on the basis of a business plans. The Visual Legal Analytics approach aims to provide a visual analysis interface to validate the automatically identified legal conflicts resulting from the pre-processing stage with a graphical overview about the derivation down to the law roots and the option to check the original sources to get further details. At the end analyst can so verify conflicts as relevant and resolve it by advancing e.g. the business plan or as irrelevant. An evaluation performed with lawyers has proofed our approach.

Peer review under responsibility of the scientific committee of the ICTE in Transportation and Logistics 2018 (ICTE2018).

Keywords: Legal analysis; Law visualization; Visual analytics; e-Government; Semantic data; e-Mobility Services; e-Transportation Services

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1. Introduction

The electrification of vehicle has already generated a huge impact on the automotive industry. This impact is not limited on design and car constructions as most people would think. Changes on engines and transmissions are just one part. It also comes along with dramatical changes surround the car itself. New car renting models in big cities as well as infrastructure services to load cars lead to new services where the billing and legal situation is still not clear.

The more the electromobility proceed, the more the transportation and logistic domain has to deal with this phenomenon too. It starts with electrified trucks that have to pay lower tolls on motorways and lower yearly taxes, and continues in the individual behaviors of e-trucks. The distance that can be drove with e-trucks is actually smaller, however, the total yearly costs can be much smaller. So finally, it is to check, if the own business could be more finally more economic if electrified and without risking the current quality and service level. A good example for this scenario is the German post. Due the lack of available e-trucks, they started building their own e-scooters and have a great success with that. But even for them, the loading infrastructure is still poor and requires further ideas how the loading logistics can get optimized.

A major challenge in introduction new technologies and especially e-services in the field of mobility and logistics is the legal situation. In particular the data privacy in Europe is one point that was and is a quite complex situation, due to high barriers on what agreements and terms the customers need to accept or what is prohibited in general [1]. A well know negative example is that even today the legal situation of smart meters is very fragile, for private and business customers as well. Indeed, lawyers could clarify the legal situation and help to avoid bigger law conflicts, but many innovations are nowadays initiated by startups, who do not have the budgets to hire cost intensive lawyers to verify the legal status of their planned services. And so, most of these startups start their business with significant legal uncertainty.

In this we aimed to face this problem with a solution that enables to verify business planes and models against laws to identify legal conflicts early and support resolution fining to put new planned services on a solid legal fundament. Therefore, we brought two new approaches on track. Firstly, we created a Norm-graph visualization that enables to visualize law in easier understandable manner. As known from a number of other domains, data and information visualizations can help in understanding data better. Therewith, it seems logic that even for law visualizations it could help to understand the context much better and easier either for legal experts such as lawyers or casual users, as it similarly does to other public affairs e.g. in policy modelling or e-government [2, 3]. Secondly, we created a visual legal analysis solution, that enables to elaborate and very automatically identified conflicts visually. As a result, in particular startups in the mobility and transportation domain should be able to identify legal conflicts of new technologies and services early and solve the conflicts for a legal business.

2. Related works

Visualizations and visual analysis systems are rarely represented in the legal domain [4], although visualization techniques offer a high potential for the easy understanding of complex issues. Schematic representations of references between legal texts, facts or relationships between different legal norms are everyday use cases. Nevertheless, there are some examples that demonstrate the potential of visualizations for the legal domain. For example, Röhl et al. [5] uses the radiance of fundamental rights with the distinction between the conceptual kernel and the term court [5] to visualize legal knowledge. They also use a pyramid of terms to convey legal methods [5]. These didactic representations of legal knowledge serve to impart legal knowledge and can be found in textbooks on methodology. However, these representations are designed for lawyers and legal experts, but not for end users who need legal support or a legal expert to understand legal norms. In addition, these representations are static and not driven by ICT. The use of ICT in the legal domain is still a relatively young discipline. Nevertheless, there are already a few approaches that integrate the potential of visualizations in interactive applications. The following sections introduce some of these systems to give an overview of today's visualization approaches in the legal domain.

Most systems focus on managing legal cases, such as the case navigator [6] by Faktor Logik, which is a computer-aided case processing system. The innovative approach supports the application of legal norms, contractual conditions and work instructions that are loaded as an ontology-formalized knowledge base. After a regulation (legal norm) has been loaded, the legal texts are presented in a structured way. In contrast to the previously presented approaches, the case navigator also allows a visual description of the facts in a graph-based visualization.

