

REGNET: Regulatory Information Management, Compliance and Analysis

Kincho H. Law and Gloria Lau

Engineering Informatics Group

Department of Civil and Environmental Engineering

Stanford University

Stanford, CA, 95014, USA

Email: law@stanford.edu; glau@stanford.edu

ABSTRACT

This paper describes a research effort that aims to develop information infrastructure and tools to facilitate access, compliance and analysis of government regulations. It is well recognized that the complexity, diversity, and volume of government regulations are detrimental to business and hinder public understanding of government. The burden of complying with regulations can fall disproportionately on small businesses since these businesses may not have the expertise or resources to keep track of the regulations and the requirements. The situation can potentially be improved by developing appropriate tools that can help facilitate the regulatory and compliance process. To illustrate, this paper discusses the applications of information technology for selected services related to regulations, such as compliance assistance, comparison of regulation from diverse sources, and e-rulemaking.

Categories and Subject Descriptors

H.3.3 [Information Storage and Retrieval]: Information Search and Retrieval – retrieval models, I.2.1 [Artificial Intelligence]: Applications and Expert Systems – law.

General Terms

Algorithms, Management, Legal Aspects.

Keywords

regulations; compliance assistance; relatedness analysis; e-rulemaking; information retrieval; e-government.

1. INTRODUCTION

This paper provides an overview of the REGNET research project at Stanford University, which aims to gain insights on information infrastructure and tools that can facilitate access, compliance, analysis and use of government regulations. Regulations, in general, provide many social benefits, such as protecting our

environment and improving public safety and accessibility. However, the complexity, diversity, and volume of Federal and State regulations are detrimental to business and also hinder public understanding of government. As new issues arise, new regulations are promulgated; old regulations, however, are rarely removed. Regulations emanating from different agencies often overlap; because settings and objectives differ, they may be inconsistent. The scope of concern and the terminology used to express those concerns often differs among agencies. The distributed responsibilities also increase the complexity in dealing with regulations. Advances in information technology can potentially improve the situation by developing appropriate tools that can help facilitate the regulatory process, from rulemaking to compliance assistance.

“Deciphering and complying with federal regulations is a legal and paperwork nightmare for many businesses. To keep pace, some hire consultants--sort of regulatory accountants--to keep track of the applicable health, safety, environmental and equal-opportunity rules [1].” Regulations can be particularly burdensome on small businesses since they often do not have the resources to keep track of and to deal with these complicated regulations and the compliance procedures. This burden has been recognized and targeted by legislation through the Regulatory Flexibility Act (RFA), which was amended by Small Business Regulatory Enforcement Fairness Act (SBREFA). Agencies have a commitment to take into account the burden that regulations can place on small businesses. SBREFA requires that agencies to establish procedures, policies and guides to promote compliance with RFA. Agencies published, in accordance to SBREFA, Small Entity Compliance Guides that are written in plain language and elucidate the rights of small entities in enforcement actions (e.g. reducing civil penalties for violations). Furthermore, agencies, such as EPA, must provide Congress and the General Accounting Office with copies of all final rules and supporting analyses [2]. The act clearly recognizes the information problem facing business, particularly small businesses, in compliance with regulations. The Small Business Administration (SBA) (with participation from various federal agencies, including EPA, FDA, OSHA, etc.) launched an initiative to build a “one-stop” portal to assist small businesses to comply with regulations [3]. In recent years, governmental portals (such as the FirstGov.gov and USA.gov) have emerged to provide public to gain access to US government information and services on the web. Government regulations are available online (for examples, see www.gpoaccess.gov/cfr/ and www.regulations.gov). Most of the online portals are designed primarily for displaying the regulatory information and often usable only by experienced users, who are

familiar with the subject and the portal. Some primitive searching capabilities may be provided; however, it remains difficult to locate cross-referenced information and to link the regulatory information with useful applications. Utilization of advanced information technologies and development of new and innovative high quality tools are crucial to move the regulatory information available and useful to the public.

This paper describes a research effort investigating useful information services related to regulatory information. The paper is organized as follows: First, a brief literature review on applications of IT in laws and regulations is provided in the next section. Example applications are then presented to illustrate some of the research issues investigated in the REGNET project. The paper is concluded with a brief summary and discussion on current research.