Beside the strong visualization-driven approaches, there are also ICT solutions that include basic visualization metaphors. One representative is the Legal Information Retrieval and Focused Semantic Search (LIRFSS). The main focus of Legal Information Retrieval [7] focuses on finding information in legal sources. These include ordinances, legal texts and historical sources such as judgment databases and precedents. The system takes account of various metadata such as date, place of action and IPC (Indian Panel Code). The downside is that the approach only integrates rudimentary visualization techniques to visualize and present the results obtained for a better overview.

Another approach in Legal Information Retrieval is Parallel Tag Clouds [8]. The aim of this visualization technique is to present court decisions facetted and thus to graphically communicate a comparison between different courts. For this purpose, Parallel Tag Clouds uses the faceting approach in which the set of documents (judgments) is grouped according to a given facet (category). Each facet then extracts a set of keywords that are displayed vertically in a column. The keywords are sorted alphabetically by column and the font size is adjusted to the relevance values identified by the analysis. By combining the same keywords between the search results, this approach allows comparison of different courts and allows conclusions about the topics and judgments dealt with there. For a selection of key terms, a second view shows the corresponding documents and the relevance of the key terms in the respective documents. Thus, in addition to the overview of the judgments, the lawyer also has the opportunity to verify hypotheses based on the found textual sources.

Another approach that goes beyond the mere search for information in the legal domain is a demonstrator for visualizing legal rules on tungsten [9]. In an interactive graph the representation of logical rules are visualized which connect a legal norm based on different legal arguments. In this way it is possible to visualize a fact to judge a legal consequence. The approach demonstrates in a flexible way how visualizations in the legal domain can be used to establish relationships between legal norms and facts. Although the demonstrator is a first example of automated legal education using visualizations, even if the system is still rudimentary.

Another example of Legal Information Retrieval is LexisNexis [10]. The company specializes in information search for lawyers and legal experts and offers various solutions for identifying relevant information. The company offers several platforms for the search of legal facts. Among other things, the solutions enable searches in case databases. The search results are usually presented in textual form, but rudimentary visualization approaches are also integrated.

3. Semantic data modeling and conflict detection

In a first step, we outline the data side and how the data needs to be (pre-)processed to finally be able to visually analysis it. Therefore, this section aims describe the data processing foundations for the conflict analysis.

3.1. Semantical data processing of legal and law texts

On the basis of raw texts of existing laws, it is actually not possible to generate effective law visualizations on the fly. For that reason, it is essential to pre-process the data for the final visualization purpose. In our use case we use supervised methods to manually generate the data basis, but for the wide use it is definitely recommended to enhance the approach by the use of semi- or non-supervised methods [11]. As data fundament, we aim to generate a Legal-Concept-Ontology [12, 13], where all law elements are represented in a semantic schema.
The process of legal modelling includes the systematic transformation of legal texts into a formal ontological description language, which can be processed by a machine. This process is divided into the following sub-steps (the steps are described in more detail in [11]) [12, 13]:

- Normalization of legal texts: The normalization corresponds to an editorial adaptation of the legal texts. Implicit references within a legal clause are explicitly mapped to ensure correctness for the formalization

- Legislative modeling (conceptual level): Starting from the normalized legal textual text, legal concepts that need to be modeled are identified, annotated and formalized as classes or relations in a Legal-Conceptual-Ontology (LCO)
- Legal sentence modeling (symbolic level): The legal terms formalized in Legal-Conceptual-Ontology (LCO) form the vocabulary for machine-processable definitions of legal sentences. For this process step, the identified legal terms for the extraction of a complete header are logically linked

In addition to the formal depiction of legal concepts and legal principles, another task for the lawyer is the enrichment of the legal knowledge base with additional materials. In this step, for example, the modeled legal terms are supplemented with references to definitions, which are interactively integrated into the development environment for the client in order to provide a more detailed insight into the applicable legal situation.

3.2. Semantical legal issue processing

For determining legal conflicts, a Legal-Issue-Ontology (LIC), e.g. based on a business plan, has to be modelled in a semantic format too. In this first prototype version we used the same tools as we used to create the Legal-Concept-Ontology (see therefore the Norm-graph visualization publication [11]). It follows almost the same three steps as the semantic data processing in the section before: (1) normalization of legal text, (2) legislative modeling, and (3) legal sentence modeling. However, there are significant differences between the LOC and LIC:

- In general, the LIC is not modeling laws, it just focuses on modeling the major part of a certain case (non-law). But the focus is still the same, to cover all the relevant aspect as precise as possible and by using legal terms instead of slang etc. Therefore, it is important the use the same or at least similar legislative model (conceptual level) as the LOC already has. Otherwise the following conflict detection loses quality
- The LIC misses legal consecution in its modelling. The intention here is to use the consecution more in perspective that it should be done like this by business plan or so. In case of contradiction with the LOC, it will finally be shown as legal conflict in the visual analysis phase

3.3. Legal conflict detection through subsumption analysis

The legal conflict detection is performed on the basis of a proprietary algorithm that majorly could identify problems based on equally used terms in the LOC and LIC, such as ‘collection” of ‘personal data’. If terms could be found in the LIC as well as in the LOC, it is checked if the LOC claims some restriction. If a restriction is identified, the system handles this a possible legal conflict and stores it for the later following visual legal conflict analysis.

Major challenges are legal dependencies and hierarchical definitions in the LOC. If the top legal sentence covers terms like ‘collecting’ of data, which is later on specified in another legal sentence, it is important to tracer and resolve the most detailed legal sentences first, and identify the legal consecution, before you could resolve the top legal sentence. What sounds logic and simple on the description level, becomes challenging in the semantic worlds since there are no hierarchies of created instances predefined in the ontology. So, the subsumption algorithm [14, 15] has to handle these hierarchies and dependencies during runtime in a decision-tree manner. After creation of the decision-tree, the system resolve the legal connection up to the upper level.

The result of the subsumption is stored for the following visual legal conflict analysis, where the experts finally check if the concrete planned procedure is allowed, allowed under consideration of further aspects or prohibited.

4. Visual legal conflict analytics

In the second step, build up on the previously described data processing foundations, the visual processing is described in this section. Therefore, we explain how the data is consumed in our Norm-graph visualization to show laws and legal aspects, but also how the visual conflict analysis works will be described.

4.1. Data foundation for norm-graph visualizations

To outline better how the Norm-graph is generated, it is important to understand the principle structure of norms. In contrast to the written paragraphs in law books, only the main relevant parts are considered and follow a strict template [11]. On this basis any kind of norm can modeled and finally visualized.

A concrete norm or law consist of a number of constraints that are connected with different operators (AND, OR, XOR, NOT, etc.). It is to indicate that there is also a logical structure (see Fig. 1) of how certain aspects correspond to each other, such as objects like 'personal data' or actions like 'processing of'.

Followed on a number of connected constraints there is always a clear consecution (indicated with '→'). This consecution indicates if something is valid, in particular if a certain action is allowed or prohibited.

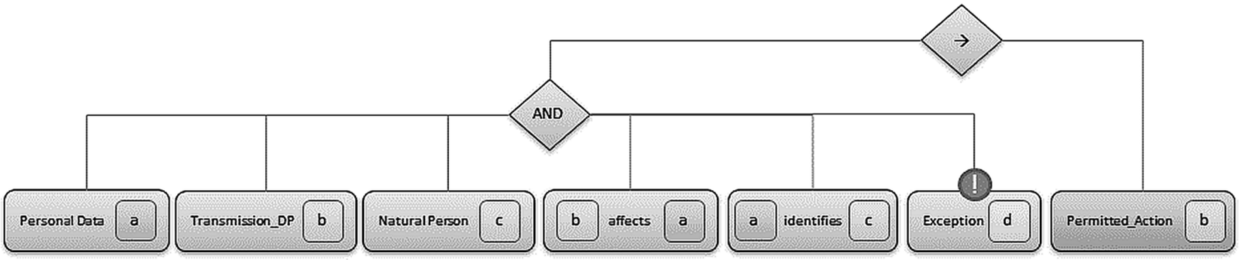

Fig. 1. Template for a single Norm on the basis of the underlaying semantic structure.