2. LITERATURE REVIEW

Research on information science and technology applicable to regulations and laws has been active research area for decades. There has been a great deal of work done on building expert systems for law [4,5]. T. Bench-Capon provided a review on the applications of knowledge-based systems for legal applications, particularly the research and development efforts related to the Alvey DHSS Demonstrator project in U.K. [6]. The reference includes several hundreds of citations that appeared before 1990 which are related to logic and rule based approaches and their application in legal systems. Erdelez and O'Hare also provided an overview of the research and status of legal informatics in the 1990s [7]. Applications of case-based reasoning and information retrieval techniques have been proposed [5,8]. Current state on information technology and laws can also be found in a recent book edited by Lodder and Oskamp [9]. While legal knowledge representation and reasoning has been an active research topic, an integrated approach covering the management of regulations, efficient access and retrieval of regulatory and related documents and tools for compliance assistance is missing.

Policies and public interests concerning how IT can be appropriately and effectively applied to regulation management, rulemaking and compliance assistance have been actively discussed in workshops and public forums [10-12]. It has been recognized that information technologies, including information retrieval, text mining, knowledge representation, logic reasoning, natural language processing and many other areas, can find applications in legal informatics and further enhance the development of regulatory information systems. Issues such as what types of support are needed to go from the textual information of the regulations to the formal models that can support computations, to integrate and link diverse source of related documents to regulations, and to provide means to analyze and compare regulatory data, are fundamentally important to an effective regulatory information system. Practical applications require that the computer be able to interpret the situation or circumstances, scenarios and exceptional cases. Solutions that do emerge must support the treatment of multiple, heterogeneous regulations and related documents from diverse sources. Modeling regulations requires not only the understanding of individual content within a regulation provision, but also the relationships among and within provisions as well as mechanisms for linking applications, supplemental documents and related

information with the regulations. Research in this field must proceed in two parallel tracks: (1) representing the regulations so that they can be accessed according to the needs of the users and the regulatory agencies, and (2) structuring the regulations so that they can be assessed automatically to support applications, such as compliance assistance, business processes and others. The research of REGNET investigates information service infrastructure that takes textual repositories as a base and develop methodologies and tools to locate, merge, compare, and analyze the information. This paper describes selected examples to illustrate some of the research issues investigated in the REGNET project.

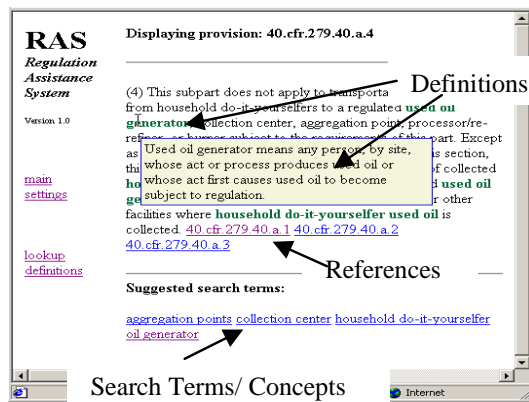
3. A REGULATION-CENTRIC COMPLIANCE ASSISTANCE FRAMEWORK

There has been a push for government agencies to put more emphasis on compliance assistance in lieu of enforcement to encourage companies to comply with regulations [13]. Towards this end, specialized programs, using expert system technologies for example, have been built to assist users in understanding regulations and fulfilling the requirements [14]. Among the limitations of many compliance assistance systems is that the tools do not directly map or link to the source documents that they represent. Our research adopts a regulation-centric approach to structuring a compliance assistance system around the regulation itself [15,16]. The rules together with the metadata about the regulations are directly embedded within the provisions they represent. This framework allows clear linkages to the regulation text. Because all encoded regulation rules are tied to particular regulation provisions, it is straightforward to map the compliance process to the provisions. The following briefly describes the structure of the document repository for the regulations and the regulation assistance system.