4.2. Visualizing laws with norm-graphs

The Norm-graph shows the major aspect of a law or legal aspect in one line with the legal consecution at the end. The shown aspects in the top line are different to the original text of laws, where now only the major aspects as annotated before are considered. But even on this level the message is easy to understand when read by humans [11].

Since a number of aspects are not defined in a single paragraph and sometimes references to terms from other statutes, the major advantage is the interactivity. Through clicking on a concrete aspect, it shows underneath where an aspect is further explained, defined or where is derived from.

Since some referenced paragraphs or term definitions are representing an own norm, a second line is opened. Based on this recursive approach, the user is able to elaborate the full bunch of underlaying laws to understand e.g. what "personal data" are and how they are defined. This simple overview about legal aspects and how each single aspect and term resolves to all kind of law sources enables a fast and clear understanding.

4.3. Legal conflict analytics based on subsumption analysis

The subsumption in the narrower sense between law and fact occurs through the ontological hierarchy comparison between the individual legal concepts of the legal clause, as well as their characteristics and the factual characteristics. In order to visualize this process of subsumption visually, for each legal concept, the three subsumption results are visualized in animated form, which receive the highest score by the subsumption algorithm. Once the animation for a legal term has been completed, the considered legal term, together with the subsumed factual instance, stops, and the animation for the next legal term is started with a column next to it.

If the subsumption animation has been completed for all legal concepts of the legal clause, then in the following the disconfirmed part of the legal clause with the best subsumption result is displayed together with the subsumed factual instances. If during subsumption in the narrower sense conflicts between law and facts have been identified, the legal term for which the conflict was detected is given a warning sign (see Fig. 2). Likewise, the symbol of legal reasoning (for example, admissibility) receives the same warning sign, which remains in effect until all existing conflicts between the law and the facts have been resolved.