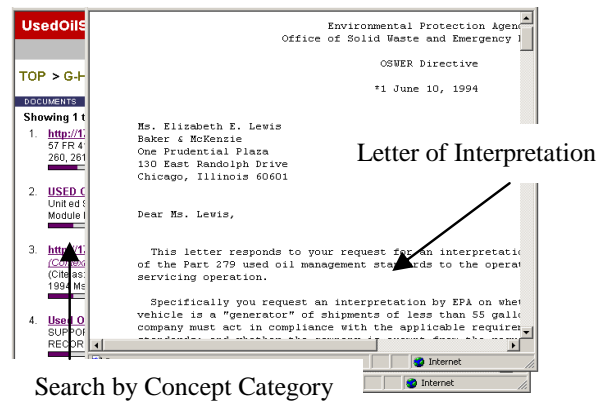
3.1 A. Document Repository

The scope of our research and the document repository demonstrative development cover Title 40 of the US Code of Federal Regulations (40 CFR): Protection of the Environment [17]. Besides the regulations themselves, the repository also includes supplementary and supportive documents that are important for the accurate interpretation of the federal regulation(s) to which they refer [18].¹ For the research prototype, supplemental documents dealing with used oil, which include the preamble to the regulation text found in 40 CFR 261 and 279, administrative decisions, guidance documents, federal

¹ Supplementary and supportive documents are important part of regulatory information and are commonly considered in judiciary decisions. To illustrate, for the case "Beazer East, Inc. v. U.S. EPA, Region III" (963 F.2d 603, 3rd Cir. 1992), Beazer East, Inc., argued that the aeration basins were "tanks", not "surface impoundments", and were therefore not subject to RCRA's groundwater-monitoring regulations. The court ruled in favor of EPA by considering the so called "Weddle memorandum", which was issued to clarify the definitions of a "tank" and a "surface impoundment," as an interpretive rule, which can be exempted from the notice and comment requirements of the Administrative Procedures Act.



(a) Definition, definition and concept tags



(b) Retrieving supporting document using concepts

Figure 1: Metadata defined for regulations

cases, letters from the general counsel and letters of interpretation from the issuing agency. The document repository is designed not only to facilitate displaying the provisions but also to support compliance assistance by making these important documents more accessible.

A document-centric repository is designed to structure and to organize the regulation texts and metadata. Mirroring the standard structure of regulations, the XML-based framework includes tags for each level of regulation text – for example part, subpart, section or subsection. A parsing system using basic pattern matching according to the regulation structures is built to transform the regulations from Portable Document Format (PDF) or HTML into the XML-based document framework. In addition to the regulation texts, the XML-based structure is augmented with regulation-specific metadata, including concept tags, reference tags and definition tags (see Figure 1).

- With existing text mining and information retrieval tools, concepts can be generated automatically or semi-automatically from the regulation texts. The concept tags are introduced so that links to related supporting documents in the document repository can be dynamically generated. This is useful because supporting documents and regulations may not directly reference each other even when they address the same topic. The automatic application of concept tags to the XML framework means that as new supporting documents are added to the document repository, regulations stored in the framework can automatically be linked to them via the terms that they share.
- Regulation provisions tend to include casual references to other provisions. Simple references (for example, “as stated in 40 CFR section 262.14(a)(2)”) and complex references (for example, “the requirements in subparts G through I of this part” as in part 265) exist. Manually translating such references would be time consuming. A parsing system was developed using a context-free grammar and a semantic representation/interpretation system that is capable of tagging regulation provisions with the list of references they contain. The references serve not only for retrieval of related provisions, but also provide a list of provisions that may

require consideration during the compliance checking process.

- Regulation contain many domain-specific terms and acronyms that can make regulation text difficult for novices to understand. Adding the definition tags would allow a regulation viewing system to incorporate explicit definitions of terms and acronyms into its user interface (for example, by mousing over the term). Definitions can be extracted from the regulations (and other sources) and automatically attached to the terms identified by a parser.

3.2 Compliance Assistance

Our research of a compliance assistance infrastructure builds upon the XML regulation framework and takes advantage of the regulation metadata described earlier. Besides the concept, reference and definition tags, logic and control processing metadata are added into the XML regulation framework. The logic metadata represents a rule or concept from a regulation. First Order Predicate logic sentences are used to represent the rules that must be followed for an entity to be in compliance with the regulations. Control processing metadata provides information about what provisions need to be checked for compliance. Metadata are also introduced to manage the interaction between the user and the system. Each logic or control processing metadata is associated with a specific regulation provision and is manually tagged with logic and control process metadata.

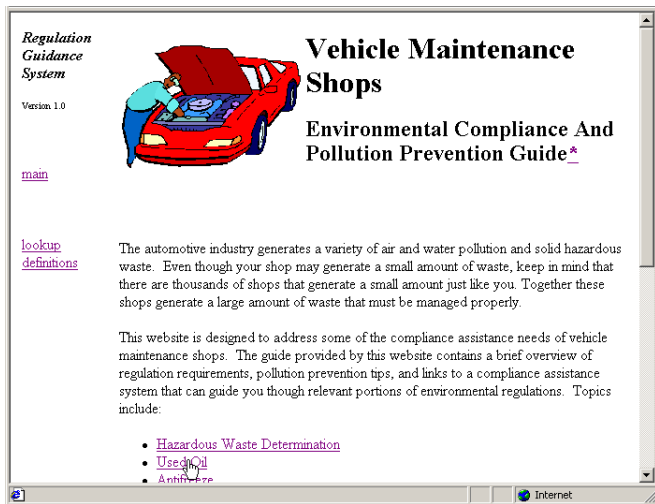
The compliance assistance system controls the process by taking advantage of the metadata information. First, the system parses the XML-structured regulation to extract the information necessary to run a compliance check. Only those logic rules and control processing metadata (based on the information from the reference tags) are acquired and dynamically loaded into the reasoning system. Logic reasoning tools, such as a theorem prover, can then be used to perform the logic checks [19].

One essential feature of the web-based compliance assistance system is that it helps guide the user through the regulations. Utilizing the metadata tagged with the regulations, the system can link to any referenced regulation provisions and display terms and definitions. Key conceptual phrases for the provision are

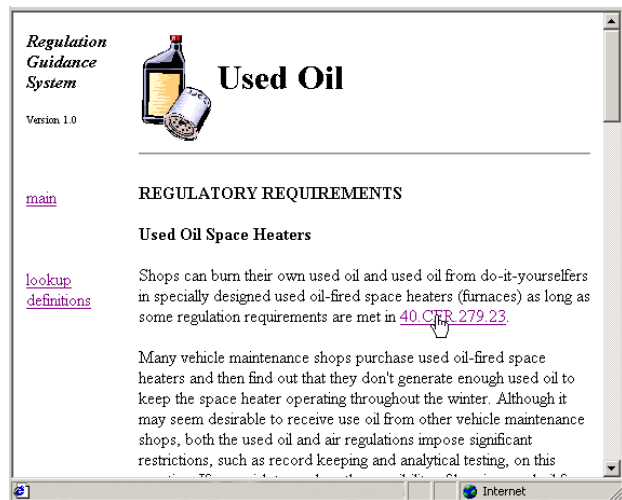
displayed and linked, enabling instant access to repository documents related to the provision. When the system completes the check against the regulation provisions or detects a conflict between the user's answers and the regulation, it displays a summary of the question-and-answer history as well as the results of the compliance check.

One can easily build a compliance system for specific application utilizing the regulation compliance assistance system and the repository as a back end. To illustrate, Figure 2 shows linking the provisions from the used oil regulations of the New York state to the federal regulations implemented in the prototype. The online guide is built for vehicle maintenance shops to check compliance with the used oil based on paper-based 2002 guide developed by the New York State department of Environmental Conservation Prevention Unit [20]. As noted in Figure 2(b), the provision references 40 CFR 279.23, which can be used as a link to the regulation assistance system, as shown in Figure 2(c). Figure 2(d) shows the compliance result which shows the questions, answers and the related provisions that contributed to the logical conclusion.

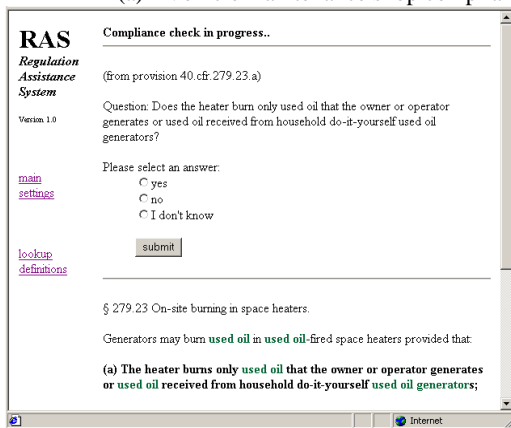
There are many challenges in developing a compliance assistance system. The regulation-centric approach where the document repository includes not only the regulation documents but also the supplemental document as well as rules and computational logic embedded within the provisions can offer many advantages. First, because users can see the regulation text as they interact with the system, users may have better understanding of the results produced by the system. Second, since users can see the regulations during compliance process they may be able to learn how the regulation works, and re-tracing the results easier for validation purposes. Third, with supplementary documents linking with the regulation, users can not only track how the system is proceeding with its analysis, but also enquire background information on the intents and issues of the regulations, and directly address the questions that the regulation is intended. Fourth, updating the system as the regulation changes would become easier, since with the mapping between the regulation and the rules in the system, what parts of the system need to be changed become more obvious when the regulation is altered. Last but not least, even though regulations are often ambiguous, contain many exceptions, and are not written in the