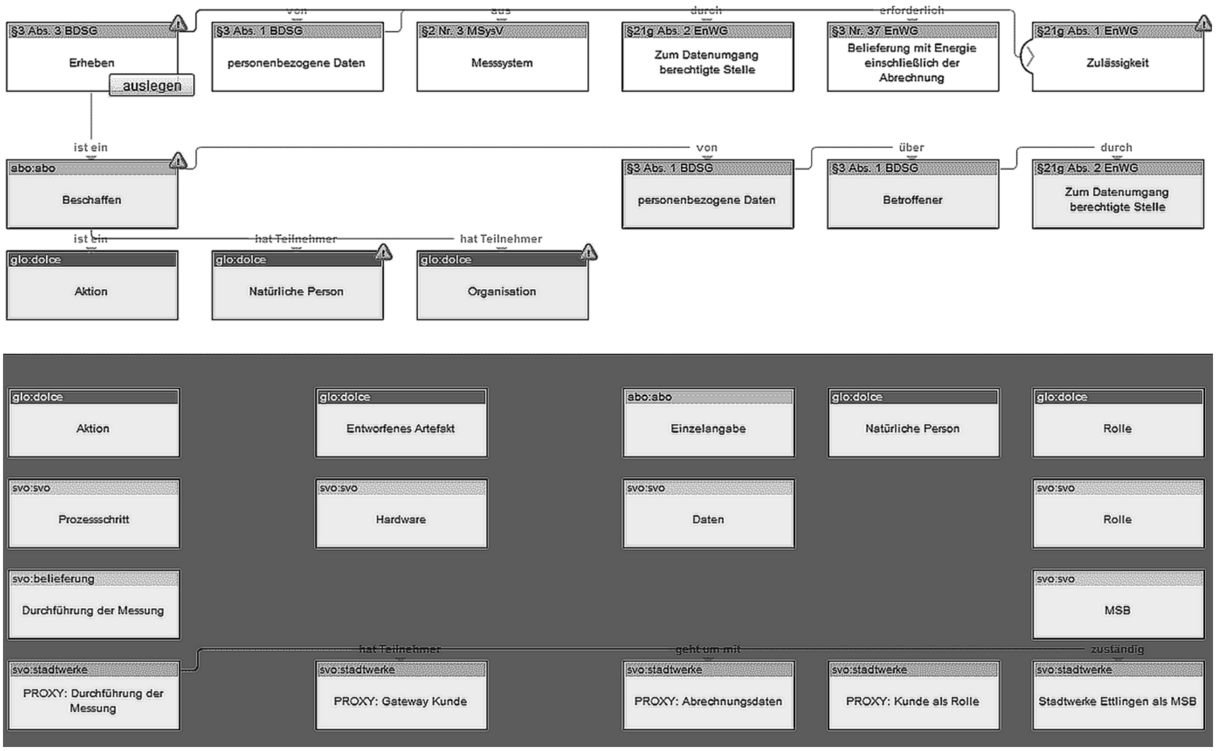

Fig. 2. Presentation of a detailed subsumption conflict with the option to start the interpretation process.

By clicking on the warning symbol of a legal symbol, the previously described feature view is unfolded to such an extent that the point of conflict between the features and the facts instances becomes visible. At this point, the user is now shown that a user interaction to resolve the conflict is necessary and immediately offers the opportunity to start the design process.

In addition, the user is now also free to examine the respective subsumed subject instances by means of the navigation of the features. Here, the facts are displayed on a color-delimiting level with an opposite hierarchical direction in the ontology. While the features of the theorem approach vertically downwards to the root of the ontology, this approximation for the facts instances upwards, so that the meeting point in ontology between the two levels can be visualized visibly. Also, in the case of existing sub-selection results, a representation of the features going beyond this meeting point is prevented in order not to unnecessarily confuse the user at this point.

By double-clicking on an entity, also the full trace of the original source (law books, encyclopedia etc.) could be analyzed with the view to resolve conflict.

5. Evaluation

To evaluate our law conflict analysis approach, we prepared a user study where we invited majorly lawyers to test the system. The evaluation is performed with our web-based evaluation system [16] that enables users to perform practical tasks with web-based applications next to answering questionnaires.

5.1. Purpose and procedure

The major contribution, even of the conflict analysis tool, is the Norm-graph visualization, so that we focused on evaluating this visualization in an editor environment. This Norm-graph visualization enables an easier understanding of complex legal aspects, dictate of justice and legal features on the one hand and with its editing functions it can also act as an easy editing of complex legal aspects on the other hand. Therefore, the participants should try to model the Legal-Issue-Ontology with our graphical editor that consist about a dashboard of editor-visualizations [17] as well as with a standard ontology editor. As standard editor we used Web-Protegé, which is quite similar to the ontology editor Protegé, but runs as web-application and therefore is suitable for our web-based evaluation.

The procedures follow a so called within-subject design (cross-evaluation) with a randomization based on gender and age. The procedure is sketched in Fig. 3.

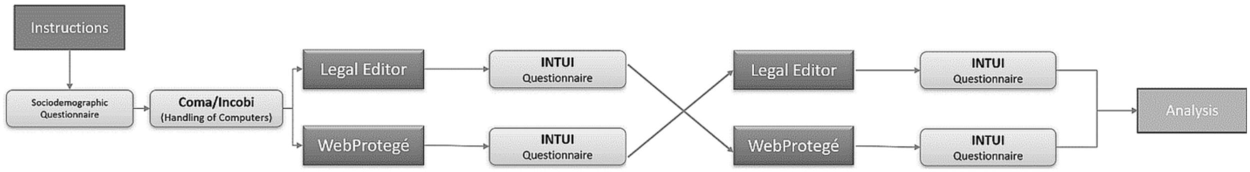

Fig. 3. Evaluation procedure that considers randomization.

5.2. Participants

In the evaluation we considered 14 participants who were all lawyers or students of the law faculty. The participants where between 25 and 44 years old (mean: 31.26; standard deviation: 4.09) and 30.77% where female. The participants have used computers since 15 to 30 years (mean: 20.8; standard deviation: 3.54) and use those between 4 and 70 hours the week (mean: 47.66; standard deviation: 17.41).

Based on Apriori Power Analysis for one tail and effect size $dz = 0.5$ and α err prob ≈ 0.0493959 we could calculate a validity for these 14 participants of 68%. In perspective of the specific expert target group consisting of lawyers, this is a satisfying validity value.

5.3. Results

In the following two section we present the evaluation results, first regarding the practical system usage and achieved task completion results and the task completion times, and second the questionnaire results regarding the intuitiveness and other subjective experiences.