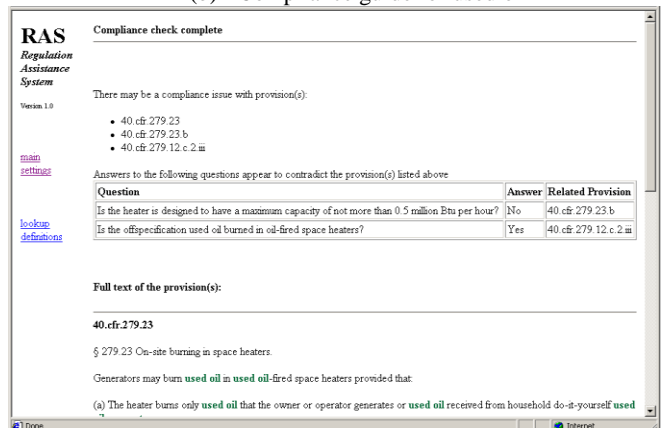
(a) Vehicle maintenance shop compliance guide



(b) Compliance guide for used oil



(c) Compliance guides linking to RAS



(d) Results displaying questions, answers and provision

Figure 2: A regulation assistance system

form that is computationally sound, the regulation texts are often well structured and organized. By implementing the compliance assistance system according to the regulation structure can greatly facilitate modular development of a compliance assistance system.

4. COMPARATIVE STUDIES OF REGULATORY INFORMATION

Government regulations should ideally be understandable and retrievable with ease by practitioners as well as the general public. Requirements for a given situation could be different from different regulations. Multiple sources of regulations, for instance, from the Federal, State and local governments, amend, complement and potentially conflict with one another. Regulations from different agencies on similar and related issues could differ and inconsistent with their intents. There are many reference guides that are published independent of governing bodies, attempting to help the public to better understand and comply with the regulations. The regulations, amending provisions and interpretive manuals together create a massive volume of documents with potentially similar content but possible differences in format, terminology and context. An information infrastructure that can consolidate, compare and contrast different regulatory documents will greatly enhance and aid the understanding of regulations.

Retrieving and interpreting particular US government regulations have become easier with the establishment of government portals to enhance transparency to the public. For example, business.gov (or sba.gov) is a centralized portal that contains information to guide business owners and entrepreneurs through government rules and regulations and to identify resources that can help them start, grow and succeed in business. Regulations.gov provides a forum for users to comment on existing and pending federal rules. Government portals now provide useful information to help citizens to access regulations and submit feedbacks. However, what is needed is an information framework that enables individuals and small businesses with limited resources to retrieve related regulations from multiple copies of governing regulations and related regulatory documents and then perform comparative analysis. The REGNET project seeks to establish such a framework and have initiated a number of studies focusing on US national and regional regulations and codes in the domains of environmental and accessibility standards.

4.1 Relatedness Analysis of Regulatory Documents

Text document comparison, in particular similarity analysis between documents, has been an active research area in Information Retrieval [21,22]. Regulatory documents differ from generic text documents in that sections are organized hierarchically and they are heavily cross referenced. As noted earlier, a wide variety of meaningful concepts can be extracted and categorized using text mining and information retrieval tools. However, terminologies used in the regulations for a specific application, such as hazardous wastes, are better defined than free form text documents. On the other hand, common sense or dictionary knowledge may not substitute domain knowledge; “lift” and “elevator”, for example, are synonymic terms in normal

English usage, but each have specific meanings in accessibility regulations. In addition to traditional information retrieval techniques, our framework exploits the structural organization of the regulatory documents, references and their distributions, and the “bounded” terminology set to further enhance comparative analysis of regulations [23-25]. To illustrate, we compare similarities between sections from different regulations. Our attempt is to identify the most related provisions between different regulations. The “relatedness” analysis framework takes into consideration the structure (section hierarchy, referencing) of the document and the features (concepts, synonyms, etc.) that are specific to the corpus. In our current approach, a base score for each pair of provisions is first computed by matching extracted features (including concept phrases, synonym information, measurements and units, etc.). The scoring scheme for each of the features essentially reflects how much resemblance can be inferred between the pair of sections based on that particular feature. The score is then refined by taking into account the hierarchical organization of regulations. Finally, we further refine the score by considering reference distribution, which takes into account that regulations are heavily self-referenced and cross-referenced.

Figure 3 shows an example that reveals the similarity (almost identical texts) discovered between sections from Parts 141-143 of 40 CFR and Division 4 of 22 CCR on regulations related to drinking water [17,26]. It is not uncommon that one agency directly adopts provisions issued by another agency. However, subtle differences exist and can have significant effects to the public. As an example, Figure 4 shows the barium requirements for drinking water by both the US EPA and the California DHS [17,26]. While the two provisions contain identical texts (except for the agencies), a careful reader might also note that the EPA and the California DHS *do* have different barium requirements – the EPA requires 2 parts per million while the California DHS sets the requirement at 1 part per million. This example also illustrates the importance of domain knowledge, where a measurement comparison would reveal that these two provisions are not identical, even though the wordings are almost the same. Another interesting application for comparison analysis is to locate similar provisions from different states [27].

In developing a regulation information management (RIM) system that would allow searching, retrieving and comparing regulations, domain knowledge plays a very important role in understanding regulations and the relationships between them. For instance, different regulations use different chemical acronyms, such as TTHM or HAA (used in 40CFR) and “total trihalomethanes” or “haloacetic acids” (appeared in 22CCR). Besides typical text mining and information retrieval methodologies, we believe a knowledge driven approach, combining with similar analysis, is a powerful way to develop a RIM system. In particular, distinct knowledge sources or regulations do not have to be made completely consistent, only the terms and the concepts that *articulate* their application connections are involved. Ontological information (terms, features and relationships) commonly used by industry experts can be important to search and compare regulations for specific industry sectors and regulatory domains [28,29].