5.3.1. Task completion and task completion time

The participants had to solve a couple of tasks with each of the two systems while in background the time consumption and the correct answering (based on given set of possible answers to given task) was logged. The given task for each of the two system were always similar, but never equal. The tasks were:

- How many features does the "personal data" symbol have? (three answers, one was correct)
- Identify the relation "required" and indicate which matters of fact connect them! (three answers, one was correct)
- Create the rule header "Permissibility" by filling out the dialog box to properties of the legal consequence. Could you solve the task? (three answers, one was correct)
- Now create the definition characteristics of the created legal consequence. Could you solve the task? (three answers, one was correct)
- Create the matter of fact "acquire" within the scope of the legal sentence. Could you solve the task? (three answers, one was correct)
- Now create the definition characteristics of the term "collection". Could you solve the task? (three answers, one was correct)

- Create the relation "required for" in the legal clause in the right place between the corresponding matter of facts. Could you solve the task? (three answers, one was correct)
- Create the definition characteristics of the relation "required for". Could you solve the task? (three answers, one was correct)
- Within the legal term "collection", create the definition characteristics of the general term "procurement". Could you solve the task? (three answers, one was correct)

The participants (see Fig. 4) could solve a task with approx. 46% (SD: 2.13) correctly with our graphical legal editor in contrast to approx. 8% (SD: 1,73) with WebProtegé. In further Chi-Suqare + F-Test analysis we could measure $p(F) = 0.027, X^2 = 5.75\ and\ SD = 1.93$.

Our graphical legal editor was significantly better than WebProtegé ($p < 0.05$). We could measure an average task completion time for a solved task with our graphical legal editor of 58 seconds (SD: 18,94) and with WebProtegé 61 seconds (SD: 61,83). Due the fact that for a few tasks all users where unable to solve the task correctly with WebProtegé and hence no task completion time could be measured, we could not perform a Chie-Square + F-Test analysis.

5.3.2. Questionnaires regarding intuitiveness and subjective experiences

To measure the subjective experiences as well as the intuitiveness, we let the participants answer the INTUI questionnaire for any of the systems after they had to solve the practical tasks with it.

For the *Magical Experience* we could measure a score of 1,46 (SD: 1,54) for our graphical legal editor and 0,69 (SD: 1,69), while a min. of 0 and max. of 6 was possible. Our graphical legal editor was significantly better than WebProtegé based on an F-Test analysis ($p < 0.05$).

For the *Gut Feeling* we could measure a score of 2,10 (SD: 1,63) for our graphical legal editor and 2,17 (SD: 1,85) for WebProtegé, while a min. of 0 and max. of 6 was possible.

For the *Verbalizeability* we could measure a score of 2,00 (SD: 1,58) for our graphical legal editor and 1,11 (SD: 1,69) for WebProtegé, while a min. of 0 and a max. of 6 was possible. Our graphical legal editor was significantly better than WebProtegé based on an F-Test analysis ($p < 0.05$).

For the *Effortlessness* we could measure a score of 2,43 (SD: 1,67) for our graphical legal editor and 1,47 (SD: 1,21) for WebProtegé, while a min. of 0 and max. of 6 was possible. Our graphical legal editor was significantly better than WebProtegé based on an F-Test analysis ($p < 0.05$).

For the *Intuitiveness* we could measure a score of 2,40 (SD: 1,90) for our graphical legal editor and 0,00 (SD: 0,00) for WebProtegé, while a min. of 0 and max. of 6 was possible.

It can be summarized that our legal conflict analysis was not only working better in the practical tasks (objective perspective), also the higher ranked participants' perception proofs the necessity of our system (subjective perspective).

6. Conclusion

The e-mobility is already revolutionizing the automotive industry in many ways and is not limited on car manufacturing only. But the more e-vehicles came on the market, the more it effects among other the transportation and logistics domain too. New technologies and in particular services aim to modernize this sector, but due to its unique state, many of these new services may have legal uncertainties in their business models. Unfortunately, to analyze the complex legal situation is most often cost intensive, which is for many startups not affordable.