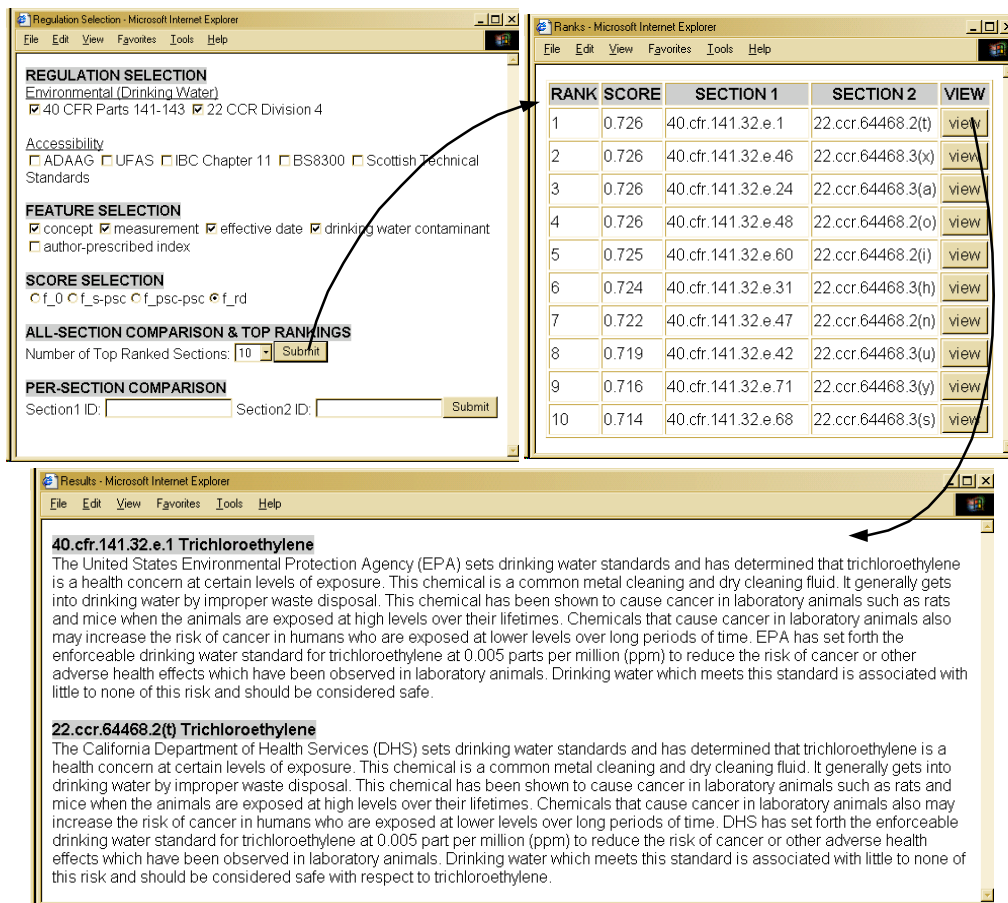


Figure 3: Comparison of similar sections in 40CFR [17] and 22CCR [26] on drinking water regulations

40.cfr.141.32.e.16 Barium

The United States Environmental Protection Agency (EPA) sets drinking water standards and has determined that barium is a health concern at certain levels of exposure. . . .In humans, EPA believes that effects from barium on blood pressure should not occur below 2 parts per million (ppm) in drinking water. EPA has set the drinking water standard for barium at **2 parts per million (ppm)** to protect against the risk of these adverse health effects. Drinking water that meets the EPA standard is associated with little to none of this risk and is considered safe with respect to barium.

22.ccr.64468.1(c) Barium

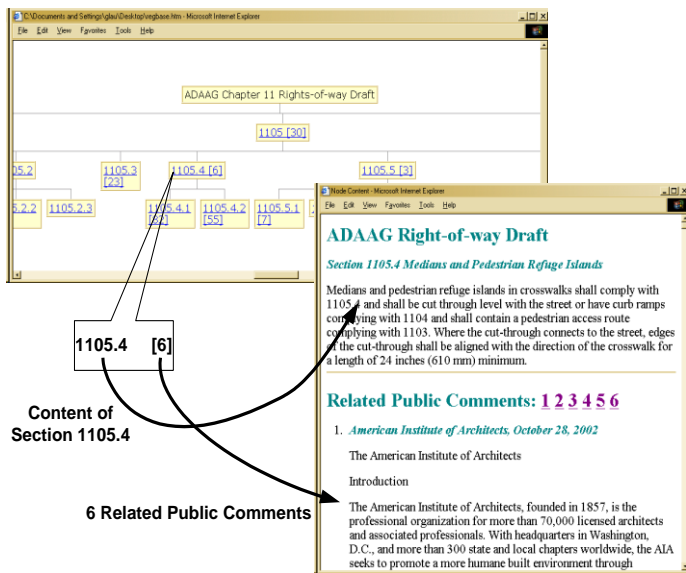
The California Department of Health Services (DHS) sets drinking water standards and has determined that barium is a health concern at certain levels of exposure. . . . In humans, DHS believes that effects from barium on blood pressure should not occur below 2 parts per million (ppm) in drinking water. DHS has set the drinking water standard for barium at **1 part per million (ppm)** to protect against the risk of these adverse health effects. Drinking water that meets the DHS standard is associated with little to none of this risk and is considered safe with respect to barium.

Figure 4: Comparison of drinking water standards for barium between US EPA [17] and CA DHS [26]

4.2 Comparing Drafted Regulations with Public Comments

The making of government regulations involves communication between the issuing agency and the public. During the rule-

making process, government agencies are required to inform the public about the drafted rules and to solicit comments and reviews. E-rulemaking redefines the process of rule drafting and commenting by utilizing electronic media, such as the Internet. For example, email has become a popular communication channel for the public to submit comments on proposed rules.



(a) Comparison of drafted rules with public comments

ADAAG rights-of-way draft

1105.4.1 Length

Where signal timing is inadequate for full crossing of all traffic lanes or where the crossing is not signalized, ...

Public comment

Deborah Wood, October 29, 2002

... This often means walk lights that are so short in duration that by the time a person who is blind realizes they have the light, ...

(b) Related draft rule and comment

ADAAG rights-of-way draft

No relevant section identified

Public Comment

Donna Ring, September 6, 2002

If you become blind, no amount of electronics on your body or in the environment will make you safe and give back to you your freedom of movement. You have to learn modern blindness skills from a good teacher. ...

(c) Comment not related to drafted rules

Figure 5: Application of relatedness analysis for e-rulemaking

The process of e-rulemaking with participation from the public involves sorting through and organizing a massive volume of electronically submitted comments. We extended the related analysis framework to compare drafted regulations with associated public comments [23,30,31]. To locate related materials, we use regulation structures and features as well as certain characteristics of the drafted rules to add knowledge to the comparison. In particular, most drafted rules are domain-specific, focusing on a narrowly-defined issue or area of interest. The relatedness analysis takes advantage of the added knowledge to facilitate the comparison between the drafted rules and public comments.

To illustrate, we applied the prototype system to a 15-page drafted chapter for the ADAAG titled, “Guidelines for Accessible Public Right of Way,” which has received over 1400 public comments [32,33]. Figure 5 shows the results indicating the public comments that are related to a specific drafted rule as well as an example that is not relevant to the proposed rules. Figure 5(b) shows a typical pair consisting of drafted section and its identified related comment. The draft discusses situations that “signal timing is inadequate for full crossing of traffic lanes,” while the commenter wrote “walk lights that are so short in duration”. The result shows the importance of a full content comparison between provisions and comments is necessary instead of just simple keyword matching. Figure 5(c) shows a different type of comment screening that a particular piece of public comment is not latched with any drafted section. The commenter suggests how a visually impaired person should practice blindness skills as opposed to the drafted rule which concerns with installing electronic devices on streets to help.

Although this experiment is performed on regulations with a relative small set of comments, the potential of such knowledge-driven similarity analysis approach could be quite useful for the e-rulemaking process, where electronic media, such as emails and the internet, are used by the public to comment on proposed rules and regulations.

5. SUMMARY AND DISCUSSION

This paper has demonstrated, in a small way, how information technology can potentially be used effectively to facilitate regulatory information management and compliance assistance. The complexity and scale of regulations pose many challenges to information technology research. In REGNET we have investigated fundamental issues related to government regulations, their features, characteristics and properties that need to be addressed. In this paper, we have presented a regulatory compliance assistance framework that not only focuses on translating requirements into computational rules but also takes into consideration the organization of regulations as well as the supplementary information that are needed to enable better understanding and interpretation of the regulations. We have presented examples to illustrate how advanced IT development can be applied to facilitate retrieval of regulatory information and to compare related regulations issued by different agencies and organizations. The relatedness analysis methodology has been shown to be potentially useful for supporting the e-rulemaking process.

Ongoing research in REGNET continues to explore how information technology can facilitate better understanding of regulations and public policies. For instance, regulations are traditionally issued and managed by isolated individual state and federal agencies. Coordination among different agencies about what issues agencies need to collaborate and in what capacity is not always easy. As part of the REGNET effort, Ekstrom has led the development of a tool to gauge agency involvement in a specific topic related to marine ecosystem management [34,35]. Utilizing information retrieval techniques and text analysis, the tool first maps out agency’s involvement in a particular topic based on the laws and regulations issued by an agency, and then analyze possible areas of overlaps and disparities among the

regulations by the different agencies on the topic. The tool has the potential to identify objectively what agencies are involved in the management of a topic across sectors and levels of government. In a collaborative effort with Prof. Jay Kesan at University of Illinois, our research has been extended to deal with laws and regulations related to intellectual properties (IP) [36,37]. Information pertaining to IP includes not only laws and regulations, but also patents, court cases, scientific literature, and other related data. Our research is to develop a computational framework that can assist in retrieving related information about a specific topic across these diverse domains, with the objective to mitigate and help solve many of the complicated issues involved in patent filings and compliance.

While our research has demonstrated the potential use of information science and technology in government regulation domain, much research and development efforts remain. Among the challenges include interpretation and validation of regulations, which are often ambiguous in nature. Translating regulations in computable rules, even manually, can be difficult. Automated translations would require the development of formal models for rule making and rule writing. Last but not least, technology transfer mechanisms are needed to bridge the gap between fundamental research demonstration and the development of tools ready for deployment.

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