As an alternative, we created a visual legal conflict analysis solution that aims to analyze business models and plans against laws to identify and able a closer analysis for legal conflicts. This could reduce conflict risks, since a number of critical aspects are directly shown and can be checked, if these are really affecting the planned business idea. As a major contribution is next to the Norm-graph visualization, the visual conflict analytics approach where the users can interactively analyze the potential conflicts.

In an evaluation, we could show, that our visual tools are helpful features in the work with legal aspects and laws. Against traditional systems we could provide a better useable solution that could also practically used with a lower error rate.

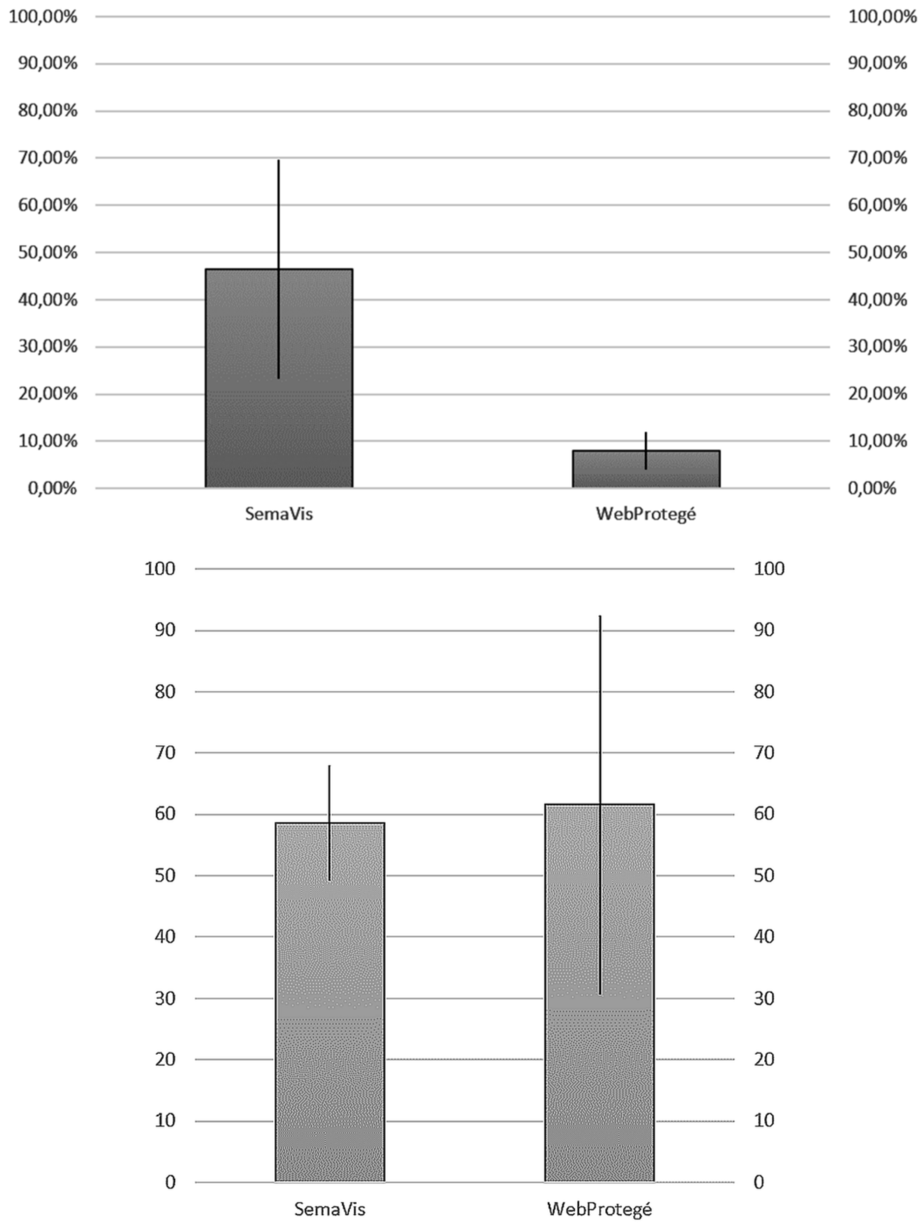

Fig. 4. The mean task: (a) correctness in percent; (b) completion time in milliseconds about the correctly solved practical tasks.

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